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Is there room for science at aquariums? An analysis of family conversations and interactions during visits to AquaRio, Rio de Janeiro, Brazil

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Abstract

In this study, we use a mixed methods approach to analyze the conversational content and interactions constituting five family groups' visits to the Marine Aquarium of Rio de Janeiro (AquaRio), the largest marine aquarium in South America, to understand how families interact with science and construct meaning regarding science and conservation. The audiovisual records of the family groups were analyzed using categories that investigate the types of interactions and conversations that may take place in scientific-cultural venues. The results suggest that, throughout the visits, family members were driven by their observation and contemplation of the animals on exhibit to interact with each other to share information about marine biodiversity and its conservation. The adults, children, and explainers all had fundamental roles in the construction of dialogues on scientific topics. The adults adopted behaviors that facilitated learning, made associations with previous experiences, read panels, and contextualized the information to their family's reality. The children were notable for their protagonism, asking questions, giving explanations, and sharing their previous knowledge, experiences and opinions about the animals and the conservation of marine biodiversity based on scientific reasoning. Therefore, this study provides evidence of the important role that AquaRio could play in providing opportunities for families to

have conversations about biodiversity and conservation while raising awareness about the impacts of human activities on the oceans.

KEYWORDS
aquarium, families, free-choice learning, informal education, marine biodiversity conservation

1 | INTRODUCTION

The oceans are home to a level of biodiversity estimated at 2.2 million species, are a source of food and income for three billion people, act as climate regulators and provide at least 50% of the oxygen available, ensuring the sustainability of marine and terrestrial ecosystems (Convenção da Diversidade Biológica–CDB, 2012; United Nations, 2021). However, they have been severely threatened by exploitative anthropogenic activities, such as the conversion of areas of native vegetation into agricultural land and pasture, contributing to greenhouse gas emissions and thus to air and water pollution, as well as affecting biogeochemical cycles and marine biodiversity, as in the cases of coral bleaching and water acidification (Barbier, 2017).

Considering that ocean degradation is a threat to marine ecosystems and human beings themselves and that the transboundary nature of oceans requires the engagement of governments and civil society at a regional, national, and global level, the United Nations has declared that the decade running from 2021 to 2030 is the Decade of Ocean Science for Sustainable Development or the Ocean Decade. One of its stated objectives is to promote debate among the global population about the importance of the oceans and, drawing on scientific approaches, to contribute to the fulfillment of the 17 Sustainable Development Goals (SDGs), especially SDG 14, which relates to the protection and sustainable use of the seas and oceans (United Nations, 2021; United Nations Educational Scientific and Cultural Organization—UNESCO/IOC, 2021).

In the context of this scenario, education for sustainable development (EDS) has become a catalyzing and indispensable element in reaching sustainable development, seeing as it is understood as holistic education in which learning takes place over a person's lifetime and has the power to transform society. As such, it has the objective of empowering learners to make informed decisions and act in a conscious and responsible way for the benefit of environmental integrity (United Nations, Educational, Scientific and Cultural Organization—UNESCO, 2014, 2017).

That way, informal educational settings have great potential for reaching, involving, and engaging the public with ocean conservation (National Research Council—NRC, 2009). Authors such as Dierking and Falk (2003), Falk and Dierking (2000, 2010, 2014), and Falk and Storesdieck (2005) have shown that informal education settings enable children and adults to engage in collaborative learning experiences. These spaces, which include different types of museums, such as botanical gardens, zoos, and aquariums, are able to attract a wide range of visitors, but their main audience is families composed of children and adults in search of leisure and learning, as the studies by Kelly et al. (2020), Kisielet al. (2012), Massarani et al. (2021), and Nomura and Bizerra (2015) demonstrate.

1.1 | The educational role of aquariums

The educational dimension of aquariums gained prominence in the late twentieth century in response to pressure from the scientific community for aquariums to educate and provide guidance to civil society to support the conservation of marine biodiversity (Salgado & Marandino, 2014). To meet this goal, they have been organized around a clearly defined pedagogical discourse and taken on museum-like attributes, displaying objects,

information, and live animals on their premises in a way that encourages social interaction of visitors and explainers to enable the sharing of information and knowledge about the ocean and its resources.

Currently, aquariums around the world highlight educational objectives in their mission statements that align with the vision of their respective associations, such as the World Association of Zoos and Aquariums (WAZA), the Association of Zoos and Aquariums (AZA), and the Latin American Association of Zoological and Aquatic Parks (ALPZA). The efforts of aquariums toward conservation and education are held in positive regard when promoting interactive exhibitions, some with touch tanks, mediated visits, signage with interpretive informational content on the biology of a certain species, and the development of educational initiatives that contribute to the approximation of visitors and marine life (Kelly et al., 2021; Packer & Ballantyne, 2010).

When visitors come into close contact with animals, an experience which, as a general rule, is not part of their typical routines, they feel closer to their natural environment and experience situations that lead them to reflect on environmental problems and express emotions and the desire to change their behavior based on a sense of respect for wildlife (Ballantyne et al., 2018; Clayton et al., 2009; Collins et al., 2020). In these moments of contemplation, conversations can come about that address science-related concepts, from biology and ecology, for example, showing evidence of learning from this experience (Kelly et al., 2020).

It is important to note that, while educational objectives are desirable for aquariums, learning in these environments is of a self-directed and free-choice nature (Falk, 2005). However, as argued by Moss and Esson (2014), some visitors, given their personal motivations, may not be interested in educational involvement. They may be seeking pleasant experiences, entertainment, and leisure, while recognizing that conservation education is an important aspect of their visit (Ballantyne & Packer, 2016). Moss and Esson (2014) argue as well that research investigating learning in zoos and aquariums is limited in scope to the educational objectives of the institution, focusing on the positive potential results of visits, and that a widening of this perspective is necessary, including an expanded evaluation of social, cultural and emotional results, as well as negatives impacts caused by visits to aquariums. From this point of view, an integrated analysis of the visitor experience, including their conversations and interactions, avails itself as a promising methodology for the comprehension of collaborative, intergenerational learning experiences (Fraser et al., 2010).

1.2 | Conversations and interactions of families visiting aquariums

In this study, we understand conversations and interactions as distinct and intrinsically connected processes. Interactions include active experiences in which the visitors physically, intellectually, emotionally, and/or socially engage with the exhibition. Conversations qualify as interactions, but interaction may occur in nonverbal forms as well (Scalfi et al., 2022; Shaby et al., 2018). Conversations involve exchanges of words and/or ideas between two or more people and, in general, are characterized by mutually engaged participants, in which one completes the sentences of the other, and there are constant interruptions, pauses, explanations and insertions of ideas, memories, prior knowledge, and so on, that are essential for the construction of meaning (Davidsson & Jakobsson, 2012; Linell, 2001). In this interpretation, using informal education as a reference and context, we consider that the interactions between individuals and mediating elements, as well as conversations, are fundamental processes in the effort to understand visitors' learning experiences.

The importance of interactions and conversations of families in aquariums is demonstrated in the extant literature. Ash (2004), for example, argues that conversations contribute to collaborative construction of meaning when the family is engaged in reflections and discussions on scientific concepts. Briseño-Grazon et al., 2007) showed that learning experiences of adults through social interactions in family groups involve cognitive, social, and affective domains, demonstrating that this learning persists throughout time. Rowe and Kisiel (2012) indicate that, when interacting with animals, families are engaged in scientific practices and, principally, in discussions that contribute to a rich learning experience. In the same vein, Kisiel et al. (2012) observed that conversations can

demonstrate learning, engagement, and the utilization of scientific thinking that facilitates the understanding of ecological concepts while families converse and interact with animals and mediators. Kopczak et al. (2013), in turn, observed that interactions between families and animals on exhibit, as well as with mediators, enable the development of deeper conversations and the sharing of information regarding the ecology of the species observed.

Upon examining the literature on learning in aquariums, the authors observe that the analysis of conversational content is concentrated on family knowledge of biological phenomena and characteristics inherent to the animals on exhibit (see, e.g., Borun & Dristas, 1997; Kelly et al., 2020; Kopczak et al., 2015) and, in some cases, consider conservation (see, e.g., Dove & Byrne, 2014; Falk & Adelman, 2003; Moss et al., 2017). Fewer studies, in comparison, investigate the experiences that occur in family groups that visit aquariums, focusing on the relationship between interactions (social and with the exhibition) and conversations in the joint construction of meanings and experiences that may constitute learning.

It is important to mention that studies on family learning experiences in aquariums are predominantly performed in North America and Europe, exemplified by the studies cited in this article. Studies of this type in the Latin American context are less common in the literature (Massarani et al., 2021). In Brazil, for example, we highlight the study by Massarani, Rowe, et al. (2022), which evaluated the conversational content of 20 adolescents during visits to AquaRio to understand the interest of this audience in issues related to science and technology.

Considering the above, it becomes evident that the investigation of conversations and interactions of families in aquariums in the Brazilian/Latin American context can contribute to the understanding of the manner in which visitors construct their perceptions, understandings, and interest in science, as discussed in Archer et al. (2014, 2015). As such, we concentrate our discussion around the construction of meanings regarding science and the conservation of the oceans, but, in addition, we highlight the collaboration of children in conversations and interactions, favored by the social context of the experience, as indicated by Ryu and Sikorski (2018).

1.2.1 | Theoretical framework

Free-choice learning, one of the theoretical models used to understand learning in museums, is centered on the interest and learning intentions of the subjects themselves, who, in turn, are considered a central element in the educational process. This learning perspective is characterized by the subjects' autonomy in choosing what, when, and how they will learn. Furthermore, this type of learning is a process that continues throughout a subject's life and is built on significant experiences, contributing to the development of their personal identity (Falk & Dierking, 2002).

According to Falk and Dierking (2010, 2014), what makes these experiences meaningful is the degree to which the visitors' learning needs and expectations are met. Accordingly, they recommend designing exhibitions to serve a diverse audience, with activities that are contextualized to the visitors' reality. In this sense, exhibitions should provide visitors with experiences that encompass three key elements: physical (architecture of the setting, involving the arrangement of the objects, and information about the topic in question), personal (interests, expectations, and prior knowledge that visitors bring with them, which come from their lived experiences), and sociocultural (experiences shared by those who interact during visits, including the family members, visitors from outside the group, and explainers). At the intersection of these three contexts, visitors have learning experiences, although these are not restricted to the time of visit.

This study on family learning in informal educational settings is based on a sociocultural perspective, as it understands learning as a situated, social, culturally mediated process (Ellenbogen, 2002). In this way, the sociocultural characteristics of each family are fundamental to the understanding of how individual, social, and cultural elements are brought into conversation and appropriated by the group to build learning and make sense of lived experiences. Brizeño-Garzón and Anderson (2012), for example, indicate that Latin American families attribute

a value to education that supersedes academic contexts and, for this reason, concern themselves with the emotional, social, moral, cultural, and cognitive aspects that are constructed over the course of childhood education. Moreover, according to the authors, these families consider themselves the foundation for learning, leading to adults involving themselves and actively participating in the experiences of their peers.

Learning experiences arise through the mediation of multiple agents who are capable of engaging families in socially significant activities (Rowe & Bachman-Kise, 2012). There is a growing body of evidence regarding how families learn in these spaces. Among these findings, we highlight studies that demonstrate that personal memories shared with others out loud during family conversations are aspects with the capacity to mold the production of new knowledge (Bell & Linn, 2002; McClain & Zimmerman, 2016). When family groups visit scientific-cultural spaces, they bring their own cultural histories, patterns of dialogue, and interested (Ellenbogen et al., 2004) and connect personally relevant experiences to new concepts and ideas that they encounter, explore, and construct meaning with together (Ash, 2003; Crowley et al., 2001; Ellenbogen et al., 2004; McClain & Zimmerman, 2019). Other studies demonstrate the importance of the role of the parents, who frequently explain phenomena, ask and answer questions, and relay information displayed in exhibitions (Allen, 2002; Ash, 2003; Crowley et al., 2001). When utilizing exhibition contexts as an educational resource during participating in multisensorial activities, families may yet develop abilities related to science learning, such as identification, observation, comparison, analysis, scientific reasoning, motivation, engagement, identity, and metacognition (Allen & Gutwill, 2016).

Although some research points to the occurrence of learning in such settings, Falk and Storesdieck (2005) warn of the difficulty in measuring it, since each family will have its own interests when embarking on such a visit, and it is these interests that will mediate the way they engage with the topics addressed. Accordingly, studies on learning in informal educational settings have been based on conversations and interactions among family members and between them and the explainers and exhibits, revealing that families can establish cognitive ties through such exposure and may often trigger emotional and cognitive responses, leading to learning (Allen, 2002; Guimarães et al., 2019; Massarani et al., 2021). It is interesting to note that, when they are on visits, families involved in the exhibition adopt behaviors that facilitate learning.

Considering the points stated above, it is evident that these studies have contributed to the advancement of knowledge regarding family learning experiences during visits to scientific-cultural spaces. However, these studies also show that there is a gap in understanding regarding how these conversations and interactions contribute to learning experiences and joint construction of meaning in the Latin American context (Brizeño-Gazón & Anderson, 2012; Massarani et al., 2021).

1.3 | Purpose and objective

The objective of this qualitative study is to understand the learning experience of families during nonguided visits to AquaRio (Rio de Janeiro, Brazil), the largest aquarium in South America. Five families' visits were evaluated, with observations focused on the family members' interactions with each other and with the exhibitions. This was accomplished through an examination of video and audio recordings of the visits in terms of the types of interactions and conversational content they contained, as will be discussed in detail in Section 2, seeking to ascertain answers to the following questions:

1. What interactive practice used by Latin American families favors engagement with science?
2. What conversational strategies are utilized by families in the joint construction of meaning about science and marine biodiversity conservation?

This article contributes to the body of research on learning in aquariums by virtue of its investigation of family experiences to better understand the social aspects that constitute learning experiences. This will be performed

specifically in the Brazilian context, an area in which there are few studies on the experience of family visits to aquariums.

2 | METHOD

This study can be characterized as a case study as it involves an empirical investigation of a contemporary phenomenon, in its actual context and setting, that is based on numerous sources of evidence, permitting a global vision of the object of study (Yin, 2005). As well as being the largest aquarium in South America, the Marine Aquarium of Rio de Janeiro is an institution with a strong conservationist outlook, located in a port region with high anthropogenic impact, that seeks to align its touristic character with business concerns and local educational projects.

The criteria for choosing the location were the facts that it is the largest marine aquarium in South America (WAZA, 2022), has higher visitor numbers than similar institutions in the country, and has a clear intention to contribute to the SDGs (especially SDG 14). In addition, it has a permanent education department whose work is designed to enable visits to have a positive impact on visitors, using objects and gadgets that show in detail the marine biodiversity on display, as well as plaques and panels containing information on said biodiversity and how to conserve it. This study is part of a larger project developed within the scope of National Institute of Public of Communication of Science and Technology (INCT–CPCT) with the aim of understanding the learning processes that take place in science spaces and the meanings created by different audiences around the informal education activities offered in these cultural-scientific venues (Massarani, Chagas, et al., 2019; Massarani, Fazio, et al., 2019, Massarani, Mucci Poenaru, et al., 2019).

2.1 | Study location & setting

AquaRio was founded in November 2016 and is located in the Port Zone of Rio de Janeiro, an area that underwent an urban renovation to host the Olympic Games in the same year as the aquarium's foundation. Its construction was facilitated through a public initiative, which donated the land on which the aquarium was built, and a private initiative that funded its construction (Aquário Marinho do Rio de Janeiro, 2019a). In addition to AquaRio, the Museum of Tomorrow and the Rio Art Museum (MAR) are located in this complex, which includes space for pedestrians, bike lanes, public and private transport, whether by land, sea, or air. This region occupies an area of 5 million square meters divided between six districts that hold approximately 32 thousand inhabitants (Diniz, 2014). That being said, it is important to note that these characteristics are specific to this region and not representative of the city as a whole, which contains 736 communities composed of residents in vulnerable social situations which, in turn, correspond to 22% of the population of the city of Rio de Janeiro (Olerj, 2022).

The aquarium is open every day of the week and the minimum admission fee is R$70.00 (US$14.21), representing a slightly higher cost than the average trip to the cinema in the area. Its goal is to promote education, research, and the conservation of endangered marine species. In 2019, it received the title of Godfather of the Nurse Shark from the Association of Zoos and Aquariums of Brazil for its work in the conservation of the species, classified as “vulnerable” by the International Union for Conservation of Nature (IUCN) (Aquário Marinho do Rio de Janeiro, 2019b).

The aquarium occupies a three-story building and has 26,000 m² of floor space, with the first floor being used for administration. Upon entering the aquarium, on the first floor, visitors come face-to-face with the skeleton of a humpback whale measuring 15 m in length, suspended by steel cables. This point is where the animal exhibits begin and end. From here, visitors go up to the third floor and then down to the second floor, accessing them by ramps or elevators. In total, there are 28 different enclosures that house 5000 animals of 350 species, some of which have been rescued from captivity or animal trafficking (WAZA, 2022).

Visitors can tour the enclosures on their own, with the main enclosure being the Oceans and Diving Area, which is a 7-meter-high tank containing 3.5 million liters of water with a tunnel passing through it which visitors can walk through to see the fish, which include sharks and rays.

The animals on display at the aquarium include jellyfish, moray eels, rockfish, sea urchins, sharks, rays, seahorses, corals, clownfish, anemones, and octopuses. The information provided for visitors includes the popular and scientific names, geographic distribution, and characteristics of the species displayed on panels and informational signage, as well as visuals and skeletons for the visitors to view.

The aquarium aims to bring marine life closer to the public, though its educational environmental initiatives, from the perspective that familiarity is key to conservation and, as such, inspire change in visitors' attitudes and behaviors. Since its inauguration in mid-2019, AquaRio has received a total of 180 thousand students from 2400 schools, with 72 thousand students being from public schools that visit free of charge as per the partnership established between the aquarium and the Municipal Secretary of Education of Rio de Janeiro (Szpilman, 2019). There is an educational sector that plans school visits and makes available a list of 12 themes, from which teachers can choose one, around which the itinerary of the visit is constructed (APPAI, 2019).

The aquarium uses a variety of strategies to reach a wide audience, including the aquarium website, which contains information and fun facts about the animals on display and videos with its professionals addressing information on conservation-related topics, and a YouTube channel with videos, both playful and serious, on different topics, enabling interaction between the general public and the aquarium team through live video streams (AquaRio, 2019a).

AquaRio also performs a social role together with the vulnerable communities of Rio de Janeiro. In 2020, for example, during the Coronavirus disease 2019 (Covid-19) pandemic, the institution donated roughly 28 tons of food to four low-income communities, as well as personal protective equipment (PPI) for health professionals working on the front lines of state hospitals (Neo Mondo, 2020).

2.2 | Procedures

Data collection took place from January 16 to 24 of 2018, on weekdays and one weekend during school vacation. When family groups arrived at AquaRio, they were randomly invited to participate in the study by a member of the research team, who explained the purpose of the study and invited them to participate. Two criteria were necessary for participation: the groups were required to have at least one adult and one child (aged 7–12 years), and no more than five members (for better data recording, which would not have been possible in larger groups). Upon acceptance, one of the adults filled out and signed the informed consent form, as set forth in the study's proposal, which received approval from the research ethics committee of the Biosciences Institute at the University of São Paulo (CAAE 72217717.6.0000.5464).

The study included the recording of the family visit experience and two interviews: pre- and postvisit. The previsit interview data were used in this article to contextualize the profile of the participating families; complementary issues and postvisit interviews were not considered in this article and will be analyzed in further studies. Of a total of 10 families approached, 5 declined to participate in the study citing, among other reasons, a shortage of time or desire not to use the camera or sign the consent form.

To record the interactions, the "subjective camera" method proposed by Glăveanu and Lahlou (2012) was used. One child in the family was chosen to use the Zoom Q3 HD camera, which was worn on a cord around their neck. The decision of who took the camera in groups with more than one child was taken by the family, provided that the child was within the age group defined in this study. At the meeting point for the beginning of the visit (first venue: Plankton Station), the researcher turned on the camera and began recording footage of the whole family from the perspective of the visitor who carried the camera. The camera was turned off by the researcher after the last enclosure (Ocean and Diving Enclosure), following the procedure delineated in previous studies by the same

research group (Massarani, Chagas, et al., 2019; Massarani, Fazio, et al., 2019; Massarani, Mucci Poenaru, et al., 2019; Massarani, Reznik, et al., 2019).

2.3 | Study participants

Five family groups participated in the study (G1–G5) comprising 17 subjects: 10 females (9 adults and 1 child) and 7 males (1 adult and 6 children). Details of each group and the length of their visits are shown in Table 1. In this study, families are defined as an intimately related group, independently of biological relationships (Bizerra, 2009; Briseño-Garzón & Anderson, 2012). It is noteworthy that this was the families' first visit to AquaRio and, with the exception of G5, the families stated that they had not visited any aquariums in the 12 months before the data collection period, but that they had visited zoos. As such, it can be observed that these families have the habit of visiting zoos, but not aquariums.

2.4 | Data analysis

The data were analyzed with the aid of a coding protocol developed by the researchers who coordinate and participate in the project which this study is part of. The protocol was adapted from Allard and Boucher (1998) and was designed to enable the investigation of the relationships between the three main actors in scientific/cultural spaces: (i) the exhibits, (ii) the explainers, and (iii) the visitors, arranged in a "pedagogical triangle." The protocol is divided into different categories that cover five dimensions: (1) Conversation, (2) Types of Interaction, (3) Photos and Videos, (4) Change, and (5) Emotion. The process of defining these categories followed a top-down perspective (i.e., deductively constructed from theoretical references and initial research questions). The categories and subcategories were posteriorly validated through blind review by six researchers/coders in charge of their application in the project that this study is a part of.

The most commonly occurring codes appeared within the dimensions of Conversations, Interaction, and Emotions. These three areas are discussed below (Table 2). Furthermore, these categories are in line with our research objectives.

The quantitative and qualitative analysis software Dedoose 8.0.23 was used to help categorize the segments of audio and video showing the visitors' bodily, textual, and attitudinal actions simultaneously, optimizing the coding. Excerpts from each dimension were identified and coded in such a way that one code could overlap another, as the categories of the analysis protocol are not exclusive and may occur simultaneously during a visit. The study was carried out in Brazil and, as such, the visitors spoke in Portuguese. The process of coding was carried out in

TABLE 1 Information on the members of each family group (G) and visiting time

Groups	Number of members	Gender	Length of visit
G1	3	2♀ (adults), 1♂ (child)	56 min 46 s
G2	2	1♀ (adult), 1♂ (child)	35 min 51 s
G3	4	2♀ (adult and child), 2♂ (adult and child)	40 min 33 s
G4	3	2♀ (adults), 1♂ (child)	16 min 18 s
G5	5	3♀ (adults), 2♂ (children)	39 min 48 s
Total	17	11♀, 6♂	3 h 9 min 16 s

Source: Original data.

TABLE 2 Dimensions of the categories studied

1. Conversations	
1.1 Content of conversations	
1.1.1 Conversations on science-related topics	Dialogue on a scientific topic, discussing ethical and moral dilemmas of science, the social impact of scientific activities, introducing scientific data or content, etc.
1.1.2 Conversations in which associations are made with previous and lived experiences	Mobilization, use, and questioning of knowledge, beliefs, rituals, ways of living, in the museum experience, referring to childhood experiences, knowledge acquired at school, movies, books, TV series and programs, etc.
2. Types of interaction	
2.1 Visitor-exhibit	
2.1.1 Contemplative interaction	Contemplation, observation, viewing without touching/manipulating an individual exhibit or a specific part of it.
2.1.2 Reading of panel/text/photo	Interaction through the reading aloud of texts (in full or in part) from informational signage, panels, labels, texts, and visuals on the exhibits.
2.2 Visitor-visitor	When visitors talk among themselves, irrespective of whether the subject is directly or indirectly related to the exhibition.
2.3 Visitor-mediator	Dialogue established between explainers and visitors or when visitors are listening to the guidance and information given by a mediator, irrespective of the content of this dialogue.
3. Emotions	Expression of feeling, positive or negative, during the visit.

Source: Adapted from Massarani, Chagas, et al. (2019).

Portuguese. The excerpts from each of the categories and subcategories were translated into English for the scope of this article. Although the transcripts reinforce the conversations, the encodings performed in the software take interactions into consideration, and videos were accessed during data interpretation for any necessary confirmations. Visitors were numbered from 1 to 5 in each group and, to preserve their identity, were named "A" (adult), "C" (child), "M" (mediator), and "EV" (external visitor), with C1 always being the child carrying the camera. The conversations and interactions are discussed in light of relevant theoretical references that, in turn, explore North-American and European contexts, allowing us to indicate similarities and differences between the results obtained in the current study (Latin America/Brazilian context) and those available in the literature.

3 | RESULTS AND DISCUSSION

The interactions of the families during their visits to the aquarium were recorded in a total of 3 h 9 min 16 s of video footage. The sections relating to each activity were identified, and a total of 857 codes were applied. The time of each family's visit ranged from 16 min 18 s (G4) to 56 min 46 s (G1), with the mean time being 37 min, a recurring average visit time in aquarium audience studies (e.g., Massarani et al., 2021; Kopczak et al., 2013), and an amount of time considered satisfactory for the recording of both interactions and conversations (Falk et al., 1985). Table 3 shows details of the dimensions, categories, and subcategories, the total number and duration of each occurrence, and their ratios to the total time of the visit (given as a percentage).

TABLE 3 Categories of interaction, number of occurrences, duration of occurrences, and percentage relative to total visiting time

Categories/subcategories	Number of occurrences	Duration of occurrence	% in relation to total time
1. Conversation			
1.1 Conversations about science-related topics	78	21 min 24 s	11.3%
1.2 Conversations in which associations are made with previous and lived experiences	47	12 min 47 s	6.8%
2. Types of Interaction			
2.1 Visitor-exhibit			
2.1.1 Contemplative interaction	113	1 h 6 min	34.9%
2.1.2 Reading of panel/text/photo	60	25 min 19 s	13.4%
2.2 Visitor-visitor	110	1 h 12 min 40 s	38.4%
2.3 Visitor-mediator	22	5 min 48 s	3.1%
3. Emotions	103	51 min 46 s	27.4%

Source: Adapted from Massarani, Chagas, et al., (2019); to include only the categories analyzed in this article.

3.1 | What types of conversations did the families engage in during the visit?

In the Conversation category, the code *conversations on science-related topics* ($n = 78$) occurred during 11.3% of the total visit times, especially when the family members were talking to each other and when they were looking at the animals in the enclosures, which explains the co-occurrence with the code *contemplative interaction* ($n = 45$). Other co-occurrences occurred between the codes *conversations in which associations are made with previous and lived experiences* ($n = 11$) and *emotion* ($n = 16$). Examples of these conversations are presented in Table 4.

The examples show that contemplation and association with previous experiences were the driving elements for the *conversations on science-related topics*, which ranged from the identification of the animal (Example 1) and its behavior (Examples 1 and 2) to the impact of human activities on marine ecosystems (Examples 3 and 4).

We can see that the adult from G2 (Examples 1 and 3) explains complex scientific concepts, such as mutualistic symbiotic relationships and biological invasion, in a simplified way for the child, making the subject understandable. For these conversations, the adult drew on previous experiences, as s/he is a recreational diver, and also on his/her reading of the nameplate, which allowed the identification of the sun coral. On the other hand, in Example 2, the child gave an explanation of the scorpionfish's hunting strategy in response to the adults' questions. This exemplifies the active participation of children in the dialogues, fostering *conversations on science-related topics*, which took place collaboratively based on the observation of the animal. In this way, the children were able to elaborate explanations about the biological and behavioral characteristics of the animals based on scientific reasoning and previous experiences.

Similar results were reported by Clayton et al. (2009), Kisiel et al., (2012), and Nomura and Bizerra (2015) in studies of family conversations during visits to zoos and aquariums. According to the authors, observation and/or interaction with animals leads to predominantly perceptual conversations (see, e.g., Allen, 2002) and encompasses the identification of animals. However, in this and in previous studies, the families sometimes went beyond mere observation, making inferences through scientific thinking and prior knowledge to explain the anatomy and behavior exhibited by the animal in question.

As well as envisaging the development of scientific skills (asking questions, exploring, experimenting, applying ideas, predicting, drawing conclusions from evidence, reasoning, articulating thoughts in conversations with others

TABLE 4 Examples of excerpts coded as *conversations on science-related topics*

Example 1 - (G2). A1: Oh, look it's Nemo, let's look at Nemo. We don't have him in Brazil, the clownfish/C1: Nemo?/A1: Yes. We don't have him here, just when he's brought to an aquarium, but not at the bottom of the sea/C1: Hm, but I went to São Paulo, I saw him/A1: Yes, son, at the aquarium, not in the sea. He's not from Brazil … (…) A1: Here [pointing at the aquarium] the anemone where Nemo lived [talking about the symbiotic and mutualistic relationship between the animals]/C1: Look at this little creature here/A1: Look, this one here's an anemone/C1: Where Nemo lives/A1: Where Nemo lives/C1: Hey, I managed to take a photo of this from here, the fish over there/A1: It's a clownfish. You only find it in Australia. You can see them here in the aquarium, only in the aquarium… But you know, really, at the bottom of the sea, you can only see it on a trip, in Australia/C1: Wow! Look at that, those algae where the clownfish is resting (talking about the anemones).
Example 2 (G5). C1: Awesome! [excited at what s/he is seeing], there's a pufferfish there/A1: Look, what a pretty fish that one is. It looks like a butterfly/C1: Just think, if someone takes him out of the water and tickles him… you know? underneath… he's going to suddenly get all puffed up [explaining the defensive behavior of puffers, which expand their volume by ingesting air or water]/C1: Awesome!! There are two pufferfish… one here and another one there [pointing at the fish] Let's see… Ah, this one's really cool too. Did you know that fish is really dangerous in the sea?/A1: Which one?/C1: This one, the scorpionfish [referring to the spotted scorpionfish]/A2: Where does he hide out?/C1: He hides away… and what happens is… [explaining the fish's hunting strategy to his/her mother and aunt] when a fish swims up near him, he opens his mouth really big, like this… and eats the fish.
Example 3 - (G2). A1: "Sun coral" {reading} This one here burns!/C1: That one too?/A1: This coral… I'll read it for you. The coral wasn't from here in Rio. It came on the hull of a ship [in reality, it came attached to oil rigs] and then it invaded here [explaining the concept of biological invasion]/C1: Really? That thing… that makes you feel sick/A1: No, not that. It invaded, it wasn't from here/C1: It's got poison!/A1: It's not poisonous, it came here. It's not got poison, that's not it/C1: Is it alive?/A1: But it's taking the place of the coral that's from here… it came here I don't know where from.
Example 4 - (G3). C1: Mom, all the animals eat garbage and die, right?/A1: Yes, if you throw garbage in the water/C1: Oh, look, mom, ooh [shocked]/A1: If you throw garbage in the water, plastic, those plastic bottles, everything gets bad/C1: And if you throw it in the forest?/A1: Same thing/C1: Look here, mom! Look, he's going over the other side. Do you think he eats these fish?/A2: No! You just have to feed him/C1: Does the shark we're taking pictures of eat garbage?/A2: No/A1: Did you see? He swam right by us/C1: Or can he tell the difference/A2: He can tell the difference. And also they give him food/C1: So like, if I throw something, some garbage, in the water, can they eat it?/A2: If you [unclear]/C1: Throw garbage in the forest?/A2: If you throw garbage?/C1: In the forest!/A2: In, in the forest… it won't reach here. It depends if the forest has…/C1: But if I throw garbage in a forest and a river begins there… then what?/A2: Then if the river reaches…/C1: the sea?/A2: the sea… gets as far as a shark, reaches him, yes. Then the turtles will try to eat the plastic because they get caught out/C1: They're a bit blind, aren't they?/A2: And then what happens is they go and eat it and it gets stuck… they get ill… and then they die/A1: Choked to death/A2: Yes. And a plastic bottle takes a long time to break down (…)/C1: I think it's fish that die most because of garbage. I think so, I think so/A1: Why?/C1: Because fish are the ones that die most from it/A1: Really, C1? Because of pollution of the sea?/C1: People eat and don't throw it in the garbage. They don't throw it in the garbage. They throw it where they shouldn't throw it.

Source: Video recording of G2, G5, and G3, respectively.

and applying knowledge to one's daily life) (National Research Council—NRC, 2009), these scientific/cultural spaces that are members of WAZA have the mission of inspiring their visitors to take small everyday conservation actions with the potential to develop into long-term conservation commitments (Barongi et al., 2015).

In this sense, the "voice" declared in the mission of these institutions must be "audible" to visitors and this implies creating an environment in which information on conservation is displayed in visuals and expressed in the speech of explainers. For example, Moss et al. (2017) divided 5000 visitors from 20 WAZA member zoos and aquariums into two groups: individuals with access to educational material and individuals without access to such material, and then administered questionnaires before and after the visit. The results show an improvement in knowledge about biodiversity and how to protect it on the part of the visitors with access to educational material, suggesting that the educational actions of these institutions can engage the public in issues related to biodiversity conservation.

Regarding this aspect, Example 4 shows us that the information displayed on the panels contributed to the conversation about conservation actions among the family members. Although there is a conceptual error in the explanation given by adults regarding the ingestion of plastic by turtles (Wilcox et al., 2017), the dialogue suggests that the family reflected on the impact caused by garbage when it is disposed of inappropriately and far from the oceans, as we can see in the speech of C1: "People eat and don't throw it in the garbage. They don't throw it in the garbage. They throw it where they shouldn't throw it." This speech indicates that the child was able to draw conclusions about the issue discussed by the family, suggesting that, at other opportunities, they could apply the knowledge built in their daily lives, potentially contributing to environmentally responsible behavior.

Although our results are encouraging from the point of view of conservation education, it is essential to consider, as argued by Dove and Byrne (2014), that visitors do not necessarily need scientific knowledge about animals to understand the importance of conservation and the negative impact of anthropogenic action on ecosystems. Moss and Esson (2014) go further in their understanding and argue that presuming that visitors will change their behavior due to the acquisition of knowledge is equivalent to attributing the responsibility of conservation education exclusively to zoos and aquariums, approximating the educational initiatives of these institutions to the "deficit model," which consists of top-down communication approach from communicator to receiver.

Regarding this aspect, it is relevant to highlight that aquarium managers and educators confront a great challenge in projecting exhibitions that entertain, provide conservation education, and are enjoyable for visitors (Massarani et al., 2021). Ballantyne and Packer (2016) suggest that the use of panels with scientific information on the taxonomy and conservation of species can please visitors, as well as stimulate them to reflect and adopt environmentally responsible behaviors. For McGhie (2019) and Kelly et al. (2021), aquariums can provide authoritative information on which visitor habits can change to construct a more sustainable lifestyle.

Example 4 illustrates that the *conversations on science-related topics* that touched on the conservation of marine biodiversity drew on the subjects' prior knowledge and the children's curiosity, expressed in the form of questions and explanations, suggesting that the family engaged with the theme of conservation through their own experiences, making the knowledge constructed meaningful because it was related to the family context. A similar result was reported by DeWitt et al. (2018), who also highlighted that the involvement of visitors with objects, interpretations, and conversations can be important, even if it is not with the science present in the exhibition.

As for the code *conversations in which associations are made with previous and lived experiences*, its occurrence was observed in 44 occurrences (6.8%), relating to dialogues in which the visitors associated the animals they were viewing with ones they had seen in supermarkets and in movies, as shown in Table 5.

There were occasional *conversations in which associations are made with previous and lived experiences* that resulted in short conversations, but the code occurred more often than it did in previous studies in a science museum context that used the protocol adopted in this study (see e.g., Massarani, Bizerra, et al., 2022).

Allen (2002) reports that adults connect exposure to previous experiences as a way to facilitate the understanding of information or objects observed and thus contribute to a meaningful experience. In pursuit of this goal, the adults associated the animal in question with cookery (Example 5) and relatives (Example 6), in addition to encouraging the children to identify (Example 6), recognize (Example 5), and compare (Example 7) the animals. In Example 7, it is the child who associates the information presented on the panel to a subject previously studied at school, suggesting that such knowledge helped make the subject at hand less abstract, since the information presented within the context of the oceans involves specific concepts and terminology.

Similarly, McClain and Zimmerman (2014), who analyzed the role of previous experiences in the conversations of 16 families during trips to Shaver's Creek Environmental Center (Pennsylvania, United States), argue that the use of the previous repertoire pertaining to individual or collective family experiences is frequent in conversations for making the topics covered meaningful. They mention that such conversations are generally associated with the conversation processes of (i) reminding, (ii) prompting, (iii) explaining, and (iv) orienting. They also note that, in family conversations, it was common for adults and children to start science-based conversations by sharing memories of relatives or previous experiences to explain their ideas.

TABLE 5 Examples of excerpts coded as *conversations in which associations are made with previous and lived experiences*

Example 5 - (G1). A1: What's that, C1?/C1: Octopussy! [They laugh]/A1: Octopus! Well done, C1. Remember we saw some at the supermarket yesterday?/A1: Where's it gone? [looking into the tank to see the animal] There it is, all curled up/C1: There are lots of fish there/A1: Look at it, that bit we cut off [when cooking it] is for it to breathe [referring to the animal's siphon] really, I didn't realize… when you get it… look at that, can you see on its head?
Example 6 - (G2). C1: Mom, look how many fish there are/C1: Look! Gosh, there's fish with hands, see?/A1: Ah, that's a snook. It's a fish we eat. He's a big one, isn't he? Come over here… The moray eels, the eels are really dangerous fish. In Arraial there's a huge eel at Saco do Cherne [popular diving location in the state of Rio de Janeiro]. You can get a fever… just from the eel, see? [pointing into the tank] You know who's nickname is eel? Uncle [says name of uncle].
Example 7 - (G3). C1: Look, mom, it's written here. And…/A1: "Photic light, photic zone, which is 200 meters, look. Disphotic, half-light, look, up to a thousand meters, then you can't see anything anymore" {reading}/C1: I saw it, I saw it here, it's talking about global warming… which I studied last year [associating the text with something learned at school]/A1: Ah, there… below a thousand meters, you can't see anything, did you see? Look there! [pointing at the sign with the images and information] Did you see? He's talking about the light there.
Example 8 – (G3). C1: Dory [speaking "whale", the language from the movie *Finding Nemo*]/A1: Look at that, C2, that one there, that one there, look/C1: Dory/A1: It's [unclear]/C1: Can you hear me? [speaking "whale"]/A2: But there's a… look, guys, look at this. He suddenly appeared. Wow! Look here, isn't it lovely!/C1: Hey, Dory, can you hear me [speaking "whale"], hey Dory, hey Dory/A1: Actually, those movies, those movies about the ocean, with fish, they help us with our conversation, right? Because everyone begins to think more/A2: Yeh!/A1: Preserving more/C1: Dory ["whale"]/A2: He's all toothy. Look at his tooth/A1: After Nemo, you know, that was it… everyone got crazy!/A2: But there's Dory, Nemo down there, look. There's a Nemo down there [pointing at the tank]/A1: There's a little Nemo there, look/C1: It stopped to have its picture taken … There, more Dorys. There's a goldfish there… Every child must have had one [fish] that died…/C2: Is the clownfish Dory or Nemo?/A2: It's Nemo. It's Nemo. Look at this one with a forelock/C2: Mom, look at Dory and Nemo/A2: Yeh/A1: Look at that big fish!/C2: Dad, the fish has four eyes/A2: This one's cool, isn't it? This one here's that friend that tried to get out of the aquarium [referring to the movie]/C1: Yes. It's the Nemo couple [singing].

Source: Video recording of G1, G2, and G3, respectively.

Kisiel et al. (2012) also observed that the families studied during interactions with animals exhibited in touch tanks at four aquariums located in California and Oregon (United States) used previous experiences to develop conversations, statements, and arguments that explained the animals' behavior and their biological adaptations. In this way, the families endeavored to build new knowledge by connecting the observations and information obtained during the interaction to the animals to what they already knew. They also found that the mention of movies and cartoon characters was recurrent among the families and contributed to engagement in the conversations.

The association of the animals with the media (movies and animations) is observed in Example 8, in which the child and adult associate the animals in the tank with the film *Finding Nemo*. However, only the adults engaged in the conversation about marine biodiversity conservation. In addition, A1 also points out that movies that represent the oceans in a fun way can help develop awareness about conservation for a wide audience, as in the statement: "Actually, those movies, those movies about the ocean, with fish, they help us with our conversation, right? Because everyone begins to think more." It is interesting to note that the adults' involvement, the children's captivation, and the associations made are elements that indicate the potential for the experience to be imprinted in the family's memory (Falk, 2009) and could be converted into learning, since this occurs over time (Falk & Dierking, 2010, 2014).

3.2 | What interactions occurred during the visit?

In the Interactions dimension, the *contemplative interaction* code was present in 113 excerpts, corresponding to 34.9% of the total visit time, and co-occurred with *conversations on science-related topics* ($n = 49$) and *emotion*

(*n* = 44). This was expected, given the predominantly contemplative design of the aquarium. Examples of some of these interactions are shown in Table 6.

The examples presented in the table above show that, based on the observation of the animals, the families sought to identify them (Examples 9 and 10) or tried to locate the fish hidden in burrows or camouflaged (Examples 9 and 11). Example 10 shows that the observation of the behavior exhibited by the grouper allowed the family to develop a hypothesis to explain the solitary behavior of the fish in question "A2: It's on its own. It can't be very friendly if it's on its own." Similar observations were reported by Allen (2002) when studying families on a visit to the exhibition *Frogs* at the Exploratorium science museum (United States), as the exhibition of live animals (in this case, frogs in terrariums) drew a lot of attention from the visitors, who were intrigued by the animals and their behavior. This made the family members interact with each other to answer their questions and curiosities arising from the observation of animals.

Similarly, in a study of families visiting the New Jersey State Aquarium, Outside-In Children's Nature Museum at The Academy of Natural Sciences, Philadelphia Zoological Garden, and The Franklin Institute, Borun et al. (1996) reported that the families contemplated the animals with the purpose of identifying them and explaining the behavior they displayed. As in our study, they also found that interactions between family members culminated in dialogues about the characteristics of the animals and their enclosures.

In this sense, the aquarium setting is also a point to be considered in the families' learning experiences. In this study, the interactions analyzed provide evidence that the animals and habitats represented in each tank attracted the attention of the families. According to Salgado and Marandino (2014), the lighting of the location, the tanks representing different themes and animals characteristic of specific ecosystems, and the information displayed on panels and signage connect the visitors to the aquarium, making them feel part of that environment and emotionally engaged with it. In this way, the exhibition design enabled the families in question to participate actively in the search for answers to their questions and curiosities, jointly building their own meanings for marine biodiversity.

Turning to *reading of panel/text/photo*, this code was observed in 13.4% of the total time of the visits (*n* = 60). Some readings triggered questions and discussions about science, but mostly the families used reading as a way to identify the popular names of the animals, which explains this occurrence alongside the visitor–visitor code (*n* = 31). Examples of this type of interaction are described in Table 7.

TABLE 6 Examples of excerpts coded as *contemplative interaction*

Example 9 - (G5). C1: Man, I feel like there's something here in this hole, just think. There's an eel right there/A1: Feel just there/C1: Mom, there's an eel right there, look, opening its mouth/A1: Where? Oh right, in there. Stay there, I'm going to try to get it... It's working, hang on, I'm going to get it with its mouth open [trying to photograph the animal]/ C1: Man, I found the fish, that fish hidden there, the hidden fish, guys, man, he's right there/A1: Camouflaged/EV: They don't like people. They're right/C1: It's really camouflaged... it's really camouflaged, man, my god! Man, guys, he's right there. We found the camouflaged fish.
Example 10 - (G3). A2: Did you see this one here?/C1: What? This here?/A2: No, the fish.../C1: What? This?/A2: What's this here?/C1: What, on me?/A2: No, here... [pointing at the fish in front of them] What fish is it?/C1: It's... er... I don't know!/A2: It's on its own. It can't be very friendly if it's on its own/C1: Oh, mom. I took a picture... electric eel/A2: Gag grouper {reading} Hmm. Grouper.
Example 11 - (G4). A1: Look how pretty!/C1: Where, auntie?/A1: Here. Coming this way/C1: Auntie, look at that stonefish.../A1: He's filming the stonefish. Look at this here, C1, its head [pointing at the moray eel in the burrow]/ C1: Little one/A1: Look here at the rock. Can you see? Look there. Look at this green one, coming out. Look at the green one here coming out, C1, the moray eel/A1: Wow! That's lovely, I'd never seen that! Only on National Geographic [TV channel]. I'm going to leave it for [male name]... look, C1! How lovely, C1. Look, another one there, C1. Can you see?/C1: This one.../A1: It's just like [male name]'s fish. They like to stay behind the rock, don't they? Look/C1: I'm looking at this one [pointing at the moray eel].

Source: Video recording of G5, G3, and G4, respectively.

TABLE 7 Examples of excerpts coded as *reading of panel/text/photo*

Example 12 – (G2). A1: Look, come here to see how big the things are. Look at the size of the pufferfish, octopus, loggerhead sea turtle {Reads the size of the animals from the panel}, pretty much like a human, but you're not one meter eighty-eight. Look at the great white shark/C1: Does it have to be one meter eighty-eight to be human?/A1: No, one meter eighty is an average size.
Example 13 - (G3). C1: Blue Amazon. It's Blue Amazon, from [unclear] Amazon {reading} Where do I press? [asking about how to work the interactive panel on the Amazon] Blue Amazon. "The term Blue Amazon {reading} that people throw garbage there… [continues reading] It's maritime territory. Oh, a conservation area" {reading}/A1: There's something wrong with this machine [talking about the interactive panel]/C1: There, pollution! [excited, runs towards the interactive panel on pollution] Pollution. I'm going to see/A1: Have you seen your mother? Where is she?/C1: "No! Pollution should be defined as degradation" … {reading} There, the trees… Aren't there those trees…? [she is about to give an example, but the father continues reading]/A1: "Ah, result of activities …" [pauses for the daughter to complete the sentence] {reading}/C1: It's… [thinks a few seconds, and the father completes it]/A1: Humans! "who directly or indirectly have a negative effect on the biota" {reading}/C1: Hey dad, doesn't that happen when you throw garbage in, in the forest?/A1: What are the main types of pollution of the ocean? "Sewage, toxic substances, and waste" {reading}/C1: Coral bleaching, it does away with everything.
Example 14 - (G5). A2: "Biological invasion" {reading}/C1: "Sun coral" {reading} Is there sun coral here?/A2: That fish there's really cool/C1: Where's the sun coral? Aaah, there it is [points to coral in the tank] Look C2, it's there on the bottom, but we want to see everything here, we want to make the most of the trip/A1: I only took one picture of the fish/C1: Let's go.

Source: Video recording of G2, G3, and G5, respectively.

The examples presented in Table 7 show that the children remained focused on the readings and explanations given by the adults, who in turn acted as contextualizers of the information presented in the panels. We can divide the readings into two types: quick and extended. In general, both adults and children engaged in quick reading to exemplify the characteristics of the animals they were looking at (Example 12) or to identify animals and concepts (Example 14), and this type of reading did not lead to in-depth conversations. There was little evidence of extended reading, but when it happened, it was collaborative and associated with deeper conversations about conservation (Example 13).

In a study involving 1207 adults and children on visits to three zoos in the United States (Bronx Zoo, Brookfield Zoo, and Cleveland Metroparks Zoo), Clayton et al. (2009) found that only 27% read the signs or interpretive materials. Although evidence of learning was found across all the interactions among the visitors, it was felt that the information displayed could spark dialogue and offer educational opportunities that would connect visitors to the animals, especially when the information allowed for human and nonhuman animals to be compared, as seen in Example 12.

In the same sense, Briseño-Garzón et al. (2007), in a study of family learning at the Vancouver Aquarium Marine Science Center (Canada), reported that, in the 13 groups studied, the adults pursued educational conversations with their children and that reading out loud was a factor that corroborated this process, as the information kindled dialogues that mostly covered the identification of animals, without delving into complex scientific concepts.

This result is similar to that observed in example 14, where the adult took a very short time to read ("A2: Biological Invasion"), and the same adult did not take interest in what the child read ("C1: sun coral"). This meant that no in-depth conversation ensued about biological invasion by the sun coral in Brazilian territories as a result of anthropic activities. However, it is possible that the visitors' lack of familiarity with the animal contributed to this quick reading. That being said, visitors do come into contact with the popular names of the species on exhibit and begin to recognize peculiar attributes, classifying them within specific zoological categories. For this reason, Patrick and Tunniclife (2013) recommend that the popular names of species be present on the identification labels along with the scientific name.

In a demonstration of a different style, the G3 family group read more and, in so doing, discovered more about the topic in question, namely the Amazon, as explained in the interactive panel. This episode (Example 13) models negotiation between adult and child about the impact of deforestation on the oceans, as explained by C1: "Coral bleaching, it does away with everything." It is also curious how the name of the group of conservation areas, Blue

Amazon, elicited the idea of the Amazon forest on the part of the child, suggesting his/her intention to connect ocean pollution to forests, although the adult did not engage in this discussion. According to Borun et al. (1996), the behavior of families reading out loud or to themselves is associated with deeper levels of learning, which they refer to as: Describing (visitors give multiword answers and make connections between elements on display and previous experiences) and Interpreting and Applying (visitors give multiword responses, understand abstract concepts, and make connections to previous experiences). Thus, we can infer that reading enabled the family to have a positive learning experience.

As for the interactions between the families, 110 sections were coded *visitor-visitor*, with this code co-occurring with *emotion* ($n = 42$) and *conversations on science-related topics* ($n = 40$). From the analysis of the videos, we observed that the family group members generally remained together throughout the visit, with the exception of G3, which split off into pairs (son and mother; daughter and father), but, after having observed all the tanks, came together to share what they had seen. For all the family groups, the behavior of pointing out the location or identification of an animal was recurrent, as were conversations about the animals, as shown in Table 8.

In the examples in Table 8, there are passages that demonstrate the behavior of both parents and children in drawing attention to and/or directing others' gaze to the same animal (e.g., "Here C1, come here" [A1, G2], "Come and see the most dangerous predator on the planet!" [C2, G4]), adjusting the pace and time or logistics of the visit (e.g., "Hang on, hang on" [C1, G3], "Slow down, C2, goodness!" [A1, G4], and "Come on, dad" [C1, G3]), or for reading (category discussed above) (e.g., "The most dangerous predator on the planet!" {reading} [C1, G4] and "groupers and whiting" {reading} [C1,G3]). Curiosity was also very evident in the interactions, especially in Example 16, where the child indicates the number of fatalities caused by dogs. In Example 17, curiosity is also present when A1 and C2 prompt C1 to think about the most dangerous predator on the planet (human beings).

It is interesting to note that, in the examples in Table 8, opportunities for conversation arose when adults' and children's attention was drawn to the same animal (Tomasello, 1995). This is how the adults sparked the children's curiosity (Example 17), asked questions, gave explanations (Example 15), and drew associations with the family's previous experiences (Example 16). In our study, it was not only the adults who were responsible for directing the families' actions

TABLE 8 Examples of *visitor–visitor* interactions

Example 15 - (G2). A1: Oh, that picture's horrible. With a lot of exposure it's bad … Here C1, come here. When we dive in Arraial do Cabo… we (…)/C1: Gosh/A1: We see, like, the sandy bottom with gravel, the animals that live on the bottom, there's that crab there that I don't know the name of/C1: Wow, but look!/A1: Look how big it is! And there the shellfish on the rock/C1: Mom, it's afraid of us/A1: Listen, whenever we dive in Arraial, we dive near a rock. Look there in the middle there's another one, can you see? Look at that one there going up, that lobster there going up/C1: But hang on, what do they share this with?/A1: Yes, here it happens that they're together, but I'm telling you about how the sea bottom is. And the little fish are swimming around/C1: That's cool/C1: Look over there. The shell has an animal inside. It's going to move around. Which one?/A1: Yes, there are different, different lobsters there behind the rock. Come up here/C1: No, you can't/A1: I don't know. There's nothing saying you can't. Up you get/C1: You can't/A1: Just so you can see behind the rock/C1: Right, I can see/A1: There are three there, lots of them/C1: Right, I can see, but you can't step here.
Example 16 - (G3). [C1 Silently reading an information plaque that shows how many deaths are caused by sharks a year in comparison with other accidents] C1: Come on, dad [they walk on in silence] Wow! Look how many dogs kill… Gosh! Thirty people a year {reading} Let's see some more!/A1: Have you seen the little Nemo there, C1?/C1: Hang on, hang on [reading the information]/A1: Have you seen the little Nemo, C1?/C1: It's over there, right?/A1: Here, there, look. Take one! [photo]/C1: Done. Here, dad: groupers and whiting {reading}/A1: Groupers/C1: Haven't we eaten this fish?/A1: Whiting we have… but I don't think I've eaten grouper.
Example 17 - (G4). A1: Here there's the most dangerous predator on the planet/C1: Really?/C2: Really?/C1: I want to see it (…)/C2: Come and see the most dangerous predator on the planet!/A1: Slow down, C2, goodness!/C1: Where? Where's the predator?/C2: Look in the mirror!/A1: It's you, C1. Look in the mirror/C2: It's you!/C1: "The most dangerous predator on the planet" {reading}.

Source: Video recording of G2, G3, and G4, respectively.

and conversations during the visit: the children also played an important role in this respect, a topic that is still little explored in the literature, as indicated by Ayudhya and Vavoula (2017). According to Ornstein et al. (2004), this kind of interaction enables families to engage in conversation, build knowledge, and give meaning to the visit, allowing the experience to remain imprinted in the memory of the whole family. Another important point is that conversation arising from the group's attention makes each visitor devote more of their time to talking about the object they are contemplating, as reported by Frischen and Tipper (2004) and also observed in our study, since the families studied invested 38.4% of their time interacting focused on the animals, whose focus was directed by the adults.

The other code in the Interactions dimension, *visitor-mediator*, occurred in 55 sections, representing only 3.1% of the total visit time. It appeared so little because of the way the explainers were placed strategically around the aquarium, making their interactions with visitors limited to these spaces. The explainers provided explanations about the animals, their environment, and the role of AquaRio in the conservation of marine biodiversity, as shown in Table 9.

TABLE 9 Examples of excerpts coded as *visitor–mediator*

Example 18 - (G2). M: So, I'm going to tell you something curious .../C1: "Blacktip" {reading} [entering the Sharks Grotto, catching the mediator's explanation halfway through]/EV: So it doesn't see us as food?/M: No! Just for you to have an idea, sharks first appeared 400 to 200 million years before the first dinosaurs. Human beings, our species, *Homo sapiens sapiens*, are 300,000 years old. Terrestrial [pointing to the figure of the human on the board], aquatic [pointing to the figure of the shark on the board], aquatic, terrestrial [reinforcing]. The evolution of this animal shaped its feeding habits just for aquatic animals. It doesn't eat terrestrial animals. So when by chance it bites a human, it tastes something completely unfamiliar. It doesn't find the flavor pleasing. He sees it as food, but food that's bad, and rejects it. There is no record in the world of a shark eating human meat. What there is is the accidental ingestion of human parts. When it accidentally bites a human, it ends up ingesting an arm, part of a leg, but by accident, not on purpose. Like when you're riding a motorbike and there's that opening in the helmet and you swallow a fly. It's not on purpose. Do any of you eat cockroaches?/A1: No!/M: Neither does it. It will only eat what's good for it, not trash. It's not... really! Human flesh is the worst thing you can get. There are very few species that are adapted to eating human flesh, that actually hunt humans. Crocodilians, which are generalists, will eat anything at all. Lions and tigers, which have a little evolution near humans, they have had some very close contact with humans, since the beginning, so they're adapted to consume it. And occasionally bears, some bear species and wolves, that's all... Wolves and bears occasionally... If they find a dead human, they may eat that meat. But actually hunting, just lions, tigers, and crocodiles... Apart from them, forget it, no-one wants that junk/A1: We eat so much junk that they wouldn't want to eat us/M: Right! We eat so much junk that they wouldn't want to eat us. Now, eat shark meat if you want to shorten your lifespan... Because as it's at the top of the food chain, it has a lot of heavy metal in it, which is highly toxic, like mercury, lead, and ingesting that could be fatal. Organochlorine, which isn't toxic like mercury and lead, but it's just carcinogenic, right? And urea, which builds up naturally in their flesh by their own physiological process. Because urea is excreted by some animal species. If it's excreted, it's because it's bad for you, like our urine. Would it be a good idea to ingest it again? So, their meat has high urea content... what a yummy treat!

Example 19 - (G1). After receiving information from the mediator on sharks A1: Now, that's something that, if lots of children had access to.../M: They do!/A1: No, bringing them, but coming here?/M: Here at AquaRio, we receive public school children for free, not a cent more... without being paid a cent for them. We receive all the public [schools] for free. And the private schools, which have more money, come too. Our biggest audience throughout the year is schools/A1: Right, because that [the information on protecting sharks] must be something you develop, right?/M: We receive them here and we make sure we ask them this question... This here [the shark grotto] is on the must-see list of almost all the schools. Even if they don't stop here, we talk about it in the other grotto. Talk about plankton, talk at the end. So at some point they're going to hear it. Why? Their future is at stake/A1: Absolutely/M: It's a crucial question... it cuts across the preservation issue... but that's the thing... the aquarium itself, without this issue of environmental education, conservation, and research, is pointless. So what are the three pillars that support our work? For us here, what sustains the aquarium: research, education, and conservation. These are the three main principles we work on here. And I'm from the Education department. We have the people who actually take care of the animals, and the people who work on conservation, work on research. There are 16 world-class, pioneer studies going on here at the aquarium. Nobody's doing the kind of research we do here. We're doing stuff that's new. So we work on all of this. We have all three pillars really working/A1: I think it's brilliant, the point you made here for us, it's something we won't forget/M: Right/A1: It's really important. Congratulations/M: Thanks/A1: Really great.

Source: Video recording of G2, and G1, respectively.

The examples from Table 9 show that interactions between visitors and explainers were sporadic and occurred between mediators and adults, but covered complex scientific aspects of the relationship between eating habits and the evolution of sharks. When analyzing conversations about conservation between school children visiting London Zoo (United Kingdom), Jensen (2013) found similar results on the way explainers support the visits. Among the 2839 school-age (7–15 years old) visitors studied with the aim of ascertaining whether guided school visits enabled greater learning about conservation than unguided visits, 41% of the guided visits and 34% of the unguided visits were found to result in the desired learning. The role of the mediator was found to help them have learning conversations about conservation, indicating that the zoo should adopt more efficient strategies to communicate conservation.

Similarly, a study of 41 families on visits to four aquariums in the United States by Kopczak et al. (2013) revealed that the interaction between families and explainers resulted in long and in-depth conversations about the ecological interactions between animals, their environment, and their relationship with human beings. However, when the interaction was just between family members, the conversations were short and had little depth, showing that the explainers provided conceptual support for visitors to talk and learn about ecology.

In the above examples, the mediator clearly plays a role in enabling deeper conversations about science that demonstrate evidence of learning. In addition, in Example 19, the explanation made by the mediator about scientific information on sharks and AquaRio's educational programs contribute to the issue of their conservations, sensitizing the adult to the topic, who at the end of the conversation says: "I think it's brilliant (…) It's really important. Congratulations." The excerpt also suggests a positive perception of the role of the mediator, in which the adult (A1) demonstrates appreciation of their work (Jarvis & Pell, 2005; Pattison & Dierking, 2013).

In summary, the explainers helped draw out longer and more in-depth conversations on complex scientific concepts, which they adapted to enable the content to be understood by a wide audience. They used strategies such as analogies and comparisons between the eating habits of the animals in question and those of humans, rhetorical questions, allowing visitors to reflect on the examples given, and explanations of the environmental problems that threaten marine biodiversity adapted and contextualized to the visitors' reality (Pattison & Dierking, 2013). It is important to note two aspects regarding this point: (a) interaction with mediators does not necessarily signify that families changed their behavior and mode of interacting among themselves and with the exhibition after their conversation with the mediator; (b) it is to be hoped that the contemplation of animals and visitor–mediator interactions can sensitize visitors to the importance of conservation (Clayton et al., 2009).

3.3 | What emotions emerged from the conversations and interactions?

Eighty-eight passages were coded as emotions, summing 27.4% of the total time of the videos. The conversations and interactions stemmed from contemplating the animals and reading the information panels and labels, sparking a broad range of emotions, as shown in Table 10.

The examples show feelings of joy and wonderment at the marine biodiversity (Example 20) and enrapture and curiosity about animals (Example 21). Negative feelings were observed when the visitor, faced with a great diversity of animals and looking for information on the panel, realized the great impact of ocean pollution (Example 22). The opportunity to interact and talk about animals and marine ecosystems connected the families to AquaRio and this interest could facilitate learning and raise awareness of environmental issues (Salgado & Marandino, 2014).

Studying the conversational content of 10 families on a visit to the temporary exhibition Oceanos (Oceans) at the Museum of Life (Rio de Janeiro, Brazil), Guimarães et al. (2019) found that they had positive learning experiences, took ownership of the topic in question, and reflected on their own habits with regard to the conservation of marine biodiversity. Specifically, they noted that the visitors expressed emotions throughout the entire visit. In particular, one module that simulated the presence of garbage in the oceans, blocking

TABLE 10 Examples of excerpts coded as emotions

Example 20 - (G1). A1: C1!/C1: Oh, my God [surprise at seeing animal] What's it called?/A1: They're cuttlefish/C1: Awesome!/A1: It's very important to take care of the species in this study. Otherwise…/C1: How pretty! [demonstrating happiness, awestruck)/A1: We might not be able to see them today. They're very rare… [said with feeling]/C1: Mmhm. Wooow!! [excited at seeing the animal]/A1: The sea has its, its charms, right?/C1: Look here how pretty [excited]/A1: Isn't it, son?
Example 21 - (G2). A1: Whoa, shark and ray!/C1: There, there, there! [excited]/A1: Look there, the ray. They're baby rays/C1: This one's the ray/A1: The ray [laughs]/C1: It's the ray/A1: It's a ray/C1: Ray!/A1: Let's wait for it to come back here/C1: Where is it?/A1: They hide in the sand, and you can only see them from their outline/C1: Really pretty! [said with feeling]/A1: What's this colorful thing here?/C1: I haven't a clue/A1: It's coral.
Example 22 - (G3). C1: Look, the electric eel. False hering {reading}, hang on, Capiracupena {reading}. Wow, that's cool! [surprised by what s/he reads on the panel] Shame they're killed, they die easily, right? With all the garbage everyone throws away [sad, disappointed]

Source: Video recording of G1, G2, and G3, respectively.

the way of animals, elicited stronger emotions and aroused empathy for the animals that live in polluted environments.

The emotional connection established with animals has a more lasting effect on visitors' memory, as reported by Ballantyne et al. (2011) in a study of 240 visitors 4 months after visiting aquariums in Australia. According to the authors, visitors were able to provide richly detailed descriptions of their observations, emotions, and sensations, showing that they reflected on the lived experiences after the visit. However, although they learned about the animals and the damage resulting from human activities, only 7% of the visitors claimed to have developed environmentally responsible and sustainable attitudes.

Finally, we consider that, as argued by Falk and Storksdieck (2005), free-choice learning has a lasting impact on visitors, marking their memory, as it occurs when their personal contexts are brought into contact with the topics addressed by an exhibition (the aquarium). The visitors engage socially in numerous topics with the possibility of applying them in their daily lives, as voluntarily explained to researchers: "When we're up so close, we see it's not just a media issue, something just to talk about. There has to be action" (A1, G5); and "Everything they show, especially in the information, is in favor of preservation. Because you see the animals here, you see that they're dying because they're not conserving biodiversity… There's no way for you to leave here and say: I'm going to throw some paper in the sea. There's no way!" (A1, G2).

3.4 | What do the results show?

Our results show that the five families that participated in the study adopted interactive practices and conversational strategies that favored engagement in reflections and conversations that contributed to the joint construction of meaning on themes of science and conservation. As such, we observed that the adults adopted behaviors that facilitated learning and the interactive practices were: reading panels made together by the family, directing the child's attention to an animal or object and contemplating the animals; and the conversational strategy were: simplified explanations of complex concepts, association with prior experiences, elaboration of questions, and from children's curiosity to develop conversations. Similar results were observed in studies with families in visits to aquariums in North-American contexts (see, e.g., Kisiel et al., 2012), European contexts (see, e.g., Collins et al., 2020), and Latin American contexts (Massarani et al., 2021; Scalfi et al., 2022; and Massarani, 2022).

Our results demonstrate the active role of children, as in practically all of the conversations and interactions, with the exception of *visitor–mediator interactions*, which occurred between adults and mediators, children acted as protagonists in their own learning, as they involved themselves in conversations by sharing their knowledge and

opinions. Children's protagonism was also reported in studies that investigated the family learning experiences in North-American contexts (see, e.g., Kopczak et al., 2013), European contexts (Collins et al., 2020), and Latin American contexts (Scalfi et al., 2022; Massarani et al., 2021).

Among the differences observed, we highlight that in the Latin American context, studies often cover the environmental perception of zoo visitors (see, e.g., Aragão & Kazama, 2014; Lopes et al., 2011; Pellizzetti et al., 2021). We also highlight that a study that used a similar methodology to analyze the interactions and conversations of seven families (Scalfi et al., 2022), showed that despite families emotionally connecting with animals, they did not develop in-depth conversations about the conservation of these species. These data are different from what we observed in this study, where families also connect emotionally with animals, but the conversations they develop are more in-depth involving scientific concepts about the species and its conservation.

Thus, in our study, we observed that the cognitive connections established through the encounter with the exposed animals, the interactions, and the conversations developed by the families and the mediators raised reflections from which the visitors were able to expand their knowledge and reflect on marine biodiversity and conservation. The emotional connection was essential to establish links between environmental problems and how human actions can impact the oceans. In addition, emotion is fundamental for learning by free choice, as it is from it that conversations become meaningful and families can be sensitized to adopting environmentally responsible behaviors (Ballantyne & Packer, 2016; Ballantyne et al., 2018; Scalfi et al., 2022). And just as desired by the EDS, visitors can, based on awareness, get involved with conservation and make oriented decisions in favor of sustainable development (McGhie, 2019).

The knowledge and behaviors shown by families are valued in this study as they are indicative of how they view environmental and conservation issues—families are sensitized to the importance of adopting environmentally responsible behaviors. However, the conversations analyzed in our study do not allow us to say that in their daily lives, such families will act as active and moral agents, with changes in behavior, for example. Even so, it is clear that the exhibitions play the role of facilitators for individual and collective reflection.

Although our results cannot be extrapolated to the Brazilian context as a whole, it is relevant to mention that analyzing them with a basis in conversational content is uncommon in the Latin American context. As such, the majority of studies about family learning in informal educational environments are descriptive and analyze learning through an evaluation of exhibitions (design, objects, apparatus, and activities) aligned with the style in which the public makes use of them, or alternatively evaluated visitors' knowledge through responses to questionnaires before and after their visit (Massarani, Fazio, et al., 2019).

Moreover, it is understood that this study contributes to research in the area of family learning in informal educational spaces, especially in the Brazilian/Latin American context, as it investigates yet unstudied issues and presents results on family learning from the point of view of conversational content. Additionally, it can contribute to the advancement of knowledge of how Brazilian families act during aquarium visits, a currently little-understood aspect in the country.

4 | CONCLUDING REMARKS

In this study, we had as our objective the analysis of conversational content and interactions of families during visits to AquaRio to understand how their interactive practices favored the involvement with science and which conversational strategies were used for joint construction of meaning on science and conservation.

Our results demonstrate that the exhibition provoked the interest of the five families studied, who, in turn, shared information and/or validated their knowledge about the animals, their ecological relationships, behaviors, and attitudes toward conservation. The analysis of these conversations and interactions indicates that these families had collaborative learning experiences facilitated by the three pillars of the pedagogical triangle utilized in this study: visitors, exhibitions, and mediators.

To answer the initial question posed in the title of this article, we can state that there is room for science at aquariums and that the exhibition was able to communicate scientific issues, prompting awareness, pleasure, interest, experiences and emotions capable of shaping opinions and understandings about marine biodiversity and actions for its conservation. But we emphasize that the experience of families was not centered only on scientific content with scientifically accepted terminology, but also involved conversations on ecological ideas in everyday language and conversations about conservation and issues related to how living beings interact with each other and with the environment.

As a whole, our study presents data similar to those in previous studies performed in the North-American and European contexts, despite the extant cultural differences. As an example, we highlight the role of parents in children's learning— contextualizing information and scientific concepts, helping them identify and understand behavior exhibited by the animals and the impact of human activities on the ocean. Additional corroborating evidence includes our findings on the importance of reading in deepening conversations on scientific themes and the significant role of explainers in visitors' experiences: providing support for more extensive conversation between family members, facilitating their understanding of scientific topics (e.g., demystifying shark attacks by explaining their evolutionary trajectory and feeding habits) through connections and analogies with the information on the animals being viewed.

Additionally, the role of protagonist was played by the children as they engaged in the family conversations and interactions, expressed curiosity and interest in the animals and conservation initiatives, asked questions and searched for answers, shared their prior knowledge and opinions, and also elaborated explanations based on scientific reasoning.

We highlight as a point of interest particular to this study the analysis of conversational content with the aim of understanding the families' learning experiences, a little-studied area in the Brazilian/Latin American context. We observed the families employing strategies to attribute meaning to the exhibition, such as the association of information on display in panels with prior experiences, through which both adults and children were able to contextualize said information to their personal, family realities, and the use of questions, allowing for reflections and conversations on animals and anthropogenic effects that threaten the marine ecosystem. It is also noteworthy that, although it was not the focus of this study, the families were observed exercising procedural and evaluative practices related to science, such as observation and reflection on the behavior of the animals. They achieved this by informally designing hypotheses and making evaluations using the scientific concepts present in the exhibition to plan actions or, alternatively, by making use of explanatory models.

Generally speaking, our study provided evidence that visits to the aquarium can help bring the general public into contact with scientific knowledge about the biodiversity and conservation of marine ecosystems. In addition, they can prompt visitors to adopt environmentally responsible and sustainable behaviors, helping to galvanize ocean conservation efforts and promote responsible citizenship among the visitors. Nonetheless, it should be noted, that due to the methodology, it was impossible to draw any conclusions as to whether or to what extent a visit to the aquarium actually causes visitors to adopt sustainable habits in their daily lives, even if it is reasonable to assume that this only occurs among a small proportion of visitors. This indicates the need for systematic actions to be taken at educational different levels to encourage more sustainable behaviors.

In conclusion, AquaRio may play an important role in the promotion of scientific culture, allowing for direct contact between families and themes related to aquatic life that few have the opportunity to observe in natural conditions. As such, the understanding of these families' experiences and the strategies they utilize for the joint construction of meaning can facilitate professionals and educators in the formulation of educational initiatives that encourage active participation and appreciate the diverse forms of discussing and interacting with science. To achieve such a goal, the aquarium would be well-served by investing in educational strategies that favor the adoption of behaviors that facilitate learning by adults, as well as the protagonism of children.

5 | LIMITATIONS

Before closing, it is important to recognize the limitations of this study. The analyzed sample size is considerably small, not permitting an extrapolation of the data to describe the Brazilian population as a whole (which was not the purpose of this study). We additionally reinforce that, although the participating families were invited randomly, the parents were characterized by a relatively high level of formal education, which is typical across many museum studies, and the data should be interpreted with this in mind.

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DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the manuscript. However, further inquiries can be directed to the corresponding author.

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