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How science outreach with children can promote equity and diversity

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Science outreach is key to closing the gap between science and society. However, it often fails to reach those who feel excluded from science or are dismissive of it. By sharing our experience at Native Scientist, we demonstrate how outreach activities can help improve equity, diversity, and inclusion (EDI).

Not all members of society have access to scientific knowledge, and, for various reasons (e.g., cost, location, language, interest), certain groups are underserved and/or underrepresented in science. To tackle inequities in science, public engagement and outreach – in their multiple purposes ranging from entertaining and informing to educating, creating knowledge, enabling, or empowering [1] – are powerful ways to oppose scientific misconceptions and make science more accessible and attractive to everyone, including those who are systematically excluded or who feel that science leaves them out. Questions of belonging, social justice, equity, and exclusion have long been questions of interest in the field of science communication; yet, the participants and audiences of most initiatives predominantly reflect the characteristics and values of dominant groups. Despite being high on the agenda of many universities, research institutions, and funding bodies, public engagement and science outreach activities that target the full sociodemographic profile of the population are still scarce and unevenly distributed [2].

Two major occurrences in 2020 – the Black Lives Matter movement and the coronavirus disease 2019 (COVID-19) pandemic – have put the spotlight on issues of justice and belonging in science and education. They triggered individuals and institutions worldwide to consider a broader dimension of EDI that contemplates the inequities faced by different underrepresented communities (e.g., people with an ethnic minority background, low socioeconomic status, or disability). According to the National Academies of Sciences, Engineering, and Medicine [3], science outreach should ensure that diverse perspectives on science are considered when solutions to societal problems are pursued while increasing the public's appreciation, knowledge, or understanding of science. Thus, an inclusive, empowering model of science communication and outreach involves multiple voices, spaces, and audiences and is mindful not only of the barriers faced by underrepresented and underserved groups but also of the biases that exist when selecting the content, format, location, or language of the activities.

Whereas rigorous social science methodologies (e.g., randomized controlled trials, longitudinal designs, systematic reviews) [4] have yet to be sufficiently applied to the science communication field to provide answers about what works and what does not, findings based on interview and questionnaire data indicate that direct interactions between scientists and audiences in informal settings enhance scientific knowledge and enthusiasm for science. In this context, a promising model for outreach activities includes audience-centered small-group approaches in which participants engage in a conversation-like communication process with in-group experts (i.e., scientists with characteristics similar to those of the target audience; e.g., the same gender identity or cultural background). Activities involving in-group experts can boost feelings of belonging and empowerment, expose participants to relatable role models, provide perspective and guidance, and build a sense of opportunity and confidence [5,6].

Born from a conversation in a pub in London (UK) between Portuguese PhD students and postdoctoral scientists with a common desire to reduce inequities and broaden the horizons of underachieving migrant children, Native Scientist (www.nativescientist.com) develops science outreach programs that are built on EDI values and have the purpose of educating. Its most popular program, Native Schools (Figure 1), was based on the principles described in Box 1 and Figure I in Box 1 with the intentions to both provide a rich, hands-on learning experience between scientists and children and connect migrant students with migrant scientists who have a common cultural background and speak the same heritage language. What began as an adventurous and fun workshop in a London school for Portuguese-speaking children has now become an award-winning pan-European program targeting migrant communities speaking a total of 11 languages (Arabic, Croatian, Estonian, French, German, Greek, Italian, Polish, Portuguese, Spanish, and Turkish) across 28 cities from eight European countries (France, Germany, Ireland, Portugal, Sweden, Switzerland, The Netherlands, and the UK). By bringing together migrant students and migrant scientists, Native Scientist helps create meaningful connections with science among migrant communities, thus boosting students' motivation for science and empowering participating scientists in their careers.

Child: '*The Native Scientist workshop was important because I didn't know there were people like me attending university.*'

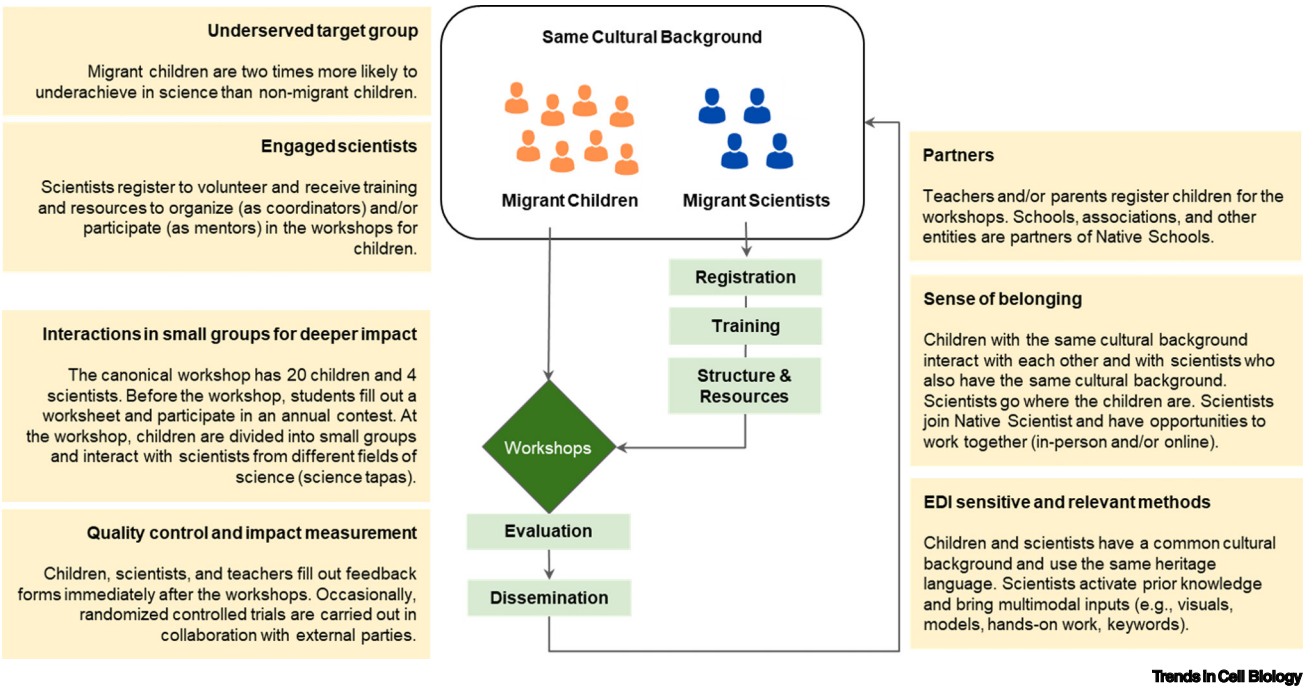

Figure 1. Native Schools – a science outreach program built on equity, diversity, and inclusion (EDI) values. Named 'Native Schools' and conceptualized and implemented by Native Scientist, this science outreach program was created by migrant scientists for migrant children (6–16 years old) to take science and scientists out of their laboratories and offices and place them in schools. Using a workshop format, STEM (science, technology, engineering, and mathematics) professionals engage with students in the scientists' fields of expertise. Students get a 'taste' of science from different disciplines in a single 90-min-long workshop with a carousel-teaching format (a method referred to by the organization as 'science tapas'), and scientists and students interact in their common heritage language, making science feel close and relevant to the students, broadening the students' horizons in relation to science careers and higher education, and boosting students' multilingual skills. The workshops also empower the scientists, who receive training and real-life experiences in communicating science to children. Every year, this program attracts the attention of hundreds of scientists who volunteer to talk about their work to migrant children.

To deliver science outreach programs that are based on direct interactions with scientists, scientists' participation is key. However, the barriers to participating are numerous, and it has been our experience over the years that they can be divided into two main types (Native Scientist, unpublished data): intrinsic barriers (e.g., 'I don't have the time'; 'My research is very specific, and no one outside the field can understand it'; 'What if they ask me about something I don't know?'; 'I don't speak the local language') and extrinsic barriers (e.g., 'My supervisor wouldn't approve of me doing outreach'; 'My institution doesn't have an outreach office'). Nevertheless, many scientists overcome these barriers and effectively engage in outreach, especially when they belong to institutions where outreach is considered normal and beneficial and the available opportunities appeal to them (e.g., they are not too time-consuming, they seem rewarding and fun, they will make a difference, the audience is 'relevant to me', or the initiative is 'in a language I know'). In the particular case of early-stage professionals, engaging in outreach provides research-enhancing opportunities, including gaining new perspectives and networking or practicing a variety of soft and transferable skills [7]. To date, more than 1200 scientists have engaged with students through Native Scientist and have reported gains in their communication skills, project and time management, creativity, and adaptability (Native Scientist, unpublished data). Furthermore, participating scientists describe improved feelings of self-confidence and personal reward, the ability to connect with compatriot scientists, or a reignited passion for science [8]. At a professional level, increased opportunities for project funding, enhanced visibility and recognition, and participation in new interdisciplinary research projects have also been reported.

A critical aspect of the Native Schools program is language. Language is an important dimension when considering EDI in outreach projects, because some groups can be excluded either due to the (excessive) use of technical words or because they are not fluent in the dominant language of a region or country. With Native Schools, linguistic barriers, which can generate feelings of inequality [9], are explicitly tackled by supporting and instructing scientists to organize their interactions around keywords and to simplify their messages. Both students and scientists can also be encouraged to communicate in their heritage

language while using culturally relevant content. Following the example of the acronym STEAM (science, technology, engineering, arts, and mathematics), which denotes the interplay between science and the arts and is a derivative of the popular acronym STEM (science, technology, engineering, and mathematics), we called the Native Schools approach a STEM+LANG (science, technology, engineering, mathematics, and language) approach to highlight the vital interplay between science and language. Adapted from the Content and Language Integrated Learning (CLIL) pedagogy in which new content is learned through a foreign language and vice versa [10], using the STEM+LANG approach for the interactions between students and scientists in Native Schools follows a Science and Heritage Language Integrated Learning method in which students learn specifically about STEM subjects through their heritage language and vice versa (J. Schiefer *et al.*, unpublished). At first, our STEM+LANG outreach concept was controversial because some funders and educators believed that (i) teaching students science in their heritage language could impair their ability to learn in the school language and (ii) the approach targeted only a restricted number of students and did not have a direct whole-school benefit. Yet, with time, the STEM+LANG concept gained momentum and support, especially from heritage language teachers; the school staff responsible for the integration, teaching, and well-being of migrant students; and cultural institutions (e.g., Instituto Camões, Portugal; or Goethe-Institut, Germany). Rooted in pedagogies such as CLIL [10], the science capital teaching approach [11], and the carousel teaching strategy [12], scientists are encouraged to talk about their work and what motivated them to become a scientist using interesting, personally relevant, and hands-on/minds-on activities that emphasize the importance of science and foster children's feelings of competence, belonging, and representation. Using an approach that connects children and scientists with a shared cultural identity, teachers have reported that the Native Schools workshops are an effective way not only to enable the integrated learning of science and language but also to present role models to children.

Teacher: '*Our students thoroughly enjoyed the Native Scientist workshop, including those who may be a bit reluctant to learn. I was very impressed with the design of the workshop and the scientists' abilities to engage our students in their research.*'

Around the world, there are countless numbers of science outreach activities that are designed to get children to engage with science both in and out of school (e.g., see https://falling-walls.com/engage/map or https://system2020.education). These activities can be distinguished from each other on the basis of several criteria, such as format,

Box 1. Seven guiding principles for promoting EDI in science outreach

The following steps were considered key for developing the STEM+LANG approach and the Native Schools program as a whole:

(i) Defining the underserved audience

It is crucial to define and understand the needs of the audience to be targeted as well as to identify the methods and/or platforms most suited to reaching out to the defined audience.

(ii) Supporting scientists

It is important to provide structure and resources to scientists, including training. It is also important to ease the administrative and logistical burden associated with getting involved in outreach activities. Creating a network of like-minded scientists or scientists from the same group as the target audience can be very powerful for both the scientists (by enhancing their confidence and enjoyment) and the audiences (by identifying and overcoming barriers to engagement).

(iii) Partnering up

Mutually beneficial partnerships with representatives of the target group can be key to taking into consideration the target audience's specific needs and interests, especially in the planning and implementation stages of the initiative.

(iv) Opportunities that promote a sense of belonging

Providing evidence-based, informal learning settings and exposure to in-group experts might be helpful for building or improving the target audience's sense of belonging.

(v) EDI-sensitive and relevant content and materials

This involves thinking about how the connection with the audience will be established and will be effective. Sharing stories, materials, and knowledge that are relevant to the target group and with which they can identify is fundamental.

(vi) Quality monitoring and impact evaluation

It is key to assess the desired impact for the short-term to midterm period and creating the tools to evaluate it. Collaborating with entities who are already assessing it, using known frameworks, and working with social scientists to evaluate the effectiveness of the program should be considered.

(vii) Balancing depth and size

This requires considering the depth versus the size of the initiative and providing options so that people can choose what is most adequate. Long-lasting or profound impact may be the most desirable outcome when including EDI in outreach programs. Initiatives with a light touch that reach a large number of participants might not be the most suitable approaches when the aim is to achieve a profound impact in underserved or underrepresented communities.

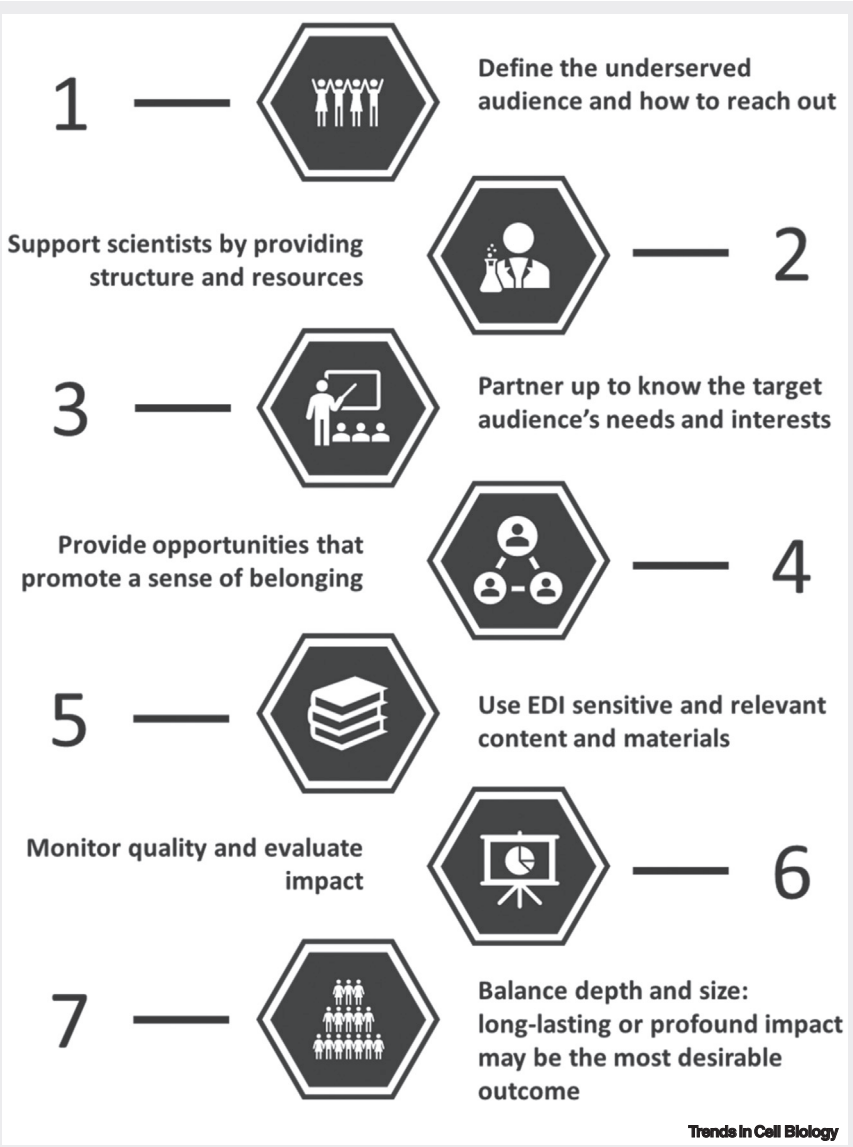

Figure I. Seven guiding principles for promoting equity, diversity, and inclusion in science outreach.

approach, target audience, learning goals, and target region. Native Schools has a similar approach to other initiatives that bring scientists and children together (e.g., Cartas com Ciência, https://en.cartascomciencia.org) or that have been built on EDI values (e.g., LifePorte Educational Project, https://www.facebook.com/LifePorteEdu; Navonmesh Prasar, https://navprasar.org). However, to the best of our knowledge, Native Scientist's approach is unique because it focuses on science and language and in engaging children and scientists from migrant communities through small-group direct interactions. In addition to being innovative, it was also built as a structured and scalable program with well-defined long-term goals of generating impact by establishing meaningful connections between students and scientists and broadening the horizons of ethnic minority and migrant children. By exposing the key characteristics of Native Schools, a science education and outreach program built on EDI values (Figure 1), and explaining the principles that were followed in its conceptualization (Box 1), we hope to inspire scientists and science communicators from around the world and across all fields of knowledge to see science outreach and public engagement from a new perspective. The novel STEM+LANG approach of Native Scientist and the seven guiding principles for promoting EDI in science outreach (Box 1) can pave the way for deeper engagement, commitment, and innovation in the field, ultimately improving access to science and scientific knowledge for everyone.

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Declaration of interests

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: the author J.A.M. is employed by Native Scientist, headquartered in London, UK. The other authors report no conflict of interest.

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