JCOM

Socioscientific issues in science exhibitions: examining contributions of the informal science education sector

Ana Maria Navas Iannini

Abstract

This paper examines how a particular subset of informal science education settings — science exhibitions — embraces contemporary socioscientific issues (SSI) and fosters public engagement with them. A qualitative cross-case analysis of two SSI exhibitions about teen pregnancy (Brazil) and sustainability (Canada) was conducted. It revealed complex issues around operational funding, and institutional tensions related to the nature, balance, and relevance of the topics displayed. The analysis unravelled opportunities for SSI exhibits to engage with contextualized and situated knowledge; articulate the deficit model with other models of science communication; and consider visitors as agents of change.

Keywords

Public engagement with science and technology; Science centres and museums; Science education

DOI

https://doi.org/10.22323/2.22020202

Submitted: 11th November 2022
Accepted: 23rd February 2023
Published: 3rd April 2023

Introduction

Informal science education (ISE) represents an expanding sector comprising a diverse arrange of organizations, settings, and programs including museums, science clubs, festivals, and science cafés [Bell et al., 2016]. Initiatives that are part of this landscape are increasingly engaging with critical issues at the intersection of science, technology, and society, and are looking to promote active participation from the public [e.g., Aguirre, 2014; S. Davies, McCallie, Simonsson, Lehr & Duensing, 2009; Kunz Kollmann, Reich, Bell & Goss, 2013]. For example, science cafés have been involving audiences in conversations around mining, water pollution, fake news, coronavirus, and mental health (e.g., *Café controverso* [*Controversial Café*] — Espaço do Conhecimento, Minas Gerais; *Lates* — Science Museum, London). Similarly, complex topics such as food waste, C-sections, and biodiversity have become part of the repertoire of science museums and their exhibitions (e.g., *Comer* [*Eating*], Parque Explora; *Sentidos do Nascer* [*Senses of birth*], Brazilian Ministry of Health; *Life in Crises: Schad Gallery of Biodiversity*, Royal Ontario Museum).

As such, ISE settings have started to challenge dominant narratives and ways of (re)presenting science [Delicado, 2009; Hine & Medvecky, 2015], re-imagine who the publics are and need [S. Davies et al., 2009; Dawson, 2014], and foster different ways and possibilities for engagement [Aguirre, 2014; Bell et al., 2016; Kunz Kollmann et al., 2013; Lundgren et al., 2019]. Justifications for including and embracing socioscientific issues (SSI) are closely related to the idea of promoting scientific citizenry [Yacoubian & Bazzul, 2015]. Scholarly works have advocated for the social role of ISE settings in helping individuals to navigate the complexities of scientific and technological advancement in their everyday life, make informed decisions, and develop agency [S. Davies et al., 2009; Otrel-Cass, Campbell & Wilson, 2012; Rennie, Venville & Wallace, 2020]. In this context, it is important to explore how ISE initiatives take on these emerging social roles and identify the challenges, strengths, and possibilities envisioned in this trend.

Drawing from these considerations, this paper focuses on a particular subset of ISE settings: science museum exhibitions. Through a cross-case analysis of two SSI exhibits, the study aims to examine: (1) how these exhibits included SSI in their agendas; (2) what are some of the opportunities and tensions that emerged while developing work on SSI; and (3) how public engagement with SSI was fostered. The work centers around *Preventing Youth Pregnancy* (Catavento Museum, São Paulo), and *Our World: BMO Sustainability Gallery* (Science World, Vancouver).

Theoretical perspectives

This study uses theoretical perspectives related to SSI and public engagement. These are discussed below and situated in the context of science museum exhibitions.

Socioscientific issues and science exhibits

Issues that articulate the scientific with the social have been at the core of the SSI movement [Bencze et al., 2020; Kolstø et al., 2006; Zeidler, Sadler, Simmons & Howes, 2005]. As such, Zeidler recognized the emphasis that SSI has on "connecting science to matters of social significance" [Bencze et al., 2020, p. 833], while Simonneaux [2014, p. 38] speaks about social dilemmas that "impinge on scientific fields". Regarding the pedagogical implication of the SSI framework, Bencze et al. [2020] discuss practices that work towards citizenship and social virtue. In formal education contexts, they highlight student-centred pedagogies involving perspective-taking exercises, discussion, formulation of arguments, and opportunities for intellectual risk alongside examination of diverse forms of evidence and moral principles.

Within the ISE sector, science museums have started to engage with complex SSI [Pedretti, 2002, 2004] and foster active involvement and participation around them [Pedretti & Navas Iannini, 2020; Kunz Kollmann et al., 2013; Eikeland & Frøyland, 2020; Lundgren et al., 2019; Yun, Shi & Jun, 2022]. In this regard, Kunz Kollmann et al. [2013] relate SSI exhibitions with Kolstø et al.'s [2006] SSI argumentation framework, due to its alleged suitability for ISE. This framework involves three core elements that speak about opinions (*claims*), scientific evidence (*data*), and personal worldviews, perspectives, and values (*warrants*). In a different context, Yun et al. [2022], suggest three characteristics of SSI exhibitions: *critical reflection*,

contextualized information, and *opinion sharing*. The first one involves awareness and critical consideration of the exhibits' topics and narratives. The second characteristic could be related to the need for engaging with situated issues so that visitors could develop a sense of belonging and commitment. The third characteristic considers how visitors' knowledge, perspectives and opinions on the subject matter can be shared in appropriate spaces/moments, as part of the visit.

When discussing the social roles of ISE, Rennie and Williams [2006] urge consideration of the civic dimension of scientific literacy and, therefore, to the ideas of promoting awareness of public issues in science and technology, and full participation of citizens in democratic processes associated with these discussions. According to Rennie and Williams [2006], this could be done if some conditions are met, including the presentation of relevant SSI and the articulation of different communication strategies and experiences that will provide the audience with opportunities to enact or apply these forms of literacy. More will be said about this in the following section.

Public engagement in/through ISE initiatives

Literature about *engagement* with science and technology has centred around different foci. According to Weingart, Joubert, and Connoway's [2021] review, *engagement* can be defined in terms of its objectives, intended audiences, new roles for the publics, nature of the relationships between science and society, type of activities, and upstream technology assessment. When considering the notion of *public engagement*, McCallie et al. [2009] and Weingart et al. [2021] declare that the term has been loosely defined. This is due, in part, to the fact that the term has become a buzzword and label for actions of producers and organizers of ISE initiatives and their different publics [Bucchi & Trench, 2016; Weingart et al., 2021]. However, the ideas of two-way interactions, open exchange, mutual learning, co-creation of knowledge, and public discussions are being described as important aspects of this notion [Bucchi & Trench, 2016; S. R. Davies, 2011; Haywood & Besley, 2014; Lewenstein, 2016; McCallie et al., 2009; Weingart et al., 2021].

These reflections can lead to valorizing public knowledge and skills related to civic scientific literacy. As expressed by Albe and Pedretti [2013, p. 305] these include "the ability to analyze, synthesize, and evaluate information; engage in informed decision making; address nature of science perspectives, couple science, ethics, and moral reasoning; and foster agency". Central to this paper are the ideas of empowerment, development of skills for participating in civic activities, and recognition of the importance of applying multiple domains of knowledge to understanding, making decisions, and acting about SSI. These considerations evoke the models of science communication [Bucchi, 2008; Bucchi & Trench, 2016] and the different dimensions and scopes within science communication practices. Recently, Pedretti and Navas Iannini [2020] developed a multi-model of science communication (Table 1) that comprises four models — *deficit*, *dialogue*, *participation* and *dissent, and conflict/action* — useful to describe the relationships between science and society in the context of science museums and their exhibits.

As presented in Table 1, the deficit model focuses on the dissemination of scientific content through one-way, and often, one-time, opportunities for communication,

Table 1. Multi-model of science communication [Pedretti & Navas Iannini, 2020, p. 38].

Models of science communication	*Emphasis*	*Communication approach*	*Goals*
Deficit	Content	Transfer, popularisation, one-way, one-time	Transferring knowledge
Dialogue	Context	Consultation, negotiation, two-ways, iterative	Discussing implications of research; deliberating about context-oriented problems; making decisions
Participation	Content and context	Knowledge co-production, communal knowledge deviation, multi-directional, open-ended	Achieving scientific literacy as a collective learning; acting for change; setting the aims, shaping the agenda of research
Dissent and Conflict/Action	Content and context (emphasizing political literacy)	Knowledge distributed, emergent on a need-to-know basis, multi-directional, open-ended	Developing positive feelings of agency; attaining political understanding, action for changing the agenda of research; generating social and political change

emphasizing the transfer of knowledge from specialists to non-specialists (e.g., exhibit's informative panels). The dialogic, participatory, and dissent and conflict/action models portray different goals and make use of communication approaches that go beyond the transfer of knowledge. These include, for instance, negotiations (e.g., between specialists and non-specialists) about scientific issues and their impacts, co-production of knowledge (relying on open-ended and multi-directional interactions) and the emergence of new knowledge, as non-specialists (positively) experience dissensus around specific issues that call for transformative practices. Using Weingart et al.'s [2021] framework, it is possible to envision through these models a shift in discourse from participation and deliberation to (public) 'engagement'. Pertinent to this work are the implications of this shift in the specific context of science museum exhibits.

Methodology

Methodological positioning

This study emerged from a large qualitative research project on science museum exhibitions delving into contemporary SSI [Pedretti & Navas Iannini, 2020]. Acknowledging that science museum exhibits focusing on SSI represent a more recent feature of the ISE landscape [Yun et al., 2022], the project used purposeful sampling for the selection of units of analysis/exhibit. This strategy allowed for a focus on promising and useful case studies that could advance understanding of the phenomena of interest. From that initial set of case studies, this paper focuses on cross-case analysis [Stake, 2006] of *Preventing Youth Pregnancy* (São Paulo, Brazil) and *Our World* (Vancouver, Canada). These two exhibits were selected for cross-case analysis as they both: (1) engage with complex and contemporary SSI relevant to their local communities; (2) were permanent exhibitions in their institutions; and (3) were developed/hosted by large-size museums with high attendance rates.

Research sites

Preventing Youth Pregnancy was displayed at the Catavento Museum from 2009 to 2015. As its title suggests, this exhibit delves into the pressing topics of unexpected teen pregnancies, sexual practices, and associated risks. These topics, as expressed by the São Paulo Government [2020], have represented contested issues for different communities in São Paulo during the past decades. The exhibit was created through a partnership between the Kaplan Institute for Sexual Education, the Sao Paulo State Secretary of Education, and the Catavento Museum. The idea originated from educational resources and games produced by the Kaplan Institute about teen pregnancy and sexually transmitted diseases.

Preventing Youth Pregnancy starts in a room where visitors gather and sit in comfortable puff chairs (Figure 1). With the doors closed, visitors are welcomed by a sex educator who is responsible for guiding the experience and organizing the different moments that compose the visit. The first moment is an introspective activity. Visitors are invited to dream about what their future would look like. Here, images projected on the room's wall, soft music, and audio speeches move visitors to 'dream' and report this dream on a piece of paper that they will 'carry' during the whole visit.

Following, visitors engage with a party. In the same room where the puff chairs were located, panels come down from the ceiling and create a labyrinth. This labyrinth has the purpose of displaying narratives involving sexual practices and sexual behavior and offering visitors the possibility to choose between different courses of action. In the labyrinth, music and lights recreate the atmosphere of a party, while the panels and stories presented (e.g., leaving the party with someone, and deciding whether to use a condom to have sex) define visitors' journeys. In front of each panel, visitors decide what to do and, based on their choice, they are directed to another panel where a new situation is awaiting (Figure 2).

Once the party is over, visitors encounter a different scenario. The labyrinth is removed, music is turned off, and they are invited to sit again in the puff chairs

Figure 1. Conversational space at *Preventing Youth Pregnancy*. Credit: Ana Maria Navas Iannini.

Figure 2. Labyrinth/party at *Preventing Youth Pregnancy*. Credits: Ana Maria Navas Iannini.

with the sex educator. This is an opportunity to see that some of them 'are pregnant' (and this is visible because visitors are invited to wear a balloon under their clothes), others 'got' a sexually transmitted disease (identifiable through a bracelet), and others left the party 'with no news'. In this final moment, visitors engage in a discussion mediated by the sex educator. This conversation can be about their experiences in (and outside) the party, their impressions, fears, doubts, emotions, and perspectives. On some occasions, this conversational moment is accompanied by activities that sex educators believe could clarify doubts. Among them, they can learn how to properly put a condom on a dildo [Navas Iannini & Pedretti, 2017].

Our World: BMO Sustainability Gallery was a permanent exhibition at the Science World (Vancouver). This installation addresses the complex socioscientific issues of water, energy, and food consumption and waste (Figure 3). According to B.C. Environmental Protection and Sustainability resolutions [Government of British Columbia, 2022] and the Environmental Management Act [Government of British Columbia, 2003], sustainable environmental management should be a priority for the province of B.C. and related metropolitan areas, including the city of Vancouver. Therein, laws, awareness programs, and campaigns have been developed in the last two decades for the province of British Columbia [Government of British Columbia, 2022, 2003] around such purposes.

With a focus on these topics, the exhibit is a renovated version of the previous *Our Word*, to which new themes and narratives were added. In this context, topics such as water and food consumption and waste were integrated into the original exhibition, which emphasized energy consumption. Different from *Preventing Youth Pregnancy*, *Our World* follows a more traditional structure and organization, in the sense that it is composed of different installations and objects that can be accessed by visitors at any time (Figure 4). At the entrance, visitors can find interactive statistics calculating the consumption of water and oil in Vancouver. They can also encounter newspapers and audiovisuals about the impact of water consumption in Canada. Passing the entrance, visitors can transit across different

Figure 3. Entrance of *Our World*. Credits: Ana Maria Navas Iannini.

displays, without following a suggested pathway. For example, they can stop at a dialogue box that invites them to answer a daily question involving consumption options. They can also come across maps that highlight waste pathways departing from Canada, and large-size striking photos (projected on the walls) related to the impact of pollution and waste on different living beings and environments. At *Our World* visitors can also find containers full of unrecyclable materials, interactives about water use/consumption, and games about compost [Navas Iannini & Pedretti, 2022]. The exhibit has mediators in the space available, if needed, for clarifications of the exhibit's narratives and/or explanations about how to interact with certain displays.

Research participants

At *Preventing Youth Pregnancy* four mediators — undergraduate students in the fields of biology and philosophy — and a sex educator/psychologist were involved in the study. The curator of the exhibit was contacted by email before the visit to the exhibit and from this initial contact, the other museum staffers were engaged in the research. Following the same approach, the coordinator of *Our World* was initially contacted and, then, a senior curator and two mediators — undergrad students in areas related to science and environment — were involved in the study.

Data collection

In both research sites, data was gathered through: (1) interviews with museum professionals; (2) observation and field notes; (3) documents and artifacts; and (4) interviews with visitors (the latter not included in this publication).

Figure 4. Installations and displays at *Our World*. Credits: Ana Maria Navas Iannini.

For the interviews with museum professionals, the same protocol with guiding questions was used at both research sites (e.g., *How did the idea of the exhibit originate? In your view, how have visitors responded to the exhibit? Were specific communication approaches implemented?*). This allowed for an in-depth exploration of prominent goals for the exhibits, characterization of the subject matter, and expectations for the visitor experience. Based on staff availability at each institution, six interviews were conducted at the Catavento, and four interviews were conducted at the Science World. These interviews lasted 45 to 80 minutes and were all audio-recorded.

Observations of the exhibits included photographic records and field notes done by the author (in Brazil) and by the author and a research assistant (in Canada). Field notes were taken while observing visitors interacting with the exhibits and with museum mediators. In addition, collected documents included educational programs related to the exhibits, training materials for museum educators, and educational materials for visitors.

Data analysis

In the first analytical stage, portraits of each exhibit were created through inductive and deductive approaches to content analysis [Hsieh & Shannon, 2005] and constant comparative methods [Boeije, 2002; Fram, 2013]. Major analytical themes related to the individual findings of each exhibit have been presented elsewhere

[see Navas Iannini & Pedretti, 2017, 2022]. In this paper, however, the focus is on a subsequent analytical stage associated with the cross-case analysis of the exhibits. About this kind of analysis, Stake [2006] suggests following one of three possible analytical tracks. In the first one, the various situations and findings of each case are emphasized; therefore the 'uniqueness' of the cases becomes a predominant piece. In the second track, it is desirable to merge findings across the cases without preserving in detail the "situationality of the findings" [Stake, 2006, p. 58]. In the third track, the focus is on the factors as "[a]nalysts working in a quantitative mode usually convert Themes or Findings into variables or Factors to be measured and compared or correlated." [p. 64]. Although this study followed track II and worked with merged findings across the two case studies, a space was opened to consider unique findings, or "findings which occur in only one case" [p. 60], that were relevant for discussing emergent themes.

Findings and discussion

The cross-case analysis conducted around the exhibits *Preventing Youth Pregnancy* and *Our World* generated five major analytical themes that speak to: pathways for creating and sustaining SSI exhibits; tensions and controversy about SSI narratives; the role of contextualized knowledge and ISE professionals; patterns of (public) engagement; and visitors of SSI exhibits. Each theme is discussed below.

Pathways for creating and sustaining SSI exhibitions

Exhibitions engaging with SSI can be completely new endeavours — developed around specific critical topics/issues — or renovations to existing exhibitions, in search of more criticality, depth, and/or novel ways for visitors' participation. *Preventing Youth Pregnancy* represents the first pathway described:

> *They* [professionals from the Kaplan Institute] *developed a game that they distributed in public schools… They saw a good response to the game… teenagers understood what was that about and they understood the idea and they started to have a different view… related to sexuality. They started to see sexuality as something natural. Then they* [the Kaplan professionals] *found a space in the museum, they gave the idea to the Catavento Museum and they made a test and they mounted the exhibition and it has been a success.* (Interview, Museum Mediator)

Contrarily, *Our World* represents the second pathway introduced at the beginning of this section. Here, the original topic of energy consumption was integrated into new ones, such as water and food consumption and waste:

> *We received some money from BC Hydro to redevelop our energy exhibits… When it was moving downstairs I said 'well… it was decided* [that] *we really need to develop it all together'. So, I said 'we will bring the electrical and energy stuff down here'…* another *area that was really weak before, in Our World, was the water area…* (Interview, Curator)

As such, new installations were added to *Our World* including a dialogue box about sustainable food consumption practices, a game about compost, and infographics about food production and waste management.

Independent from their creation pathways, both exhibits struggled with operational funding. When reflecting on the roles of science museums, Rennie and Williams [2006] and Rennie et al. [2020] consider the difficulties of moving away from traditional (grand) stories and educational emphasis towards a new role where controversial SSI topics, dialogue opportunities, and co-creation of knowledge could be at the core. According to Rennie and Williams [2006], this is particularly difficult due to the costs of developing and sustaining new exhibits; cost being a factor that can lead institutions to retain their traditional features. In the exhibitions that were analyzed, barriers imposed by funding were visible, but they had different effects. *Our World* had limitations regarding the objects and artifacts to be added, due to the new (albeit limited) funding available. As one of the curators commented: "We redid recycling in here and these [displays] received the major money and, then, we had a little bit of money left over and we wanted to do something on food" (Interview, curator, *Our World*). *Preventing Youth Pregnancy* closed after six years of being a permanent exhibit as operational funding to maintain full-time staff and produce resources for visitors ended [Curator, personal communication, 2015].

As Chittenden [2011] points out, it is common that museum initiatives looking to promote and facilitate public engagement with controversial SSI are not often the focus of admission-driven museums as they might garner lower attendance and higher participant costs. With these reflections in mind, it is important to reinforce the possibilities that supportive operating models based on alliances [Achiam & Sølberg, 2017; Chittenden, 2011] and co-design projects can offer to the science museums landscape [Eikeland & Frøyland, 2020]. The partnership between Kaplan, the São Paulo State Secretary of Education, and the Catavento created and sustained the exhibit for six years without private sponsors. It is not ideal, but it matters to have a display functioning for such a long period and assisting a population that is usually silent, othered and stigmatized in discussions on such SSI. In this context, science museums should consider answering a call for rethinking "institutional priorities, operational models, and community service aspirations" [Chittenden, 2011, p. 1552], and nurturing supportive environments that can result from partnerships with local and national institutions and community organizations.

Tensions and controversy about SSI narratives

Exhibitions engaging with difficult SSI are exciting and provocative terrains; however, they can also be difficult endeavours due to the tensions that can emerge while producing, hosting [Macdonald, 1998; Meyer, 2009], and/or consuming the exhibitions [Kunz Kollmann et al., 2013]. Institutional struggles and complex negotiations about the kind of stories presented to visitors accompanied both exhibitions. At *Preventing Youth Pregnancy* controversy surrounded the premier of the exhibition because of the nature of the subject matter and the direct way in which it was communicated:

> *On the opening day… we had everything ready and one of the architects* [from the Catavento] *said 'no, the exhibit is not going to be opened to the public* [today]*'. The public were invited guests. It was a ceremony with government representatives and so on… 'They are not coming here'* [the architect continued]*. And then, I looked at*

> *him and* [asked] *'what do you mean?'. 'Because language is too inappropriate'* [the architect answered]. *By this time, the position of my director* [at Kapla] *was critical. My director turned to him and said 'yes, they can come, we are going to welcome them, the content is appropriate'… The architect did not allow his daughter to come and visit the exhibit.* (Interview, Curator)

When reflecting on exhibition development around edgy topics, Cameron [2006] reminds us of the ambiguities and 'savory' aspects that might be disguised or displaced from the exhibits' contents due, for example, to perceived cultural, moral, and religious sensibilities of the audiences. To these complexities, we can add another layer represented by the preferences and roles of sponsors in shaping/negotiating features of the exhibits [Delicado, 2009]. While *Preventing Youth Pregnancy* relied on a partnership between governmental, and non-governmental institutions and the museum, *Our World* had private sponsors that funded the renovation of the displays. Due to this sponsorship, the exhibit was renamed after the renovation as *Our World: BMO Sustainability Gallery* — where BMO stands for one of the biggest financial groups in Canada. *Our World* represents a scenario where, also, diverse voices were at play negotiating the stories to be told about water, energy and food consumption, and waste. In this case, curators and mediators experienced tensions (once the exhibit was renovated) regarding the balance and relevance of the topics displayed:

> *I think that they have lots of different stuff about power generation… tons of stuff about that. I think that they could have more information, maybe, about… environmental impact of different foods that you eat… Because, I recently became aware of the amount of carbon and water it takes… for the dairy industry and agriculture industry to function. It is crazy! And I feel like it is one of those things that not a lot of people know about.* (Interview, Museum mediator)

Issues around balance and relevance take us to Cameron's [2006] reflections about *surface* or *deep* in the development of exhibits' contents. While the first notion (surface) relates to the reaffirmation of consensual views, the second one (deep) is consistent with the possibility of challenging the status quo. As we can see in the quote above, there is an envisioned opportunity for gaining depth about difficult topics such as food production, consumption, and waste. However, the kind of sponsorship involved in the renovation of *Our World* made the exhibit retain and enhance celebratory experiences and installations [Delicado, 2009] related, for example, to energy production.

In this context, Bucchi [2008] invites us to consider the practice of science communication "in the broader context of science in society" [p. 68]. As such, it is important to examine how science communication and science education practices in museums are subjected to pressures that originate from privatization and commodification.

The role of contextualized knowledge and ISE professionals

As expressed by Yun et al. [2022, p. 48], "simply introducing socio-scientific issues does not conform to the purpose of the socio-scientific issues-based exhibition. The exhibition should be able to raise the visitors' awareness of the subject matter and

expand their thoughts, which stimulate critical reflection". In similar lines, Zeidler, Herman and Sadler [2019, p. 6] remind us that "the situatedness and contextual features of the learning environment, including the cultural milieu involving the stakeholders impacted by SSI, are crucial components necessary for scaffolding students [and, in our case, visitors] to more sophisticated ways of conceptualizing and resolving SSI".

To some extent, both case studies offered opportunities to explore the complexities of situated and contextualized issues and opened a space for critique — this being more prominent in *Preventing Youth Pregnancy*. At the Brazilian exhibit, social, cultural, economic, and political considerations framed mediated discussions (between visitors and the sex educator) about abortion, sexually transmitted diseases, and contraceptives:

> *Sex educator: What about the issue of prevention? Why do those who say they know how to use* [condoms] *don't use them?*
>
> *Visitor 1: Some people say condoms are uncomfortable…*
>
> *Sex educator: Is it easy to get a sexually transmitted disease or get pregnant? It is not always that having many partners implies that you are at risk… Is it easy to use and find condoms?*
>
> *Visitor 2: It is all about wanting, condoms are everywhere, even in our local health centres* [for free] (Field notes taken by the researcher)

When discussing contextualized information as a feature of SSI exhibitions, Yun et al. [2022] highlight the value of presenting the subject matter as a process, not as enclosed scientific content. This, in turn — as it happens in *Preventing Youth Pregnancy* — reflects a shift from answer-type to question-type exhibits, where critique and open-ended interactions are desired. Through thought-provoking questions, *Our World* also opened a space to examine contextualized subject matter (Figure 5). It was expected, however, that the exhibit could assist visitors in developing their own perspectives without engaging them in deliberative practices.

Some elements, however, differentiated both exhibits and impacted how criticality was promoted. In the Brazilian exhibit, museum mediators and specialists played a central role: they questioned the validity of the content presented, framed it with subjectivities, and — alongside visitors — reflected upon issues of power and control regarding relevant information not necessarily displayed:

> *There are things* [in the exhibit] *that are banned but you have to talk about them, there is no other way. Even when you don't, there are visitors who talk about certain issues and you cannot just say "No, sorry, we have to put that idea aside". Are you going to repress teenagers? It is already difficult to establish connections with them and then when you open… are you going to repress them? Sometimes we end up talking about such* [difficult] *issues, but for us* [mediators]*… the gallery is locked when visitors are in and so you have a chance to talk about those issues that matter to them.* (Interview, Museum mediator)

In contrast, at *Our World*, the museum team expected that visitors could unravel the complexities of the subject matter by reading the panels and being exposed to diverse sources of information. Here, desires of keeping the exhibit as a 'neutral' territory [Navas Iannini & Pedretti, 2022] were at play:

Figure 5. In this map/infographic, visitors can critically consider where Metro Vancouver companies send waste to be recycled. Credits: Ana Maria Navas Iannini.

> *One of the things I am always nervous about is… I do not want to go and… rant at a visitor and say… 'well you should be doing this and you should be doing that' because it is going to have the opposite effect on them and they are not going to feel* [well]*… Things like asking people to change their diet, remove red meat from it… some people would passionately say 'no, I do not want to do that'… So, I feel… the way that it* [the exhibit] *presents it is like 'here is some information and you can do what you want with it'.* (Interview, Museum mediator)

According to Meyer [2009, p. 10] "[e]xhibition makers [. . .] have to negotiate a position between a politics of moderation and a politics of controversy". These reflections also apply to the role of mediators in SSI exhibits. At this point is it important to note that: (1) while some exhibit practices might be controversial in certain sociocultural contexts (e.g., engaging visitors in conversations about difficult topics), they can help to generate a sense of commitment, and agency in other contexts; and (2) museum mediators (and other professionals in the space) can play a new role in creating pathways to critical reflection and deliberations about SSI at societal and personal levels. About this latter point, some questions can be asked: *Can and should mediators bring into conversation social, economic, and political angles that are not displayed in the exhibit? Should training courses prepare mediators to critically explore the issues displayed with visitors? Can and should they elicit from, or share with, visitors' positions that are different from those displayed?*

Patterns of (public) engagement in SSI exhibits

Dimensions of scientific literacy can be related to goals of science education to be pursued by/through an exhibit, and therefore, to motivations and expectations about the displays. The models of science communication [Bucchi, 2008; Bucchi & Trench, 2016; Pedretti & Navas Iannini, 2020] can offer concrete examples of how these goals can be achieved through practices established between the exhibits and the audience. In both case studies the deficit model and the sharing of scientific and technical factual knowledge were at play. Detailed information about

contraceptives and sexually transmitted diseases and descriptions of human techno-scientific developments (e.g., turbines) are just some examples of what this model entails. However, what makes a difference and frames a pathway for embracing SSI (and civic approaches to scientific literacy) is the possibility to articulate different models of science communication to a deficit model based on the dissemination of useful and relevant information [Levinson, 2010].

As such, both case studies reflect this articulation moving these installations towards the idea of inviting the audience to participate and engage. *Our World* primarily uses the deficit and the dialogic models of science communication — the latter being courted through a call for personal stories and points of view through the dialogue box. About this, a curator commented: "[The dialogue box] was a way that you provide some sort of profound question and then watch for people's response to it… and, then you know, to challenge that" (Interview, Curator). This was done, prominently, through daily questions posed to visitors about consumption and local issues: "What if we could only eat food raised less than 100 miles from our home. How would your life change?" (Field notes).

Preventing Youth Pregnancy exemplifies the articulation between different models of science communication. These include: making decisions about fictional stories/situations that can impact the rest of your visit (*participation*); being part of a conversation that involves answering complex questions that require your positions, values, and beliefs (*dialogue*); learning about scientific evidence related to sexual practices and associated risks (*deficit*); and, revisiting your perspectives, acknowledging points of view that differ from yours and considering practices that could foster social transformation (*participation*, *dissent, and conflict/action*). Focusing simultaneously on different dimensions of scientific literacy and models of science communication is not an easy task; in fact, this is particularly difficult for a single space (such as an exhibition) that usually provides a very short period of interaction with the public (a mean of 27 minutes, as data from the two exhibits revealed). Despite time constraints, as Zeidler and Sadler [2011] noticed, fostering different dimensions of scientific literacy — through an arrangement of communication models — can provide advantages for decision-making processes related (in this case) to the issues that are approached in the exhibit and, therefore, to possibilities for more critical and complex interactions.

Visitors of SSI exhibits

Through the idea of *challenging beliefs*, museum teams in both exhibits were willing to consider and promote social change in individual and collective instances. When discussing critical issues-based exhibitions, Pedretti [2004] suggests that visitors should be seen as *active commentators* of science and technology issues and *agents of change*. Building on these reflections, and considering SSI exhibits, it is possible to examine the idea of visitors as *moral agents*. This view implies an active consideration of visitors' values, beliefs, and moral systems and how they can contribute new meanings regarding what is being displayed.

When reflecting on students' values and moral systems, Zeidler and Sadler [2011] discuss the opportunities that SSI provide for creating connections with individuals' lives. In this regard, the teen pregnancy exhibit offers explicit

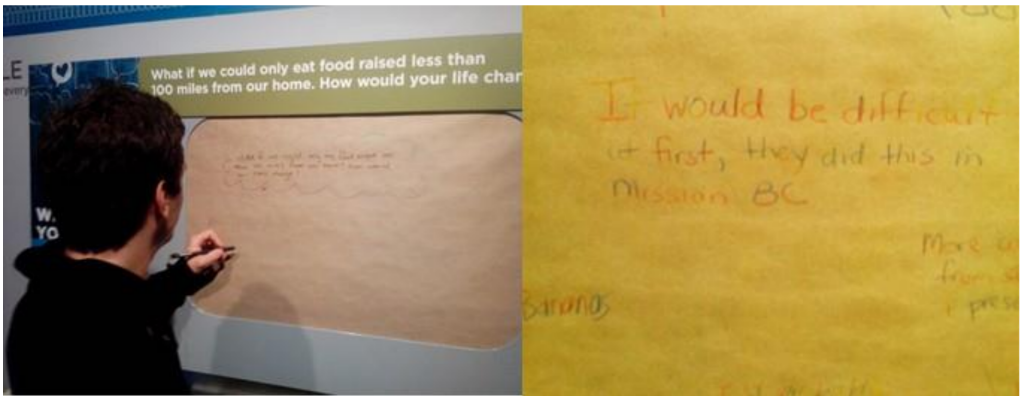

Figure 6. Dialogue box (left) and visitors' responses (right) to the question "What if we could only eat food raised less than 100 miles from our home. How would your life change?". One of the responses reads: "It would be difficult at first, they did this in Mission, B.C." Credits: Ana Maria Navas Iannini.

connections with youth culture and opportunities to consider teenage visitors as moral agents ("what is your personal search about…?", "how do you feel about?") and agents of change ("how do we name this preconception?", "what can we do about it?"; Field notes taken by the researcher from a Mediator's speech). Similarly, in the Canadian exhibit, the dialogue box has the role of eliciting (from visitors) beliefs, values, sentiments, opinions, and, hopefully, pathways for agency about their local environment (Figure 6).

As noted earlier, the display of SSI might have an impact on personal and public spheres. In this regard, Kunz Kollmann et al. [2013] suggest that science museums could be considered places for teaching about science, and at the same time, share authority with visitors, acknowledging that they have an important role in "adding their own knowledge, expertise, values, and personal experiences to these conversations" [p. 174]. Similarly, Lundgren et al. [2019] highlight the possibilities that participatory design methods offer to SSI exhibits.

To some extent, the Brazilian exhibit reveals what it looks like to create opportunities for sharing epistemic authority. *Preventing Youth Pregnancy* had an agenda defined by curators and other actors involved in the production of the exhibit; the exhibit, however, through the work of the sex educators, generated opportunities for visitors to identify and share content, stories, and perspectives that were relevant for them. During the conversations, visitors often found opportunities to share substantial and personal information or ask for needed information. In this way visitors could reframe, contextualize, expand, and personalize the stories being told:

> *Visitor 1: Look at me! I got pregnant!" And I already have a 15-year-old and a girl who is 4…*
>
> *Visitor 2: Maybe you didn't stop to fully consider the issues* [presented in the panels of the exhibit]. *There are so many fantasies as well…*
>
> *Visitor 1: And condoms are not only for avoiding a pregnancy…*
>
> *Sex educator: Information is important to prevent, but it* [prevention] *must be a practice.* (Field notes taken by the researcher in a conversational space)

Furthermore, this exhibit had the potential to provide safe and trustful environments where visitors and museum professionals could experience democratic mechanisms. By considering visitors as *moral agents* and *agents of change*, SSI exhibitions can challenge undifferentiated views of visitors, honour individual voices, acknowledge ways of knowing and being, facilitate social inclusion, and move towards civic dimensions of scientific literacy.

Concluding thoughts

This study examined the role of ISE settings in fostering public engagement with complex SSI. Particularly, the cross-case analysis conducted on the permanent exhibits *Preventing Youth Pregnancy* and *Our World* revealed important aspects of the synergy between theory and practice, funding, civic scientific literacy, and participation.

Firstly, engaging with SSI can be a powerful yet difficult undertaking for ISE settings. As we saw in the exhibits analyzed, institutional tensions marked by sponsorship, patronage, concerns about the nature of the narratives, and contrasting ideas about how to establish a rapport with visitors [Pedretti & Navas Iannini, 2020; Chittenden, 2011; Macdonald, 1998; Meyer, 2009] were at play. In this context, theoretical perspectives about SSI (e.g., pedagogical strategies to engage with SSI, characteristics of SSI exhibits) and science communication (e.g., models of science communication, theory about public engagement) can provide language, context, and support for practice for ISE initiatives willing to join conversations and develop work about SSI. The synergy between theory and practice can be seen as an opportunity for expanding (and questioning) mandates and social roles [Pedretti & Navas Iannini, 2020; Kunz Kollmann et al., 2013], revisiting priorities [Chittenden, 2011; Hine & Medvecky, 2015], and re-imagining how epistemic democracy and two-way communication approaches can be embraced in/through ISE settings [Kunz Kollmann et al., 2013; Lundgren et al., 2019].

Secondly, operational funding is a critical issue for SSI exhibits that do not represent blockbuster revenue opportunities for science museums. Recalling Chittenden's [2011] reflections, exhibits about controversial SSI do not often constitute the focus of admission-driven museums. As such, rethinking operational funding is essential to ensure consistently available resources for these kinds of exhibitions. In light of this, *allyship* can be seen as a promising pathway for temporary SSI exhibits developed and/or hosted by government-line department museums and not-for-profit associations. As Achiam and Sølberg [2017, p. 12] pointed out, relationships with universities, national institutions, and community organizations can generate space for "collaborative efforts, pooled resources and joint decision-making". Although there is a risk that allyships can be ephemeral and/or unpredictable [Chittenden, 2011], if sustained — as it happened with *Preventing Youth Pregnancy* — they can create opportunities for SSI exhibits to endure in short and mid-term projections.

Thirdly, in the broader landscape of the ISE sector, exhibits engaging with complex SSI represent powerful scenarios for nurturing civic scientific literacy [Rennie & Williams, 2006]. The cross-case analysis brought to the fore how science exhibits narratives involving situated and contextualized SSI have the potential to generate commitment about the issues displayed. As we saw in both exhibits, situated issues allow for a kind of engagement that gains depth and enables attachment,

criticality, and opinion sharing [Rennie et al., 2020; Tagüeña, Sánchez & Reynoso, 2011; Zeidler et al., 2019; Yun et al., 2022]. In tandem with these ideas, the role of ISE professionals can be revisited. Training courses and supporting materials (e.g., about the complexities of the subject matter, or desired communication approaches to be established with visitors), can redefine the roles of museum mediators in new and existing exhibitions. With proper training and experience, and within safe environments that acknowledge and honour the sociocultural context, museum mediators can bring into conversations new layers for visitors to consider their own views and perspectives about the topics and narratives.

Finally, when it comes to promoting public engagement about SSI, it is important to consider who visitors and audiences are, what they need, and how they can be involved [Kunz Kollmann et al., 2013; Lundgren et al., 2019]. If ISE initiatives engaging with SSI consider visitors as moral agents and agents of change, opportunities for them to share and co-create knowledge (with scientists, curators, educators and so on) are needed [Lundgren et al., 2019]. Here, the ideas of participatory and co-design methods for SSI exhibits, involving for instance, museum professionals, researchers, and community members [Eikeland & Frøyland, 2020; Lundgren et al., 2019] are powerful and pertinent to this discussion. As Lundgren et al.'s, [2019] pointed out, encouraging multiple forms of participation can foment not just appreciation of SSI, but also critical consideration and action for change.

Acknowledgments

A warm thank you to the museum communities that participated in this study and to the research assistant who contributed to the process of data collection. An extended thank you to MITACS for funding this research.

References

Achiam, M. & Sølberg, J. (2017). Nine meta-functions for science museums and science centres. *Museum Management and Curatorship 32* (2), 123–143. doi:10.1080/09647775.2016.1266282

Aguirre, C. (2014). Science Centers. Which role can they play to participate in a city social reconstruction? *JCOM 13* (02), C04. doi:10.22323/2.13020304

Albe, V. & Pedretti, E. (2013). Introduction to the Special Issue on Courting Controversy: Socioscientific Issues and School Science and Technology / Introduction au numéro spécial sur rechercher la controverse: les questions socio-scientifiques dans les cours de sciences et de technologie à l'école. *Canadian Journal of Science, Mathematics and Technology Education 13* (4), 303–312. doi:10.1080/14926156.2013.847219

Bell, J., Falk, J., Hughes, R., Hunt, G., Parrish, J., Ruffin, M., … Troxel, G. (2016). *Informal STEM education: resources for outreach, engagement and broader impacts. A report by the Center for Advancement of Informal Science Education*. CAISE. Washington, D.C., U.S.A. Retrieved September 2022, from http://www.informalscience.org/informal-stem-education-resources-outreach-engagement-and-broader-impacts

Bencze, L., Pouliot, C., Pedretti, E., Simonneaux, L., Simonneaux, J. & Zeidler, D. (2020). SAQ, SSI and STSE education: defending and extending "science-in-context". *Cultural Studies of Science Education 15* (3), 825–851. doi:10.1007/s11422-019-09962-7

Boeije, H. (2002). A purposeful approach to the constant comparative method in the analysis of qualitative interviews. *Quality and Quantity 36* (4), 391–409. doi:10.1023/A:1020909529486

Bucchi, M. (2008). Of deficits, deviations and dialogues: theories of public communication of science. In M. Bucchi & B. Trench (Eds.), *Handbook of Public Communication of Science and Technology* (1st ed., pp. 57–76). doi:10.4324/9780203928240-11

Bucchi, M. & Trench, B. (2016). Science communication and science in society: a conceptual review in ten keywords. *Tecnoscienza: Italian Journal of Science & Technology Studies 7* (2), 151–168. Retrieved from http://www.tecnoscienza.net/index.php/tsj/article/view/277

Cameron, F. (2006). Beyond surface representations: museums, 'edgy' topics, civic responsibilities and modes of engagement. *Open Museum Journal: Contest and Contemporary Society 8*, 332–342. Retrieved from http://handle.uws.edu.au:8081/1959.7/34066

Chittenden, D. (2011). Commentary: roles, opportunities, and challenges — science museums engaging the public in emerging science and technology. *Journal of Nanoparticle Research 13* (4), 1549–1556. doi:10.1007/s11051-011-0311-5

Davies, S., McCallie, E., Simonsson, E., Lehr, J. L. & Duensing, S. (2009). Discussing dialogue: perspectives on the value of science dialogue events that do not inform policy. *Public Understanding of Science 18* (3), 338–353. doi:10.1177/0963662507079760

Davies, S. R. (2011). The rules of engagement: power and interaction in dialogue events. *Public Understanding of Science 22* (1), 65–79. doi:10.1177/0963662511399685

Dawson, E. (2014). "Not designed for us": how science museums and science centers socially exclude low-income, minority ethnic groups. *Science Education 98* (6), 981–1008. doi:10.1002/sce.21133

Delicado, A. (2009). Scientific controversies in museums: notes from a semi-peripheral country. *Public Understanding of Science 18* (6), 759–767. doi:10.1177/0963662508098577

Eikeland, I. & Frøyland, M. (2020). Pedagogical considerations when educators and researchers design a controversy-based educational programme in a science centre. *Nordic Studies in Science Education 16* (1), 84–100. doi:10.5617/nordina.7001

Fram, S. M. (2013). The constant comparative analysis method outside of grounded theory. *The Qualitative Report 18* (1), 1. doi:10.46743/2160-3715/2013.1569

Government of British Columbia (2003). Environmental Management Act. Chapter 53. Retrieved from https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/03053_00

Government of British Columbia (2022). Waste management. Retrieved from https://www2.gov.bc.ca/gov/content/environment/waste-management

Haywood, B. K. & Besley, J. C. (2014). Education, outreach, and inclusive engagement: towards integrated indicators of successful program outcomes in participatory science. *Public Understanding of Science 23* (1), 92–106. doi:10.1177/0963662513494560

Hine, A. & Medvecky, F. (2015). Unfinished science in museums: a push for critical science literacy. *JCOM 14* (02), A04. doi:10.22323/2.14020204

Hsieh, H.-F. & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research 15* (9), 1277–1288. doi:10.1177/1049732305276687

Kolstø, S. D., Bungum, B., Arnesen, E., Isnes, A., Kristensen, T., Mathiassen, K., … Ulvik, M. (2006). Science students' critical examination of scientific information related to socioscientific issues. *Science Education 90* (4), 632–655. doi:10.1002/sce.20133

Kunz Kollmann, E., Reich, C., Bell, L. & Goss, J. (2013). Tackling tough topics: using socio-scientific issues to help museum visitors participate in democratic dialogue and increase their understandings of current science and technology. *Journal of Museum Education 38* (2), 174–186. doi:10.1080/10598650.2013.11510768

Levinson, R. (2010). Science education and democratic participation: an uneasy congruence? *Studies in Science Education 46* (1), 69–119. doi:10.1080/03057260903562433

Lewenstein, B. (2016). Public engagement. *Reimagining Equity and Values in Informal STEM Education (REVISE)*. Retrieved from https://www.informalscience.org/news-views/public-engagement

Lundgren, L., Stofer, K., Dunckel, B., Krieger, J., Lange, M. & James, V. (2019). Panel-based exhibit using participatory design elements may motivate behavior change. *JCOM 18* (02), A03. doi:10.22323/2.18020203

Macdonald, S. (1998). Exhibitions of power and powers of exhibition: an introduction to the politics of display. In S. Macdonald (Ed.), *The politics of display: museums, science, culture* (pp. 1–21). doi:10.4324/9780203838600-7

McCallie, E., Bell, L., Lohwater, T., Falk, J. H., Lehr, J. L., Lewenstein, B. V., … Wiehe, B. (2009). *Many experts, many audiences: public engagement with science and informal science education. A CAISE Inquiry Group report*. Center for Advancement of Informal Science Education. Washington, D.C., U.S.A. Retrieved from http://digitalcommons.calpoly.edu/eth_fac/12/

Meyer, M. (2009). From 'cold' science to 'hot' research: the texture of controversy. Retrieved from https://shs.hal.science/halshs-00417427

Navas Iannini, A. M. & Pedretti, E. (2017). Preventing Youth Pregnancy: dialogue and deliberation in a science museum exhibit. *Canadian Journal of Science, Mathematics and Technology Education 17* (4), 271–287. doi:10.1080/14926156.2017.1381285

Navas Iannini, A. M. & Pedretti, E. (2022). Museum staff perspectives about a sustainability exhibition: what do they tell us about scientific literacy? *International Journal of Science Education, Part B 12* (1), 1–21. doi:10.1080/21548455.2021.2015638

Otrel-Cass, K., Campbell, A. & Wilson, M. (2012). Fostering opportunities to talk about Science: the value of Café Scientifique. In B. France & V. Compton (Eds.), *Bringing communities together: connecting learners with scientists or technologists* (pp. 187–196). doi:10.1007/978-94-6091-791-2

Pedretti, E. (2002). T. Kuhn meets T. Rex: critical conversations and new directions in science centres and science museums. *Studies in Science Education 37* (1), 1–41. doi:10.1080/03057260208560176

Pedretti, E. (2004). Perspectives on learning through research on critical issues-based science center exhibitions. *Science Education 88* (S1), S34–S47. doi:10.1002/sce.20019

Pedretti, E. & Navas Iannini, A. M. (2020). *Controversy in science museums: re-imagining exhibition spaces and practice*. doi:10.4324/9780429507588

Rennie, L. J., Venville, G. & Wallace, J. (2020). A worldly perspective: applying theory to STEM education. In C. C. Johnson, M. J. Mohr-Schroeder, T. J. Moore & L. D. English (Eds.), *Handbook of research on STEM education* (pp. 39–50). doi:10.4324/9780429021381-5

Rennie, L. J. & Williams, G. F. (2006). Communication about science in a traditional museum: visitors' and staff's perceptions. *Cultural Studies of Science Education 1* (4), 791–820. doi:10.1007/s11422-006-9035-8

São Paulo Government (2020). SP lança campanha 'Gravidez na adolescência é para a vida toda'. Retrieved from https://www.saopaulo.sp.gov.br/spnoticias/sp-lanca-campanha-gravidez-na-adolescencia-e-para-a-vida-toda/

Simonneaux, L. (2014). *Questions Socialement Vives* and socio-scientific issues: new trends of research to meet the training needs of postmodern society. In C. Bruguière, A. Tiberghien & P. Clément (Eds.), *Topics and trends in current science education: 9th ESERA conference selected contributions* (pp. 37–54). doi:10.1007/978-94-007-7281-6_3

Stake, R. E. (2006). *Multiple case study analysis*. New York, NY, U.S.A.: Guilford Press.

Tagüeña, J., Sánchez, C. & Reynoso, E. (2011). El museo glocal y sus audiencias. *6th International Congress for University Museums*, 127–140. doi:10.18452/8610

Weingart, P., Joubert, M. & Connoway, K. (2021). Public engagement with science — origins, motives and impact in academic literature and science policy. *PLoS ONE 16* (7), e0254201. doi:10.1371/journal.pone.0254201

Yacoubian, H. A. & Bazzul, J. (2015). Introduction to the Special Issue on Rethinking Education for Citizenship. *Canadian Journal of Science, Mathematics and Technology Education 15* (3), 211–215. doi:10.1080/14926156.2015.1062940

Yun, A., Shi, C. & Jun, B. G. (2022). Dealing with socio-scientific issues in science exhibition: a literature review. *Research in Science Education 52* (1), 99–110. doi:10.1007/s11165-020-09930-0

Zeidler, D. L., Herman, B. C. & Sadler, T. D. (2019). New directions in socioscientific issues research. *Disciplinary and Interdisciplinary Science Education Research 1*, 11. doi:10.1186/s43031-019-0008-7

Zeidler, D. L. & Sadler, T. D. (2011). An inclusive view of scientific literacy: core issues and future directions. In C. Linder, L. Östman, D. A. Roberts, P.-O. Wickman, G. Ericksen & A. MacKinnon (Eds.), *Exploring the landscape of scientific literacy* (pp. 176–192). doi:10.4324/9780203843284

Zeidler, D. L., Sadler, T. D., Simmons, M. L. & Howes, E. V. (2005). Beyond STS: a research-based framework for socioscientific issues education. *Science Education 89* (3), 357–377. doi:10.1002/sce.20048

Author

Ana Maria Navas Iannini (Ph.D., M.A., BSc) is Assistant Professor at Simon Fraser University (SFU), in the Faculty of Education. She is a researcher in the fields of science education, science communication and science museum studies. She is particularly interested in the ways in which informal science education settings nurture relationships between science and society, commit to social responsibility, and foster civic agency. Ana Maria has numerous academic publications related to the science museum landscape, including her co-authored book "Controversy in Science Museums: Re-imagining exhibition spaces and practice" (Routledge, 2020) derived from her international research on controversial science exhibitions. She has recently received external and internal grants to support her research including

a FAPA Grant by Los Andes University (Colombia, 2020), for a study on public engagement with socioscientific issues in/through science museums. Currently, she is developing a pilot study, funded by SFU, about Canadian science museums' mindful institutional responses to the Covid-19 pandemic.

 anavasia@sfu.ca.

How to cite

Navas Iannini, A. M. (2023). 'Socioscientific issues in science exhibitions: examining contributions of the informal science education sector'. *JCOM* 22 (02), A02. https://doi.org/10.22323/2.22020202.

ISSN 1824-2049. Published by SISSA Medialab. jcom.sissa.it