

## **ZOOLOGY IN NON-FORMAL SPACES: A TEACHING SEQUENCE ON THE AQUATIC AND SEMIAQUATIC FAUNA OF THE AMAZON BIOME**

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### **ABSTRACT**

Environmental conservation is a topic addressed in basic education, but Biology content rarely highlights Amazonian fauna. The current research investigated the teaching of aquatic and semi-aquatic fauna of the Amazon in a Non-Formal Space, through a didactic sequence applied at the Amazon Museum Botanical Garden (MUSA). Approximately thirty graduating high school students from a public school in Manaus, Amazonas, participated in the activity. The methodology adopted a mixed-methods approach, combining action research and questionnaire administration. The didactic sequence occurred in six stages: (1) planning and prior questionnaire, (2) interactive lectures on Amazonian Zoology, (3) preparation for the visit to MUSA, (4) field class with observation and recording of aquatic and semi-aquatic species, (5) pedagogical workshop with playful activities, and (6) closing of data collection. The results indicated that the students were unfamiliar with some Amazonian species. However, after applying the teaching sequence, they demonstrated greater scientific knowledge of the local biota, greater appreciation for teamwork, and greater environmental awareness. The research highlights the importance of active methodologies for teaching Zoology, fostering students' critical thinking and assisting teachers in teaching about Amazonian fauna.

**Keywords:** active learning strategies, in loco observation, bony fish, chelonians, rainforest.

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## 1. INTRODUCTION

In biology textbooks, aquatic and semi-aquatic vertebrates are addressed in a general, fragmented manner. Characterization is usually based on animals from the Atlantic Forest, Cerrado, and Pampas biomes, with little discussion of Amazonian fauna (ALBUQUERQUE AND COSTA, 2023). According to the National Common Curriculum Basis (BNCC), the area of Natural Sciences and its Technologies is organized into three principal axes: Matter and Energy, Life and Evolution, and Earth and Universe, which promote deep conceptual understanding within each theme. The study of Zoology is included in the “Life and Evolution” line, enabling high school students to develop skills in scientific investigation, analysis of problem situations, and evaluation of the applications of scientific and technological knowledge in different contexts (BRASIL, 2018).

The school, as a formal learning space, should promote discussions of environmental problems that affect students’ lives and communities, both locally and globally (GOMES et al., 2024; MOREIRA, 2018; NERY et al., 2026). Thus, the school environment, being institutionalized and organized, constitutes an ideal setting for research and teaching activities, involving students and teachers in producing knowledge about Amazonian species during the final years of basic education and fostering studies that stimulate students’ interest (ANGELINI, 2021).

In contrast, non-formal education offers greater flexibility in educational practices, expanding possibilities and allowing the planning of specific actions with defined organization and timeframes within the spaces where these activities take place (ANGELINI, 2021; PAIVA et al., 2023, 2024). Non-formal spaces contribute to dynamic learning experiences through visits to institutions such as museums, zoos, botanical gardens, and aquariums that display elements of a biome’s biodiversity (MORHY et al., 2016). These institutions, which interact with the community and have education as one of their primary objectives, constitute non-formal educational spaces that typically serve audiences in large urban centers, providing knowledge and opportunities for direct interaction with the natural world and its diversity (OLIVEIRA et al., 2017).

In this context, after identifying the lack of emphasis on the aquatic and semi-aquatic fauna of the Amazon region in the zoology content presented in natural sciences textbooks for high

school biology, this research proposed a didactic sequence for teaching Zoology at the high school level. This sequence is centered on the study of aquatic and semi-aquatic vertebrates of the Amazon and was developed through a technical visit to a non-formal educational space, the Botanical Garden Museum of the Amazon (MUSA).

## **2. LITERATURE REVIEW**

Biology subjects can stand out as among the most relevant and stimulating for students or, conversely, be perceived as unattractive, depending on the teacher's approach in the classroom (KRASILCHIK, 2011). To turn biology teaching more dynamic and meaningful, it is essential to adopt methodologies that go beyond the formal school environment. Practical field activities, science laboratories, workshops, debates, and technical visits to non-formal spaces constitute essential strategies in this process (SILVA et al., 2019). These environments promote environmental awareness by providing direct contact with local flora and fauna, enabling teachers to develop pedagogical practices that stimulate learning (SILVA et al., 2019).

Zoology encompasses the study of vertebrate animals, characterized by the presence of a notochord at least during one stage of their development (ANDRADE et al., 2023, 2024; LADISLAU et al., 2021; LEMOS et al., 2015; LIEBL et al., 2021; MAGRO et al., 2015; OLIVEIRA et al., 2020, 2023). This group includes fish, amphibians, reptiles, birds, and mammals (AZEVEDO et al., 2016). Several vertebrate species inhabit aquatic environments, either entirely or partially. Animals that exclusively inhabit aquatic environments, such as most fishes, some amphibians and mammals, as well as those that alternate between terrestrial and aquatic environments, such as certain amphibians and reptiles, are classified as aquatic and semi-aquatic, respectively (ARIDE et al., 2024; POUGH et al., 2012).

Amazonian aquatic biota exhibits remarkable biodiversity, including algae, plants, porifera, rotifera, insects, mollusks, crustaceans, fish, amphibians, reptiles, and mammals. Some of these organisms spend part of their life cycle on land, while others live predominantly in aquatic environments. Among the groups that stand out in this ecosystem are aquatic plants, fish, reptiles, and mammals (VAL, 2019). The study of the Amazonian aquatic environment is of great importance to the local population, as knowledge about this biome can promote

greater individual, social, and environmental responsibility, contributing to the conservation and sustainable use of the region's natural resources (SANTOS AND TÉRAN, 2017).

The school plays an essential role in this process, from the early years of basic education to high school, where the study of zoology can be further deepened. Practical field classes conducted in non-formal spaces allow students to observe Amazonian animals directly, thereby facilitating learning (SANTOS AND TÉRAN, 2017). These experiences enable the study of interactions between living beings and the environment, enriching knowledge about regional fauna (OLIVEIRA, 2017).

Furthermore, associating zoology content with ecology in biology classes stimulates critical thinking and encourages students to reflect on solutions to environmental challenges affecting Amazonian ecosystems (LIMA et al., 2024). In this context, several studies have explored the educational potential of non-formal spaces. Maciel et al. (2012) highlighted the bridge over the Rio Negro, in Manaus, as a space that teachers can use for educational activities.

Rodríguez and Filho (2013) conducted a study in the countryside of Amazonas, in the city of Parintins, where they identified the slaughterhouse and the public garbage dump as opportunities to apply the teaching–learning process through non-formal spaces. Souza et al. (2017) explored the Bosque da Ciência in the capital of Amazonas as another site with potential for educational activities. Similarly, Leal et al. (2017) investigated the Adolpho Ducke Botanical Garden, a space within the city of Manaus that offers pedagogical opportunities for science teaching in the Amazon.

When discussing non-formal spaces, Santos and Terán (2017) state that school activities can take place in both science teaching laboratories (STLs) and external environments, such as botanical gardens, zoos, and nature reserves. These locations are essential for knowledge construction and can be considered non-formal educational spaces. Oliveira (2017) emphasizes that innovative pedagogical methodologies, such as contextualized and reflective practices, should be adopted to value local ecosystems. Such approaches promote critical reflection among students and encourage environmental awareness aimed at nature conservation.

Barnabé et al. (2020) conducted research with students from the Academic Master's Program in Science Education in the Amazon at the State University of Amazonas (UEA), aiming to analyze the pedagogical potential of non-formal spaces in the Mindú Ecological Corridor. In this sense, practices in science teaching, when used as strategies in non-formal spaces, aim to provide teachers with tools that enable students to learn and attribute new meaning to existing knowledge.

The national curriculum guidelines for education advocate contextualizing teaching content to students' lived realities. This approach gives meaning to learning, stimulates active participation, and supports the construction of scientific knowledge in more concrete and realistic ways (BRAZIL, 1999). Field trips conducted in non-formal spaces enable the development of educational activities that overcome knowledge fragmentation and promote integrated learning. These practices are fundamental to knowledge construction, as they stimulate investigation and encourage student protagonism by leading learners to problematize issues and seek solutions to the challenges presented (DE PAIVA AND SUDÉRIO, 2019).

Given the wide availability of visual and technological information outside the school environment, schools must provide students with new experiences that broaden their worldview. Non-formal education aims to offer engaging experiences by presenting content in a dynamic, exploratory manner (SEIFFERT-SANTOS, 2023). Unlike systematized teaching, it opens pathways to discoveries and alternative learning perspectives (DARLING-HAMMOND AND BRANSFORD, 2019). Such pedagogical practices expand students' scientific understanding, enable them to become active agents in their own learning, foster teamwork, and make science classes more dynamic (FAGUNDES et al., 2018).

### **3. METHODOLOGY**

#### **3.1 Research approach**

The research was conducted between May and June 2023 with a class of 34 senior-year students at Waldocke Fricke State School in Manaus, Amazonas. The study employed an action research approach, understood as a form of investigative practice that uses established research techniques to inform actions aimed at improving educational practice (ARAGÃO AND DIAS, 2018).

A mixed-methods approach, combining qualitative and quantitative data, was adopted for data collection. The data were analyzed from this perspective using questionnaires (CHIZZOTTI, 2001). In this context, in situ observation of aquatic and semi-aquatic species present at MUSA was proposed.

### 3.2 Data acquisition and analysis

Initially, the project was presented to the students, followed by an explanation that they should complete the preliminary questionnaire below to assess their basic knowledge of Zoology content (Table 1). All questions were related to the proposed research topic.

Table 1 – Previous questionnaire.

|                                                                                                                                                         |             |                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------|
| Do you know what zoology means? ( ) Yes ( ) No (If yes, then, comment)                                                                                  |             |                   |
| Do you know any Amazonian ecosystems? ( ) Yes ( ) No (Se sim, write which one)                                                                          |             |                   |
| Are Amazon animals presented in the school book? ( ) Yes ( ) No (If yes, then, comment)                                                                 |             |                   |
| Do you think that it is important to know the animals from the Amazonian ecosystem in a constructed environment? ( ) Yes ( ) No (If yes, then, comment) |             |                   |
| Which animals listed below do you know?                                                                                                                 |             |                   |
| <b>Animal Name</b>                                                                                                                                      | <b>Know</b> | <b>Don't know</b> |
| Aruanã                                                                                                                                                  |             |                   |
| Bodó                                                                                                                                                    |             |                   |
| Girino                                                                                                                                                  |             |                   |
| Jaraqui-de-escama-grossa                                                                                                                                |             |                   |
| Pacú-manteiga                                                                                                                                           |             |                   |
| Piramboia                                                                                                                                               |             |                   |
| Pirarara                                                                                                                                                |             |                   |
| Pirarucu                                                                                                                                                |             |                   |
| Rívulo                                                                                                                                                  |             |                   |
| Tambaqui                                                                                                                                                |             |                   |
| Tartaruga                                                                                                                                               |             |                   |
| How do you get the info about the environment?                                                                                                          |             |                   |
| ( ) TV                                                                                                                                                  |             |                   |
| ( ) School                                                                                                                                              |             |                   |
| ( ) Internet                                                                                                                                            |             |                   |
| ( ) Researches                                                                                                                                          |             |                   |
| ( ) Social Media                                                                                                                                        |             |                   |
| ( ) Friends                                                                                                                                             |             |                   |
| ( ) Other: _____                                                                                                                                        |             |                   |

Source: Own Authorship (2023).

Next, the teaching sequence was implemented in accordance with the qualitative–quantitative research design, using a questionnaire (Table 2). A teaching sequence consists of a set of activities planned for educational purposes, coordinated across the implementation of a teaching unit, generally over a short period of time. This approach enables the planning,

execution, and organization of activities in a practical and accessible manner for both teachers and students (SILVA et al., 1998).

Table 2 – Didactic sequence steps.

|                                                                                                                                                                            |                     |                                                                                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Number of students:</b> 34<br><b>Year:</b> 12<br><b>Age:</b> 17 & 18 years<br><b>Hours:</b> 16 hours                                                                    |                     |                                                                                                                                                                                                                                        |
| <b>General objective:</b> Apply activities from the didactic sequence to develop students' perceptions of aquatic fauna during investigative teaching, aiming at learning. |                     |                                                                                                                                                                                                                                        |
| <b>Participation:</b> 30 students answered the Previous questionnaire, and 34 participated in the pedagogical workshop.                                                    |                     |                                                                                                                                                                                                                                        |
| <b>1º Moment:</b><br>Data collection                                                                                                                                       | Specific Objectives | Assessment of students' prior knowledge.                                                                                                                                                                                               |
|                                                                                                                                                                            | Method              | Application of the diagnostic questionnaire for data collection.                                                                                                                                                                       |
|                                                                                                                                                                            | Resources           | Preliminary questionnaire                                                                                                                                                                                                              |
|                                                                                                                                                                            | Activity            | Answer the preliminary questionnaire.                                                                                                                                                                                                  |
| <b>2º Moment:</b><br>Concepts about the Amazonian ecosystem                                                                                                                | Specific Objectives | Understanding the concepts of aquatic environments: lentic waters, lotic waters, and the living organisms that inhabit these environments.                                                                                             |
|                                                                                                                                                                            | Method              | Lecture and dialogue with slide presentation.                                                                                                                                                                                          |
|                                                                                                                                                                            | Resources           | Data projector, computer, whiteboard marker, and whiteboard.                                                                                                                                                                           |
|                                                                                                                                                                            | Activity            | General notes were taken to serve as a theoretical framework for future classes.                                                                                                                                                       |
| <b>3º Moment:</b><br>Getting to know the bony fish, amphibians, and reptiles of the Amazon biome                                                                           | Specific Objectives | Identify the importance of bony fish, amphibians, and reptiles in the ecology and economy of the Amazon region.                                                                                                                        |
|                                                                                                                                                                            | Method              | Interactive practical activity, expository lesson, and dialogic lesson.                                                                                                                                                                |
|                                                                                                                                                                            | Resources           | Cell phone, data projector, computer, whiteboard marker, and whiteboard.                                                                                                                                                               |
|                                                                                                                                                                            | Activity            | Research on the Amazon Museum website to carry out the practical research activity "Getting to Know the Fish of the Amazon" and general notes from the expository lesson entitled "Bony Fish, Amphibians, and Reptiles of the Amazon". |
| <b>4º Moment:</b><br>Learning about a scientific article on the Amazon biome                                                                                               | Specific Objectives | To provide students with the ability to recognize the main characteristics of a scientific article.                                                                                                                                    |
|                                                                                                                                                                            | Method              | Presentation of a scientific article to illustrate scientific research.                                                                                                                                                                |
|                                                                                                                                                                            | Resources           | Materials: Scientific article; Paper and pencil for completing the activity.                                                                                                                                                           |
|                                                                                                                                                                            | Activity            | Reading and analysis of a scientific article that addresses the conservation of aquatic biota in the Amazon.                                                                                                                           |
| <b>5º Moment:</b>                                                                                                                                                          | Specific Objectives | Allow students to have an immersive experience observing aquatic animals from the Amazon region                                                                                                                                        |

|                                                                                                                                     |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Field Trip: Technical Visit to the Non-Formal Space of the Amazon Museum (MUSA)<br>Location: Musa da Amazônia Botanical Garden      |                     | and understand their importance to the region's ecosystem.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                                                                                                                                     | Method              | Field Trip: <ul style="list-style-type: none"> <li>• Division into teams for the visit;</li> <li>• Observation of the aquariums located in the Museum at the following points:               <ul style="list-style-type: none"> <li>○ White tent;</li> <li>○ Larger aquarium, Denis and Luciana Minev;</li> <li>○ Victoria regia lake;</li> <li>○ Walk along the trails.</li> </ul> </li> </ul>                                                                                                                                                                         |
|                                                                                                                                     | Resources           | Field notebooks for recording observations; Maps, brochures and cell phones.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                                                                                                     | Activity            | <ul style="list-style-type: none"> <li>• Enjoy the visit, take notes during the visits to the places you go.</li> <li>• Make photographic and written records about the practical field trip.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                |
| <b>6º Moment:</b><br>Educational Workshop:<br>Building the morphological characteristics of Amazonian aquatic fish in a playful way | Specific Objectives | Identify the main morphological characteristics of bony fish and the Amazonian turtle species.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                                                                                                                     | Method              | <ul style="list-style-type: none"> <li>• Describe how the workshop will be developed: construction of Amazonian fish on panels using different materials.</li> <li>• Before starting the activity, the groups should organize themselves to:               <ul style="list-style-type: none"> <li>○ Define the position of each participant.</li> <li>○ Organize the time to carry out the activities and the resources provided by the teacher.</li> <li>○ Complete the practice report at the end of the application of the didactic sequence.</li> </ul> </li> </ul> |
|                                                                                                                                     | Resources           | Key for identification; Colored pencils; Pens and brushes; Photographic paper; EVA foam paper; Scissors; Glue; Panels; Easel                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                                                                                                     | Activity            | <ul style="list-style-type: none"> <li>• Reflective discussion on the characteristics of bony fish and reptiles of the Amazon.</li> <li>• Practical class for making the fish and the turtle.</li> <li>• Presentation of the material made by the teams in the form of a seminar.</li> <li>• Application of the final evaluation through the completion of a practice report by the team.</li> <li>• Application of the final individual questionnaire to close the data collection.</li> </ul>                                                                         |

Source: Own Authorship (2023).

The evaluation of the pedagogical workshop was conducted through a seminar presentation based on the activities students performed. Subsequently, the practice report presented below was used to assess the teams' attitudinal performance (Table 3).

Table 3 – Questionnaire on the practice of the pedagogical workshop.

|                                                                              |
|------------------------------------------------------------------------------|
| 1) Was the time used to complete each phase sufficient?                      |
| 2) Difficulties encountered.                                                 |
| 3) Significant contributions from team members.                              |
| 4) Highlight the positive aspects of the activity, indicating your learning. |

Source: Own Authorship (2023).

Feedback was provided to the students after analyzing their answers. Throughout the development of the activities, the objective was to engage students with the topic, encourage participation in classroom discussions, and promote engagement in both theoretical and practical lessons, thereby stimulating their active involvement in the activities proposed in the project, from planning through completion. The data analysis concluded with the application of the following final questionnaire in Table 4.

Table 4 – Final Questionnaire.

|                                                                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Based on the progress of the teaching sequence, how would you rate the development of the research? Justify your answer. ( ) Excellent ( ) Good ( ) Fair ( ) Poor |
| What did you think of the teaching workshop?                                                                                                                      |

Source: Own Authorship (2023).

The analysis of the content results was based on Bardin's (2016) proposal, which relies on a form of meaning analysis characterized by objective, systematic, quantitative, and qualitative descriptions, enabling the extraction of relevant interpretations from the data. The use of questionnaires offers a practical means of data collection in both the initial and final stages of the research, serving as an investigative technique comprising a variable number of written questions presented to participants. This method aims to understand opinions, interests, expectations, and lived experiences, thereby enabling rapid data collection (GIL, 2008).

This research employed tables, charts, and graphs for the statistical analysis of the results, obtaining values and percentages to facilitate data visualization. In this approach, the researcher does not interfere with the observed phenomena, but rather records and describes them as they occur (PRODANOV AND FREITAS, 2013). The workshop was evaluated throughout the implementation of the teaching sequence through observations of the

materials produced, such as students' drawings, the completion of the practice report, and the teams' presentations in the form of a seminar, which constituted the research outcome.

## 4. EXPERIMENTAL DEVELOPMENT

### 4.1 Analysis of the preliminary questionnaire

In the application of the diagnostic questionnaire, when asked, "Do you know what Zoology means?" 22 students correctly associated the term Zoology with the study of animals, while 8 were unable to answer the question (Table 5). This result highlights students' interest in Zoology content, as this area tends to attract their attention, regardless of their level of prior familiarity or identification with the subject (DURÉ et al., 2018; LEITÃO DA SILVA et al., 2021).

Table 5 – Data from the students' preliminary questionnaire about what the term Zoology means to them.

| Do you know what "Zoology" means? | Answers |
|-----------------------------------|---------|
| Yes                               | 22      |
| No                                | 8       |

Source: Own Authorship (2023).

Knowledge of Amazonian ecosystems proved relevant to this research. It was observed that 53% of the students had previous contact with some Amazonian ecosystem, with the Amazon rainforest, streams, and rivers being the most frequently mentioned environments (Figure 1). These results corroborate the need to emphasize this theme, as it is relevant for sparking students' interest in expanding their knowledge of the Amazon region (SILVA et al., 2024).

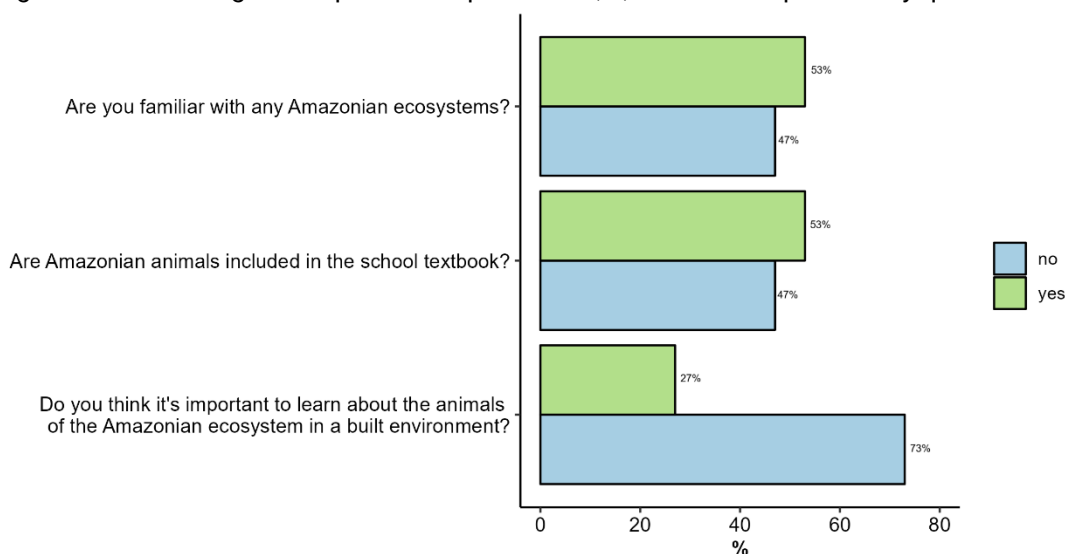
The study of ecosystems highlights the importance of systems composed of living beings (biotic components), the places where they live (abiotic components), and all the relationships established both with the environment and among organisms (HIGUCHI AND HIGUCHI, 2004). Addressing this content in school promotes students' environmental awareness, enabling them to build fundamental concepts about the world they live in and to consider teaching practices in non-formal spaces (SOUZA et al., 2020).

When asked about the importance of learning about animals from the Amazonian ecosystem in built environments, most students (53%) expressed interest in access to such spaces. These environments present animals in situ and are external to the school context, being

classified as non-formal spaces (SANTOS AND TERÁN, 2017). The objective of this question was to identify whether students were familiar with built environments, that is, places suitable for observing Amazonian fauna, such as botanical gardens and zoos (MORHY et al., 2016).

Textbooks typically do not address Amazonian aquatic animals, and the diversity of Brazilian fauna is often presented in a limited, fragmented manner, which negatively affects the teaching of content related to the Amazon region (TEIXEIRA, 2019). This finding is consistent with the results of the present study, which showed that 73% of students reported that animals from the Amazonian fauna are not included in the school textbook (Figure 1). The textbook remains a widely used teaching resource and is often the only instructional support available to teachers (VASCONCELOS et al., 2023).

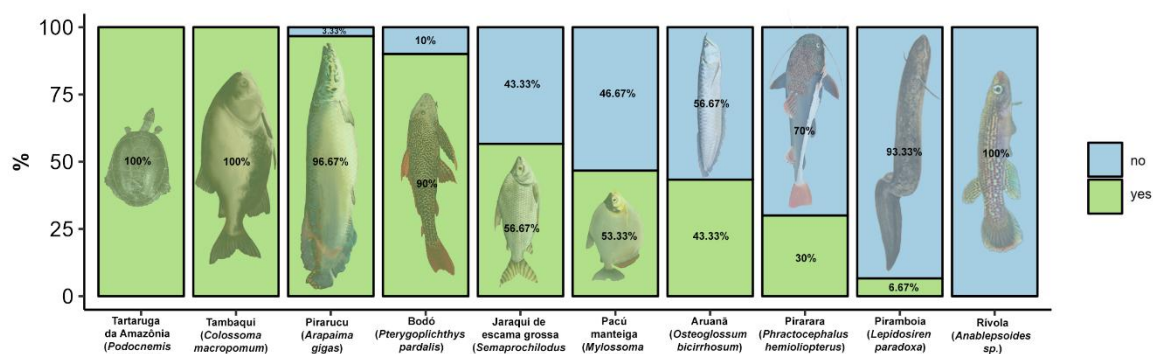
Figure 1 — Percentage of responses to questions 2, 3, and 4 of the preliminary questionnaire.



Source: Own Authorship (2023).

Analysis of responses to Question 5 found that the fish species tambaqui (*Colossoma macropomum*) and pirarucu (*Arapaima gigas*), as well as the Amazon River turtle (*Podocnemis expansa*), were cited by all participating students as the animals they were most familiar with (Figure 2). This result can be explained by the fact that these species are part of the diet of Amazonian populations and are commonly sold in markets throughout Manaus (OLIVEIRA et al., 2024; SANTOS et al., 2009).

Figure 2 — Answers to question 5 of the preliminary questionnaire.



Source: Own Authorship (2023).

Among the fish species marketed, tambaqui and jaraqui account for the highest share, together representing approximately 47% of total fish production. Although pirarucu is not included in this percentage, even when sold in smaller quantities, it maintains a consistent presence at fairs and markets in Manaus and was historically considered a staple food for the Amazonian population (SANTOS et al., 2009; VERÍSSIMO, 1895).

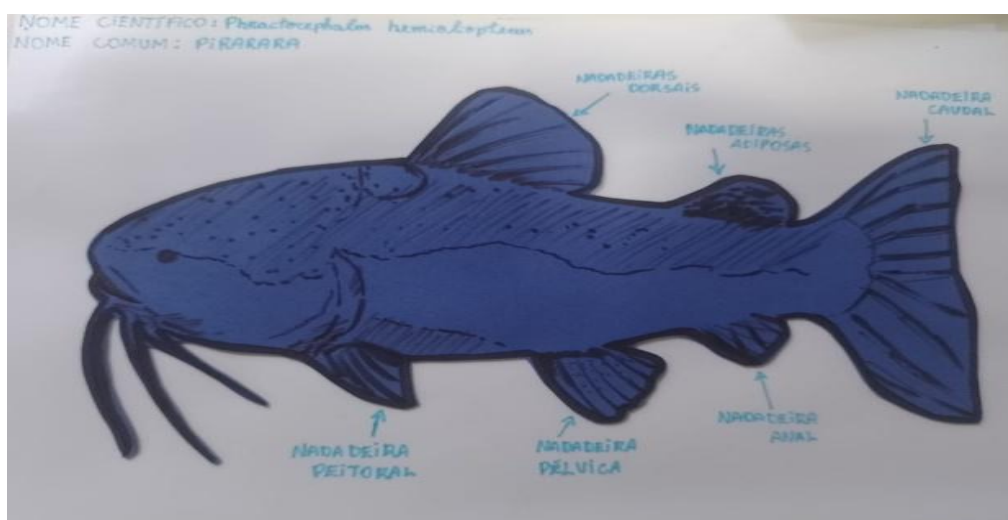
Reptiles have been hunted and exploited since the nineteenth century, and turtles stand out for their historical and cultural importance in human diets (VAL, 2019). The tambaqui *C. macropomum* is one of the best-known fish species in the Amazon region. It belongs to the Characidae family and was first described in 1818 by Georges Cuvier. This species stands out as one of the most consumed fish in Brazil; it is a freshwater species native to South America and is present in 24 Brazilian states (SANTOS et al., 2019). Therefore, including the study of aquatic and semi-aquatic animals in Biology classes is indispensable for students' learning.

In the sixth question, students were asked how they obtain information about the environment, and the internet was the most frequently cited source (26%). This was followed by social networks, school, and television (18%), research activities (13%), conversations with friends (6%), and documentaries (1%). According to Gomes (2020), when introducing the theme of the Amazon in the classroom, university research institutions and specialized forest centers should collaborate, particularly when school-based discussions lead to debates about situations and problems that students seek to address.

#### 4.1.1 Pedagogical workshop

The creation of specific fish drawings by five student groups, using resources such as identification keys for different animals, EVA foam, scissors, glue, photographic paper, brushes, pencils, pens, and colored pencils, allowed students to move beyond passivity, stimulated autonomy, and promoted meaningful learning in the study of Amazonian fauna (Figure 3). The proposed group activities served as an incentive for student interaction, active participation, and knowledge construction (SANTOS et al., 2022).

Figure 3 – Drawing of the Pirarara fish (*Phractocephalus hemiliopterus*) made by one of the groups.



Source: Own Authorship (2023).

The groups began by cutting out images of bony fish and the Amazonian River turtle (*Podocnemis expansa*). They then drew the animals on EVA foam, painted and identified the species, and glued the materials onto photographic paper. Once completed, the work was displayed on a panel, initiating the seminar presentation. Initially, the groups were instructed to read the provided materials, after which the teacher guided them in dividing the tasks. These instructions were aligned with the theoretical lessons previously taught, allowing students to put the proposed activities into practice.

#### **4.1.2 Analysis of the report on the pedagogical workshop practice**

In the first question, participants were asked whether the time allocated for each phase of the workshop was sufficient. Most students reported difficulties with the time available (52.94%), while 47.06% stated that the allotted time was sufficient for developing the activities. These

data indicate that implementing pedagogical workshops requires additional time for practical work, a need also recognized by teachers, who often lack sufficient time to carry out project-oriented activities (SANTOS AND TERÁN, 2017).

According to the authors, limited time was the most frequently identified category, reflecting insufficient time for planning, a limited number of classes with specific groups, inadequate time to develop activities, and insufficient time for students to understand the proposed actions fully. Teachers' time constraints characterize this situation, as the reduced number of Biology classes per week affects the development of an extensive curriculum. On the other hand, encouraging diversified teaching strategies allows students to move from passivity to autonomy.

In the second question, related to the difficulties encountered during the practical workshop session, the following responses were obtained:

- G1 – The difficulties encountered were the short amount of time available to develop the activity and the seminar presentation.
- G2 – The group experienced some difficulties in making the fish and preparing the presentation.
- G3 – Difficulty in making the fish templates.
- G4 – It was difficult to cut out the drawings and write the scientific names.
- G5 – We had no difficulty whatsoever during the teamwork.

The responses from the groups indicated that students faced difficulties with time management, the development of manual skills, and public speaking. Therefore, teachers need to encourage teamwork, the development of motor skills, and the practice of oral presentations within established deadlines. Proposing such challenges is necessary to help students learn to follow rules and manage time skills that will be essential throughout their academic and professional lives.

According to Silva (2019), the concept of a didactic sequence presupposes that this process should be applied within a relatively short time frame and in a proportion appropriate to students' learning capacities. In this sense, pedagogical workshops must be carefully designed and planned so that students can exercise protagonism. The pedagogical workshop seeks to transcend traditional teaching, representing a form of knowledge construction

grounded in action and autonomy while maintaining a solid theoretical foundation (LEAL, 2019).

The third question emphasized the importance of teamwork, which enabled students to connect and collaborate toward shared learning goals. In this section of the report, students addressed the significant contributions of team members, including their involvement, attitudes, and task assignments. Regarding team members' contributions, the following responses were obtained:

G1 – In the group, all members helped each other, from writing and cutting to assembling the fish templates.

G2 – Two team members cut out the figures, another studied the characteristics of the fish for the presentation, and another answered the questionnaire.

G3 – Two team members studied for the presentation. One member made the drawings, and another student timed the activity. The contributions of the other students were of paramount importance to the development of the work.

G4 – The members worked as a team, the tasks were well distributed, and everyone was committed.

G5 – The team contributed with full support, helping each team member; each person did their part so that the work could be done.

Teamwork is an effective strategy for promoting socialization and cooperation, as it addresses different learning levels and paces. It is used to solve group dynamics issues and to stimulate and support peer learning. Through social interaction and collaborative activities, students are encouraged to learn collectively (SILVA, 2022; ZABALA, 1998).

The fourth question of the activity aimed to identify the positive aspects of implementing the pedagogical workshop, and the following responses were obtained:

G1 – The positive aspects of this activity were teamwork and what we learned about fish.

G2 – Each person learned a little more about the fish indicated.

G3 – This activity promoted teamwork, learning from colleagues, motivated student participation, and developed knowledge of the species, as well as differentiation from others.

G4 – Each team member, with their differences, managed to adapt and develop the proposed activities within the time allotted.

G5 – The positive aspects that the group learned were the characteristics, scientific names, and types of fins of each fish and its species.

These activities are based on the principle that students should participate in playful experiences, which may be enjoyable for some students and less engaging for others. From the teacher's perspective, the positive aspects included the school's infrastructure, the low cost of materials, and students' participation. The negative aspects were that some students did not participate in the workshop and that the limited time hindered the development of the proposed activities. Overall, the activity can provide students with a new perspective on Zoology and the Amazon, yielding positive outcomes for the research. Promoting and fostering students' moral autonomy, which involves not only establishing spaces for its practice but also creating opportunities for students to experiment in knowledge-construction processes that encourage autonomy, can lead to satisfactory results (ZABALA, 1998).

Procedural content developed through research, when properly planned and organized, is essential for autonomous inquiry, leading to direct observation in the construction of knowledge. Attitudinal content associated with socialization, cooperation, and integration into the environment underpins most of the activities that constitute the proposed method (ZABALA, 1998). In this sense, the proposed teaching sequence enabled students to experiment, expand their knowledge, and develop new understandings.

#### **4.1.3 Analysis of the final questionnaire**

In evaluating the workshop's development and application, some students expanded their knowledge of aquatic animals despite time constraints. Silva (2019) emphasizes that students do not assimilate information in the same way or within the same pedagogical timeframe; therefore, activities should be planned to reach a broader range of learners. In this sense, students have distinct characteristics, and planned activities should aim to engage as many students as possible.

In the first question, students provided the following evaluation of the application of the didactic sequence during the development of the research:

Student 1 – EXCELLENT. I found it interesting because we know how fish survive and what they eat, so we know how they live.

Student 2 – EXCELLENT. The research was very important, not only for improving knowledge but also for teamwork, which helped complete the project within the allotted time.

Student 3 – EXCELLENT. I rated the teacher's teaching method as excellent because it was very dynamic, and I could observe the teacher's great dedication, both in helping us acquire knowledge and in its application.

Student 4 – EXCELLENT. As a result of this didactic research, I learned about fish through drawings and a small seminar presented by the students themselves.

Student 5 – EXCELLENT. It is a complete, well-structured research project.

Student 6 – GOOD. I found the teaching method and the workshop excellent, but we couldn't make the most of everything due to time constraints.

The results presented below illustrate students' evaluations of the pedagogical workshop. This evaluative parameter indicates that students are interested in playful activities that allow them to exercise protagonism in the learning process.

Student 1 – GREAT.

Student 2 – Cool, because I got to draw, something I enjoy doing.

Student 3 – Admirable, because each student was able to explain and learn about the various types of fish.

Student 4 – I found it very cool and relevant. It was something done that is not commonplace, and having this opportunity to learn in practice was very good for assimilating the content.

Student 5 – I thought it was cool, a good and didactic way to learn about ecosystems, types of fish, aquatic and semi-aquatic animals.

Student 6 – I found it very interesting that each person presented the characteristics of the fish; I, who is passionate about them, loved it from beginning to end.

Student 7 – It was great to have studied the species in more depth.

Student 8 – By far one of the best activities developed this year, my group and I dedicated ourselves to the work and delivered a high-quality presentation.

Chaves (2020) reports that the use of educational workshops creates situations in which practice fosters attitudes and processes that actively mediate between subject and object, leading to student autonomy, stimulating learning, and promoting the socialization of knowledge. The results demonstrated that, by the end of the activities, students had assimilated new concepts, learned about animal morphology, and recognized the importance of understanding the fauna of the Amazon region.

## **5. CONCLUSION**

The teaching sequence aimed to provide students with the opportunity to become disseminators of scientific knowledge through Biology teaching, focusing on the study of aquatic and semi-aquatic animals of the Amazon in the non-formal educational space of the Museum of the Amazon (MUSA). The questions guiding this research corroborated students' knowledge of Amazonian fauna and aquatic environments in the region, highlighting the relevance of this knowledge to the teaching-learning process.

The results showed that students were unfamiliar with some Amazonian animals and that, after the pedagogical workshop was implemented within the teaching sequence, they improved their scientific knowledge of Amazonian biota. In addition, students valued teamwork, developed social interaction skills, and were motivated to foster environmental awareness and conservation. The detailed description of the teaching sequence presented in this research aims to support Biology teachers in the teaching of Zoology.

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