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Identification of Fish Species in Lake Lanao, Lanao Del Sur: Basis for Contextualized Biodiversity STEM Lesson

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Abstract

This study aims to assess the endemic fish species of fauna in Lake Lanao. Also, it developed a Contextualized STEM Lesson on Biodiversity and Contextualized Biodiversity Handbook. Philippines Republic Act 105333 mandates the utilization of Contextualization and localization of the curriculum in education. However, the unavailability of prepared contextualized STEM Lessons on Biodiversity hinders its goals and functions in improving science education specifically regarding scientific literacy. To its end, the development of contextualized STEM Lessons on Biodiversity is conceived to address this gap. Before the development of contextualized teaching-learning material, pre-assessment biodiversity services interview of the residents of Lake Lanao, picture documentation, and identification of living organisms found in the area were conducted. The results of these steps become the main outputs of the developed teaching-learning material. The contextualized STEM Lesson Plan on Biodiversity underwent the following steps during its development: (a) identification of fish species; (b) determining the lesson focus; (c) crafting of competency and activity; (d) designing and conceptualizing of the Contextualized STEM Lesson on Biodiversity; (e) expert validation; (f) revision; (g) developed Contextualized STEM Lesson on Biodiversity.
Keywords: STEM Lesson, Contextualization, Biodiversity

1. Introduction

Lake Lanao, the second largest lake in the Philippines, is geographically located in the province of Lanao del Sur, Central Mindanao. It lies between 8° N. Latitude and 124° E. Longitude (Lewis 1978). Frey (1969) considered its basin volcanic due to its collapse associated with the 1955 earthquake. Lake Lanao has a vast watershed of approximately 147, 460 ha (hectares). It exerts considerable influence over the local climate, making Marawi City the summer capital of Southern Philippines.

One of the areas for which the lack of scientific literacy is present on the pressing biodiversity and environmental issues that the country is facing. Endowed with several centers of diversity, endemism, and biological richness, the Philippines is hailed as the 'Galapagos times ten' (Heaney & Regalado, 1998) and considered as one of the 18 megadiverse countries in the world (NEDA, 2011). Most Filipinos are unaware of the country's biodiversity and the need for its conservation (Bagarinao,1999). This resulted in the endangerment of Philippine biodiversity whereas of 2008, 221 species of fauna and 526 species of flora have been included in the list of threatened species (NEDA, 2011).

Apart from biodiversity conservation in the lake watershed, the flux of nutrients and pollutants should be a top priority of an ecosystem-based management that needs to employ innovative socio-environmental approaches involving participatory, multisectoral, multidisciplinary, integrated, and ecomanagement efforts. The looming climate change, which may undoubtedly lead to further loss of biodiversity services, needs to be incorporated into the watershed modelling and management framework.

In addition to contextualization, integration of STEM (Science, Technology, Engineering, and Mathematics) is one of the current trends in education that aims to develop the deep mathematical and scientific underpinnings that students need to be competitive in the 21st-century workforce (Jolly, 2014). This approach to STEM education is called the integrated approach where STEM content areas are taught as though they are in one subject and can be done with a minimum but not limited to two disciplines (Roberts & Cantu, 2012).

To provide a viable solution to the gaps mentioned may it be in terms of strengthening the weak link between what is learned at school and the contexts that surround the learner to strengthen learning, low scientific literacy, the limited literature of studies of species in Lake Lanao (Marawi City, Lanao del Sur), and the utilization of results of such studies in improving the teaching-learning process have motivated the researcher to develop a Contextualized STEM Lesson on Biodiversity and Contextualized Biodiversity Handbook.

1.1 Research Questions

1. Teaching the concept of biodiversity in learning activities, especially science education is an important urgency to bring up biodiversity literacy competence. Education plays a crucial place where biodiversity education should be mainstreamed through the development of scientific literacy among students (Jose-Castillo, 2019).

2. The dismal performance of the Philippines in the 2022 Program for International Student Assessment (PISA) indicates that the students in the country are five to six years behind in learning competencies, according to the Department of Education (DepEd). Overall, the Philippines achieved a 2.2-percent point hike in mathematics from 2018 to 2022, 6.9 percent in reading, and a 0.8 percent drop in science proficiency. Contextualization of lessons to empower students to be more responsive to real-world issues while at the same time improving the learning process (DepEd, 2016). However, there is a lack of contextualized materials available and if available are confusing (Valin & Jenner, 2020).

3. It is vital to develop a ready-to-use Contextualized STEM Lesson and Contextualized Biodiversity Handbook that will influence a scientifically literate citizenry in environmental decision-making. Bagarinao (1999) suggested Protected areas as sources for biodiversity education. Mainstreaming Biodiversity Education in formal education will enable people to recognize the relationship between the health of biodiversity and their well-being (Jose-Castillo, 2018).

1.2 Objectives of the Study

This study aims to:

1. Identify the local fish species of fauna found in Lake Lanao;
2. Develop the Contextualized STEM Lesson on Biodiversity; and,
3. Create a Contextualized Biodiversity Handbook.

2. Methodology

This study utilized both qualitative and quantitative research design. The descriptive method with qualitative support was used to treat the responses of the learners, administrators, and teachers during the semi-structured needs assessment interview, as well as the elders' and residents' responses during the semi-structured assessment interview on the fish species and their services in Lake Lanao, and the panel of experts' comments and suggestions. On the other hand, the qualitative research design aspect was utilized in the evaluation of the developed Contextualized STEM Lesson on Biodiversity and Contextualized Biodiversity Handbook. Meanwhile, during the identification of fish species in Lake Lanao, purposive and opportunistic sampling was utilized to identify the species that are necessary inputs for the development of the Contextualized STEM Lesson on Biodiversity and Contextualized Biodiversity Handbook.

There were four (4) major phases in the conduct of this study. The first major phase was the conduct of the semi-structured interview with the elders and residents of Lake Lanao about the species (plants and animals) and their benefits. Responses were categorized based on the species' services, local name, and common name. The data gathered from this stage were analyzed and the results became the springboard in the conduct of the identification of the species in Lake Lanao.

The second major phase was the field species observation in Lake Lanao (presence of plants and animals) where sampling and interviews were utilized.

The third phase was the development of the Contextualized STEM Lesson on Biodiversity which was based on a needs assessment interview of key informants (learners, teachers, and administrators) for the need to develop a contextualized STEM Lesson on Biodiversity and Contextualized Biodiversity Handbook. The data gathered from this stage were analyzed and the results became the springboard in the development of the Contextualized STEM Lesson Plan on Biodiversity and the Contextualized Biodiversity Handbook. The design of the lesson was adapted from the STEM lesson plan structure designed by Theerasan and Yuenyong (2019) where the context was based on the local area of Lake Lanao which included examples like the fish species in Lake Lanao and organisms found in it.

The fourth major phase was the evaluation of the developed Contextualized STEM Lesson on Biodiversity and the Contextualized Biodiversity Handbook. This phase involved a "panel of experts" which was comprised of in-service teachers from MSU-Baloi Community High School, in-service Biology teachers, and STEM experts who evaluated the developed teaching-learning material.

In addition, the researcher thoroughly explained to the students the purpose and the objectives of the study, so that the students become completely aware of what they're

about to participate in. The researcher also emphasized to the students that the data gathered from the study was confidential and was solely for academic purposes only.

Furthermore, the researcher exerted an effort to the extent of creating a positive environment among the participants of the study.

3. Results and Discussion

The local species and the services of Lake Lanao were the bases of the development of the Contextualized STEM lesson on Biodiversity and Contextualized Biodiversity Handbook. This was evaluated by STEM experts, and in-service teachers through a STEM rubric of Tecson (2019). The following subsections were the results and discussion of identified fish species and the evaluators' ratings of the developed learning material.

4.1 Identified Fish Species in Lake Lanao

This is a pioneering study on the identification of fish species found in Lake Lanao. In this study, a total of five (5) species were recorded and identified from Lake Lanao. the identified fish species inhabiting the lake were classified based on the family as illustrated in Table 1.

Table 1. List of fish species recorded in Lake Lanao

Family	Species	Local Name	Origin
Channidae	*Ophiocephalus striatus*	Aruan	Native (FAO, 2005) (Bloch, 1793:141) Catalog of fishes, 2003
Cichlidae	*Oreochromis niloticus*	Tilapia	Introduced (FAO, 2005)
Osteoglossidae	*Clarias macrocephalus*	Katipa	Introduced (FAO, 2005)
Eleotridae	*Hypseleotris agilis*	Katulong	Introduced (FAO, 1960s)
Osphronemidae and Helostomatidae	*Trichogaster pectoralis*	Gourami	Indonesian origin (FAO, 2012)

Of the five (5) freshwater fish species identified, four (4) freshwater fish species belong to the Channidae family which is the Ophiocephalus striatus (Aruan). The other (5) freshwater fish belonging to the Cichlidae family which is the Oreochromis niloticus (Tilapia), (1) freshwater fish belong to the Osteoglossidae family which is the Clarias macrocephalus (katipa), and (1) freshwater fish belonging to the Eleotridae family which is the Hypseleotris agilis (katulong). There is also (1) freshwater fish Trichogaster pectoralis (Gourami) which belongs to the family Osphronemidae and Helostomatidae. These are the fish species found in Lake Lanao during the conduct of the study.

3.2 Local Species and its Services of Lake Lanao

A semi-structured interview on the local species and its services was conducted which serves as a preliminary assessment tool on the species present in Lake Lanao and their uses as identified by the residents living in the area. This assessment gave the research insights into the species found in Lake Lanao. The data gathered was deemed important as a springboard for the conduct of the entire study as it functions as an indicator of the species that can be identified in the area. The results of this component indicated the use of species and their services by the residents of Lake Lanao as well as to determine what are the prospective products of these services that can provide more livelihood to the residents.

3.3 Development of Contextualized STEM Lesson on Biodiversity

The development of contextualized STEM lessons on biodiversity underwent several processes. In this section, the major findings of the stage are presented along with its implications.

3.4 Identified Fish Species in Lake Lanao

Aruan is another native favorite fish species of the Maranao dwellers living in Lake Lanao. They are very common in freshwater plains and survive the dry season by burrowing in the bottom mud of lakes, canals, and swamps, and feed on fish and crustaceous (FAO, 1999).

Oreochromis niloticus (Tilapia) is one of the sources of food and livelihood for the people living on the banks of Lake Lanao. In the early 1970s, the introduction of Nile tilapia (Oreochromis niloticus) in the country was made. It is a species light in color, enhanced the image of tilapia, and boosted commercial production (FAO, 2005). According to the Food and Agriculture Organization of the United Nations (2017), is the most consumed farmed fish in the Philippines, with an average yearly consumption of 4.6 kg per person.

The freshwater catfish *Clarias macrocephalus* is native to the Philippines but is fast becoming scarce in many natural habitats. It is a favorite food fish due to its tender and delicious meat. Recently, the farming of Clarias macrocephalus has gained interest among catfish growers. Like other catfish species, it is resistant to diseases, can be stocked at high densities, and can tolerate low water quality, FAO (2005).

Hypseleotris agilis Herre of Lake Lanao, Philippines as a possible source of indigenous drugs. The fish is locally known as *katulong* belonging to the family Eleotridae which is believed to have been accidentally introduced sometime in the 1960s along with tilapia and milkfish fry stocking in the lake for aquaculture, FAO (1960s).

One of the freshwater fish in Lake Lanao used as food and is also sold is *Trichogaster pectoralis* (Gourami) locally known as *gourami/mirakulo*. It was introduced to the Philippines from Thailand in 1938 (FAO, n.d.). Figures 9 to 12 show the different freshwater fish species found in Lake Lanao. These freshwater fish species are a main source of food and a vital livelihood for the people along the banks of the lake. According to the Food and Agriculture Organization of the United Nations (2008), fish is a source that has a localized economic and nutritional dependence as it provides a crucial source of protein.

3.5 Experts' Rating of the Contextualized STEM Lesson on Biodiversity

In-service science teachers, in-service Biology teachers, and STEM experts evaluated the developed Contextualized STEM Lesson on Biodiversity. Figure 1 shows the distribution of ratings in each of the criteria for the teaching-learning material. The scale used in rating included Needs Improvement (1.0 – 1.54), Good (1.75 – 2.49), Very Good (2.50 – 3.24), and Excellent(3.25 – 4.00).

Figure 1 below shows the summary of ratings by the in-service and in-service biology teachers. The Contextualized STEM Lesson on Biodiversity was rated Excellent in terms of its learning objectives where it is characterized as SMART, based on behavioral terms that can be easily observed, appropriate to the content it offers a clear and concise description of the concept. In the criteria for the degree of contextualization, it is rated as excellent which shows that it links the lesson to the local context of Lake Lanao and the real-world problems. In summary, the whole material got a total weighted average of 3.85 which means excellent and indicates that the material has an exemplary quality in terms of its learning objectives, learning content, degree of contextualization, and the STEM

stages denoting that it is now ready to be used in teaching Biodiversity topic for Grade 8 learners.

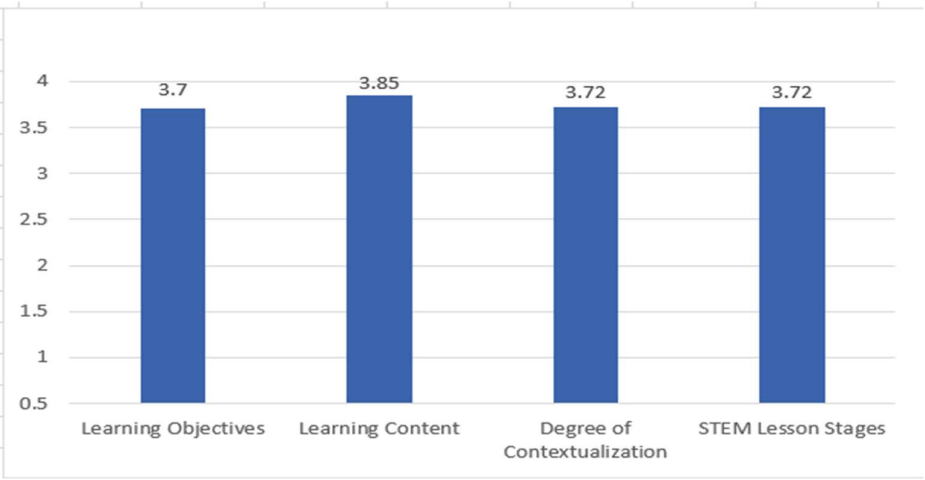

Figure 1. Experts' rating of the Developed Contextualized STEM Lesson Plan on Biodiversity

3.6 Comments and Suggestions of the Panel of Experts of the Contextualized STEM Lesson on Biodiversity

One of the components of the rubric in evaluating the developed Contextualized STEM Lesson on Biodiversity is the comments and suggestions sections. This was done to gather more insights and comments to improve the teaching-learning material figures below show the comments and suggestions of the developed Contextualized STEM Lesson on Biodiversity:

Table 2. Revisions based on the comments and suggestions of the panel of experts

Before	After
Contextualized STEM Lesson on Biodiversity Lesson description • To define biodiversity its significant and uses. • To identify local species found in Lake Lanao • To design sustainable fishing gears for the protection of endangered economically important species found in Lake Lanao.	**Contextualized STEM Lesson on Biodiversity** Lesson description This lesson explores the concept of biodiversity within the local content of Lake Lanao • To define biodiversity its significant and uses. • To identify local species found in Lake Lanao • To design sustainable fishing gears for the protection of endangered economically important species found in Lake Lanao.

<table>
<tr><td></td><td>• To involved themselves in the protection of biodiversity in Lake Lanao.</td></tr>
<tr><td colspan="2">Comment: Identification of the social issue stage, change the picture of fish in the lake, and ask students more questions about the lake until they can reach the presence of the fish in the lake.</td></tr>
<tr><td>
<table>
<tr><th>STAGE</th><th>ACTIVITY</th></tr>
<tr><td>1. Identification of social issues</td><td>A. Show a picture of Clarias macrocephalus:
 
Q1: Have you seen this fish before?
Q2: Have you tried eating this fish before?

B. Background information presented in a power point side:
One of the fishes that can be caught in Lake Lanao that are utilized as food is what is locally known as katipa (Clarias macrocephalus). Clarias macrocephalus is one of the remaining endemic cyprinids species in Lake Lanao (Abdulmalik-Labe & Quilang, 2019). It is distributed in Lanao plateau where Lake Lanao, Lake Dapao, Lake Uyaan and Sigawat river are located (Herre 1924, 1953).</td></tr>
</table>
</td><td>
<table>
<tr><th>STAGE</th><th>ACTIVITY</th></tr>
<tr><td>1. Identification of social issues</td><td>A. Show the following pictures:
social
 
Q1: Where do you think is this place
Q2: Have you been to this place before?
Q3: What are the animals or plants that we can find in this place?
When the students identify fish as one of the organisms found in the lake show the picture of Clarias macrocephalus;
 
Present Background information:
One of the fishes that can be caught in Lake Lanao that are utilized as food is what is locally known as Katipa (Clarias macrocephalus). Clarias macrocephalus is one of the two remaining endemic cyprinids species in Lake Lanao. (Abdulmalik-Labe & Quilang, 2019).</td></tr>
</table>
</td></tr>
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Table 2 shows the addition of a new learning objective which is an effective one. This was added because in making the objectives for the lesson, the three domains of learning should be shown especially the affective domain. The lesson can have more than 3 objectives but it must contain cognitive, psychomotor, and affective objectives.

3.7 Development of the Contextualized Biodiversity Handbook

The development of the Contextualized Biodiversity Handbook underwent several processes. In this section, the major findings of the stage are presented along with its implications.

1. Chosen topic standards and competencies

The competencies that were used as the basis for the learning objectives in each of the activities of the handbook were to explain the concept of a species and explain the advantage of high biodiversity in the stability of an ecosystem. These standards were transformed into specific learning objectives in the different activities in the Handbook.

2. Incorporation of the identified species present in Lake Lanao, Lanao del Sur

In this stage, the species identified were depicted in each of the activities for contextualization of the lessons making it relevant and timely for the learners.

3. Designing and Conceptualization of the Contextualized Biodiversity Handbook

The design and conceptualization of the contextualized Biodiversity handbook were based upon the contextual learning theory where a constructivist hands-on approach

using the learners' context was utilized. The handbook was composed of teachers' lesson guides, students' activity sheets, and rubrics.

4. Face Validation

The material was face-validated by the panel members and thesis adviser for initial comments and suggestions to improve the developed Contextualized Biodiversity Handbook.

5. First Phase Revision

The comments and suggestions of the thesis adviser and the panel members were applied in revising the Contextualized Biodiversity Handbook.

6. Expert Validation

It was evaluated based on its learning objectives, learning content, degree of contextualization, spelling and grammar, and illustrations and images used.

7. Second Phase Revision

During the second phase of revision, the comments and suggestions of the panel of experts were applied in terms of the learning objectives, learning content, degree of contextualization, spelling and grammar, and illustrations and images used.

8. Developed Contextualized Biodiversity Handbook

After the second phase revision, the developed contextualized biodiversity handbook was now complete which includes the teacher's learning guide, students' activity sheet, and rubrics for the activities and outputs. The developed Contextualized Biodiversity Handbook is a supplementary material for the developed Contextualized STEM Lessons on Biodiversity that will be used in teaching biodiversity to Grade 8 students.

3.8 Experts' Rating of the Contextualized Biodiversity Handbook

In-service science teachers, in-service Biology teachers, and STEM experts evaluated the developed Contextualized Biodiversity Handbook in terms of learning objectives, learning content, degree of contextualization, grammar and spelling, illustration, and images. Figure 2 shows the rating in each of the criteria of an excellent teaching-learning material.

Figure 2 shows the summary of the experts' rating in each of the criteria of an excellent teaching-learning material using the following scale including Needs Improvement (1.0 – 1.54), Good (1.75 – 2.49), Very Good (2.50 – 3.24), and Excellent(3.25 – 4.00).

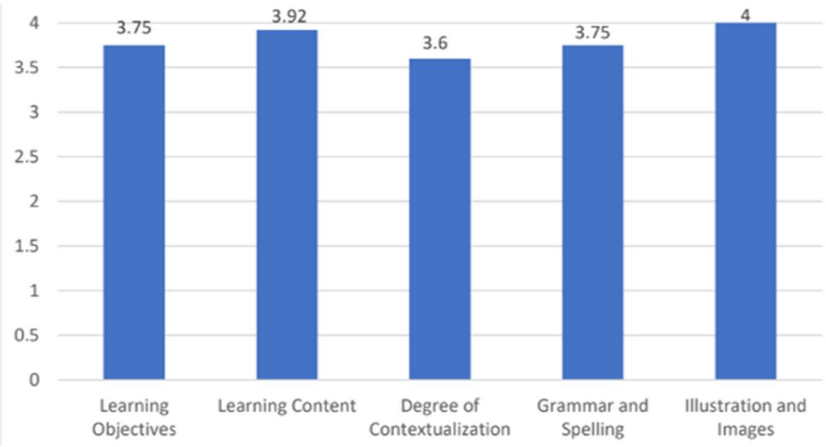


Figure 2. Experts' rating of the developed Contextualized Biodiversity Handbook

Figure 2 shows the summary ratings of the panel of experts which was comprised of in-service biology teachers, in-service teachers, and STEM experts. The Contextualized Biodiversity Handbook was rated excellent in terms of its learning objectives which implies that the learning objectives were SMART (Specific, Measurable, Attainable, Relevant, Time-bounded) and expressed in behavioral terms. On the other hand, in terms of learning content, it was also rated as excellent where the organization of content is in a logical order and the concepts were accurately presented. The degree of contextualization is also excellent which means that the handbook was creatively modified to accommodate the unique context and values of the locality and connected to real-world problems. The spelling and grammar were also excellent where few errors of English grammar were spotted.

Lastly, in terms of the images and illustrations used it was also rated as excellent where appropriate illustrations and images were used that effectively draw the attention of the readers and aid in the delivery of the concept. In summary, the developed Contextualized Biodiversity Handbook was rated Excellent and can be utilized as a supplement for any learning material and the developed Contextualized STEM Biodiversity Lesson.

Table 3. Revisions based on the comments and suggestions of the panel of experts.

<table>
<tr><td colspan="2">Comment: Add an introduction page after the table of contents.</td></tr>
<tr><td>Before</td><td>After</td></tr>
<tr><td>No introductory page</td><td>WHAT IS BIODIVERSITY?
 
Melastoma malabathricum Lake Lanao (Marantao, LDS) Snakehead murrel

LOOK AROUND. What do you see? Trees? Birds? Insects? How many types of trees, birds, and insects do you see? A LOT right?

Aside from these organisms, there are still more than meets the eyes for you need microscopes to see them like bacteria. When you think about what you are actually surrounded by a variety of organisms. Biodiversity is defined by the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species between species, and of ecosystems. Biodiversity is the main foundation of many ecological services that we enjoy like food, water, clothing, and energy which are all critical for our survival. Lake Lanao is a home to a wide variety of organisms that in this handbook you shall explore and utilize what you lean in protecting the natural wonders of your place.</td></tr>
<tr><td colspan="2">Comment: In activity two hide the species cards around the school for the students to find instead of handing them to them directly.</td></tr>
<tr><td>1. Scatter the pictures of the species around the school.
2. Let them write the name of each species that they can find as the total number of different species that they can write as “species richness”
3. Instruct students to count and record the number of individuals</td><td>1.Hand the students the picture of the sticky note activity test meeting.
2.Get students two minutes to write down the names that they see in the picture and define the total number of different species that they can write as ‘species richness’.
3.Instruct students to count and record the number of individuals of each species- something like 1 robin bird, 3 katipa fish, and 2 Aruan fish.</td></tr>
</table>

of each species – something like 4 Philippine Eagles, 3 tilapia fish, and 5 bumblebees. Define the number of individuals of each species as the species abundance. 4. Define species diversity as the species richness (number of species in an area) and species abundance (number of individuals in each species) 5. Divide the class into 5 groups and let them find the pictures of the species you hid around the campus, student, activity sheet 2 (species diversity), and manila paper. 6. Have the students sample the school area 2 times.	Define the number of individuals of each species as the species abundance. 4.Define species diversity as the species richness (number of species in an area) and species abundance (number of individuals in each species). 5.Divide the class into five groups and hand them the species cards, and students' activity sheet 2 (species diversity). 6. Instruct them to shuffle the species cards and get 10 species cards without looking at them.

3.9 Comments and Suggestions of the Panel of Experts of the Contextualized Biodiversity Handbook.

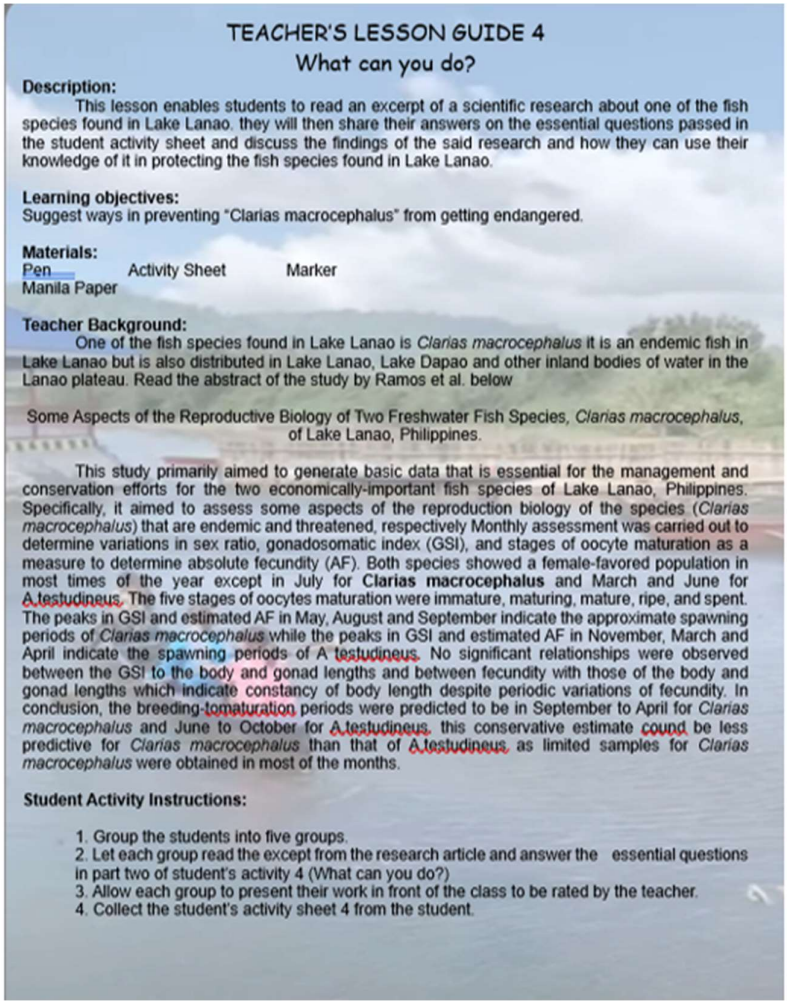
The in-service biology evaluated the developed contextualized teaching-learning material and some of the comments and suggestions of the experts. This component of the rubric for the evaluation of the developed contextualized allows the panel of experts to write down and illustrate the corrections and changes that should be made to improve the contextualized teaching-learning material. To this end, this gave the researcher the necessary feedback that is needed to improve the teaching-learning materials that she developed. The comments and suggestions are illustrated in Table 3.

A new page was added to the developed contextualized Biodiversity Handbook. This new page contains the introduction on the topic of Biodiversity and acts as a springboard for the teachers to get an overview of what biodiversity is. One of the panel of experts suggested that in activity two hide the species cards around the school for the students to find instead of handing them to them directly. This was done for students to experience and be engaged in their role as biologists looking for samples for their studies.

4.10 Features of the developed Contextualized Biodiversity Handbook

The Contextualized Biodiversity Handbook was developed to become the supplementary material for the implementation of the developed Contextualized STEM Lesson on Biodiversity. Figure 3 shows the cover page of the developed material:

Figure 3. Cover page of the Contextualized Biodiversity Handbook



TEACHER'S LESSON GUIDE 4

What can you do?

Description:

This lesson enables students to read an excerpt of a scientific research about one of the fish species found in Lake Lanao. they will then share their answers on the essential questions passed in the student activity sheet and discuss the findings of the said research and how they can use their knowledge of it in protecting the fish species found in Lake Lanao.

Learning objectives:

Suggest ways in preventing "Clarias macrocephalus" from getting endangered.

Materials:

Pen Activity Sheet Marker
Manila Paper

Teacher Background:

One of the fish species found in Lake Lanao is *Clarias macrocephalus* it is an endemic fish in Lake Lanao but is also distributed in Lake Lanao, Lake Dapao and other inland bodies of water in the Lanao plateau. Read the abstract of the study by Ramos et al. below

Some Aspects of the Reproductive Biology of Two Freshwater Fish Species, *Clarias macrocephalus*, of Lake Lanao, Philippines.

This study primarily aimed to generate basic data that is essential for the management and conservation efforts for the two economically-important fish species of Lake Lanao, Philippines. Specifically, it aimed to assess some aspects of the reproduction biology of the species (*Clarias macrocephalus*) that are endemic and threatened, respectively Monthly assessment was carried out to determine variations in sex ratio, gonadosomatic index (GSI), and stages of oocyte maturation as a measure to determine absolute fecundity (AF). Both species showed a female-favored population in most times of the year except in July for **Clarias macrocephalus** and March and June for A.testudineus. The five stages of oocytes maturation were immature, maturing, mature, ripe, and spent. The peaks in GSI and estimated AF in May, August and September indicate the approximate spawning periods of *Clarias macrocephalus* while the peaks in GSI and estimated AF in November, March and April indicate the spawning periods of A testudineus. No significant relationships were observed between the GSI to the body and gonad lengths and between fecundity with those of the body and gonad lengths which indicate constancy of body length despite periodic variations of fecundity. In conclusion, the breeding-tomaturation periods were predicted to be in September to April for *Clarias macrocephalus* and June to October for A.testudineus. this conservative estimate cound be less predictive for *Clarias macrocephalus* than that of A.testudineus as limited samples for *Clarias macrocephalus* were obtained in most of the months.

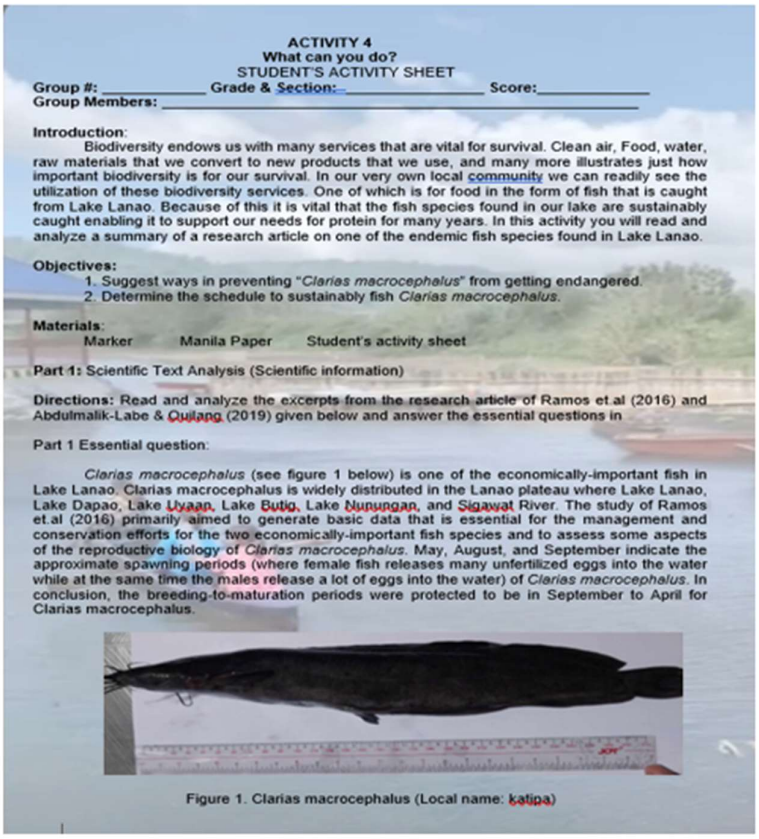
Student Activity Instructions:

1. Group the students into five groups.
2. Let each group read the except from the research article and answer the essential questions in part two of student's activity 4 (What can you do?)
3. Allow each group to present their work in front of the class to be rated by the teacher.
4. Collect the student's activity sheet 4 from the student.

Figure 4. Sample teacher's guide (teacher's lesson guide 4)

Figure 4 shows a sample teacher's guide that will be used by the teachers as a guide and as a reference for conducting the activity that each lesson has. The contextualized biodiversity handbook contains four (4) lesson guides for four different activities that are the foundational concepts to be delivered during the implementation of the Contextualized STEM Lesson on Biodiversity specifically on the need for knowledge stage.

The teacher's guide in the contextualized Biodiversity Handbook contains: (1) Description – this part of the teacher's guide describes the lesson that will be presented and an overview of what the students will be doing; (2) Learning objectives/s – contains the specific learning objective for the lesson; (3) Materials – this section shows the list of the materials that must be prepared for the conduct of the lesson; (4) Teacher Background – This section provides the background knowledge that the teacher will use to deliver the concepts for the lesson; and (5) Student Activity Instructions – which will be used by the teachers to carry out the activities for each of the lessons.



ACTIVITY 4
What can you do?
STUDENT'S ACTIVITY SHEET

Group #: _____ Grade & Section: _____ Score:_____
Group Members: _____

Introduction:
Biodiversity endows us with many services that are vital for survival. Clean air, Food, water, raw materials that we convert to new products that we use, and many more illustrates just how important biodiversity is for our survival. In our very own local community we can readily see the utilization of these biodiversity services. One of which is for food in the form of fish that is caught from Lake Lanao. Because of this it is vital that the fish species found in our lake are sustainably caught enabling it to support our needs for protein for many years. In this activity you will read and analyze a summary of a research article on one of the endemic fish species found in Lake Lanao.

Objectives:
1. Suggest ways in preventing "*Clarias macrocephalus*" from getting endangered.
2. Determine the schedule to sustainably fish *Clarias macrocephalus*.

Materials:
Marker Manila Paper Student's activity sheet

Part 1: Scientific Text Analysis (Scientific information)

Directions: Read and analyze the excerpts from the research article of Ramos et.al (2016) and Abdulmalik-Labe & Quilang (2019) given below and answer the essential questions in

Part 1 Essential question:

Clarias macrocephalus (see figure 1 below) is one of the economically-important fish in Lake Lanao. Clarias macrocephalus is widely distributed in the Lanao plateau where Lake Lanao, Lake Dapao, Lake Liyaan, Lake Butig, Lake Nunungan, and Sigawat River. The study of Ramos et.al (2016) primarily aimed to generate basic data that is essential for the management and conservation efforts for the two economically-important fish species and to assess some aspects of the reproductive biology of *Clarias macrocephalus*. May, August, and September indicate the approximate spawning periods (where female fish releases many unfertilized eggs into the water while at the same time the males release a lot of eggs into the water) of *Clarias macrocephalus*. In conclusion, the breeding-to-maturation periods were protected to be in September to April for Clarias macrocephalus.

Figure 1. Clarias macrocephalus (Local name: katipa)

Figure 5. Sample student's guide (activity 4)

Figure 5 shows a sample of students' activity sheets that will be used by the learners during each lesson. Each activity sheet contains: (1) Introduction – a short overview of the topic for the students to know; (2) Learning objectives – the objectives of the activity the what and the how of the activity; (3) Materials – in this section the materials needed for the activity are listed for early preparation; (4) Task – this contains the tasks that must be done by the students to achieve the objectives; (5) Essential questions – this section provides students with questions that must be answered to assess what they learned from the activity; and (6) action plan – in this section a plan, proposal or solution will be provided by the learners based on the tasks or social issues presented in the lesson.

4. Conclusion and Recommendations

The developed Contextualized STEM Lesson was rated Excellent in terms of its learning objectives where it is characterized as SMART (Specific, Measurable, Attainable, Relevant, Time-bounded) based on behavioral terms that can be easily observed, appropriate to the content where it offers a clear and concise description of the concept and the comments and suggestions of the panel experts of the Contextualized STEM Lesson adding of a new learning objective which is an effective one. Moreover, the Contextualized Biodiversity Handbook was rated excellent in terms of its learning objectives and expressed in behavioral terms.

Further studies on the Biodiversity of Lake Lanao must be carried out to have a holistic assessment of the state of the lake and the possible practices and programs that

must be carried out to protect it. Specifically, the abundance of each of the species as compared to the alien invasive species must be further investigated.

It is further recommended to implement the developed Contextualized STEM Lessons on Biodiversity and the Contextualized Biodiversity Handbook for Grade 8 Learners. This way it can aid students in making decisions when faced with biodiversity-related dilemmas in life.

5. Ethical Consideration

The researcher asked the school principal and the parents of the participants because the study entails the involvement of the residents in Lake Lanao. This was done to guarantee that the student's involvement in the study was entirely voluntary and guided and that they were free to decline or withdraw at any moment.

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