frontiers | Frontiers in Communication

TYPE Original Research
PUBLISHED 23 November 2023
DOI 10.3389/fcomm.2023.1168598

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OPEN ACCESS

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RECEIVED 20 February 2023
ACCEPTED 09 October 2023
PUBLISHED 23 November 2023

CITATION
Bento A, Catarino AI and Moscoso JA (2023) An exploratory study of the motivations, expectations and impact for scientists coordinating science engagement activities. *Front. Commun.* 8:1168598.
doi: 10.3389/fcomm.2023.1168598

An exploratory study of the motivations, expectations and impact for scientists coordinating science engagement activities

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Public engagement with science and science outreach initiatives have intensified their efforts to prioritize inclusivity and diversity as main core features. In this work, we describe a European-wide science engagement program designed to promote scientific literacy and multilingualism. The program consists of small-group, in-person interventions that foster interactions between scientists and school students from the same migrant community through workshops, delivered in a shared heritage language. Through an exploratory qualitative analysis of open-ended surveys, we analyzed the motivations, expectations and outcomes of scientists enrolled as coordinators in the program. We observed that the scientists coordinating the program have two major sets of motivations to participate: societal motives and personal motives. Furthermore, our results indicate a strong alignment between scientists' expectations and outcomes, in particular regarding the attainment of transferable skills, networking and personal fulfillment. We also explored in more depth the category of personal fulfillment as a motivation, expectation and outcome, leading us to identify the in-person feature of the workshops, as well as the shared characteristics of scientists and audience, as potential engagement factors to be explored in future research. We argue that the concept of embodied narratives, where scientists serve as visible living proof of achievement to a particular audience, can help frame this research.

KEYWORDS

science outreach, scientist engagement, Scientist-student interaction, diversity, inclusion

1. Introduction and state of the art

Public engagement with science (PES) has been fostered over the years using different delivery models for various purposes (Del and Sánchez-Mora, 2016; Scheufele et al., 2021). Following Poliakoff and Webb (2007, p. 244) we rely on a broad definition of engagement that sees "...public engagement as any scientific communication that engages an audience outside of academia". Recently, various PES programs have intensified their efforts to place inclusivity and engagement with diverse communities at the core of their activities (Dawson, 2018; Kennedy et al., 2018; Humm et al., 2020; Ocobock and Hawley, 2020). In these cases, science engagement programs relying on interactions between scientists and the audience using small-group approaches (e.g., school workshops, community gatherings, guided visits, etc.) or group-relevant media (e.g., books, radio, social media, etc.) where the scientists are in-group experts—i.e., scientists have characteristics such as age, gender, language, disability, socioeconomic context, ethnicity, cultural background or other similar to those of the audience—, have emerged as promising initiatives that widen representation and promote scientific literacy (Golle et al., 2022). However, in programs where the scientist-audience interaction is key, most literature examines the impact of the interventions on the audience as opposed to on the scientist. Research looking into the participation of scientists in such programs suggests that disseminating one's scientific work and field, increasing the public's enthusiasm and knowledge for science, improving communication or engagement skills and obtaining personal satisfaction and enjoyment are important motivations for engagement (Martín-Sempere et al., 2008; Woods-Townsend et al., 2015; Fogg-Rogers et al., 2017). The development of communication and engagement skills, the increase of the perception of self-efficacy, the willingness to further participate in these activities, an increased awareness of the challenges posed by these interactions as well as enjoyment, were cited as outcomes of this type of engagement (Grant et al., 2014; Clark et al., 2016; Fogg-Rogers et al., 2017).

Other studies, focused on scientists who did not necessarily participate in any engagement activities, offer more scattered evidence. Drawing upon the Theory of Planned Behavior (Ajzen, 1991)-which states that the main predictor of a person's behavior is their intent -, authors propose that believing that the engagement activity will be an enjoyable experience (attitude), that it will make a difference (response efficacy), and scientists having the time to participate, are the most determining factors (Besley et al., 2018). Using an augmented version of the same theory, which adds additional variables to the framework, Poliakoff and Webb (2007) argued that the most important variables influencing behavioral intent were attitude but also perceived *behavioral* control (perceived ability to participate), and descriptive norms (the belief that other scientists also participate). Within their particular sample, they did not observe that time or career recognition played a significant part (Poliakoff and Webb, 2007). Other studies also did not find that gender, scientific field and age were important predictors, although different articles noted significant differences for the referred parameters (Ecklund et al., 2012; Johnson et al., 2013; Andrews et al., 2018).

When it comes to defining the audience of science engagement programs based on scientist-audience interactions, the vast majority of the programs described in the literature do not pre-defined nor explore the characteristics of the audience prior to the intervention, meaning that they might have missed the opportunity for the scientists to be perceived as in-group experts, which undermines the goals of widening representation or reducing inequalities. In programs conceived to connect underserved and/or underrepresented audiences with scientists, small and meaningful interventions that consider and respect the emotions, interests, values and context (physical, sociocultural, and personal) of the audience are expected to be more effective (Humm et al., 2020).

To carry out effective scientist-audience interactions that connect with the audience at different levels, visual communication, in particular visual narratives, are known to be a critical resource. Visual narratives are a form of storytelling which rely on single or sequential frames of images (Goodnow, 2020), of which visual media, such as photographs, graphics or videos, are some examples. Originally, a narrative can be defined as a story, i.e., a depiction of events which follows logic and structure, and it is a linguistic device that can be used in a written or oral form. Narratives are usually deployed with recourse to key components such as a plot, characters, place and narrator (Goodnow, 2020). The term is widely used in the social sciences as a fundamental way by which individuals, groups and even institutions give meaning and coherence to experiences (Caldeira, 2000; O'Connor, 2000; Mattingly et al., 2009). Narratives are a widespread tool for building identity (Fróis, 2007), advancing a social cause (Beverley, 2005) or shaping collective memory (Sorensen, 2015). In this sense, a narrative is as much a cognitive device, as a literary or social artifact. Visual narratives, more specifically, are a form of visual communication that is not verbal (Aisami, 2015) and an important difference between visual and verbal narrative is the fact that the image is not descriptive but implicit, leaving gaps of interpretation for the receiver (Barbatsis, 2005). In the field of scientific communication, it has been argued that different types of visuals—for example, "information graphics", "data visualization" or "scientific visualization" (de Vasto, 2022)—can bolster effectiveness in delivering a message (Bloomfield and Doolin, 2012; Brander et al., 2014; Lazard and Atkinson, 2014; Krause, 2016). Recently, the communication of science was influenced by the rise of "infotainment", a style of narration that seeks to converge scientific knowledge and entertainment and does not necessarily rely on a scientific interlocutor (Davis et al., 2020). In short, the concept of narrative is elastic and prone to evolve with technological developments.

Creating visually exciting and engaging experiences for students is an integral part of the science engagement program examined in this study. Designed and implemented by Native Scientists, a non-profit organization that broadens the horizons of underserved children through science outreach educational programs, this article focuses on a program that specifically connects scientists and students from the same migrant community through unique and interactive science workshops delivered in the children's heritage language. It is a program that has been taking place every year since 2013 and currently reaches 17 migrant communities in 12 cities across various European countries. The workshops work in a carousel format, where small groups of students—usually 4 students to 1 scientist—rotate between different stations every 15 min, engaging in each station, through dialogue and hands-on activities, with scientists from different fields of science (we call this the "science-tapas" approach). Mentors are trained on how to communicate their work to migrant children. This training emphasizes the need for the scientists' activities to have a coherent structure which has a beginning, a middle and an end, as in a narrative. Scientists are challenged to engage in a dialogue with students in a way that suits their personality and style, to bring materials that foster hands-on engagement and support their narratives—for example, game-like exercises, laboratory materials, samples, prototypes, tools, models, illustrations, or videos—, and to think how children might be

FIGURE 1
Native Scientists mentor carrying out an activity.

able to relate to the specific message they want to transmit. In one workshop, the volunteer brought a diagram and a home-made model of the structure of the intestine, along with some lab materials. She used gummy bears to represent the bacteria that live inside the intestine. In another occasion, the volunteer is doing an activity to measure how much air fits in the lung of a child by having them blow into a bottle (Figure 1). As was said, different activities will be related to different fields of science (i.e., "science tapas approach"), leading scientists to draw upon specific instruments, images and issues. Native Scientists also provides a canvas—a tool through which scientists can better prepare their message and activity to suit the audience they will be engaging with. This tool consists of a template that helps scientists think of the main components of their activity—who is their audience, what is the format of the workshop, what will be the structure of the activity, what is its goal and what materials are going to be needed. The scientists' narrative, the dialogue, and the use of visual elements (i.e., the materials brought to the workshops by the scientists) are considered crucial in this science outreach educational program to provide a positive memorable experience for students.

The Native Scientists' workshops are conducted in the heritage language shared by scientists and students, which typically is not the dominant language in the country or region where students attend school, but is the language through which students interact with their families. Two main components of this model make it stand apart from other scientific communication activities: first, it follows a novel Science and Heritage Language Integrated Learning (SHLIL) approach (Schiefer et al., unpublished; Golle et al., 2022) that derives from the current Content and Language Integrated Learning (CLIL) approach, where the students learn about science in their heritage language rather than a foreign language. Second, it builds upon the concept of scientists as in-group experts and implements a relational approach (Kuper, 1992; Strathern, 1996; Toren, 1996; Haslam, 2004) to science communication, i.e., the workshops draw upon the common cultural background of scientists and students to make science feel part of their identity and a part of their broader relationships and communities. As such, it relies on building a sense of mutual belonging. Both these components converge to help address and mitigate the inequalities that affect first and second-generation migrant students—found to underperform academically (Martin et al., 2016; UNESCO, 2019), to raise the profile of multilingualism and to help strengthen local communities. Through post-workshop surveys conducted along with the participating children, we have found that the program is effective in boosting levels of scientific literacy, as well as perceptions of scientists, science and the use of their own heritage language (Native Scientists, unpublished data).[1] An independent study evaluating the effectiveness of the program on children has also shown that the program boosts migrant students' attainment value for science and self-concept of ability for their heritage language 4 weeks after the intervention (Schiefer et al., unpublished).

There has been little attention given to the scientists who are involved in science outreach programs focused on promoting diversity and representation. For this reason, the goal of this article was to investigate the motivations, expectations and outcomes of the scientists that coordinate (as opposed to mentor) the Native Scientists program for migrant communities, which is carried out as small group in-person interventions in the audience's heritage language. Our specific objectives were: (1) to present and analyze the motivations and expectations of the scientists that coordinate the program's workshops; (2) to present and analyze the outcomes of the workshops for these scientists; (3) to argue for the importance of understanding scientists' participation as embodied narratives in science engagement.

2. Materials and methods

2.1. Open-ended questions

Scientists participating in the Native Scientists program are voluntary and can have two types of roles: the role of coordinating the workshops (coordinators) and the role of creating and presenting a scientific activity to children (mentors). Coordinators play a vital role in the program, organizing and guaranteeing the adequate implementation of the workshops, including recruiting the mentors and supporting them throughout the entire cycle of the program implementation. Our analysis was focused on a preliminary qualitative analysis of open-ended answers given by Native Scientists coordinators to three separate questions:

1. Please state your motivations to become a Native Coordinator (1–3 sentences).

1 After every workshop, children are asked to answer four multiple choice questions: "Did you like meeting the scientists" (the possible answers being: "a lot", "more or less", "not really"); "Did you learn something new?" (the possible answers being: "a lot", "more or less", "not really"); Which word best describes the workshop? (the possible answers being: "fun; boring; amazing; difficult"); "Is speaking more than one language important to you?" (the possible answers being: "a lot", "more or less", "not really").

2. What do you expect to gain from having the opportunity to be a Native Coordinator?
3. How do you feel that participating in Native Scientists impacted you and your work?

The first two questions were answered before the workshop's implementation, when scientists filled in an online questionnaire to join the program. The third question was answered following the same method but after the scientists had implemented one or more workshops. In total, we analyzed the answers received between 2019 and 2021, corresponding to 93 scientists for the first two questions and to 35 scientists for the third question.

2.2. Study sample

Every year Native Scientists trains over 100 scientists to either perform the role of coordinator or mentor. These volunteers are recruited through dissemination efforts led by relevant partners, such as universities, research centers or diaspora research organizations. In the case of coordinators, scientists volunteer to be the liaison of the organization in their city and be responsible for the logistics necessary for carrying out workshops in their heritage language. Once trained and onboarded, these coordinators will act as community organizers, finding and connecting an audience of children from their migrant community with scientists (mentors) who share their heritage language. They engage with mentors in developing the content of the activities and oversee their implementation in schools, embassies and scientific institutions. By performing this role, scientists gain experience in program management, organizational skills and networking beyond the academic setting. The training given to coordinators emphasizes these different aspects and takes scientists through all the necessary phases to implement an engagement activity, from planning and recruiting to overseeing the activity and gathering feedback and disseminating results. These coordinators become an integral part of the organization, being routinely in touch with the core team, actively contributing to the engagement with different stakeholders from their migrant community and, in some cases, carrying out several workshops over many years. A majority of these scientists identify themselves as women (76%) and are either PhD students (55%) or post-doctoral researchers (27%), working in fields such as biology (55%), engineering (11%), mathematics (3%), physics (3%), technology (3%) or other such as social sciences, humanities. Almost half of them (42%) volunteer for the first time in a science outreach program when they engage with the program and, after participation, all scientists rate the experience "good" and "very good", with 97% saying that they would repeat the experience (Native Scientists, unpublished data).

2.3. Qualitative data analysis

To do a systematic analysis of the answers, we followed a method of qualitative content analysis based on the steps proposed by Schreier (2012) while using MAXQDA software. We used the material itself (i.e., the answers content) to generate part of the analysis framework (Thornberg and Charmaz, 2014). This means that the categories used to describe the responses of the coordinators were, in part, obtained by reading the material itself, instead of being based in a specific theoretical framework. The end product was a framework that follows closely the material itself, serving mainly a descriptive purpose.

First, within our "corpus of documents"—i.e., the entire scope of the material available—, we selected a small sample to create a preliminary framework of categories and subcategories. Main categories correspond to main concepts found in the documents, while sub-categories correspond to mutually exclusive dimensions of that concept. The main categories were found to be built into the questions themselves: "Motivations" and "Expectations". The subcategories placed under each of these main categories were reached by reading the sample of documents and using the process of "subsumption": you read the material in search of relevant dimensions, attributing provisional labels that will form categories. You keep reading until you find other relevant dimensions. If a passage does not add anything new, you mentally place it under an already existing subcategory.

What followed was the segmenting of all the content into different mutually exclusive units. We divided the material according to a "thematic" criterion, instead of a "formal" one. This means units of analysis correspond to changes of topics that could fit within a specific subcategory, instead of a "formal" division corresponding to changes of phrase or paragraphs. We used that preliminary framework to carry out a pilot phase and, next, the analysis of all documents (i.e., allocating those unit segments into different subcategories). All analyses were discussed in three group meetings by the three authors, leading to a refinement of the framework itself, which has up to three distinct levels of analyses (i.e., some of the subcategories were themselves attributed dimensions) (Figure 2). The end product was a framework created in an iterative fashion, whose categories not only are representative of the analyzed material but also can be used in further analyses.

2.4. Limitations

There are some limitations to this study that should be considered. First of all, this should be considered a preliminary study since the coding frame was not evaluated for its "reliability" or its "consistency". This means that this framework has the potential to be further refined and tested. Second, the data used for this study was sourced from internal reporting mechanisms of the organization, meaning it was not gathered with research purposes in mind. This has an important implication: because of our concerns with the privacy of the volunteers that collaborate with us, we are not able to use socio-demographic variables to describe the population of this study. This also means that we did not track the response of the same person across the two surveys. Finally, the size of the population considered for the first two questions ($N = 93$) regarding expectation and motivations is substantially larger than the one considered for the third question

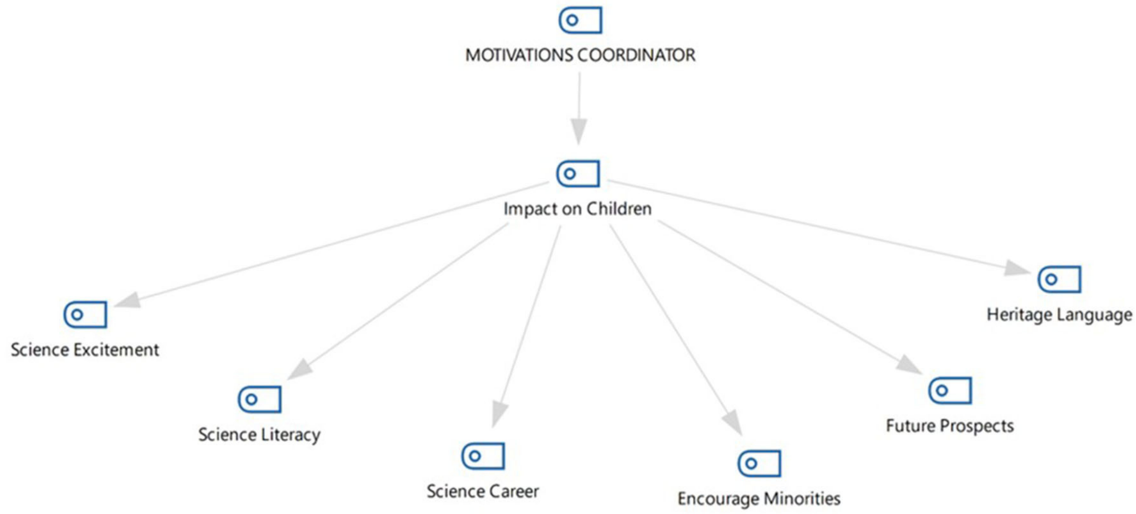

FIGURE 2
Segment of the coding framework.

regarding outcomes ($N = 35$). The reason for this discrepancy is related to the fact that not all people registering to become a coordinator end up following through the necessary steps to occupy that position or, in other cases, manage to organize a workshop.

3. Results

3.1. Identification with the purpose of the program and anticipated impact on children were the main motives

Fourteen categories and twelve subcategories were identified when analyzing the responses of scientists when asked to state their "motivations to become a Native Coordinator" in 1–3 sentences (Table 1). After classifying all the answers according to these categories, results show that the two most prevalent motivations for scientists to enroll in the science engagement program being studied were the identification with the work of the Native Scientists organization (26%) and the anticipated impact on children (25%). The first category encompasses passages referring to the mission, values and methods of the organization. Delving into the subcategories of "Identification with Native Scientists", we can see that many are moved by the general concept of bridging the gap between science and society ("Engage Science and Society"). As one scientist stated: "I am passionate about education and science outreach, which I see as a powerful tool to bring research closer to the general public and to highlight its paramount role in society". Others were driven by the specific concept of the program, believing in Native Scientists "Values" and "Methods": "Native Scientists is a very nice initiative and I identify a lot with its beliefs and commitments." and "To develop a stimulating and interesting approach to promote knowledge exchange and dialogues between scientists and the young public via the prism of language [X]". This last subcategory of motivation points to the role of heritage language in the program. Some scientists understand it as an asset they must pass on, seeking to "Promote Multilingualism" (e.g., "I am also very passionate about language and feel it is really important for bilingual children to have resources in one of their mother languages."), or their heritage language.

The category "Impact on Children" encompasses passages referring to the anticipated impact of the workshops on students. This desired impact is varied, as reflected in the subcategories identified. Some want to foster "Science Literacy". For instance, a scientist says "During the last years I have taken part in many outreach events, some of them with children. [These are] opportunities to show and educate children in science." Others were motivated to incentivize children to follow "Careers in Science", although some specifically direct their attention to engaging minorities: "I would like to encourage children to consider becoming scientists when they grow up, especially minority groups and girls. It is possible to become [a scientist] in a different country and in another language. I do believe that if we want to diminish the lack of representation in science we have to work with our children. It is a fundamental step". Under the subcategory "Encourage Minorities", we also identified passages mentioning questions of ethnicity: "I have always had an interest in science communication, and I am now pursuing this in my masters. As a [national from country X] who moved to [country Y], I am particularly keen to benefit children from minority ethnic groups like myself". Other passages focused on the impact they could have regarding the adoption and promotion of a "Heritage Language", e.g., "I am also born of an immigrant father who did not teach me his mother tongue—something I sourly regret and wish to avoid for other children".

Another prevalent motivation was a desire to engage with the community speaking the same heritage language (8%). As an example, a scientist speaking language X stated that: "Native Scientists is a great project and I would like to support it in [country Z]. It would be great to strengthen the bonds between the

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TABLE 1 List of categories, subcategories and unit count (coordinator survey 2019–2021 motivations and expectations).

1. Motivations coordinator	Unit count	Percentage
1.1 Other	**11**	5%
1.2 Altruistic motivation	**4**	2%
1.3 Impact on other scientists	**2**	1%
1.4 Impact on children	**53**	**25%**
1.4.1 Other	4	2%
1.4.2 Excitement around science	9	4%
1.4.3 Encourage minorities	7	3%
1.4.4 Heritage language	8	4%
1.4.5 Careers in science	4	2%
1.4.6 Science literacy	21	10%
1.5 Identification with native scientists	**55**	**26%**
1.5.1 Belief in native scientists values	3	1%
1.5.2 Promoting diversity in science	4	2%
1.5.3 Promoting heritage language	4	2%
1.5.4 Belief in native scientists methods	13	6%
1.5.6 Connecting science and society	27	13%
1.5.7 Promoting multilingualism	4	2%
1.6 Personal fulfillment	**14**	7%
1.7 Experience in science outreach	**10**	5%
1.8 Networking	**2**	1%
1.9 Transferable skills	**8**	4%
1.10 Sense of opportunity	**7**	3%
1.11 Heritage language community	**18**	8%
1.12 Working with young people	**8**	4%
1.13 Bigger engagement with native scientists	**15**	7%
1.14 Personal enjoyment	**8**	4%
Total	**215**	
2. Expectations coordinator		
2.1 Other	**8**	4%
2.2 Contribution to society	**6**	3%
2.3 Promoting heritage language	**2**	1%
2.4 Personal enjoyment	**10**	5%
2.5 Promoting science	**8**	4%
2.6 Impact on other scientists	**5**	2%
2.7 Heritage language community	**13**	6%
2.8 Impact students	**28**	14%
2.8.1 Other	4	2%
2.8.3 Careers in science	1	0%
2.8.4 Excitement about science	10	5%
2.8.5 Heritage language	3	1%
2.8.6 Science literacy	10	5%
2.9 Experience in science outreach	**21**	10%
2.10 Transferable skills	**50**	27%
2.11 Personal fulfillment	**22**	11%
2.12 Networking	**24**	12%
2.13 Bigger engagement with native scientists	**6**	3%
Total	**203**	

(Continued)

TABLE 1 (Continued)

The values in bold refer to the total number of the units count (and their percentage) associated with each main category. The values not in bold refer to subcategories.

scientists and the rest of the [Language X] community here.” The desire to have a “Bigger Engagement with Native Scientists” (7%), “Personal Fulfillment” (4%), and the interest in having “Experience in Science Outreach” (5%) were also important motivations. “Personal Enjoyment”, a “Sense of Opportunity”, the development of “Transferable Skills”, and an intention to work with young people were less prevalent motivations (4%). Only 1% of the units counted mentioned “Networking” or the “Impact on Scientists” as motivations to enroll in the program. Eleven units (5%) were classified in the category “Other”.

3.2. Development of transferable skills was the main expectation

When analyzing the responses to the question “What do you expect to gain from having the opportunity to be a Native Coordinator?”, thirteen categories and five subcategories were identified (Table 1). The expectation counted more often were the development of “Transferable Skills” (27%). This category encompasses statements that point to abilities gained by participating in the program as a coordinator that can also be used in other settings or contexts. As such, many pointed to the possibility of gaining “leadership skills,” “pedagogic skills,” or “communication skills,” as well as experience in “managing projects” and “events”. Many of the passages of text refereed the expectation of improving teaching skills and, more specifically, of improving and discovering new ways of communicating science. This category was followed by “Impact on Children” (14%), “Personal Fulfillment” (11%), “Networking” (12%) and interest in having “Experience in Science Outreach” (10%). Counted less frequently (2–5%) was the expectation of “Personal Enjoyment,” “Promotion of Science,” “Contribution to Society,” “Bigger Engagement with Native Scientists,” and “Impact on Scientists.” Only 1% of the units identified mentioned “Promotion of the Heritage Language”. Eight units (4%) were classified in the category “Other”.

Of these, it is important to delve into both “Networking” and “Personal Fulfillment” because of their overall weight in the analysis. When speaking of “Networking”, scientists talk of expanding their “professional network” or “meeting colleagues from other disciplines”. Under the category “Personal Fulfillment”, we allocated passages that reflected the feeling of gaining satisfaction or even happiness from carrying out these activities. In some cases, this was expressed as gaining a new perspective on science and scientific practice. A scientist stated that the workshops were "a great reminder of why we continue to do science even if almost all of our experiments fail: the curiosity and the excitement of discovering something new!". Others reveal that it is a way of gaining insight on their own work, e.g., "explaining your work to kids requires striping what we do down to their bare bases, and this requires a true understanding of our areas of work". This sense of personal satisfaction can also be related with the impact of the workshops: "I have been participating in Native Scientists workshops for two years already. Every time we do a workshop I leave with a feeling of happiness due to the fact that I truly believe that some of the kids might have had their first spark of scientific interest due to our workshop". We interpreted this sense of "Personal Fulfillment" as being different from "Enjoyment", which some people also expressed as both a motivation and an expectation. This category was created to address statements which stated the workshops were a "fun" or "enjoyable" experience.

When excluding the category "Other" from the analysis and comparing the identified categories and subcategories in the answers to the first two question on motivations and expectations, we observed a big reoccurrence of categories, i.e., ten out of twelve categories in the responses to the question about expectations were identified as categories or subcategories in the question about motivations. The only categories that did not reoccur were "Sense of Duty," "Working with Young People," "Identification with Native Scientists," and "Sense of opportunity" which are unique to motivations, and "Promotion of Science" and "Contribution to Society" which are unique to expectations. Altogether, these results suggest that the main reasons for scientists to enroll in this program are a sense of alignment with the work of the organization (contributing to society by promoting science, heritage language, diversity and multilingualism through workshops in schools connecting children and scientists from the same migrant community), and the impact that it might have on children. Additionally, the main expected gain from enrolling in the program is the development of "Transferable Skills", followed by the anticipated "Impact on Children," "Networking," and "Personal Fulfillment".

3.3. Personal fulfillment and networking were the main outcomes

When analyzing the coordinators' answers to the question: "How do you feel that participating in Native Scientists impacted you and your work?", thirteen categories were identified (Table 2). Analysis of the answers showed that the main outcomes for scientists with a coordinator role consisted of a sense of "Personal Fulfillment" (19%), "Networking" (17%,) and development of "Transferable Skills" (13%). Other outcomes mentioned were an "Improved Attitude Toward Science Outreach" (10%), "Personal Enjoyment" (8%), "Career Advancement" (8%), "Impact on Research" (6%), "Impact on Teaching Practice" (4%), and "Involvement in Native Scientists" (2%). Other passages reported the participation in the program to be "Time-consuming" (4%), while others (5%) were not found to be prevalent enough to earn a specific categorization.

TABLE 2 List of categories, subcategories and unit count (coordinator survey 2019–2021 outcomes).

1. Outcomes coordinator	Unit count	Percentage
1.1 Personal enjoyment	4	8%
1.2 Impact on research	3	6%
1.3 Other	1	2%
1.4 Teaching	2	4%
1.5 Career	4	8%
1.6 Transferable skills	6	13%
1.7 Personal fulfillment	9	19%
1.8 No impact	3	6%
1.9 Time-consuming	2	4%
1.10 Involvement in native scientists	1	2%
1.11 Networking	8	17%
1.12 Attitude regarding science outreach	5	10%
Total	48	

When comparing answers regarding expectations before participation and outcomes after participation, the data suggests a strong alignment between expected vs. actual outcomes, There were high expectations in terms of developing transferable skills (27% in expectations vs. 13% in outcomes), networking (12% in expectations vs. 17% in outcomes) and personal fulfillment (11% in expectations vs. 19% in outcomes) before participation, and indeed, these three categories not only reoccur in the question after participation, they are also three of the most prevalent outcomes reported.

4. Discussion

The data analyzed in this article was used to better understand the motivations and expectations of the scientists that coordinate and participate in a PES program connecting scientists and students that belong to the same migrant community, as well as the way their participation impacted them and their work. The data suggests that scientists were more motivated to enroll because of the scientific mission of the program (32%)—including "Science Literacy," "Careers in Science," "Excitement about Science," "Connecting Science and Society," or even "Encouraging Minorities" to do science—than by the linguistic mission the program (18%)—including "Promoting Multilingualism", the use of a "Heritage Language", the participation in their "Heritage Language Community". This is not to say that the latter is not relevant as there is an implicit narrative of mutual belonging encompassing scientists, students, and their migrant community at large. It can be that science is seen as a way of building that community. In fact, the categories of "Belief in Native Scientists Methods" and "Values" point exactly to that as they encompass passages attesting to the importance placed on the

10.3389/fcomm.2023.1168598

heritage language to help shape perceptions around science. For instance, one of the scientists said that she was motivated by the idea of promoting "...knowledge exchange and dialogues between scientists and the young public via the prism of [x] language". This reflects an adherence to the idea that heritage language learning can boost science learning and vice-versa, which is a central tenet of the program. In fact, it is not clear how both motivations, the ones centered around science and the ones around language, can be separated when participating in a program which almost erases that distinction in its messaging. To that point, it is important to note that many motivations reflected a desire to have a "Bigger engagement with Native Scientists".

Our analysis further indicates that there is a distinction between motivations and expectations focused on benefiting the communities and/or society (societal motives) and those focused on personal gains (personal motives). This means that there is a set of motivations and expectations that privilege having an impact on other people (40–30%)—such as on children, scientists or even society at large—, and others that privilege a set of skills, knowledge or connections that benefit the scientists themselves (55–66%). This is in agreement with a previous study looking at the willingness of scientists to participate in PES programs and concluding that two of the three most consistent predictors of participation were the belief that it would make a difference (response efficacy) and that it would be an enjoyable experience (attitude) (Besley et al., 2018). The importance of subcategories such as "science literacy" points to the enduring appeal of the "deficit model" in scientific communication, according to which the primary function of these types of activities is to act upon the lack of scientific knowledge by the public (von Grote and Dierkes, 2000; Irwin, 2008).

For the personal motives, categories such as "Personal Fulfillment," "Transferable skills," "Networking," and "Identification with Native Scientists" were considered. This is in line with other research which also identified two distinct groups of motivations for scientists, one relating to "personal" or "professional benefit" and the other to "more altruistic concerns" (Martín-Sempere et al., 2008). However, we should use caution regarding this interpretation. For instance, the motivation categories of "Identification with Native Scientists" and "Networking" can encompass motives that seem personal at a first glance, but might actually have a broader meaning, e.g., "celebrate languages, diversity and multiculturalism," "expand the professional network," or "make good friends and contacts with whom I share the value of promoting science." The category of "transferable skills", in particular, encompasses abilities that are directly related to impacting other people in ways that are not self-beneficial, such as pedagogical skills. For instance, a coordinator stated that: "The [workshop] process allows to understand the specific needs of a particular type of public and improve the way science is taught. Combining non-formal science teaching with the [X] language represents a challenge for the public and a way of improving both skills". This is in line with the orientations of the canvas given to scientists to help them prepare their activities, which suggests tailoring their content, materials and structure to specific publics. These scientists seem to recognize that their work is multifaceted and produces outputs and impacts that go beyond peer-reviewed scientific publications, requiring, therefore, the enhancement of a diverse set of skills. This echoes the proposals by COARA[2] and DORA,[3] which push for the reform and the broadening of the criteria taken into account in researchers' and research institutions' assessment procedures. In any case, it seems plausible to argue that the notion of a purely "civic scientist" (Lane, 1997), defined by some as a scientist's "deep call to action (..) embodied by the individual which gives his or her time and experience as a public service (...) often without forms of recognition or remuneration." (Greenwood and Riordan, 2001, p. 31) does not hold in this case.

We have observed in our data a strong alignment between expected outcomes and actual outcomes. When comparing answers regarding expectations before participation and actual impact after participation, three categories, namely "Transferable Skills," "Networking," and "Personal Fulfillment" recurred with high frequency in both questions. This attests to the success of the program in engaging the scientists. There is, however, an important expectation that does not figure in the outcomes identified by the coordinators—"Impact on Children". One possible explanation is that many of the anticipated impacts like "Excitement about Science," "Science Literacy," or "Careers in Science" are desired long-term impacts and cannot be measured in the short-term or are not immediately visible. Further work is needed to support or address scientists' expectations in relation to this. In fact, it might be the case that the question posed to the participants—"How do you feel that participating in Native Scientists impacted you and your work"—may have inadvertently nudged them toward responses focused more on personal impacts. Another aspect representing a discrepancy of expectations and outcomes is the fact that some passages described the role of coordinator as "Time-consuming", i.e., some scientists thought the program was time-consuming after participation but no scientists expected this to be the case.

Many of the coordinators placed strong importance on "Personal Fulfillment" or even "Enjoyment" when describing the expectations and impact of their participation. Some of them express it in the form of gratitude "I love Native Scientists—I find it refreshing, as a scientist but also as a human being. It gives me the opportunity to be generous with the next generations, to share my love for science but also for people, no matter where they come from and which language they speak". Other scientists also mentioned the importance of PES activities in their own experience: "I recall my own passion of science stemming from, at a very young age, attending school science event[s]. I would love to be a part of making this happen for the next generation of children!".

The importance of personal fulfillment and satisfaction as both an expectation and outcome of the program for scientists merit a deeper inspection. At face value, they hold little descriptive or explanatory value since they already have been identified by other studies as an engagement factor. Based on some passages statements classified under these categories, we can suggest some hypotheses that can be explored through further analysis and study. These are tied to specific characteristics and mechanisms of the program. First, the personal fulfillment mentioned by some coordinators is in some cases tied to the in-person, relational

2 Coalition for Advancing Research Assessment (https://coara.eu/).

3 Declaration on Research Assessment (https://sfdora.org/).

nature of the intervention, alerting us to the importance of the non-discursive–such as affect and emotion—as a factor of engagement of scientists (Davis et al., 2020). For instance, one coordinator described the "satisfaction of seeing happy faces at the end of the workshops coming from the students, their teachers and the [mentors]". Another hypothesis that can be explored in further study is how personal fulfillment is sometimes related with contributing to and connecting with an audience with a shared background and characteristics, in this case, belonging to a common diaspora and heritage language. For instance, a coordinator stated as their motivation: "I would be honored to become a Native Coordinator to promote the interaction between scientists and pupils speaking Italian in Paris". It seems that by bringing together scientists and children from the same ethnic minority background, the visual narratives of the intervention are not limited to the materials presented by the scientists. They are extendable to the scientists themselves, the way they look and behave, the stories they tell, and the dialogue they foster. Hence, the opportunity to serve as embodied narrators can be an important incentive for scientists looking to participate in PES programs whose goal is to widen representation or reduce inequalities.

The concept of embodiment stands for an important evolution in the thinking and practices of social sciences (Csordas, 1990; Mascia-Lees, 2011). It draws attention to the fact that human experience is grounded in the world and cannot be reduced to its textual or symbolic dimensions. Because human beings are inherently social (Toren, 2012, 2016; Pina-Cabral, 2017), this also means focusing on how the concrete relationships and interactions people establish with one another are crucial to finding and producing meaning (van Wolputte, 2004). Hence, based on the results and reflection of this work, one should revise the description of the main components of the science engagement program examined here to include the importance of visual and embodied narratives, not just the visual narratives. In many PES programs, science is communicated through the lens of a shared life story, with the scientists serving as visible, living, proof of possible science careers and achievement. This perspective expands the idea of what a visual narrative can be and forces us to think of it in a broader interactional context. Even the mere presence of a person—in the case of the Native Scientists program for migrant communities, a scientist that shares a heritage language and culture with the audience (school students)—can convey a message or a narrative, contributing (or not) to build trust and relationships that ultimately shapes the audience's perceptions around science.

5. Conclusion

Science engagement programs designed to widen representation in science or reduce inequalities are increasingly common and frequently involve interactions between scientists and audience. Considering that, for PES programs relying on scientist-audience interactions, scientists' motivations for participation and the alignment between their expectations and actual outcomes are vital for a positive experience, we concluded that for the science engagement program, of Native Scientists, being studied, (i) scientists' awareness of the purpose of the program and its anticipated impact on children is important for participation, (ii) the development of transferable skills is not the only expectation that scientists have of their participation but it is the main expectation, and (iii) a strong alignment exists between scientists expected and actual outcomes, especially regarding transferable skills, networking and personal fulfillment. Furthermore, we concluded that the motivations mentioned by the scientists can be divided into two major groups, societal and personal. Finally, we suggest that the concept of embodied narrative can be useful to understand the engagement of scientists in PES programs, specifically for those that build on shared characteristics of scientists and audience.

Data availability statement

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

Ethics statement

Written informed consent was obtained from the individual(s), and minor(s)' legal guardian/next of kin, for the publication of any potentially identifiable images or data included in this article.

Author contributions

AB: Conceptualization, Methodology, Validation, Formal analysis, Writing. AC: Conceptualization, Validation, Writing, Project administration, Formal analysis. JM: Conceptualization, Validation, Writing, Project administration, Supervision, Formal analysis.

Acknowledgments

The authors acknowledge all scientists who have engaged with Native Scientists over the years and contributed to driving positive social change. They also acknowledge Dr. Tatiana Correia, Dr. Sara Marques, Dr. Flávia Viana and Dr. Natacha Ogando, for shaping the program described and/or contributing to developing and delivering the training for the scientists. Finally, the authors acknowledge Dr. Ilaria Dalla Rosa for granting us consent to use the photo depicting her activities at a workshop.

Conflict of interest

AB and JM are employed by Native Scientists, headquartered in London (UK) and Braga (Portugal).

The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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