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A study of the interactions and conversations of families visiting the museum of microbiology of the Butantan institute, São Paulo, Brazil

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ABSTRACT

Science museums are key locations for informal education. They also enable research that explores how families structure their activities and conversations and how these contribute to learning experiences. The aim of this exploratory study, using qualitative and quantitative methodologies, was to analyse the process of family interactions during visits to a Brazilian science museum focused on microbiology and how their conversations mediated their learning experiences. Four groups, each consisting of a single family with children, participated in the study. Their visits were recorded using a subjective camera, and the audiovisual data were analysed regarding types of interactions and conversational content, based on an analysis protocol. The results reveal that the interactions and social dynamics that family groups engaged in during their visit provided cognitive and social learning experiences. The study also offers evidence on the role of children, the importance of conversations with adults during the visits, and the relevance of objects on exhibition in promoting learning conversations.

KEYWORDS

Learning experiences; informal education; science museums; interactions; conversations

Introduction

Studies in informal educational settings provide information on how visitors structure their activities and conversations and how these spaces can contribute to learning experiences (Dierking and Falk 1994; Ellenbogen, Luke, and Dierking 2004). Science museums offer unique experiences and are relevant places for learning, with the potential to engage their visitors cognitively, influence their attitudes and behaviours, promote the construction of meaning, and offer multiple perspectives on the development of scientific education research (Briseño-Garzón 2013; Allen and Gutwill 2015).

In this study, we understand learning as a process based on sociocultural and constructivist theories. It results from interactions between individuals and mediating elements such as tools, conversations, activity structures, signs, and symbolic systems (Ash 2003; Leinhardt, Knutson, and Crowley 2003). Under this interpretation, using the museum context as a reference, we consider that a learning experience occurs from a holistic point of view, incorporating: (i) interaction, including active experiences that involve visitors in physical, intellectual, emotional, and/or social

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ways, the use of artefacts and technologies, conversations about the exhibit, oneself, and other visitors, and non-verbal interactions (Massarani et al. 2019a; Shaby, Assaraf & Tal, 2019) and (ii) construction of meanings, as mentioned by Zimmerman, Reeve, and Bell (2010), defined as people's mental and social effort to personalise an individual and shared understanding of new information. Thus, learning includes scientific concepts, previous experiences and interactions, attitudes and behaviours, and social interactions. Moreover, it promotes an expanded sense of aesthetic appreciation and development of motivation and interest (National Research Council 2009; Schauble et al. 2002; Ellenbogen, Luke, and Dierking 2004; Falk and Dierking 2000; Rowe and Bachman 2012). Thus, learning in museums is a process of active construction of knowledge that occurs through conversation, behaviours, and interactions during the visits.

Much of the research involving science museums and their audiences investigates family interactions, emphasising the content of conversations between parents and children (Ellenbogen, Luke, and Dierking 2004; Callanan et al. 2017; Crowley et al. 2001) and how exhibits can influence the engagement and the nature of these interactions (Ash 2003). In general, museums provide exhibitions that encourage families to learn about complex themes, using their content as an educational resource during participation in multisensory activities. Although this type of learning is recognised in the literature as informal learning (Ellenbogen, Luke, and Dierking 2004), we cannot state that family visits are not structured. A diverse number of studies provide data that, in their role as talk partners, parents can, through stimuli and cooperation, facilitate children's learning (Nomura 2015).

There is growing evidence that family conversations around interactions and practical learning experiences in science museums are vital components in childrens' learning, since family members often explain phenomena, ask and answer questions, and relate the information in the exhibit to previous shared experiences (Allen 2002; Ash 2003; Crowley et al. 2001; Leinhardt and Knutson 2004; Zimmerman, Reeve, and Bell 2010). For Sanford (2009, 12), a learning conversation between parents and children can be identified as one that '(i) involves conversations about the content, (ii) assumes an explanatory position, (iii) connects to previous experiences or ideas, and (iv) provokes curiosity through questioning'. Regarding the role of previous experiences in familial learning processes, some of the research has shown that personal memories that are shared with others out loud during family conversations can shape the production of new knowledge (Bell and Linn 2002; McClain and Zimmerman 2016). When visiting science museums, family groups bring their cultural histories, patterns of dialogue and interests (Ellenbogen, Luke, and Dierking 2004) and connect personal, relevant experiences to new concepts and ideas that find, explore, and build meaning jointly (Ash 2003; Crowley et al. 2001; Ellenbogen, Luke, and Dierking 2004; McClain and Zimmerman 2019).

Adults and children are influenced by different factors in their interactions at these institutions. Neves (2020), for example, has studied the experiences of Brazilian families with children from 5 to 8 years old in an interactive exhibition on forests. She identified that adult-child, adult-adult, and child-child interactions were shaped by the types of mediation included in the exhibition as well as its design. Other studies have pointed out that parents/caregivers tend to model and adjust their level of interaction depending on their children's characteristics, including gender and knowledge regarding the content (Crowley et al. 2001; Palmquist and Crowley 2007). In turn, Povis and Crowley (2015) investigated joint attention behaviour – a sociocognitive phenomenon in which two or more people focus on the same object – of 54 families in a visit to the Museum of Natural History (Pittsburgh, Pennsylvania, U.S.A). Their study found that, when a family establishes joint attention, they are more likely to talk about the object itself, providing shared cognitive engagement. Therefore, these authors suggest that joint attention can be an effective means of supporting family learning.

Considering science museums as environments where learning occurs as part of personal contexts and sociocultural and physical settings (Falk and Dierking 1992), studying how families act and learn in these places is essential to understanding their interactions and social dynamics

during the visit, which may have specificities related to the different cultural and social context. Gaskins (2016) reinforces that the differences between families' cultures influence how they interact with children from the perspective of learning. In this sense, we understand that published studies in specific European and American journals are pertinent to the area; however, it is necessary to deepen the study of the Latin American context in order to analyse the patterns of interactions and conversations of Brazilian families.

In Brazil, for example, there are more than 260 science centres and museums (Almeida et al. 2015), but there is little research that can be of aid in understanding the characteristics of their local audiences. Two surveys developed about fifteen years ago (OMCC 2005, 2008) describe visitor profiles across different Brazilian states: mostly white, highly educated, high income female adults and young people. These surveys show how much national museums are still frequented by a restricted portion of the population (Marandino and Martins 2016) and that we know very little about the profile of these visitors. CGEE (2019) reveals the inequality of access to public cultural spaces among young people and the importance of schools in expanding their cultural experiences. The scenario they depict of a low number of museum visitors in Brazil persists.

In fact, in the last two decades – during the period from 2006 to 2015 – a series of national surveys on public perception of science revealed that the number of science museum visitors increased from 4% to 12%. At this time, Brazil experienced significant public investment into the popularisation of science throughout the country. Unfortunately, this figure decreased 5% in the latest survey, performed in 2019. Compared to European and American standards of participation in science museums, these numbers are meagre (Centro de Gestão e Estudos Estratégicos – CGEE 2015, 2019).

The aforementioned aspects reveal a great challenge for museums, especially science museums, in Brazil. We have to stimulate society to become museum visitors and, to do that, we also have to have a better understanding of who the visitors are, what they do, and how they learn during the experience. Among the few data available on this topic, we can say that, in addition to the scholastic public (Cf. Barba, Castillo, and Massarani 2019), there is a tendency of museums to attract well educated, well compensated, mostly female visitors between 20 and 59 years old (OMCC 2005, 2008).

Considering all these aspects, there is a need for the development of more evidence-based research on how, not only the Brazilian audience in general but also specific groups, such as families, interact and learn in science museums. The growing number of domestic researchers applying their efforts to this goal is a testament to the need for and relevance of this line of research (see, Bizerra 2009; Cerqueira et al. 2016; Guimarães et al., 2019; Massarani et al. 2021a, 2021b; Rufato and Bizerra 2014; Scalfi 2020 for more details). Based on results related to how families learn in Brazilian science museums, it is possible to develop policies and educational programmes at institutional and also governmental levels in order to increase both the quantity and diversity of museum visitors.

In this study, we aim to contribute to the comprehension of the museum learning processes displayed during familial interactions on visits to a microbiology science museum, focusing on conversations.

Methodology

The present study is based on a broader empirical research project (see, Massarani et al. 2019a, 2019b, 2019c, 2020) which investigates free-choice learning experiences and the construction of meaning by different audiences in informal educational spaces. Using quantitative and qualitative approaches, we associated the potential to measure and quantify the phenomena with in-depth qualitative analysis in order to achieve a global understanding of the research aims (Castro et al. 2010; Creswell 2014). We are interested in understanding visitors' learning processes and experiences, searching for patterns that would facilitate deeper understanding of this phenomenon

(Minayo 2012). The quantification of data helped build an overall image of the topic under investigation and compared other studies (Creswell 2014). In this paper, the data is based on the analysis of four families on spontaneous visits to the Butantan Institute (IBu) Museum of Microbiology (MMB), located in the city of São Paulo, Brazil.

The Microbiology museum

As part of the scientific complex of the Butantan Institute – one of the first biomedical research institutes in Brazil – MMB was launched in 2002 and receives around 120 thousand visitors per year. Its mission is to attract young audiences, support science education, promote opportunities to bring scientific culture closer to audiences and publicise the activities carried out by the Butantan Institute (Instituto Butantan 2020; Scalfi 2020).

The museum has a 500 m^2 public exhibition area located in the main hall where the long-term exhibition is located (including a central table that addresses aspects of the history of microbiology, magnifying glasses and microscopes for public interaction, historical equipment, and computers, among others), the specific exhibition for children aged 3 to 6 years 'The giant world of microbes' (in Portuguese: 'O mundo gigante dos micróbios') – with games, films, frottage, microscope, and magnifying glasses, and the short-term exhibition, which at the time of the study addressed the theme of 'Aeromicrobiology' ('Aeromicrobiologia'). A multipurpose auditorium complements the exhibition area: a laboratory with instruments and materials for teachers and high school students, as well as an outdoor covered area called 'Scientist Square' ('Praça dos Cientistas') with busts of Brazilian and international scientists who contributed to the fields of microbiology and immunology (Gruzman 2012; Scalfi 2020) (Figure 1). In addition, the museum offers educational activities performed by the institution's team in its laboratory and itinerant activities (Henrique et al. 2007). Spontaneous visits are self-guided, and the institution has mediators placed in strategic locations.

Figure 1. A) IBu Microbiology museum. B) Long-term exhibition; C) Short-term exhibition; D) Exhibition 'The giant world of microbes' and E) 'Scientist Square' . Source: the authors

Context and procedures

This paper analysed corpus data collected in 2017 (Scalfi 2020) under a research and theoretical protocol, focusing on the experience of family interaction and the conversational content – which will be detailed in the Data analysis section. For this paper, we analysed the data under a different research and theoretical protocol, focusing on the experience of family interaction and the conversational content – which will be detailed in the Data analysis section.

In general terms, we understand families as groups formed by adults and children with biological or affective ties (Briseño-Garzón and Anderson 2012). Families who arrived at the museum and met the criteria of consisting of at least one adult and two children (aged 7 to 11 years), with up to five members (for better data recording, which would not have been possible in larger groups) were randomly invited to participate in the study. The age range of children was defined as a period where they, in a school environment, are introduced to new knowledge that favours theoretical thinking, awareness and other functions, such as the capacity for reflection and mental planning (Elkonin, 1960; Vigotsky 1993), favouring dialogues with the family group.

Each family was approached at the entrance of the MMB, where the objectives and study procedures were explained. After accepting the invitation, children and adults were directed to the museum auditorium to sign the Informed Consent Form and had the recording equipment put in place: one adult from each family was given a GoPro Hero 3 camera and two children from each family were equipped with Zoom Q2HD audiovisual capture devices; the devices were attached to cords placed around the participants' necks to allow for freedom of movement. The GoPro Hero 3′s image quality allowed for the recording of family interactions as a whole, and the Zoom Q2HD – widely used by professional musicians for its accuracy in audio recording in noisy environments – allowed for the capture of the group's conversations in high quality. Both devices were attached to a cord placed around the participants' necks, allowing free movement. The visits were carried out according to the visitors' spontaneous schedule and itinerary. At the conclusion of their visit, they returned to the auditorium where the parents completed a questionnaire with demographic and sociocultural information about the adults (e.g. gender, age, profession, place of residence, etc.) and the children, which enabled a small, but essential profile for general contextualisation on the families of this study.

Description of participating families

The study included four family groups with a total of 13 participants: five adults (three women and two men) and seven children (five girls and two boys). Table 1 shows the composition of each group and their respective home location. The numbers in parentheses indicate the children's age. Regarding family composition, we highlight that in G1, the girls were friends, and the adult was one of the girl's grandfathers. In G4, the children were sisters.

Table 1. Family group compositions.

Groups	Number of people	Adult	Children gender/age	Home Location
G1 	3	Grandfather	2♀ (7)	Campinas, São Paulo
G2 	4	Father and mother	1♀ (7); 1♂ (9)	Brasília, Distrito Federal
G3 	3	Mother	1♀ (10); 1♂ (10)	Cotia, São Paulo
G4 	3	Grandmother	1 ♂ (8); 1♀ (10)	Americana, São Paulo

Source: Authors

In a brief and general overview of the profile of the families who participated in this study, we can state that they have homogeneous structures – despite being randomly invited at the museum's entrance. Concerning parents/caregivers, all of them had a university degree, and two mothers/caregivers were teachers. Also, none of the families lived in the city the museum is located in (São Paulo city): three families lived in different cities in the state of São Paulo (Campinas, Americana, and Cotia) and one family in Brasilia, in the Federal District. Two of the families (G1, G3) had already visited before. Of the families, three have some of the characteristics that the few public surveys in Brazil describe: women with a high level of education.

Data analysis

The audiovisual data were encoded in the Dedoose 8.0.23 software, allowing the body, oral language attitudes, and actions to be analysed synchronously. The protocol used for analysis is divided into five dimensions (*Conversations, Types of Interaction, Photos, Change*, and *Emotion*) and their respective categories, which act together in the relationship between three fundamental actors: the exhibition modules (in the form of themes and artefacts), the mediators (in the form of museum actors), and the visitors themselves. This protocol has been used to analyse museum visitors' experiences in different group studies (see, Massarani et al. 2019a, 2019b, 2019c, 2020). This study used a reduced version of the protocol since we will discuss the results referring to the most frequently occurring categories in the data set of all collected audiovisual material: *Types of Interaction* and *Conversations* (Table 2).

The excerpts were labelled with the duration of the activity and time at which the experience took place. The categories of the analysis protocol are not exclusive and, as such, the same video clip can receive more than one code. To identify the participants, we used letters and numbers to ensure anonymity: 'A' for adult visitors, 'C' for child visitors, and 'M' for mediators.

Table 2. Types of interactions and conversation categories.

1. Types of Interaction	
1.1 Visitor-visitor	When visitors interact and chat with each other, regardless of the content of that conversation.
1.2 Visitor-expository module	
1.2.1 Contemplative interaction	Contemplation, observation, visualisation without touching/ manipulating an exhibition module or a specific part of the module.
1.2.2 Interactive activity	The interaction takes place through immersion, experimentation, and physical interaction.
1.2.3 Reading the panel/text	The interaction occurs through information boards, panels, captions, or exhibition texts read aloud (in whole or in part).
1.3 Visitor-mediator	Dialogues established between visitors and mediators or when visitors listen to the mediators' guidance and information.
2. Conversations	
2.1 Conversations on scientific topics	Dialogues on a scientific topic, discussions on ethical and moral dilemmas of science, the social impact of scientific activity, discussion of scientific data or content, etc.
2.2 Conversations about the exhibition (operation, design, museum experience)	Dialogue triggered by the interaction of visitors with the exhibition and/ or the exhibition modules, whether about its operation, design and/or museum experience.
2.3 Conversations associated with previous experiences and personal experiences	Mobilisation, utilisation, questioning one's own knowledge, beliefs, rituals, or ways of life during the museum experience, referring to childhood experiences, school knowledge, references to movies, books, series and TV shows, etc.

Source: Adapted from (Massarani et al. 2019c).

Results and discussion

The audiovisual material totalled 2h 26min 53s, corresponding to the total visit time in the exhibition space, with an average of 36 minutes for each family group. During this visit time, 296 category occurrences were identified as specified in the table below, in which we present the number of occurrences for each code and the percentage of each occurrence in relation to the total visit time (Table 3).

Table 3. Time and occurrence of codes applied to analysed categories.

Categories/subcategories	Occurrences	Net time	% time of videos
1. Interaction types			
1.1 Visitor-visitor	78	72 min	49.6%
1.2 Visitor- exhibition module			
1.2.1 Contemplative interaction	44	21 min	16.6%
1.2.2 Interactive activity	29	24 min	14.6%
1.2.3 Reading the panel/text	54	09 min	6.6%
1.3 Visitor-mediator	35	30 min	20.5%
2. Conversations			
2.1 Conversations about scientific topics	82	55 min	38%
2.2. Conversations about the exhibition (operation, design, museum experience)	68	25 min	17%
2.3 Conversations associated with previous experiences and personal experiences	19	06 min	4.5%

Source: The authors

The results indicate that in the *Conversations* dimension, the category with the highest occurrence in family interactions was *Conversations about scientific topics*, which occurred 82 times (38%). The category *Conversations about the exhibition (operation, design, museum experience)* also showed high prevalence with 68 occurrences (17%). *Conversations associating previous experiences and personal experience* were less frequently reported (19 times, 4.5%). Still, they proved to be an essential strategy in the dialogues of families for the construction of meaning, which we will discuss in the item '*A look at family conversations in the experience of visiting the MMB'.*

In the *Types of Interaction* dimension, the subcategory *Visitor-visitor* was coded 78 times, meaning that the family groups interacted among themselves for most of the visit time (49.6%). Another part of the interactions occurred between families and mediators (*Visitor-mediator* – 35 times, 20.5%). In the subcategory recording visitor interactions with the exhibition, we found that the *Contemplative interaction* (44 times, 16.6%) was most frequent, followed by *Interactive activity* (29 times, 14.6%) and *Reading the panel/text* (54 times, 6.6%). The lowest prevalence of the *Reading the panel/text* category concerning the total time of the visit compared to *Contemplative activity* and *Interactive activity* is justified by the nature of these interactions. In general, we observe that the readings are brief and specific, while the contemplative activity, including observation and appreciation, has a longer duration. Below, we deepen this analysis and discuss the results, considering samples of the most frequently occurring categories through conversational excerpts of the interaction processes of families in the MMB in two subtopics: interaction and conversations.

A look at family interactions at the MMB

The results indicate that visiting the MMB provided family members opportunities to interact among themselves, with the mediators, and with exhibition modules from different perspectives. Neves (2020), when investigating mediation strategies, identified that adults stimulated questions and observations; children played an essential role in fostering collaboration, information sharing and more active participation of family members. McClain and Zimmerman (2016), who explored

family learning in an informal environment, described that the use of physical movements to guide the child's position, physical contact and movement to guide participation, and spatial arrangements of adults in relation to children facilitated strategies to support scientific learning.

In this study, we found results similar to those reported by Neves (2020) and McClain and Zimmerman (2016) regarding the interactions of families. In the Visitor-visitor category, we can perceive communication incidence between family members, with dialogues about scientific information regarding the exhibition modules and design. The analysis of co-occurrences, that is, interactions that happened simultaneously during the analysis, demonstrates this relationship. The *Visitor-Visitor* and *Conversations about Science* categories were found to occur simultaneously 42 times throughout the analysed video clips, while the *Visitor-Visitor* and *Conversations about the exhibition* were recorded 37 times.

An important result of this study that corroborates those found by Neves (2020) concerns the role of children in the visiting experience. We observed that the children had a critical role in directing the group's attention to the discussion of an object/theme in order to better identify what they were visualising. This consequently favours the opportunity for family exploration with a closer look at the objects and/or environment, as seen in the example below, Chart 1

Chart 1. Visitor-visitor interaction: child-adult, child-child.

Ex.1 (G1) C1: *Here, grandpa, what is this?*/A1: *It is written above: hexastate. It is a device that simulates a model that combines knowledge and possibility* (reading the explanatory panel)
Ex.2 (G2) C2: *Wow! What's in here? That: I don't know what it is. It looks like dirt.*/A1: *Dirt, no. Take a look, read there. Which is. Here, look, you have to read.*/C1: *It is a disease egg.*/A1: *Aedes egg.*/C2: *What is Aedes?*/C1: *Illness!*/A1: *From the dengue mosquito! From this one, look!*/C2: *Hum*.
Ex. 3 (G4) C2: C1, *see the bacteria moving!* (looking at one of the microscopes)/C1: *Look at the Zika virus! What bacteria, where is it?*
Ex. 4 (G4) C2: C1, *come and see this, it is that stringy virus there, but I forgot its name, it is that one that . . . long* (In one of the modules with a microscope)/C1: *Let me see, wait, I'll remember the name. . it was a virus, I didn't see the name, wait, is it that stringy thing?*/C2: *No, it's not . . . but it wasn't a virus.*

The examples presented in Chart 1 demonstrate, among other aspects, strategies used by children that reinforce their active role in the interaction with the members of their family group. In the sentences of C1 from G1: "*Here, grandpa, what is this?* (Ex. 1) and C2 of G2 '*Wow! What's in here?*' (Ex. 2), for example, we can see that children direct their parents'/caregivers' attention to what arouses their attention and use questions to understand what they see. Examples 3 and 4 reinforce the child-child interaction, where one directs the other's attention to share information, point to an object, or explore an expository module, as seen in the sentences: C2: 'C1, *come see the bacteria moving*' (Ex. 3) and C2: 'C1, *come and see this, it is that stringy virus there, but I forgot its name, it is that one that . . . long*'.

Another key point is that parents/caregivers also played a role in the visitation process involving children in the exposition themes, providing guidance and instructions, and establishing conversations that facilitate learning experiences. The following examples Chart 2 are aligned with previous studies (Ash 2003; Crowley et al. 2001; Fender and Crowley 2007; Ornstein, Haden, and Hedrick 2004).

Chart 2. Visitor-visitor – adult-child interactions.

Ex. 5 (G2) A2: *Look at this here*, C1 (in the module about ticks*). Look at the size of the tick! Male tick. Look at the small size. Look at the female*/C2: *Let me see . . . Which is the male, which is the female, which is the baby, which is the egg?*/A2: *No, you can read. Look here.*
Ex. 6 (G3) A1: *Look here, look . . . the sneeze* (Observing a panel about bacteria)/C2: *Is it a sneeze?/A1: Yeah, you're explaining the sneeze, look . . . Look what you see. Look, look how it dispersed . . .*
Ex. 7 (G3) *C1: I didn't understand that. This here*. (refers to a model in an acrylic box with representations of people, coffins and barbers)/*A1: Wait, let's read. 'Deaths caused by an epidemic'. C1: What is an epidemic?/A1: When is there an epidemic? The epidemic is like this . . . a disease that manifests itself . . . all over the world . . . /for example, there is an epidemic of Zika virus.*/C1: Epidemic is *when there's a lot of it?/A1: A disease . . . starts to proliferate . . . /C1: Like dengue* (unintelligible) *last year?/A1: Yes.*

Parents/caregivers acted as facilitators for the learning experience by frequently using strategies such as questioning, directing themes, connecting conversations, observations, and readings. The presence of sentences like A2: *Come see here*, C1 (Ex.5, G2) and A1: *Look here, look . . . the sneeze* (Ex. 6, G3) demonstrate how they stimulated the children's attention in order to share an expository theme. Although some of these conversations were brief (Ex. 5 and 6), they were necessary for the family interaction process and scientific learning opportunities. We found that, to some extent, parents/caregivers strove to give instructions or information intended to stimulate learning. This is the case in the dialogue between mother and daughter in G3 (Ex. 7), exemplifying strategies such as reading – A1: *Wait a minute, let's read. 'Deaths caused by an epidemic'*, and explanations associated with previous knowledge – A1: *Epidemic is like this . . . a disease that manifests itself . . . all over the world . . . /for example, there is an epidemic of . . . zika virus"* were used.

The examples presented in the *Visitor-visitor* category reinforce a behaviour reported in the literature as joint attention – a sociocognitive phenomenon in which two people are consciously focused on the same object, resulting in shared cognitive engagement (Povis and Crowley 2015). In this study, children and adults engaged each other – sometimes with gestures or verbalisations around an object or another focus of attention stimulus, creating simultaneous and observed focus that acted as a conversation stimulator. According to Povis and Crowley (2015), joint attention supports the processing and retention of information and people are less inclined to move quickly through the environment when it occurs, thus creating opportunities for deeper conversations to process information.

In the category *Visitor-exhibition* module, we can see that the MMB provided visitors opportunities for *contemplative interaction*, with moments to admire, familiarise with, and recognise the various objects of the exhibition collection (schemes, historical objects, busts of scientists, three-dimensional models, films, etc.). There were also opportunities for *Interactive activity* due to magnifying glasses and microscopes in which ectoparasites and microorganisms could be observed in the long-term exhibition. Additionally, the electronic games in the specific area for children contributed to physical contact and encouraged interactivity. According to Allen and Gutwill (2015), museums are designed to promote pleasure and learning. We can observe such intentions in the MMB, considering its exhibition proposal and design. Below Chart 3, we highlight some episodes of how the codes *Contemplative interaction* and *Interactive activity* were identified. We emphasise that the *Contemplative interaction* code was recorded by observing the behaviour when there was no dialogue in some instances. There were few occasions where speech and remarks illustrated the presence of the contemplation code.

Examples 8 and 9 illustrate how *Contemplative interaction* allowed families to observe, admire and appreciate the aesthetics of the exhibition modules. When G2′s C2 compares a liver cell model to a dolphin: *'It looks like a dolphin, doesn't it?'* and C1 says that the shape of the cell *looks like a living thing from the sea*, we see how important the presentation of objects and modules are for interaction and engagement with the public. In example 9, the mother is impressed when she recognises an old electronic microscope A1: *Wow, one of the first electron microscopes*! This excerpt reinforces a recurring situation: the contemplation of the apparatus associated with conversations about scientific topics – in this case, identifying a scientific instrument and understanding how it works.

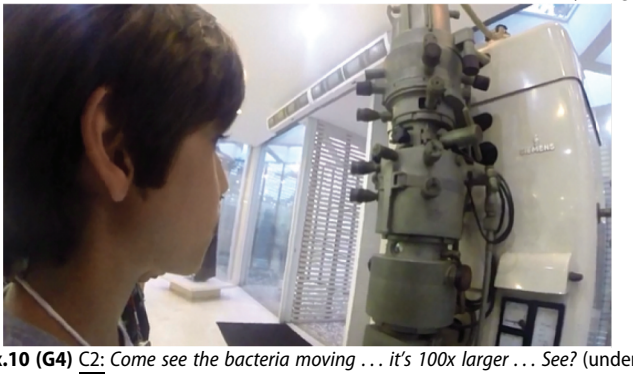
Regarding the *Interactive activity*, examples 10 and 11 reinforce how the MMB offered opportunities for families to get involved with science through practical activities. To a greater extent, the category was identified when family members handled the microscopes, such as C2: *Come and see the bacteria moving . . . it is 100x larger . . . See?* As well as in the computer games in the children's area.

Meisner et al. (2007) state that interactive experiences can be an effective means of creating engagement and participation with museum exhibitions and the scientific issues they present. In addition, research shows that the expositive elements are regularly present in the conversations the public has in museums during visits. Campos (2013) states that the attractiveness of objects can trigger epistemic operations of naming, pointing out, affectivity, and characterisation. These factors are responsible for directing attention between group members during a visit, leading them to qualify and share perceptions and playing a role in the joint construction of meanings.

Chart 3. Contemplative interaction and Interactive activity.

Ex.8 (G4) C1: *What is that?/*C2: *It looks like a dolphin, doesn't it?* A1: *It seems so . . . what is it?* (looking at one of the modules on the table), *it's a liver cell . . . (reading the panel)/*C1: *It looks like a living thing from the sea! (laughs)/*A1: *Yeah! And here, what is it?* (continues looking at the table panels)/C2: *I don't know!*

Ex.9 (G3) C1: *What does that mean? (Observing the microscope)/*A1: *Wow, one of the first electronic microscopes!/*C1: *And where did they see it?/*A1: *It zooms in to 50 thousand times. Don't touch it!/*C1: *Is this where you saw it?/*C2: *I don't know. I think . . . /*C1: *No, because there is a cable there, so it is here, because here is the only thing that has something attached.*



Ex.10 (G4) C2: *Come see the bacteria moving . . . it's 100x larger . . . See?* (under a microscope with protozoa)*/*C1*: Disgusting, what is it? Disgusting!/*C2*: Is the bacteria moving/*M*: Did you see this one?* (points to the microscope with untreated water droplet)*/*C1*: Uhum/*A1*: What is this one?/*C1*: It's the bacteria moving/*M*: Is it really bacteria?/*C1*: I don't know!/*C2*: We don't know if it's a bacterium/*M: Did you see it here in the caption? Take a look at the caption/A1*: *Here? 'Microscope . . . water drop'/*M*: Untreated water/*A1*: Ah . . . /*M*: This is a protozoan/*A1*: It is a protozoan in untreated water, look! When we drink untreated water, look at what we have. Did you see it?*

Ex. 11 (G1) M: *This is a game. Look, you have to show this symbol here on this camera, from a distance (points)./*C1: (tries to handle the piece)*/*M*: Yes, now you are not going to use it* [the yoghurt pot] *anymore and you are going to touch the screen* (shows it).

Another code with relevant occurrences in the *Visitor-exhibition module* category was that of *Reading panel/explanatory text/photo*. Borun and Dritsas (2010) state that reading the text silently or out loud demonstrates the family's learning experiences. Our data show that adults in family groups were the ones who used information panels and subtitles the most to understand what they were viewing, subsequently talking about and explaining the content to the children, as seen in examples 7 and 8. In addition, parents/caregivers had a recurring behaviour of asking children to read the panels independently, as identified in examples 1, 2, and 5. About this, Foehring et al. (2013) report that adults often use the opportunity to visit a museum to show their children how to learn, encouraging them to read the instructions. We highlight the co-occurrence of this category with the codes *Visitor-visitor* (31 times) and *Conversations about scientific themes* (19 times). We present, in Chart 4, excerpts that show how reading contributed to *Conversations about science themes* in the family.

Chart 4. Reading the panel/text.

Ex.12 (G1) C1: *Oh, grandpa, can you read it?/*A1*: Oh, smallpox vaccine. Don't touch . . . 'smallpox vaccine and the turntable', 'In order to facilitate the scraping of the pustules', that is to say, of the wounds, okay? 'In the abdomen of a calf, for example' . . . it's a calf, 'infected by the smallpox virus, the animal was tied to this table in an upright position and then turned horizontally, and the material collected was used to prepare an antiviral vaccine'. It resembles the table in an upright position, standing and then laying the table flat* (explains).

Ex.13 (G2) C2: *Mom, what is this? (question in front of the hexstat) Exestato. Istatu?* (C2 trying to read)/A2*: Exestato. 'This equipment . . . ' I will read for you what is up here. "This equipment simulates the mathematical model that associates probability knowledge. That is, chances of a random and independent event, in which case we can observe the direction of the balls in front of obstacles, forming a curve known as the normal distribution curve or . . . /*C2*: Then you put the balls here and come, come . . . /*A2*: They put these balls . . . you see that here it is full?* C2*: Yes./*A2*: They put these balls up here. And then they dropped them to see how many fall in the first, how many fall in the second one. You can see that more balls fall in the centre.* C2*: Yeah./*A2*: Most of the balls . . . I think that this one turns. No, it's stuck. More fell in the centre, that means there is a greater chance, they will always look for the easiest way, look, the easiest way is the straightest one./*C2*: Hmm./*A2*: It was a little bit beyond my knowledge, you know?*

As seen in examples 12 and 13, reading enhances more elaborate conversations between children and their families. While reading, parents/caregivers often explain and facilitate the children's understanding. In G1 (Ex.12), the grandfather pauses the reading to clarify some terms and then resumes, see: A1: '*In order to facilitate the scraping of the pustules*', that is, of the wounds, okay? '*In the abdomen of a calf, for example*' . . . it's a calf. In G2 (Ex. 13), to explain to C2 how the Hexstat device works, the mother says that she will read: A1: 'Ex estato . . . I will read it'. In this episode, the mother simplifies to the child how the equipment probably works and, when she finishes reading, she admits that the information was insufficient to achieve understanding – A1: *It was a little bit beyond my knowledge, you know*. For Riga et al. (2017), it is frequent in the family relationship for adults to mediate and interpret expository themes for children, reading the text directly to them from the caption or reinterpreting the texts in the panels. Therefore, the data in this study also supports what McManus (1989) and Allen (2002) demonstrated in their research: that reading in museums occurs in a unique, non-linear way and according to interests and objects that families read in the museum spaces, which is a joint activity, demonstrating that the legends and information panels in the MMB consisted of experiential sources of cognitive learning.

Another observed aspect that contributed to the families' learning experiences was the presence of mediators. It is recognised that these professionals play an important role in communication and education in museums, engaging in dialogue with visitors, contributing to the improvement of the exhibits on display, and collaborating in visitors' learning, interaction and participation (Norberto Rocha and Marandino 2020; Pattison and Dierking 2013). According to Gomes and Cazelli (2016), human mediation can provide a learning experience for visitors that is more faithful to the scientific knowledge presented and intended by science museums.

In this study, the *Visitor-mediator* interaction was identified in all family groups. Specifically, G4 interacted with the mediator more frequently than the other groups as the grandmother knew the museum coordinator, favouring more dialogue and more targeted mediation throughout the visit.

During the visits, mediators were in fixed locations observing visitors and the relationship between them. *Visitor-mediator* was observed in a reciprocal way: mediators offered help to families – mainly with technical issues, such as problems in viewing the microscope or help with the technological resources, while families resorted to mediators for questions, explanations, or help with a manipulation/activity, as shown in Chart 5.

Example 14 depicts when the child receives assistance from the mediator stationed at the specific exhibition to help young children manipulate the computer game. The following example (Ex. 15) demonstrates how the mediator's presence in most of the G4 visit was essential in refining information and constructing meaning. The mediator prompts the child to talk about what he is seeing, M: *Tell me what is there* . . . and from this request, the mediator and the children establish a dialogue about the cells and the staining process under the microscope with pertinent questions from the children, such as, C2: *Is our blood purple?*, and the responses given by the mediator can have significant consequences for the children's learning process. Another type of interaction between the mediator and the families is observed in example 16: the grandmother asks one of the mediators to explain how the table on smallpox works. In a part of this dialogue, we found that the mediator uses rhetorical questions to help visitors arrive at the topic at hand and investigate their previous knowledge on the subject.

In this study, we observed that the most prolonged dialogues concerning the content were mediated by MMB employees. Massarani et al. (2019c) point out that mediators are agents who contribute to the sustained cognitive engagement of visitors in the exhibition themes. Thus, we understand that mediators can foster the deepening, complexification and expansion of the discussions proposed – explicitly or implicitly – by museum exhibitions (Norberto Rocha and Marandino 2020; Massarani et al. 2019c; Pattison and Dierking 2013), thus actively contributing to the families' learning experiences.

Chart 5. *Visitor-mediator* interaction.

Ex.14 (G1) C1: *Okay, now I'm going to enter . . . Yoghurt . . . I'm going to take a picture to see it here. Fine./M: This is a game. Look, you have to show this symbol here on this camera, from a distance* (points). (C1 tries to handle the piece)/M: *Yes, now you are not going to use* [the jar of yoghurt] *anymore and you are going to touch the screen* (shows it).

Ex.15 (G4) M: *Tell me what's in there . . . /*C2: *There are white things and purple things* (seeing blood slides – leukocytes)/M: *White things and purple things? Um, cool, you managed to separate two things there, what do you think they are?/*M: *That's it* (points to Tv with protozoa)/C1: *Let me see/*M: *No, this one is the same as what's there in the first one you saw, only there is a camera, right, under the microscope/*C1: *Yeah really* (looking at leukocytes)/M: *'blood slide . . . ' what is that?/*M: *Blood . . . there is blood on the slide, you are seeing blood cells/*C1: *Ah./*C2: *Is our blood purple?/*M: *No . . . good question. Why is it purple? Because if you just put the blood there, you will not see anything, you will see a blur, and then what do we have to do? Put a dye, you know?/* C1: *Is that in our blood?/*M: *Then you see the cell, it looks like some of these here, you see it?/*C2: *Uhum.*

Ex.16 (G4) A1: C1!/C1: *What, what?/*A1: *Here they tie . . . She will explain* (smallpox table)/M: *This table here, it was actually used here at the Butantan Institute in the past to make the smallpox vaccine. Do you know about smallpox? No? Yea? Have you heard of it?/*C1: *Yeah, I have already/*A1: *Have you heard of it? No?/*C2: *Smalltox, no/*A1: *Smallpox!/*M: *It is a disease that causes lots of injuries on the skin, so it becomes full of blisters, right? It is caused by a virus, only at that time, it was unknown that it was caused by a virus. So what happened? This disease affected us, human beings, as well as oxen and cows, okay? But in oxen and cows it caused symptoms that were a little weaker. And the people who had contact with these animals, especially the women who milked the cows, they didn't get human smallpox/*C2: *Why?/*M: *Why? Can you imagine why?/*C2: *Had they been vaccinated?/*C1: *Why do they get the cow's immunity?/*A1: *Why did they take the milk from . . . the milk?/*M: *Huuummm . . . they took the milk/*C1: *Because I studied all of that at school, then someone there, who's name I don't remember, he took something from the cow and injected it into people who were sick/*M: *That, exactly. As she said, people who have contact with this virus that is in the cow, they get immunity against the disease, that is, they create a defence against the disease, right? And that was the way the first vaccine was created, right? What's in the vaccine? Do you know?* (Continues to explain how the vaccine and smallpox table work)

A look at family conversations during their MBB visit experience

Conversation is recognised as a powerful learning mechanism (Kim and Crowley 2010). Studies have shown that when conversations are associated with previous knowledge, questions, interests, and readings, there is a greater chance of contributing to family learning in museums (Ash 2003; Ellenbogen, Luke & Dierking, 2004; Knutson & Crowley, 2010).

In this study, the category *Conversations about scientific topics* was applied whenever the visitors or the mediator and visitors exchanged information about scientific information in the exhibition modules. We consider *Conversations about scientific topics* as a dialogue going beyond merely identifying objects on display. This includes comparisons and explanations, association of information with a previous family experience, generalisation, analysis, peer collaboration, scientific reasoning, conceptual change abstraction, motivation, engagement, identity, and metacognition among other cognitive behaviours (Allen and Gutwill 2015; Leinhardt, Knutson, and Crowley 2003; Siegel et al. 2007). In the examples presented below (Chart 6), we can see that children and parents/caregivers use different skills to develop conversations about scientific topics. The following resources may be highlighted as frequently drawn on by family groups: questioning strategies, reading, and association with previous knowledge and experiences.

Chart 6. Conversations about scientific topics.

Ex.17 (G2) A2: *C1, C1, come here! C1: What is this?/*A2: C1, *what machine is this here?* (in front of the autoclave)*/*C1*: What did we see there?/*A2*: No, this is for something else. Only this is really old. What is it for?/*A1*: Autoclave. Do you know what this is for? To sterilise the things we use./*C1*: What is sterilizing?/*A1*: Sterilise all types of microbes, bacteria, those things that you understand as bacteria. Do you know the dentist tools that we use?/*C1*: Um/*A1*: I can't use it in one person's mouth and then use it in another person's mouth, dirty. So we have to put it in a device called an autoclave. It washes, kills everything. Everything. Get it? Then, what happens? It creates pressure in here, the temperature gets very high and kills everything, then it's sterile. Then we can use it on another person without a problem. Only this one was how it started. Today they are very small, it seems . . . smaller than a microwave.*

Ex.18 (G2) A1: *Bacteria can be widely distributed in nature, dispersed in the air, in the bodies of living beings, in the soil, in water and in practically all environments on earth* {reading}. *So, where do you have bacteria?/*C2*: Everywhere./* C1*: Everywhere./*A1*: Everywhere./*C2*: Even inside our mouth./*A1*: Especially inside our mouth, it's full of bacteria./*C1*: Look, there are bacteria there./*A1*: There are bacteria everywhere. That's why when you . . . /*C1*: There are bacteria there./*C2*: So far there are bacteria./*A1*: You touch . . . touch here . . . how many people today or yesterday have already touched the screen and passed bacteria to the screen? So now I ran my hand over the screen and the bacteria is on my hand. What can happen if I scratch my eye, if I put my hand to my nose, to my mouth? These bacteria will enter me. So that's why we have to be careful not to spend the whole time rubbing our dirty hands on food, in your eyes. And especially fruits, the things from the market that we bring home, we cannot bring contaminated things into our home. Eh . . . the fungi, who are the fungi?/*C1*: The mushrooms./*A1*: It's mould . . . look, mould . . . the mushroom! The mushroom there, is the mushroom at home a fungus? The mushroom that you see every day growing there?/*C1*: Yeah, I keep an eye on it./* A1*: Are you watching it . . .* C1: *Uhum./* A1*: Another important thing is the virus, what are the viruses? They are everywhere, in the air, in the water, in the food, in your body . . . /*C2*: I don't understand any of this!/*A1*: You don't understand.*

In example 17, the parents want to show the child (C1) the importance of the autoclave, as it is an instrument that is present in the daily life of the mother, who is a dentist. The connection that the mother establishes with her work favours explaining how the autoclave functions as well as ethical hygiene issues, which justify the usefulness of the equipment. In the dialogue, the parents/caregivers brought the child closer to the question of how science and technology affect our lives. Although they do not use these words, this is implicit in how they guide the explanation. In this process, the simple language used by the mother introduces scientific terms and contents, such as the definition of sterilisation, A1: *It cleans, kills everything* [referring to the autoclave]. *Everything. Get it? Then, what happens? Give it pressure here, the temperature gets very high and kills everything, then it's sterile*.

Another example of how families developed their *Conversations about scientific topics* can be observed in G2 (Ex.18) when the mother uses information and scientific knowledge to explain bacteria, fungi and viruses in the short-term exhibit area on 'Aeromicrobiology'. The mother uses different strategies, among which we highlight reading to introduce the theme A1: *Bacteria can be widely distributed in nature, dispersed in the air, in the bodies of living beings, in the soil, in water and practically in all environments on earth* {reading}; the use of questions to involve and verify children's knowledge of the subject A1: *what are the fungi?* and the explanation of scientific knowledge for children, with the frequent use of associations with personal experiences: A1: *Do you know when you get the flu?*/C2: *I know.*/A1: *You get the flu virus.*

The examples (Ex. 17 and 18) also reinforce the presence of the category *Conversations associated with previous experiences and personal experience*. The category occurred less frequently, but it proved to be relevant for constructing children's understanding of the scientific topics addressed in the exhibition, as shown below Chart 7.

Chart 7. Conversations associated with previous and personal experiences.

Ex.19 (G3) C1: *Tripe . . . (Trying to read the label on the Trypanosoma cruzi module)/*A1*: Trypanossoma/*C1*: Barber?/*A1*: Barber./*C1*: What is it? It's a kind of . . . /*A1*: It's an insect . . . /*C1*: Keep talking./*A1*: It bites, it transmits this disease here, look. Do you know who had it? It's called Chagas' disease . . . /*C1*: But this gives . . . /*A1*: It makes the heart increase in size. Aunt Cinira was the one who had this disease, who died./*C2*: Aunt Cinira?/*A1*: So, she wore a pacemaker/*C1*: But it kills? Does it?/*A1*: It can kill. It is very common in small houses that have . . . that are made of clay.*

Ex.20 (G4) C1: *You know what I thought? They don't anesthetize before, but they don't, for . . .* (In the haematophagous module) A1*: Huh?/*C1*: They anesthetize before they bite?/*M*: No, there are components in its saliva that anesthetize and prevent blood clotting and . . . /*C1*: Do you know what I thought? When it bites me I go and get the vaccine and I don't feel the sting, understand?/*M*: What do you mean?/*C1*: It goes there and bites me, and then I get the vaccine on the bite . . . /*A1*: Ah, you will be vaccinated where it bit you/*M*: You don't want to feel the pain of the needle sting, is that it?* (laughs)/C1*: No* (laughs).

Studies that analysed family conversations in museums (Crowley et al. 2001; Pattison et al. 2014) have shown that parents often connect museum content to previous experiences and knowledge. Example 18 (G3) provides evidence of how parents deliver such knowledge. The episode indicates that the understanding of how the bug transmits Chagas' disease is unfamiliar to C1 and that she shows interest in understanding, asking the mother for further explanations. The mother connects Chagas disease to a family relative to support the dialogue, developing, from the point of view of cognitive engagement, operations of connections with personal life to explain the disease that the insect transmits to the child.

The children also demonstrated their own knowledge in family conversations. In example 19, C1 uses previous knowledge about mosquitoes, which she did not know how to explain correctly. Still, the mediator helped her, explaining: … *in its saliva, there are components that anesthetize and prevent blood clotting* … and with that information, she establishes an assumption, and a connection relating the bite of the female mosquito to taking the vaccine, C1: '*You know what? Just after it bites me, I go and get the vaccine, so I don't feel the sting*'. For her, if the mosquito has a component that anesthetizes the bite, she could let herself be bitten, be anesthetized, and then take the vaccine without feeling pain.

The results show that some family conversations surpass the causal levels formed from daily observations (Crowley et al. 2001; Callanan et al. 2017) and demonstrate that, when conducted by the parents/caregivers or mediator, more elaborate dialogues with open questions and associations exchanging relational thoughts are established. Haden (2010) reflects on how conversational interactions between parents and children can help children learn science. Neves (2020) also identified that when family visits are mediated, the number of superficial conversations (which includes questions, answers and individual decisions) is reduced and conversations of cumulative character (with identification and repetition of information and the use of previous knowledge) and dialogical conversations (in which participants exchange and challenge ideas, draw conclusions from experimentation/research, and establish relationships with other forms of knowledge and prior experiences) are slightly more common.

In our study, about a fifth of the conversations (17%) were about the exhibition, emphasising aspects of operation and design. According to Archer et al. (2016), to reach the opportunities to engage and learn about scientific themes in a science museum, the exhibitions must first attract visitors' attention. In the present study, we found that the category *Conversations about the exhibition (operation, design and museum experience)* illustrates how families engaged with the exhibition and indicates guidelines for the museum's educational sector on how the exhibition can be improved and/or reviewed to optimise the learning experiences of families Chart 8.

Chart 8. Conversations about the exhibition (operation, design and museum experience).

Ex.21 (G1) C1: *This is not disgusting*. (looking at microscope)/C2: *No?*/C1: *Not for me.*/A1: *Yes, it is! Full of little orange stuff inside.*/C1: *I don't like it!*
Ex.22 (G2) A1: *Did you like the apple more than the yoghurt?* (about games in the children's space)/C1: *I don't know*/A1: *Why did you stop there so quickly and here you stayed until the end? Why did you stop quickly in the yoghurt game and didn't want to finish and in the apple game you wanted to stay until the end? Did you find it more interesting?*/C1: *Yeah, the apple one*/A1: *Is the apple one more interesting?*/C1: *Uhum.*
Ex.23 (G2) C2: *What is that?* (points to leukocyte phagocytising bacteria in 3D)/A1: *This is a … /A2: It is how the serum, white blood cells, leukocytes are extracted … /A1: So, only for them. .it's too much for them./A2: It's too … /C1: Ah.*
Ex.24 (G2) A2: *That's the story of the good bacteria, right? Or not?* (in the yoghurt bacteria module)/A1: *So … you know … no, let's not get into that, because the shortcomings are already huge*. (About presenting this subject to children)
Ex.25 (G3) C2: *Why is that? Audio?* (In Scientist Square looking at a seal indicating audio description)/A1: *I think they must have a device … here, look, Braille, you see, look? They must have … this to put that one*/C2: *Oh I know … /A1: Audio guide, you know?*/C2: *I know.*

The museum experience can be identified in examples 21 and 22. Families reported their perceptions of what they felt when they saw the microorganisms under the microscope (Ex. 21) and their preference when playing computer games in the children's area (Ex. 22). Such examples demonstrate aspects that have the potential to influence how families engage with the equipment. Interest, positive and negative feelings, and difficulty in understanding the knowledge on display are some factors that can make the interaction more superficial or in-depth. Csikszentmihalyi and Hermanson (1995) offer an insightful discussion on motivation and interest in museums. The authors argue that the museum can use contextual stimuli, sounds, colours, etc., to attract the visitor's attention. However, to arouse the visitors' interest, it is necessary to create strong links between the museum and their daily lives.

Another aspect evidenced in the transcription of examples 23 and 24 refers to the complexity of some scientific themes addressed in the exhibition. Faced with issues considered to be more complicated, some parents end up depriving children of sharing scientific information, even in the face of their curiosity, because they think they would not be able to understand specific modules 'A1: *So, for them . . . it is too much*'. and . . . A1: '*no, we are not going to get into that, because the shortcomings are already huge*'. The episode also demonstrates one of the great challenges for museums: to create links between the interest of the visitor and the knowledge presented in the museum (Dindler and Iversen 2009). In summary, our data provide evidence that *Conversations about the exhibition* (operation, design, and museum experience) can demonstrate how visitors engage with the exhibition and offer signals to inform greater participation and learning.

Final considerations

This study aimed to analyse the process of family interactions on a visit to the science museum and how conversations mediated their learning experiences. Our results provide evidence that the interactions and social dynamics the family groups were exposed to during their visit to MMB provided cognitive engagement and social learning experiences. Moreover, this research reveals the proactive role of children, the importance of conversations with adults during the visits, and the relevance of exhibition objects in promoting learning conversations.

In the process of social interaction, we highlight the initiative and autonomy of children during the visit, a fact little evidenced by studies in the area. Based on their interests and motivations, the children directed the group's attention to the objects and exhibition modules that aroused their curiosity. They also demonstrated autonomy in their trajectory throughout the museum, staying at each apparatus for as long as they wished. On the other hand, we also reinforced the role of parents/caregivers in sharing their interpretations and encouraging children to learn through questions and answers, notes on various topics, and encouraging reading. In parallel, we consider that adults also had their learning experiences in teaching and/or introducing knowledge to children. In summary, the children and parents/caregivers both led the visit, but with different roles.

In general, the MMB exhibition provided families with moments of *Contemplative interaction* associated with practical activities. These multiple experiences were essential in developing conversations and encouraging discussions about the contents of their expository modules. In this process, reading proved to be a relevant factor in achieving understanding of the topics covered. We also highlight that the mediators provided the families with more in-depth explanations and conversations about the exhibition themes and sustained cognitive involvement. It is worth noting that the children were interested and engaged in the learning experience, as seen in the large number of conversations where explanations are given to their questions, for example: '*What is this*?', '*What is it for?*' etc.

In a cognitive engagement context, we highlight the *Conversations about Science and Conversations on themes that associate previous personal experience* that included explanations, questioning, and evidence and enabled the construction of meanings and knowledge about

microorganisms. We believe that MMB offered the families opportunities to have scientific learning experiences with factual conversations and the practice of scientific reasoning. Another point identified in this study refers to the visitors' expression of emotional sensations such as feelings of disgust, surprise, and joy when viewing microorganisms or ectoparasites in microscopes or magnifying glasses. These data bring evidence that the museum has a vital role in bringing the world of microorganisms closer to families, expanding knowledge of an abstract theme through experiences that instil pleasure and positive attitudes towards science, which can also be examined and discussed in future studies. We recognise as limitations of this study the number of families investigated and their homogenous profile. Even being invited randomly, the studied families represent a privileged portion of the Brazilian population, with parents having at least a university degree and self-selecting as museum visitors. These aspects can, as pointed out by Archer et al. (2012), Dawnson (2014) and Gaskins (2016), influence familial learning experiences, seeing as such visitors possess significant scientific capital. This provides opportunities for future research, especially when considering the important initiative to engage additional segments of the population.

Educational implications

This study indicates that conversations in museums provide a considerable opportunity to address gaps in current understanding as to how families interact and learn in museum environments, especially from a Latin-American perspective. We verified that families showed interest both in the objects and information made available – which contributed to their learning experiences. That being said, the absence of elements serving to establish links between the content on display and the visitors (for example: a provocative question, an illustrative image of a certain procedure, a personal story from a scientist, etc.) is seen in this study as a factor that hindered the deepening of familial discussions and even the forming of connections with previous knowledge and experiences. In this sense, childrens' questions serve to reveal the topics of their underlying interest, as well as what can be analysed and restructured in the exhibition in order to encourage a more dialogical relationship between the museum and families. As such, our study combines elements that allow for practical implications. Furthermore, our group includes both researchers and museum educators and, based on both theoretical study and practical experience, we have been writing practical guides and trainings with implementable suggestions for science museums and other initiatives focused on public engagement with science. Aside from this, knowledge of these interactions and conversations allows the educational departments of museums to gather information that allows them to refine the experience, motivation, and expectations of their visitors. It is worth noting here that our study contributes to a greater understanding of these interactions and conversations in a Latin-American context, in which few studies have been carried out. Although sections of our results are congruent with international research, as mentioned in the discussion, our data indicate strong participation of the children themselves in the strengthening of familial interactions and conversations, a result that has been little explored in the extant literature.

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