NOVAFCSH
FACULDADE DE CIÊNCIAS SOCIAIS E HUMANAS
UNIVERSIDADE NOVA DE LISBOA

Engaging socially-vulnerable communities in science: exploring Science & Art approaches

Ana Margarida de Almeida Matias

Project Report

Master of Science in Science Communication

March 2019

Project report submitted in fulfilment of the requirements for the degree of Master in Science Communication, conducted under the scientific supervision of Ana Lúcia Mena and Paulo Nuno Vicente.

Como diria o Panda do Kung Fu

"Não há dinheiro que pague a tamanha *altamentidez* e *atraentidez"* de

Miguel

Mariana, Pedro e Gil

Shanti e Ria

De Cabo Verde vestida de coragem,

bebemos esperança dos bebés da casa.

Tenho memórias bonitas do meu bairro,

estou grata pelo amor dentro do museu e

estou feliz porque o meu cérebro está ligado ao Centro de Apoio a Migrantes.

As Marias

Abstract

Social inclusion in science is a complex issue. During the past decades, research centres, science centres, museums and other institutions invested in science communication aiming to promote cultural activities to diverse audiences. Despite this investment, science communicators from all over the world face the same challenge: how to reach citizens that are not interested in science? The main goals for this project were to explore innovative techniques to engage socially-vulnerable communities with science, and propose a model of science communication built on this practice-based research. The project, named "Embodying Memories", was developed in a collaborative way between science partners (IGC - Instituto Gulbenkian de Ciência, iNOVA Media Lab), art partners (museum from FCG – Fundação Calouste Gulbenkian) and administrative partners (Câmara Municipal de Oeiras). The target audience, a senior community of women, most illiterate and migrant from Africa, was involved on the project plan since early stages, starting with the topic choice - Memory. The project implementation consisted of eight sessions that took place over a period of more than two months in 2018, covering several themes related to memory and brain. Diverse formats were used for the session's activities, from scientific presentations, neuroscience stories or study cases, community memories sharing, to more interactive activities stimulating body movement, abstraction and self-expression. Besides in-door sessions at the migrant support centre, a visit to the FCG museum and a visit to IGC laboratories were organized, and a project public presentation was performed. The project was qualitatively evaluated to identify changes in awareness, knowledge, engagement, attitude and social inclusion, which was made by the analysis of field notes, attendance record, pre/post assessment focus group, community project evaluation, project narrative, and public presentation content. Overall, it was considered that the project had a moderate achievement, from a balance between very high attendance and willingness to participate in new cultural experiences, high engagement with the project, moderate increase in knowledge about neuroscience, and some increase in awareness and engagement with science, stimulation of curiosity, abstraction and self-expression. To achieve a high level of engagement, a dynamic equilibrium was constantly in a trial between the six axes of the project (science education, art education, cultural entertainment, social inclusion, mental health promotion, institutional advertising), and respective institutions. The most important project achievements were the fluidity and fruition of the project itself, and the opportunity given to participants to engage with Science & Art, to visit the museum and laboratories, to meet scientists and science instruments. A relevant asset of the project, was the existence of the boundary spanner, which was developed along pre- and during sessions by taking actions, visits, share experiences and events to inhabit the laboratory sphere, the museum sphere, and the community world. The role of the boundary spanner was crucial, yet challenging to balance between how much would be desirable for each partner to stay in and out of their comfort zones and territories. Based on insights gained from the project development and evaluation, a model was proposed to guide science communication projects using Science & Art approaches to promote social inclusion. The model entails the following phases: Phase 1. Design, plan and collaboration; Phase 2. Implementation; and Phase 3. Evaluation.

Resumo

A inclusão social em ciência é um tema complexo. Todavia tem-se assistido nas últimas décadas a um esforço crescente por parte das instituições de investigação científica, dos centros de ciência, museus, e outras organizações, na promoção de atividades culturais dirigidas a públicos diversificados. Apesar deste investimento, por todo o mundo os comunicadores de ciência deparam-se com o mesmo desafio: como chegar a cidadão que não estão interessados em ciência. Os objetivos principais deste projeto foram a exploração de técnicas inovadoras de envolvimento de comunidades socialmente vulneráveis em ciência e a proposta de um modelo de comunicação de ciência decorrente desta investigação de base-prática. O projeto, denominado "Dar Corpo às Memórias", desenrolou-se de forma colaborativa entre os parceiros científicos (IGC - Instituto Gulbenkian de Ciência, iNOVA Media Lab), artísticos (museu da FCG – Fundação Calouste Gulbenkian) e administrativos (Câmara Municipal de Oeiras). O público-alvo, uma comunidade sénior de mulheres maioritariamente iletradas e migrantes de África, foi envolvido no projeto desde as fases iniciais, começando na própria escolha do tema – Memória. A fase de implementação do projeto consistiu num conjunto de oito sessões, ao longo de mais de dois meses, durante as quais foram abordados vários temas ligados à memória e ao cérebro. As atividades tiveram natureza diversa desde a apresentação de informação científica, narrativa de histórias da neurociência ou casos de estudo interessantes, partilha de memórias das participantes, até atividades mais interativas de estímulo ao movimento, à abstração e autoexpressão. Além das sessões que decorreram no centro de apoio a migrantes, foram também efetuadas duas visitas (ao museu da FCG e aos laboratórios do IGC) e uma apresentação pública do projeto. O projeto foi qualitativamente avaliado para identificar mudanças de consciencialização, conhecimento, envolvimento, atitude e inclusão social, com recurso à análise das notas de campo, registo de assiduidade, pré/pós grupos de foco, avaliação qualitativa feita pela comunidade, narrativa do projeto feita pela comunidade e conteúdo da apresentação pública. De forma global, considerou-se que o impacto do projeto foi moderado, com níveis de participação e abertura a novas experiências culturais muito elevados, elevado envolvimento com o projeto, moderado aumento de conhecimentos nas áreas das neurociências, e algum aumento de consciencialização, envolvimento com a ciência, estímulo da curiosidade, abstração e autoexpressão. Para atingir elevados níveis de envolvimento, foram efetuadas constantes tentativas de equilíbrio dinâmico entre os seis eixos do projeto (educação científica, educação artística, animação cultural, inclusão social, promoção da saúde mental, publicidade institucional) e respetivas instituições. Os maiores sucessos do projeto foram a sua própria fluidez e fruição e a oportunidade dada às participantes de envolvimento com a ciência e a arte, participação numa visita ao museu e noutra aos laboratórios, o encontro com cientistas e os instrumentos da ciência. Uma mais-valia relevante do projeto foi a existência de uma "boundary spanner" – uma pessoa facilitadora de várias valências - , que se foi desenvolvendo durante as fases pré-sessões e durante as sessões, através de ações, visitas, partilha de experiências e eventos para habitar a esfera do laboratório, a esfera do museu e o universo da comunidade. O papel do "boundary spanner" foi crucial, mas também desafiante, na medida em que requereu uma avaliação do quão cada parceiro estava disponível para permanecer ou sair da sua zona de conforto e territórios. Com base nos conhecimentos ganhos durante o desenvolvimento e avaliação deste projeto, foi proposto um modelo para projetos de comunicação de ciência para a promoção da inclusão social com recurso a abordagens de ciência & arte. O modelo consiste nas seguintes fases: Fase 1. Conceção, planeamento e colaboração; Fase 2. Implementação, e Fase 3. Avaliação.

Index

1. Introduction

1.1. Science & Society

Science and technology are embedded in every aspect of modern life (McCallie *et al.* 2009), therefore science literacy is considered an essential component of a democratic society, supporting a modern technology-based economy and promoting the cultural values of society (Falk *et al.*, 2007). Moreover, Science, Technology, Engineering and Maths (STEM) are enablers; they enable people to make sense of the world around them, they enable people to make informed decisions, and they enable people to pursue a wealth of exciting and fruitful career opportunities (Atkinson *et al.*, 2014). A mature science culture is a complex of high literacy, sceptical but utilitarian attitudes, and moderate interest, and these are part and parcel of a productive knowledge society (Bauer, 2008). Consequently, to pursuit this maturity the society needs to build a multi-element resource system that includes teachers, schools, governments, scientists, science communicators and science institutions and create an extensive, spacious arena for cooperation and collaboration (Donghong and Shi, 2008). As such, informal science learning, broadly defined to include attitudinal and behavioural change, as well as changes in conceptual understanding, plays an increasingly important role in cultural engagement, political practices (Dawson, 2014b) and is a lifelong endeavour (Falk *et al.* 2007).

In this work the term publics, as opposed to public or general public, is used to acknowledge the multiple identities and diversity that exist within the concept of public [as suggested in McCallie *et al.* (2009)]. In a survey undertaken by Grand *et al.* (2015) in a UK University, researchers gave a wide range of responses about the communities with which they engaged: media professionals, teachers, parents, school pupils, learned societies, health-care professionals, patients, policy-makers, non-governmental organizations, companies, industrial partners, charities, community groups, voluntary and third sector organisations, university students and anonymous audiences such as viewers, listeners and readers of mass media. This diversity highlights the challenge of identifying the publics in engaged research, and the need for resources to support the processes of public formation.

The discussion of science communication has moved through three paradigms: science literacy, public understanding of science and science and society (e.g., Bauer *et al.*, 2007). Goals for science and society, in addition to mutual learning, include civic engagement skills and empowerment, increased awareness of the cultural relevance of science, and the recognition of the importance of multiple perspectives and domains of knowledge to scientific endeavours (American Association for the Advancement of Science, 2019). The British House of Lords report, published almost two decades ago, stated that public confidence in science had been severely eroded and that science should engage the public with direct and full-scale activities (House of Lords, 2000). Public Engagement with Science (PES) can help facilitate science literacy through Informal Science Education (ISE), even though PES does not specifically include science literacy as a goal. The concept PES is substituting its predecessor, public understanding of science (PUS), and refers to activities, events, or interactions characterized by mutual learning among people of varied backgrounds, scientific expertise, and life experiences who articulate and discuss their perspectives, ideas, knowledge, and values (McCallie *et al.,* 2009). PES recognises not just the mutual learning that occurs by publics and scientists during their interactions (Bultitude, 2011), but also the increased familiarity with a breadth of perspectives, frames, and worldviews (American Association for the Advancement of Science, 2019). There are a vast range of approaches to engaging public

audiences with scientific concepts; Rowe and Frewer (2005) identified around a hundred participatory activities and Mesure (2007) identified 1500 active initiatives within the UK alone. Nevertheless, PES experiences focus on current science or science-related societal issues, such as stem cell research and cloning; evolution and science education; STEM and national security; bioterrorism; energy policy; sustainable development; the environment; climate change; genetic medicine; emerging infectious diseases; genetically modified foods; space exploration; and nanotechnology" (American Association for the Advancement of Science, 2019). For example, Newton's Law and Ohm's Law are not typically good topics for PES, although they may be for PUS (McCallie *et al.,* 2009); there is little controversy around them and therefore little room for discussion in a PES context or for public input.

Thousands of organizations dedicate themselves to developing, documenting, and improving science learning in informal environments for learners of all ages and backgrounds. They include informal learning and community-based organizations, libraries, schools, think tanks, institutions of higher education, government agencies, private companies, and philanthropic foundations (Bell *et al.*, 2009). Informal environments include a broad array of settings, such as family discussions at home, visits to museums, nature centres, or other designed settings, and everyday activities such as gardening, as well as recreational activities like hiking and fishing, and participation in clubs (Bell *et al.*, 2009). Historically, most of the focus of science education has been on pre-college and college level schooling; however, a growing body of evidence supports the assertion that science learning occurs in other places for other reasons, particularly when one looks beyond schooling for the source of that understanding. For example, people learn about science while engaged in personal investigations, through civic organizations and active leisure pursuits, such as visits to national parks, science centres and botanical gardens (Falk *et al.*, 2007). Adults take their children to these settings because they feel such experience are worthwhile, educational and fun, and that they and their children learn science in the process [e.g., Borun *et al.* (1997), Rounds (2004), Ballantyne and Packer (2005)]. Similar motivations and findings can be ascribed to watching nature or science specials on television, using the Internet to access science-, environmental- or health-related information, and engaging in science-related hobbies and special interest groups (e.g., Elder *et al.,* 1998; Eveland and Dunwoody, 1998; Batts *et al.*, 2008; Warden, 2010). Science learning is a natural and common outcome of living within a science-rich world, situated within the activities of everyday life. This more asset-based perspective, characterized as socio-cultural-centred by some investigators (e.g., Brown *et al.*, 2005), posits that science learning, like all learning, is driven by each individual's need to know. From this perspective, PUS is not some generalized body of knowledge and skills that every citizen should have by a certain age, but rather a series of specific sets of only moderately overlapping knowledge and abilities that individuals construct over their lifetimes (Falk *et al.,* 2007). For example, it has been shown that amateur astronomers are highly knowledgeable about astronomy, and years of club membership and engagement in education and public outreach activities are far better predictors of their astronomy knowledge than is formal training in science and astronomy (Berendsen, 2005). On the other hand, in an informal conversation in 1990 with the geophysicist Robert Hazen about a recent earthquake, a Nobel Prize-winning chemist stated that never heard of plate tectonics (Pool, 1991). The nature of science learning is changing worldwide as individuals have unprecedented access to science education opportunities from cradle to grave, 24/7, through an ever-growing network of educational opportunities beyond schooling which include visits to museums, zoos, aquariums, science centres, natural area parks and reserves, television, radio, films, books and magazines, and increasingly through

personal games, podcasts, the Internet, and other social networking media (Falk and Dierking, 2012). While schools and mass media will doubtless continue to represent important sites for learning and engagement with science, a growing theme within the science education literature focuses instead on the roles played by other forms of so-called 'informal' or 'free-choice' science education (Dawson, 2014a).

1.2. Science & Art

In 1959, C.P. Snow described the communication between science and art as difficult. In the Rede Lecture "The two cultures" (Snow, 1959a) and then on the book "Two Cultures and the Scientific Revolution"(Snow, 1959b), Snow called attention to the dichotomy of "two cultures", recognizing that the intellectual life of the whole of western society was increasingly being split into two polar groups: at one pole the literary intellectuals, at the other scientists. Between the two a gulf of mutual incomprehension—sometimes (particularly among the young) hostility and dislike, but most of all lack of understanding. In relation to this polarisation, Snow believed it was sheer loss to all, to people, and to society. It is at the same time practical and intellectual and creative loss, and it is false to imagine that those three considerations are clearly separable.

Today, communication is seen as a necessary (but insufficient) contribution to science and society's dialogue to reintegrate science within culture. Scientific thinking and activities are not outside culture, but well within; science in not another culture, alien to society (Donghong *et al.*, 2008). Scientific discoveries and technological advances are seen by many as cultural achievements, as worthy in shaping the average person's concept of self and a person's worldview as philosophy, art, humanities, or the personal sphere. They are part of humanity's cultural achievements and should be familiar to members of a modern, knowledge-based society (Falk *et al.,* 2007). Moreover, knowledge is a plural and malleable phenomenon that can comprise different epistemic forms and ultimately different rationalities, a concept named as cognitive polyphasia by Jovchelovitch (2002). Arts and sciences may seem opposite poles at first sight; yet both are looking for the essence of things and both need creativity and perseverance (Scheffer *et al.*, 2017). Shein *et al.* (2015) in an innovative study of publics of art museums and science and technology museums demonstrated the existence of a group of citizens open to a diverse selection of museum exhibits, which the authors named the "third culture", that complements to Snow's dichotomy of "two cultures". On this study's third culture group, those who are knowledgeable and interested in science could be as likely to visit art museums as science museums.

Strategies fusing arts and science (e.g. using games, poetry, music, painting, sketching) are becoming a favoured medium for conveying science to the public. Collaborative projects between artists and STEM fields are not new, with renewed interest over the last decades (Heras and Tàbara, 2014). Following this, STEAM (Science, Technology, Engineering, Mathematics + Arts and Humanities) integrations and cross-pollinations are becoming more relevant than ever (de la Garza and Travis, 2019). Science can benefit from philosophical, ethical and aesthetic insights, in order to better deal with issues of uncertainty and contingency. Conversely, arts and humanities disciplines can be energized by scientific understandings of dynamic processes, technological innovations and the process of exploration and discovery.

The role of the arts in communicating issues has a long tradition in the humanities, but it has been often overlooked by scientists (Belfiore and Bennett, 2007). Science & Art true cross-sectoral collaboration requires the combined efforts of one or more individuals from each sector to achieve common goals. They result in new knowledge or understanding that could not be achieved through a single sector alone (Metcalfe *et al.*, 2008).

Arts are able to attract larger audiences (Opermanis *et al.*, 2015), and the arts, together with science, can make the 'invisible visible' (Curtis, 2009). A maturing body of work indicates that the arts can deeply engage people by focusing on the affective domain of learning (i.e., engagement, attitude, or emotion) rather than on the cognitive domain (i.e., understanding, comprehension, or application), which is often emphasized in science education (Friedman, 2013). The objective of science communication through art is to bring science to the public in ways that are engaging, instructive, artistic and, always, content-driven (Schwartz, 2014). Examples of Science & Art projects for science communication are theatre as a way of communicating coastal risk (Brown *et al.,* 2017), hip-hop dance as a way of learning ecology (Wigfall, 2015), or art installations inspired in neuroscience laboratories (Lopes 2015). Varelas *et al.* (2010) observed that while participating in a play representing STEM concepts, students engaged in comprehending science from multiple perspectives. Embodied exercises situate abstract concepts in a concrete context, thus relating intangible ideas with corporeal information, and so rich multimodal distributed neural representations are forged (Hayes and Kraemer 2017). Chang (2015) compiled and environmental science artwork database that consisted of 252 artworks, but only 4% included artistic mediums like poetry, dance and performances; the majority was from the visual arts domain.

1.3. Science & Social Inclusion

Informal science education has been found to provide participants with opportunities to engage with science in ways that are inspiring, relevant and educational in both affective and cognitive terms; questions remain, however, about how accessible, inclusive and equitable ISE practices are (Dawson, 2014a). The theme of social inclusion in the science communication field is not new; the political value of science communication was explicit in many cornerstones of the history of this field (Massarani and Merzagora 2014). There is a broad consensus among governments, industry, and the science communication community that more needs to be done to increase and widen participation in science, particularly in areas such as physical sciences and engineering and among those from under-represented groups, such as women, working-class, and some minority ethnic groups (Archer *et al.,* 2015). A survey conducted by the British Science Association (2016) to 516 science communicators and public engagement practitioners in the UK showed that 45% targeted children (that represent about 16% of the UK population), with only 9% targeted those aged 65 and over. This is highly skewed towards school age children. The majority of science communicators that participated in the survey targeted those who are 'open' to science (59%); while the percentage serving those who 'do not currently think science is for them' (20%) is low compared to the proportion of the actual population in this group (30%).

Across Europe, opportunities to participate in ISE activities appear to be increasing. In 2004, it was estimated that 35 million European citizens, of whom 37% are youngsters, visit science centres and museums in Europe every year – i.e. about 10% of the whole population of Europe (European Commission 2004). However, European Union participation statistics in the field of adult lifelong learning demonstrate that those with the lowest levels of qualifications, from the

lowest socio-economic backgrounds and in the least knowledge intensive jobs do not strongly engage with education and training (Boeren and Whittaker, 2018; Desjardins *et al.*, 2006). In the UK, white, middle-class people living with their families in urban areas are more likely to participate in activities ranging from visits to botanic garden, aquaria and museums to science talks or science festivals (Dawson, 2018). Likewise in USA those most likely to participate in science communication activities are more educated, earn more money and have young children in their household (Bell *et al.*, 2009). Data from a 2012 report from the US National Science Foundation suggest that informal learning education inaccessibility and non-participation are marked by age (with older people participating less), family status (those without children participate less) and social class (those in working-class and lower socio-economic positions participate less); and it is interesting to note that ethnicity and gender were not mentioned in the US data (Dawson, 2014a).

While in the last 30 years the public have become plural and heterogeneous, this nod towards plurality does not tell the full story (Dawson, 2018). The exclusion from science communication activities is not only a statistical fact, but also a neglected matter on communication research. The field of science communication has too often neglected social class as a variable (Dawson and Jensen, 2011). There is a great deal of empirical research on how visitors to museums, science centres, aquaria or other informal science learning environments behave, learn, socialise or recall their visits, however there is comparatively little research on questions of access, inclusion/exclusion, 'non-visitors' or 'new-audiences' (Dawson, 2014a). Research by Falk *et al.* (2012) that reviewed 553 articles (between 1980 and 2011) on 'free-choice learning' and 'informal science learning' found that only 27 addressed participants, visitors or audiences who could be considered disenfranchised in some way, suggesting that questions of inclusion and exclusion from ISE are under-researched and questions about ISE participants narrowly framed.

Archer *et al.* (2015) proposed the concept of "science capital" to supplement the influential French sociologist Pierre Bourdieu's theory. Bourdieu conceptualized "cultural capital" as the legitimate, valuable, and exchangeable resources in a society that can generate forms of social advantage within specific fields (e.g., education) for those who possess it. Bourdieu identified four key types of capital— economic, social, cultural, and symbolic capital—which through interactions with habitus (a person's internalized matrix of dispositions, which guides behaviour) within fields (social contexts), produce relations of privilege or subordination within society (Bourdieu, 1986). The conceptual model of "science capital" proposes that scientific forms of cultural capital (comprising scientific literacy, a cultural appreciation of science, particular symbolic forms of capital regarding the transferability of science qualifications), behaviour and practices (including consumption of science-related media and out-of-school science learning contexts) and social capital (knowing people with science-related jobs, qualifications, talking to others about science) can have a significant use-value and/or exchange-value within society (Archer *et al.*, 2015). However, Jensen and Wright (2015) contend that the phenomena described as "science capital" should remain within the bounds of "cultural capital", given that science and other forms of legitimate culture occupy similar social space and have similar consequences; it is just one element of a larger unjust sociocultural system. There are similarities in patterns of exclusion in cultural participation and science engagement activities, including overlap between consumers of arts and culture experiences more generally and those who attend science museums and events (e.g., Jensen, 2014). The Taking Part survey, which measured engagement and non-engagement in culture, leisure and sport in England, showed that people who live in the lowest socioeconomic status

areas of England are significantly less likely than those in the highest socioeconomic status areas to visit museums and galleries, heritage sites and public libraries and they are also less likely to engage in arts (Department of Culture, Media and Sport, 2010, in Atkinson *et al.*, 2014). Results of Archer *et al.* (2015) study with 3,431 students from 45 schools across England, showed that science capital appears to align closely with cultural capital. Results of Kennedy *et al.* (2018) study with three major UK science festivals showed that for the majority of attendees, science festivals are simply one of many activities on the agenda of highly culturally active citizens. It must be stressed, however, that when Archer *et al.* (2014) firstly presented the concept of science capital, they did not propose "science capital" as a separate type of capital but rather a conceptual device for collating various types of economic, social and cultural capital that specifically relate to science. To address the equity challenge in public science communication, new tools and communication approaches are needed, and it would be helpful to document promising practices for inclusion from events around the globe (Kennedy *et al.,* 2018). Moreover, the authors propose that effective social inclusion efforts should be viewed as a key mark of event quality.

1.3.1 Projects for Social Inclusion in Science

The number of projects specifically designed and executed for social inclusion increased number during recent years, but still numbers are relatively low. Described below are eight examples of social-inclusive projects of science communication: 1) "Urban Garden" for youth in USA (1998); 2) "Questioning Workshops" for children in Palestine (2009) and Croatia (2013); 3) "Parque Explora" open for all in Colombia (2007); 4) "Native Waters" open for all in USA (2003); 5) "Knowledge Rooms" open for all in Austria (2013); 6) "Scientific Racism" for adults in the UK (2007); 7) "Creative Canals" for adults in the UK (2003 - 2009); and 8) "Propage" for adults in France (2014). These projects cover different scientific areas and require contrasting resources.

Most inclusive programmes are intended for youth, which is the case of the "Urban Garden" project. A nine-month community-based science project [described in detail in Fenichel and Schweingruber (2010), and Fusco and Barton (2001)] was developed with more than 40 children and teenagers living on a large homeless shelter in New York City that housed up to 200 families. The majority of the youths revealed that the shelter felt like prison (Fusco and Barton, 2001). Discussions about issues and concerns of the teenagers were the basis to decide what action/practice to create, that turned to be to transform an empty lot (filled with garbage, drug needles and other debris) into a usable public space. Teenagers collected relevant information, develop several plausible ideas and did conceptual drawings of the space. The agenda was shared with the group, and they had the option of not acting on suggestions; in fact, there were several sessions in which they played basketball or baseball, developed improvisational skits rather than working directly on the design of the lot. The science was enacted in the processes and methods by which the young people questioned urban violence, brainstormed ideas for bettering their community and tested their feasibility, in researching the lot – its physical (size, soil quality, living and non-living characteristics) and social elements [history as a garden, current contents that reflected political and economic conditions (Fusco, 2001)].

A shorter duration project was the "Questioning Workshops" for children in Palestinian schools, by "L' Atelier des Jours à Venir" (a French NGO for scientific culture) facilitated during the Science Days of Palestine, in 2013 (Perié *et al.*, 2014). The same organization also

performed research-based activities combined with sport and theatre activities, in Vukovar, a Croatian city, in 2009, where young Serbs & Croats still lived quite apart. These initiatives intended to let people experience scientific research and its values as tools for empowerment, which is particularly relevant whenever the target population is experiencing poverty, segregation, ongoing conflicts or their aftermath, and needs to collectively find answers to their problem (Perié *et al.,* 2014).

An excellent example of high-budget inclusive science communication developed for all ages was the creation of "Parque Explora", a science centre located in Moravia (Medellin, Colombia), a zone of great vulnerability, with a very low index of human development and quality of life (Aguirre, 2014). Within Moravia area of influence, 2'654 families were living in 10 acres of lands, in a mountain 35 meters high, totally made up by 1.5 million tons of garbage. Parque Explora developed programmes to foster neighbouring communities' reception to science and technology, to strengthen bonds with its immediate surroundings and to contribute to the reduction of the existing technology gap of the inhabitants of this area of the city. From this major project, Aguirre (2014) acknowledges that science museums should engage in creating scenarios for different audiences based on scientific and citizenship skills; should work with developers and neighbourhood leaders in vulnerable communities for a close relationship with the population; and alternative languages such as art, science and experimental activities become relevant for the approach to complex communities, which are more easily committed to the process if they feel involved in the formulation and understanding of the problem.

The "Native Waters: Sharing the Source" was a traveling exhibit designed by the Montana State University in conjunction with the Science Museum of Minnesota to share cultural views about water held by the tribal peoples of the Missouri River Basin as well as scientific concepts about the Missouri River and its watershed [description in detail in Sachatello-Sawyer and Cohn (2005), and in Fenichel and Schweingruber (2010)]. The process of developing the exhibition began by conducting over 100 interviews to tribal elders, resource specialists, educators, and cultural specialists about what they believe young people needed to know about water. The broad array of responses included cultural beliefs, cultural practices, water science, language preservation, water law, water rights, water quality, sources of contamination, environmental justice issues, and water history (Sachatello-Sawyer and Cohn, 2005). The ~46 m^2 exhibition was set up like an Indian tipi, with the inside space designed as a place to hear stories about native culture. It included a sculpture of a spring, panels of quotes from elders and tribal members, of sunrise, sunset, and the phases of the moon, and on the tipi wall was the story of the river, told as a blend of scientific and native elements. After a preview at Montana State University in September 2003, the two identical exhibit travelled to Missouri River Basin tribal communities' schools, museums, libraries, and cultural centres, reaching more than 120,000 children and adults (Sachatello-Sawyer and Cohn, 2005).

The "Knowledge Rooms" pilot project was developed in areas of Vienna (Austria) with a socially disadvantaged population, with a high migrant proportion, to temporarily offer science centre activities in empty shops (Streicher *et al.*, Schulze 2014). During 72 days of 2013, 3500 people, mostly children up to the age of 13, teenage and school groups as well as a few adult groups, entered the rooms that had a setting which would not intimidate people. To include all ethnicities, the flyer and window labels contained key words in the prevalent migrant languages (Turkish, Bosnian, Serbian, Croatian, Polish, etc.) and rules of the house were hung up in several translations. Additionally, some staff of the knowledge room spoke those

languages themselves. All knowledge rooms had access to a close-by outdoor space that at times was used for teaser activities, activities that require outdoor space and as a connect space between visitors and the community. Based on this project, (Streicher *et al.,* 2014) identified some key factors enabling to attract "difficult-to-reach" audiences with diverse socio-economic background: the location inside the community, the type of space (an everyday place), the design with an air of improvisation, the concept of openness, the self-chosen investment of time, the multiple languages and the direct contact with communities groups and representatives with the possibility to develop tailor-made activities and content together.

During 2007 the Science Museum's Dana Centre, in the UK, was involved in the project "Scientific Racism" where members of London's African-Caribbean community were consulted in order to inform a series of events about Scientific Racism at the Dana Centre (Foggett, 2008). This audience-led process resulted in two events: "Scientific Racism: A History" and "Is Science Colour Blind?". The project intended to explore the needs, wants, expectations of the African-Caribbean community in London, one of the under-catered for and under-represented in the Museum's visitor profile.

The "Creative Canal" project was carried out at the Science Museum in London, between 2003-2009, and developed relationships with 63 schools and 72 community groups to deliver a sustained programme of free outreach events (Science Museum Group 2019), with the focus on identifying and addressing barriers to using the museum and to feel confident with science. Each group enjoyed three outreach events, a show or workshop at the school or community centre, a visit to the Science Museum, a visit to the Canal Museum and a trip on the Beauchamp Lodge floating classroom on the Regents Canal. Over the course of the project, 20 groups took part, key target audiences for the museums who live in deprived areas bordering the Regents Canal. As part of the project a group of Bangladeshi women from the area of London described as 'deprived' were recruited via links with a community organisation that provided English language teaching. The project evaluation team concluded that the move from 'one off' sessions to the three-stage model is a step in the right direction to engaging more in-depth with groups but it still very much feels like they are at the beginning of the process of really understanding why the Science Museum is important to these people (Hooper-Greenhill *et al.,* 2007).

An example of inclusive engagement with science for adults was found in a citizen science initiative in 2014 in Grenoble, France, where a project (the butterfly monitoring programme "Propage" launched in 2010) developed by the French National Museum of Natural History, in collaboration with environmental non-governmental organisations involved 12 green space workers in detection and identification of butterflies (Peltola and Arpin 2018). In "Propage" project several techniques were used (such as affective techniques), which were able to involve less experienced and less privileged participants and broaden the role of participants, address their concerns and support ownership of the learning process.

1.4. Objectives and framework

The main goals for this study are to explore innovative techniques to engage socially-vulnerable communities in science, and propose a model of science communications built on this practice-based research. Our exploratory approach brings together science, art and communication to develop new conceptual and operational definitions as well as improve future research design. More specifically, this project identifies and explores ways to bring science closer to a community with limited education and resources, using unconventional techniques and artistic tools. As a secondary outcome, the project pursuits ways of participatory action and collaboration by actors and institutions from different cultures. The study intends to demonstrate how art can contribute to the engagement with the project (as shown for example in Koo, 2015), how openness and trust can contribute to communication effectiveness, and how science can relate to everyday life. The project objectives bend towards the community's empowerment, willingness to participate in cultural experiences, and awareness of science, more than to increase knowledge about science.

The project was designed as a participatory research project, giving opportunities for the community to explore and represent perspectives in their own terms; therefore, this is a project where the emphasis is not just on outcomes, but on the process itself (Cornwall and Jewkes, 1995). Participatory models of communication are thought to be able to situate science within the social context, because they not only take social concerns and insights into account but treat them as central to the communication process (Metcalfe *et al.,* 2008). All activities are done in a collective way, as a dialogue with the community, stimulating curiosity and self-expression. Communications are adequate if they reach people with the information that they need in a form that they can use (Fischhoff, 2013). There is ample evidence that children and adults reason about issues that are important to them while interacting with other people (Fenichel and Schweingruber, 2010).

Complementary to talking about science, the project adopts a Science & Art approach. The rationale behind it is that artistic techniques evoke emotions (e.g., Pinto and Riesch, 2017; Stiller-Reeve and Naznin, 2017), activate processes of participation and dialogue (e.g. Curtis *et al.*, 2012; Heras and Tàbara, 2014), and play the role of mediator between science and society (e.g., Von Roten and Moeschler, 2007; Opermanis *et al.,* 2015). Art is also a way of promoting engagement which was conceptualized by Kim (2012) as a process that develops from the acts of exposing and focusing attention to the act of cognizing.

The project bridges specialists and institutions of science communication, neuroscience research, art and art education, and social inclusion, which requires individuals who mediate and effectively inhabit multiple social entities - boundary spanners, which are key agents managing within inter-organizational theatres (Williams, 2002). These individuals allow two different cultures to communicate successfully without the need for either to adapt culturally to the other (Kirby, 2008).

For the purpose of nomenclature clarification, in this work an *activity* is considered a short-duration isolated interaction (typically around one hour or less) between two or more individuals (e.g., a lecture, a laboratory experiment, a drafting exercise). The word *session* is used for longer-duration interactions (typically more than one hour and up to one day), that generally comprise several activities and take place as part of a plan.

2. The project "Embodying Memories"

2.1. Phase 1: Project design and planning

2.1.1. Establishment and characterization of partners

The project was coordinated by the Science Communication and Outreach office from Gulbenkian Institute of Science (Instituto Gulbenkian de Ciência, IGC, Figure 1). The office's Head, Ana Lúcia Mena, is an experienced science communicator with deep knowledge of IGC's scientists, and life sciences. Besides the science communication fellow, IGC contributed with the neuroscientist that participated in the project sessions. This scientist, Cláudia Gonçalves, is a PhD student from the Integrative Behavioural Biology research group. Also, on the academic side of the project, the researcher Paulo Nuno Vicente, from iNOVA Media Lab (applied research laboratory at NOVA FCSH) was included due to expertise in Science & Art as well as projects with vulnerable communities.

From the artistic counterpart, the partner was the Calouste Gulbenkian Foundation (Fundação Calouste Gulbenkian, FCG), through the Education Service of the Calouste Gulbenkian Museum. The Foundation is a philanthropic institution whose main purpose is to improve the quality of life through art, charity, science and education. The museum fellow of the project was the art education professional Andreia Dias, experienced in both visual and performative arts.

The social partner of the project was Oeiras Municipality (Câmara Municipal de Oeiras, CMO), through the Division of Social Cohesion that promotes and executes measures, policies and projects of social inclusion and municipality programmes in the areas of social care, health, employment and professional formation. This institution contributed to the project as an expert on the municipality population, thus more equipped to identify the project target audience. The municipality social worker Maria da Assunção Tavares, was the technician from the municipality devoted to this project.
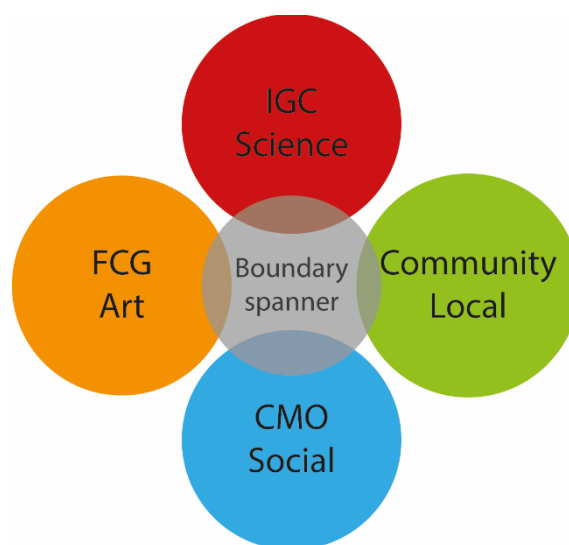

Figure 1 – Project partners of "Embodying Memories" from the science, art, social and community spheres, including project mediator - the boundary spanner.

It was defined that the target audience would be adults (because most science communication activities are devoted to children and teenagers), significantly apart from the scientific community (to allow a clearer evaluation of the engagement variation), and living within the same municipality as the research centre (to encourage institutional bounding). The study population was chosen after a series of contacts and meetings with the municipality social workers, following the defined above criteria. The project's target audience was an underprivileged community composed of 14 women, 13 of which migrants from the Republic of Cabo Verde, aged 64 to 84 years (average 73 years), and low literacy levels (maximum of fourth grade, six never attended school, Figure 2). All women were retired from jobs that required almost no scholar qualifications, such as factory manual workers, housekeepers, and fish sellers.
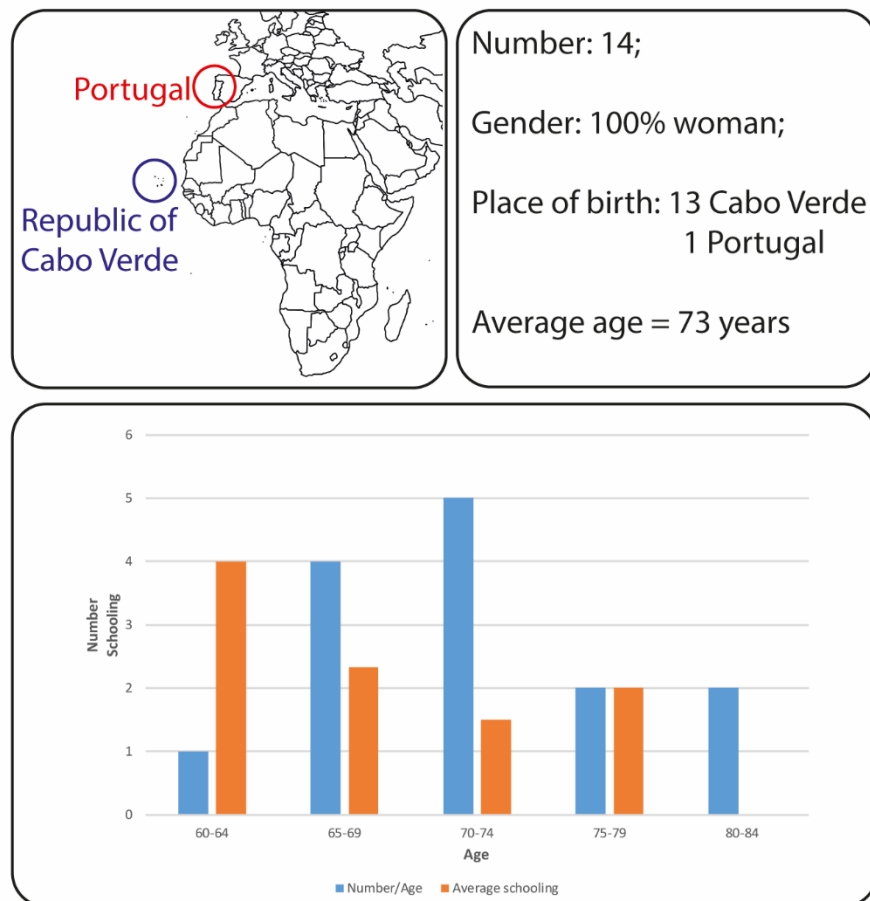

Figure 2 - Main characteristics of the project "Embodying Memories" local community. Below panel represents the number of participants in each age category (in blue), showing most have between 65-69 and 70-74; and the average schooling per age category (in orange), showing that between 60-64 year old women attended 4th grade, while none of the 80-84 women attended school.

According to the Foreign Services, in 2009 there were 10,525 foreigners living in Oeiras municipality area, and the two main origin countries were Brazil (30%) and the Republic of Cabo Verde (28%; Mendes *et al.*, 2011). Within the migrants, individuals from Cabo Verde were the ones presenting the lowest level of literacy (Mendes *et al.,* 2011). The selected target

audience was assembled as a group by the municipality social worker in November 2016 (about a year before the project), with the aim of supporting elderly women migrant from Africa (Figure 2). The initial group identified by the technician was composed of 22 women, 58 to 90 years old, named "As Marias" (Tavares, 2016). These women were under a rehousing programme from slum dwellers ("Alto de Santa Catarina" and "Pedreira dos Húngaros"). When the community was gathered to start the project, some members of the community "As Marias" were absent, mostly due to health issues.

2.1.2. Development of a boundary spanner and establishment of relationships

In a multiple partners project such as this, where each has their own ways and customs, the mediator (defined as boundary spanner in section 1.4, Figure 1) needs to reinforce his/her role as an inhabitant of the multiple social entities. In section 3.2 the role of the boundary spanner is further discussed.

The development of the boundary spanner involved the following tasks: 1) inhabiting the laboratory sphere, 2) inhabiting the museum sphere, and 3) inhabiting the community world. The boundary spanner interactions timeline (Figure 3) shows how these relationships developed over time. The boundary spanner of this project was Ana Matias, the author of this thesis.
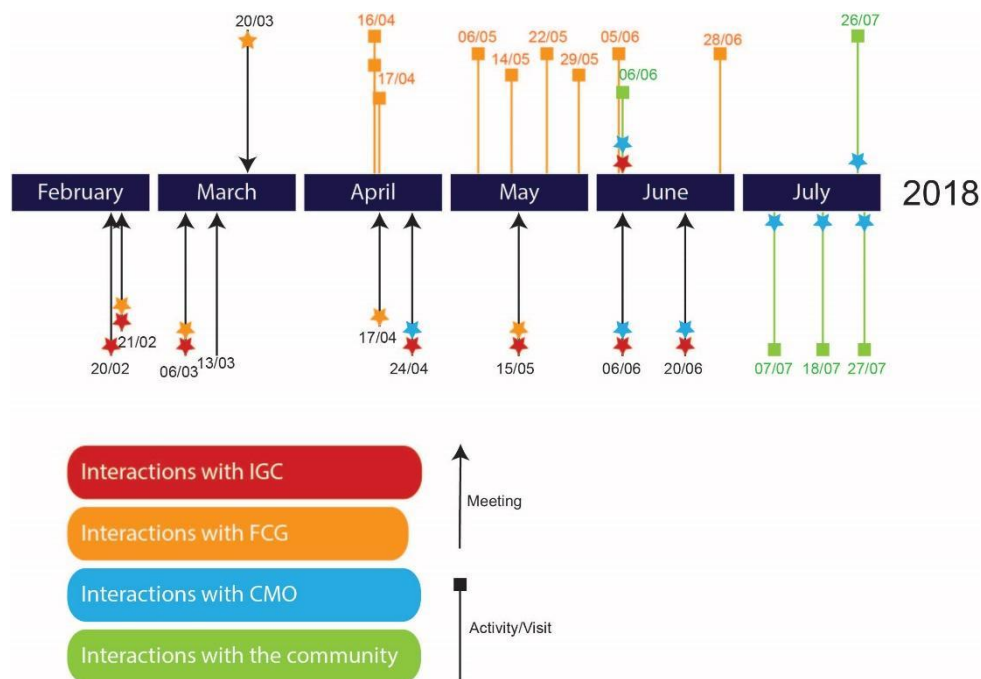

Figure 3 – Timeline of the interactions between the boundary and the several partners, during the phase of project design, plan and collaboration.

To inhabit the laboratory sphere, regular meetings with the science communicator of IGC were held at an initial stage (Figure 3). Project management was on IGC side, therefore meetings included definition of goals, technical possibilities, and available resources. To get familiar with

the space and the atmosphere, the boundary spanner benefited from sharing the IGC communication office at a number of occasions, from June to November 2018.

To inhabit the museum sphere, three meetings and contacts with the museum fellows were made to define a participation plan in the museum educational practices. In addition, the boundary spanner joined in a series of activities implemented by the museum fellows. The activities participation was divided in two types:

a) Visits and activities: The boundary spanner attended visits and activities undertaken by different guides (Susana Quaresma, Cristina Campos, Paula Ribeiro, Miguel Horta, Joana Andrade) to different target audiences from pre-school children, 5th grade students, 8th grade students, general public, disabled and incapacitated people.

b) Long-term projects: The boundary spanner attended an FCG project "Entre-Vizinhos" (Between Neighbours) with elderly people from the museum's vicinity to promote their contact with the institution, whilst stimulating creativity and art engagement. The boundary spanner attended four sessions at the social institutions, and one at the museum, coordinated by Diana Pereira and Joana Andrade.

Visitations, activities and project participation served the purpose of learning about art, getting familiar with the museum collection, getting acquaintance with the museum staff, and learning about the museum educational practices and art engagement techniques.

To inhabit the community sphere, several informal gatherings took place in June and July 2018. These occasions, mediated by the social worker, were used to establish a relationship with the community, generating empathy and trust, and to learn about the community's interests and its dynamics. This relationship was established and nurtured by a series of interactions:

1) The first contact occurred during a fund-raising lunch organized and prepared by the community serving traditional Cabo Verdean food.
2) The first formal meeting was held with representatives from other institutions that also intended to collaborate with the community. During this meeting, all members of the community introduced themselves and showed their handicrafts. To identify possible research topics to be addressed in this project, a discussion about the community was held. An ice-breaker activity was made by the IGC, which consisted on an experiment with flowers that had been put in coloured water for some minutes.
3) A meeting between the boundary spanner and the community took place to further know common interests and practices.
4) The boundary spanner participated in two summer trips to the beach within a programme from Oeiras Municipality that promotes a healthier life-style and enables beach access to people with mobility issues. During these gatherings, the boundary spanner tried to merge with the community, and at the same time identify their individual characteristics (outgoing, sceptical, insecure, interested, introvert, confidant, …).
5) The boundary spanner and the community attended a lunch gathering hosted by the Community Centre "Alto da Loba", where another vulnerable senior community from the same municipality is supported. These two communities had met during the beach summer trips, within the municipality mobility programme.

2.1.3. Definition of the project scientific topic, goals and structure

The scientific topic was defined after acknowledging on the one hand, the community's significant attachment to old memories from experiences lived in Africa, and on the other hand, some concerns expressed by the community on short-span memory deterioration. The

topic 'Memory' arose during the encounters with the community described earlier, after agreement with all partners. It is a topic that appreciates diversity, can elicit emotions, allows for clear transference of science knowledge to everyday life, it is bursting with suggestive processes and images suitable for artistic approaches, and for which all partners have different perspectives. The title of the project – Embodying Memories – was chosen to meet the topic as a multiple entendre: the body part where memories are stored (the human brain, hence the science connection), the allusion to objects that give body to individual (community's) and collective (museum pieces) memories, and the possible use of performative arts to express memories. Project "Embodying Memories" specific goals were to engage the community with the project, increase their awareness while promoting their engagement with science, increase knowledge of scientific topics related to neuroscience, stimulate creativity, curiosity, abstraction and self-expression, and to encourage the community's willingness to participate in cultural experiences.

The project was planned as a sequence of sessions, that could be small workshops, visits or round-table discussions, that intended to promote the community engagement in science through a dynamic equilibrium over several axis: science education, art education, health education, cultural animation and entertainment, social inclusion, and institutional advertising (Figure 4).
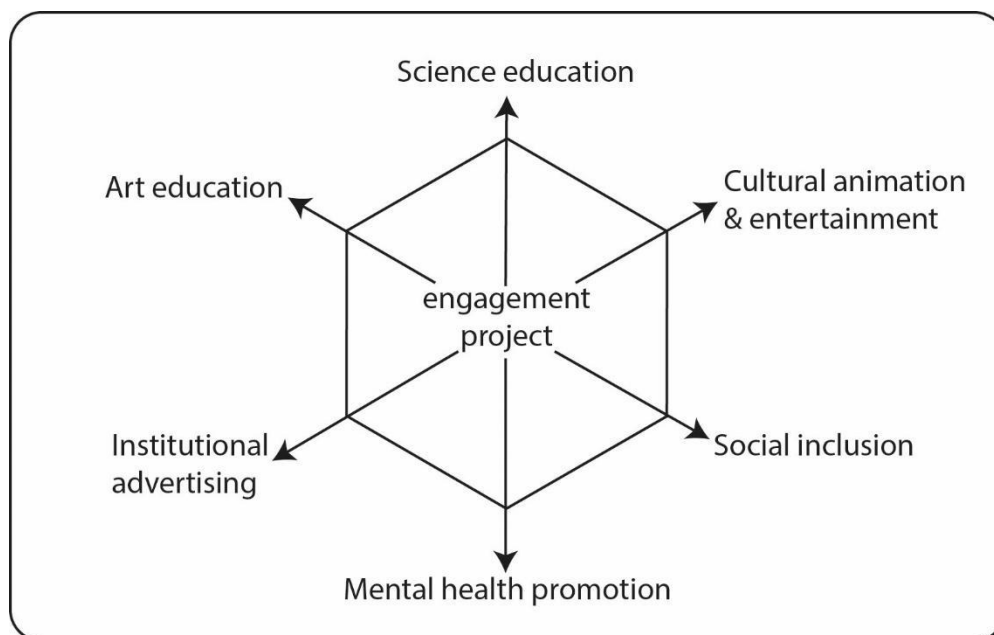

Figure 4 - Axes of the project "Embodying Memories".

Objectives and practices of these six axes can be adopted, namely techniques of art engagement and education that museums offer, science communication and education techniques that scientific and academic institutions offer, cultural animation and entertainment that cultural and social institutions offer, social inclusion that public institutions offer, with an underpinning institutional advertising from all partners. The inter-institutional proximity, a side-effect of the project, was considered important as well since most projects are single or bilateral; science, art, academic and the social institutions seldomly are involved

in a single project. Multi-partners projects although challenging to manage, have the advantage of bringing to the table multiple spaces and resources, thus have the potential to go further.

The generic structure of project sessions was established in five segments: reception, resume, science explanation, practical activities, and wrap-up. This structure incorporated elements from the project's axes. The common course consisted of: 1) an initial group reception and room arrangement; 2) a brief resume of previous activities; 3) an explanatory segment about the session theme; 4) practical activities recurring to artistic techniques and narratives in relation to the theme; and 5) a wrap-up of the session. The plan for each session was based on the generic structure, scientific outline, and former interactions with the community and the neuroscientist. A number of practical activities were proposed by the art specialist from FCG. Visits and discussions had a different scheme, depending on the institution, goals, and resources.

2.1.4. Establishment of the evaluation plan

Several evaluation elements were planned to provide evidences of the project impacts in relation to the objectives established for the project (section 2.1.3), according to the Framework for Evaluating Impacts of Informal Science Education Projects (described in detail in Allen *et al.*, 2008). This evaluation sets a system of six impact categories: 1) awareness, knowledge or understanding, 2) engagement or interest, 3) attitude, 4) behaviour, 5) skills, and 6) others - project specific. Project intended impacts should fall within some, but not all these categories (Dierking, 2008). For the project "Embodying Memories" the chosen categories were: Awareness and knowledge, Engagement, Attitude, and Social Inclusion.

Because most of the community is illiterate or has low levels of literacy (Figure 2), no questionnaires, written information or ratings could be supplied or used. The project evaluation plan consisted on the analysis of the following:

1) Two semi-structured focus groups before and after the project sessions, hereafter called pre/post assessment, addressing the community's perception and involvement with science.

2) Project logbook, hereafter called session notes.

3) Participants attendance throughout the project. This element is hereafter called attendance record.

4) At the end of the project sessions, participants were asked to list aspects they liked more, liked less, and that were relevant, during the project. This element is hereafter called project evaluation.

5) At the end of the project sessions, participants were asked to describe the project contents in their own words. This element is hereafter called the project narrative.

6) A public presentation or performance of the project by the community was foreseen. This presentation, hereafter called the project presentation, was analysed.

2.2. Phase 2: Implementation of the project

2.2.1. Project spaces and resources

Most project sessions took place at the Local Centre of Support to the Integration of Migrants (Centro Local de Apoio à Integração de Migrantes - CLAIM Carnaxide), in Outurela – Carnaxide, that resulted from a cooperation protocol established between the Oeiras Municipality and the Portuguese High Commission for Migration, a public institution dependent of the Presidency of the Ministers Council. The centre seeks to provide support tailored to migrant's needs such as family reunification, social security and social support. The centre is coordinated by the social work professional from CMO, Maria da Assunção Tavares, the project partner, that manages the space, identifies the needs, and contacts and gathers the community. A room in CLAIM was the main venue for regular sessions. Oeiras Municipality also provided transportation for the group visits to the artistic and scientific facilities.

The visit to the museum took place at the Calouste Gulbenkian Museum. The museum houses the founder's private collection, alongside a collection of modern and contemporary art, open to the public. Within the scope of this project, the museum organized and hosted an adapted activity with a guide.

The visit to a research centre occurred at the IGC. Researchers and technicians were mobilized to explain their scientific instruments, laboratory techniques, research objects, and their scientific models. The tour included laboratories, the microscopy unit and a fish room within the animal house facility.

2.2.2. Sessions execution

The project development consisted in eight sessions with diverse themes and formats, from more explanatory to more interactive, from in-door sessions in CLAIM room to visits to the museum and laboratories (Table 1). The details about the development of each session can be found in Annexe 2 (in Portuguese). The sessions started in September 11th and ended in November 28th 2018, with a duration of 90 to 120 minutes each. Because of the community's characteristics and following the social inclusion axis, the entire project was designed in order to allow the participation by illiterate people. This implied that no game or activity could require reading, no institutional leaflet could be used, and the community participants could not take notes. Moreover, modern technological tools (computers, tablets, smart phones) were avoided as much as possible since all depend on some degree of literacy. All scientific or artistic images were printed on paper or visualized in a computer screen (on session 7, at the laboratory, Figure 8).

Table 1: Session number, date, location, duration and main theme of the Project "Embodying Memories".

SESSION	DATE LOCATION	APPROXIMATE DURATION (MINUTES)	THEME
1	11-09-2018 CLAIM	100	Initial assessment Memory object/organ
2	02-10-2018 CLAIM	90	The brain functions
3	08-10-2018 CLAIM	115	The brain development
4	14-10-2018 CLAIM	90	The brain in detail (neurons)
5	22-10-2018 Museum FCG	90	Memories in the Museum
6	13-11-2018 CLAIM	90	Connecting the sessions
7	19-11-2018 IGC	120	Neuroscience laboratory
8	28-11-2018 CLAIM	120	Project evaluation

Regular sessions followed the generic scheme presented in section 2.1.3, that consisted of: 1) an initial group reception and room arrangement according to the boundary spanner and science communicator suggestions; 2) a brief resume of previous activities by the science communicator; 3) an explanatory segment about the session theme shared between the neuroscientist (sessions 1, 2, 3, 4), the science communicator (sessions 1, 2, 3, 4, 6) and the community (session 1); 4) practical activities recurring to artistic techniques and narratives in relation to the theme by the boundary spanner, the science communicator, the art specialist (session 4) and the community; and 5) a wrap-up of the session where the community members were asked to name three words related to the session. This general structure was adjusted on each session according to convenience, for example, of scientific topic fluidity, level of engagement, earlier demonstrated interest, and narrative purposes.

The scientific alignment of the project consisted in introducing the organ where memories are stored (i.e. introducing the brain anatomy, Figure 5b), presenting the areas of the brain and the main functions associated with these areas, the human brain development, and the brain cells (i.e. neurons) and connections.

Figure 5 - Photographs of the project "Embodying Memories" in-house sessions. (a) Session 1 with memory objects; (b) Session 1 with the brain model; (c) Session 2, mimic of dressing; (d) Session 3, movement of representing (brain) growth; (e) Session 3, game of brain regions and brain functions; (f) Session 4, arm coordination activity; (g) Session 6, collection of words during the poetry activity; and (h) Session 8, project narrative.
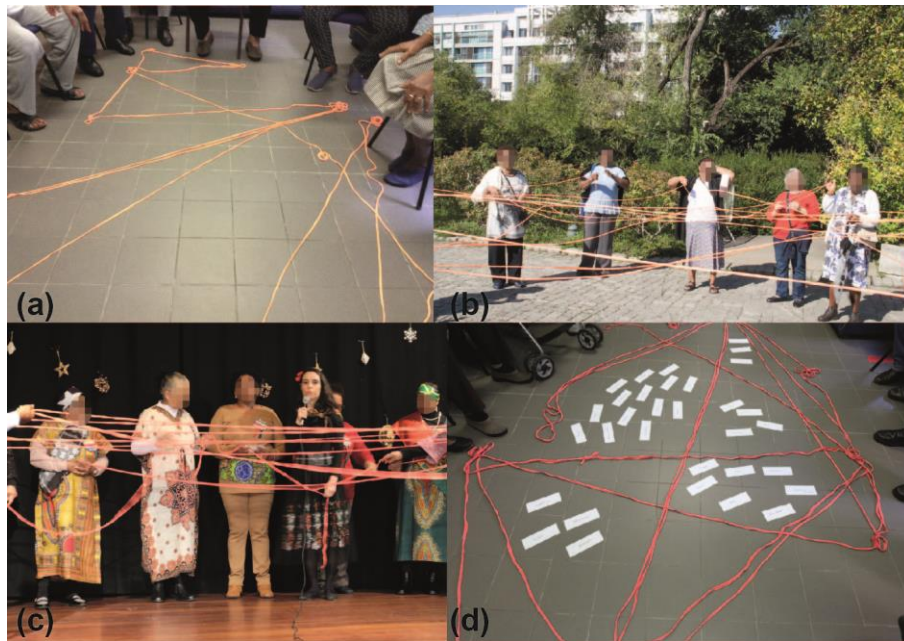
Figure 6 - Photographs of the four occasions where the fabric yarn network was used: (a) sessions 4, (b) FCG garden, (c) project presentation, and (d) session 6.

Brief description of each section:

During session 1, at CLAIM (Table 1), after the community reception, the science communicator conducted a pre-assessment focus group to assess (mainly) attitudes towards science (questions in Annexe 3). Next, participants were asked to talk about a past event related to an object of their choice brought to the session (or described). Objects included a clay craft by a granddaughter, a plant, a guitar from childhood, a dress wore during the boat trip to Portugal, a trophy earned during an evening at the casino offered by the employer, a piece of woollen fabric offered by the employer, and handmade dolls (Figure 5a). The neuroscientist presented the organ where all these memories are stored - the brain. Main morphological characteristics of the brain were mentioned, using a real-scale human brain model (Figure 5b) to support the description. The boundary spanner asked participants to provide three words that described the session (words: brain, daisy, memory, patience, and head).

During session 2, after the community reception, a resume of session 1 was made by the science communicator, giving space for the presentation of more memory objects (a mug was added). Images of a brain section with coloured regions and a matching 9-piece puzzle were distributed among participants. The neuroscientist explained several brain functions related with the coloured brain regions, and located them in her own head. The boundary spanner asked participants to create movements mimicking functions related to the memory objects (Figure 5c). The neuroscientist related the memory objects with the several functions and regions of the brain (e.g., the fabric and the sense of touch, the clay craft and the motor control region). The neuroscientist talked about other brain functions and told famous cases of brain study cases (e.g. Phineas Gage accident survival). The boundary spanner asked participants to provide three words that described the session (words: educational, dress, knead, fabric).

During session 3, at CLAIM, after the community reception, a resume of sessions 1 and 2 was made by the science communicator, mentioning memory objects, brain regions and functions. To further remember the brain functions, images and puzzles of the brain regions were shown again, and a game that relates activities with brain regions was made (Figure 5e). The neuroscientist explained the phases of brain development in uterus, childhood, adolescence, and adult life. The explanation included factors that can benefit or compromise brain development, as well as simple suggestions for everyday life brain stimulation, helpful for the community. Images of stages of brain development before birth were shown. The boundary spanner asked participants to create movements or gestures that represent stages of brain development as growth (Figure 5d), pathways, social interaction and exercise. The boundary spanner asked participants to provide three words that described the session (words: babies, hugs, kisses, affection).

During session 4, at CLAIM, after the community reception, a resume of sessions 1, 2 and 3 was made by the science communicator, mentioning memory objects, the word collection, brain regions, functions and development. The art specialist participated on the session for the first time, thus the resume worked as an update for her. The neuroscientist introduced the concept of cells in the human body, and in particular the neurons; and explained how neurons connect in networks. Images of cells (e.g. skin cell, blood cell, egg) and neuron network were shown, as well as a model of a neuron handmade by the neuroscientist. The art specialist proposed an activity carried out in groups of three people that while freely moving the arms needed to collectively maintain three hands in the centre (Figure 5f). The art specialist, inspired by the neuron network, rolled fabric yarn around participant's hands, once at a time, by participant's choice. At the end a network connecting participants (cells) was obtained (Figure 6a). The boundary spanner asked participants to provide three words that described the session (words: cell, electricity, hands, and network).

Session 5, at the Museum Calouste Gulbenkian (Table 1), was adapted from an activity offered by the museum educational service called "Between places, between cultures in 180 degrees[1]". The visit had a first part where the relevance and significance of objects was approached in an interactive way. This discussion revolved around small objects that were distributed among participants: a compass, a pen drive, a japamala (a string of prayer beads), a matryoshka doll, a mummy representation, a tea box, a cloth ring, a mikado game, and a feather lapel pin. The second part developed around four art pieces: two European paintings (Figure 7), a Persian carpet, and an ancient Egypt sculpture, which were described, put into context and discussed with participants. At the end the fabric network was done in the museum garden (Figure 6b), and participants were asked to provide a word about the session (words: holy family, paintings, carpet, St. Joseph, painting by Rubens, Mr. Gulbenkian, horses and baby Jesus, love it, gratitude, cloth ring, expectation, happiness, beautiful, thank you).

---

[1] Free translation from Portuguese: "Entre lugares, entre culturas em 180º".

Figure 7 - Photographs from the visit to the museum, session 5 in 22/10/2018; and images from the two favourite paintings in the museum collection: Top right: Portrait of Helene Fourment, by Peter Paul Rubens, ca. 1630-32; and bottom left: Holy Family and Donors by Vittore Carpaccio, 1505; © Calouste Gulbenkian Foundation.

During session 6, at CLAIM, after the community reception, the resume of previous sessions was made by the science communicator by asking participants to remember the word collection. A fabric yarn network was made while each community participant was asked to tell something to the science communicator about what happened during session 5. With the yarn network on the floor, pieces of papers with the words from the project's collection were distributed inside the polygons by word classes (nouns, verbs, adjectives, places, feelings; Figure 6d). Each participant collected five words from the five polygons and a poem line was created with each set. A five-line poem was generated in this collaborative way:

De Cabo Verde vestida de coragem,

bebemos esperança dos bebés da casa.

Tenho memórias bonitas do meu bairro,

estou grata pelo amor dentro do museu e

estou feliz porque o meu cérebro está ligado ao Centro de Apoio a Migrantes.

During session 7, at the Gulbenkian Institute of Science, several laboratories and facilities were visited (Figure 8): the space where the collaborating neuroscientist Cláudia Gonçalves works regularly (Integrative Behavioural Biology Laboratory), a room in the animal house facility hosting zebrafish production, the Histopathology Laboratory were organ samples and sections

of sampled tissues were observed, and the Advanced Imaging Laboratory were live neurons from flies were observed under the microscope.

Figure 8 - Photographs from the visit to IGC, session 7, in 19/11/2018; and an image from an embryo section from the Histopathology Unit, © Instituto Gulbenkian de Ciência.

During session 8, several elements of the project evaluation were conducted. The science communicator ran the focus group (post-assessment), the science communicator and the boundary spanner asked the community participants to describe the project in their own words (project narrative), the boundary spanner asked the community participants to evaluate the project (project evaluation, described in section 2.3). The boundary spanner, the social worker together with the community started to prepare the project public presentation.

The project public presentation took place on 30th November 2018, within a party to celebrate the second birthday of the community "As Marias" organized by the social worker, with the support of the municipality. The party took place at a concert hall/sport facility of "Associação de Moradores do Bairro 18 de Maio", a residents' association. The public presentation consisted on a sequence of individual statements about the project "Embodying Memories", created and recited by each community participant and the boundary spanner, while a network of fabric yarn was created on stage. The placement on stage, wardrobe, sequence and props (Figure 6c) were discussed, prepared and rehearsed by the community and the boundary spanner. A small exhibition of memory objects was put on display.

2.3. Phase 3: Project evaluation

The evaluation of the project was made through the analysis of the six elements mentioned above (section 2.1.4).

1) The pre/post assessment was made by the two semi-structured focus groups carried out before (11/09/2018) and after (28/11/2018) the project sessions. These focus groups explored the community's perception and involvement with science, and were audio recorded, transcribed, analysed and compared. Questions and specific topics addressed during the focus groups can be found in Annex 2.

2) The session notes on logbook were read in detail and parts used as evidence of impacts attained by the project. Throughout the project, notes were taken on the establishment of the relationships between the community and the boundary spanner, the collection of words, and statements, questions or observations made by the participants.

3) The attendance record information was used to create the project matrix to analyse how the number of participants varied throughout the project, if there was any drop-out, or if sessions in-door or outside visits had variable attendance rates (Figure 9).
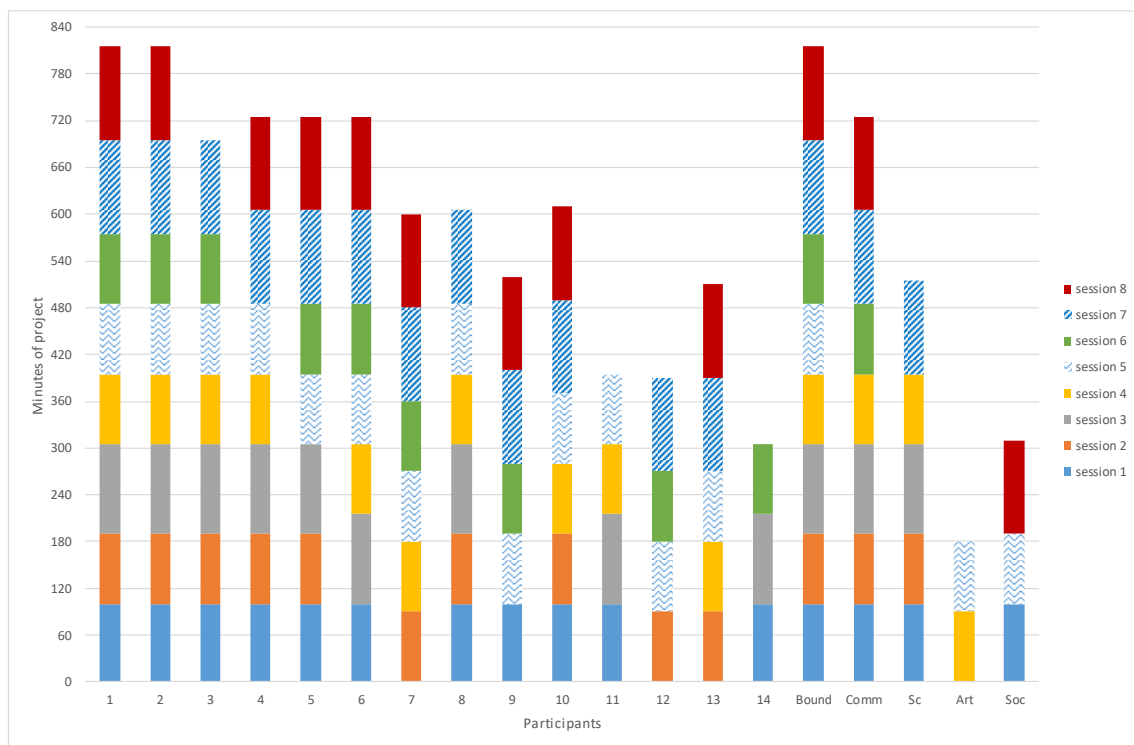

Figure 9 - Project "Embodying Memories" attendance of the sessions, including the 14 members of the community (anonymized from 1 to 14), the boundary spanner (Bound), the science communicator (Comm), the researcher (Sc), the art specialist (Art) and the social worker (Soc).

4) At the end of the project sessions, the project evaluation was made by asking each participant from the community to list three things that they liked more, three things that they

liked less, and the three most important things they learned during the project. These group interviews were video recorded, transcribed and analysed.

5) The project narrative was made during the last session. All images (e.g. brain sections, neuron network), objects used during the session (e.g., brain puzzle, fabric yarn), and sample images/objects (e.g., a copy of a painting, an object from one of the laboratories) were placed on the table. Participants were asked to described the sessions contents, relying on the objects/images as recollections. This exercise was made as much as possible by the community; however, it was backed by the science communicator and the boundary spanner that contributed to "break-the-ice" and unlock the narrative. This element was video recorded, transcribed and analysed, both in content and in the duration of the community narrative versus the science communicator and boundary spanner narrative (Figure 10).
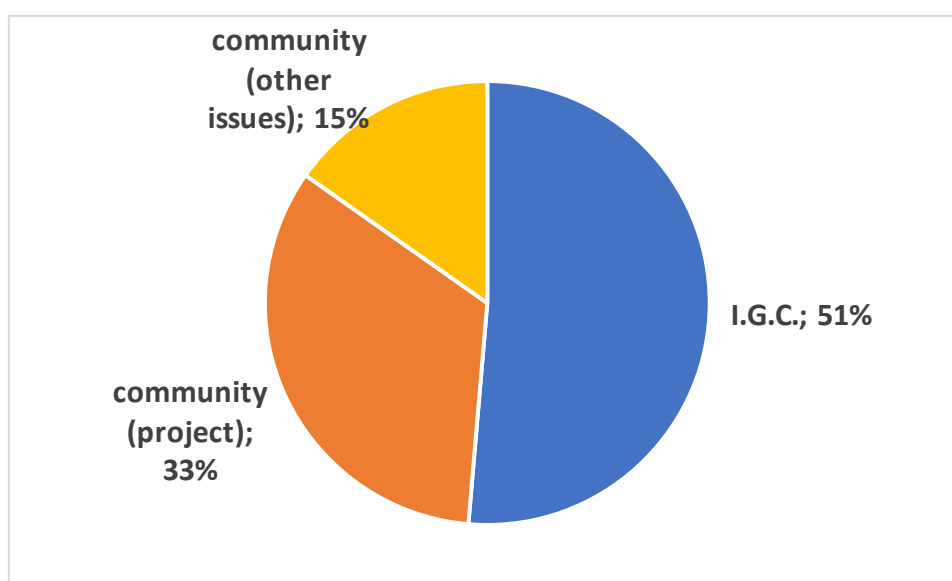

Figure 10 - Time distribution during the project's narrative. The community used 49% of the time (about 21/44 minutes duration, with 33% of time devoted to the project's narrative and the remaining 15% about other issues).

6) As described above (section 2.2.2), there was a public presentation of the project by the community on a party, where each participant made a statement. This project presentation was video recorded, transcribed and the contents were analysed.

The six elements were examined to provide evidences of the project impacts in relation to impact categories: Awareness and knowledge, Engagement, Attitude, and Social inclusion. The impact category, the project objective, the indicator and the evidences on whether impact was attained or not are described on Tables 2 to 5.

In relation to the impact category of awareness and knowledge (Table 2), the objectives were: 1) to increase awareness of science, 2) to increase knowledge of scientific topics related to neuroscience, and 3) to stimulate creativity, curiosity, abstraction and self-expression. Pre-sessions focus group denotes science unawareness, misconception (confusion with learning) or crude notion (examples of science-related words). Post-sessions focus group shows some evolution of the concept. However, the post focus group was held in the presence of new people that just came to the last sessions of the project (by invitation of the social worker),

who have contributed with their opinion to the discussion. The newcomers are two Portuguese women, aged 58 and 59 and with higher education (4th and 6th grade) than the rest of the group. Their participation might have compromised the post assessment and, therefore some of the findings from the pre/post assessment comparison.

During the project, the participants became aware of scientific instrumentation, objects of science, laboratories and scientists. Pre-session focus group evidenced a very limited scientific background (it was only mentioned that it is located on the head and that it makes many things). Project narrative evidenced some gains on understanding of the human brain. Throughout the sessions, a lack of creativity, curiosity, abstraction and oral self-expression was evident. The duration of the project was too short to consistently pursuit this purpose. Nevertheless, a few small steps were taken. Participants gain some confidence and willingness to self-express about subjects and events that pushed them outside of their everyday lives.

In relation to the impact category of engagement (Table 3), the objectives were: 1) to accomplish engagement with the project, and 2) to promote engagement with science.

There was no participant drop out of the project, therefore participants actively engaged in the project. The participation on in-house sessions as well as in the visits demonstrated that they were not just there, they were focused and involved in the explanations and exercises. There were, however, differences within the community engagement that did not seem to be related to differences in schooling (Figure 11), rather some participants were more engaged or more outgoing. These differences at times biased the analysis; one participant in particular, tended to speak more and her opinion may have shadowed others.

In relation to engagement with science, the evaluation indicators show the possibility that under particular conditions, the community may become a new public of science. Participants were able to relate the scientific content with personal issues, but this was underlying since the start because the topic of the project (memories) was chosen after hearing the community.

In relation to the impact category attitude (Table 4), the objective was to encourage the community's willingness to participate in new cultural experiences. The community, and particularly the social worker, had some initial reluctance. After the project, they demonstrated considerable willingness to participate in new cultural experiences.

In relation to the impact category of social inclusion (Table 5), the objectives were to provide new cultural experiences and to encourage closer relationships of the IGC with a new public of science. Throughout the project, we noticed a certain resistance from the social worker to take the community to participate in cultural experiences, perhaps due to concerns that they would feel misplaced. The mutual reliance between the community, the boundary spanner and the science communicator, gained during the development and implementation of the project, gave the later trust to participate on the visits to the museum and the IGC's laboratories. The community participated and enjoyed cultural experiences (tailored to their interests and schooling level) provided by the project. All the community participants entered a museum and a scientific institution for the first time. The community felt that they learned new things, enjoyed the visit to the laboratory and were able to self-express about scientific objects or instrumentation. The community expressed openness and wish to undertake more cultural experiences.

Table 2 – Framework of project evaluation impact category: Awareness and knowledge.
Note: all quotes are free translations of Portuguese language.

Impact category: Awareness and knowledge		
Objective	**Indicator**	**Evidences that impact was attained/not attained**
Increase awareness of science	Pre/post assessment	+ Pre-sessions focus group denotes science unawareness, misconception or crude notions. Post-sessions focus group shows <u>some</u> evolution of the concept. Evidence of improvement: 1) Pre: "I don't know"; Post: "One can't explain very well". 2[i]) Pre: "There are several types of sciences (social, performative, related to astronauts, related to the heart)"; Post: "It is an entity that studies the brain, human stuff (…), it is a group of studies". Evidence of some confusion, both pre- and post-sessions: 1) Pre: To the question if science is important for everyday life: "Science is important because it is something a person studies, and if a person studies it's because he's interested in something". 2) Pre: To the question if science is a good or bad thing: "It can be not so good if a person study things that shouldn't". 3) Post: To the question if science is important for everyday life: "When one decides what to do, one uses the memory, that's science". 4) Post: To the question if science is important for everyday life: "My science is all housework at my home".
	Sessions notes	+ Participants became aware of scientific instrumentation, objects of science, laboratories and meet scientists. Evidence: 1) During sessions 1, 2, 3, and 4, participants meet a neuro-scientist and during session 7 participants meet other scientists and laboratory technicians. 2) During session 7, on the IGC, the community made observations under the microscope, touched samples, visited the laboratories and talked to scientists and technicians.
Increase knowledge of scientific topics related to neuroscience	Pre-assessment vs. Project narrative	+ Pre-session focus group evidenced a very limited scientific background. Project narrative evidenced <u>some</u> gains on understanding of the human brain and science topics. Evidence from the pre-session focus group: To the question "what do you know about the brain?", only two answers were provided: 1) Participant 1: "It is in our head and does many things". 2) Participant 9: "It does good and bad things". Evidence from the project narrative: 1) "Our brain is divided in parts". 2) "We use the brain to talk, hear, move our hands, for balance, taste". 3) "Babies start to ear and communicate with their mothers before being born, after a certain point". 4) "Babies before being born start to hear and fell when we caress the belly". 5) "Those are cells". 6) "Cells in the brain are called neurons". 7) "The female fish has a bigger belly than male fish".
Stimulate creativity, curiosity, abstraction and self-expression	Session notes	+ Throughout the sessions, a lack of creativity, curiosity, abstraction and oral self-expression was evident. The duration of the project was too short to consistently pursue this purpose. Nevertheless, a few small steps were taken. Evidence of improvement: 1) At the end of each session, the community was asked to provide 3 words that described the session. During the first sessions, this moment would take time and words came generally from the same people. On session 5, all participants provided one/two words. 2) On session 4, a participant looked at the fabric yarn network on the floor, then to a neuronal network representation on an image in her hand, and stated: "That's it!" 3) On session 6, during the poetry exercise, the participants input denoted tentative steps towards creativity and abstraction thoughts (proposal/discussion of the expressions "drink hope" and "dress courage"). 4) On session 7, after looking at neurons on a microscope, a participant stated: "It is another world". 5) One of the participants has an interest in nature (plants, vegetable gardens, animals), and during the project her curiosity and self-expression was stimulated. On an activity made on a pre-session visit, where flowers were used, this participant that, according to other participants opinion was generally quiet, expressed curiosity on the experiment, manifested her interest in the topic, and felt free to made opinions about topics not related to the experiment.
	Project presentation	Participants gain some confidence and willingness to self-express about subjects and events that pushed them outside of their everyday lives. Evidence: During the presentation of the project, all participants were willing to say a few words about the project, from 2/3 words to several sentences.

Table 3 – Framework of project evaluation impact category: Engagement.
Note: all quotes are free translations of Portuguese language.

Impact category: Engagement		
Objective	**Indicator**	**Evidences that impact was attained/not attained**
Engagement with the project	Attendance record	+ There was no participant drop out of the project. Evidence: 100% of community participants stayed in the project, with variable attendance percentages ranging from 45% to 100%. The variations in session attendance, according to the community's own statements, have several reasons, mostly related to their age and social conditions: sickness, medical appointments, and care of others (grandsons and husband).
	Sessions notes & Project narrative	+ Participants actively engaged in the project. The participation on in-house sessions as well as in the visits demonstrated they were focused and involved in the explanations and exercises. There are, however, differences within the community. Evidence: 1) Increased concentration span during the activities throughout the project, i.e., the amount of side conversations during the sessions was decreased. In-house sessions took between 1h30 and 2h00, which can be demanding on a community that is not used to this type of activity. 2) The community was assembled and got together previously to the project. Even so, some participants were very quiet at the start of this project. It was noticed a beginning or increase of participation across the sessions, with relevant contributions to the project. 3) On session 6, the 3rd time the fabric yarn network was made, one of the participants that arrived late, in silence approached the yarn, and rolled it around her finger. This was interpreted as an engagement indicator. 4) On session 7, one of the participants, realising that the project was ending, stated that she was very disappointed that the project had to finish. She wanted to carry on learning. 5) During the project narrative, participants recognised most images and objects used throughout the project, and could say some words about it.
Engagement with science	Sessions notes	+ There is a possibility that this group will became a new public in particular conditions. Participants were able to relate the scientific content with personal issues. The topic of the project (memories) was chosen after hearing the community, therefore this impact was underlying since the start. Evidence: During sessions participants asked questions about personal worries regarding neurology, particularly memory loss, numbness on the arms, and difficulties in people recognition. These questions were generally made in good timings, in regard to the sessions scientific content.

Table 4 – Framework of project evaluation impact category: Attitude
Note: all quotes are free translations of Portuguese language.

| Impact category: Attitude		
Objective	**Indicator**	**Evidences that impact was attained/not attained**
Encourage the community's willingness to participate in new cultural experiences	Project presentation & Session notes	+ The community had some initial reluctance. After the project, the community demonstrated considerable willingness to participate in new cultural experiences. Evidence: 1) On project presentation, one of the participants stated: "When my daughter comes, I will pick them and take them there [to the museum]". 2) On project presentation, one of the participants stated: "I enjoyed the Gulbenkian [museum]. I would like to go there again". 3) On project presentation, one of the participants stated: "(…) It was a good experience for us. It was the first time that we faced up to all these things." 4) During session 8, one of the participants asked: "If the project is going to end, this means that we can't go to the laboratory again?".
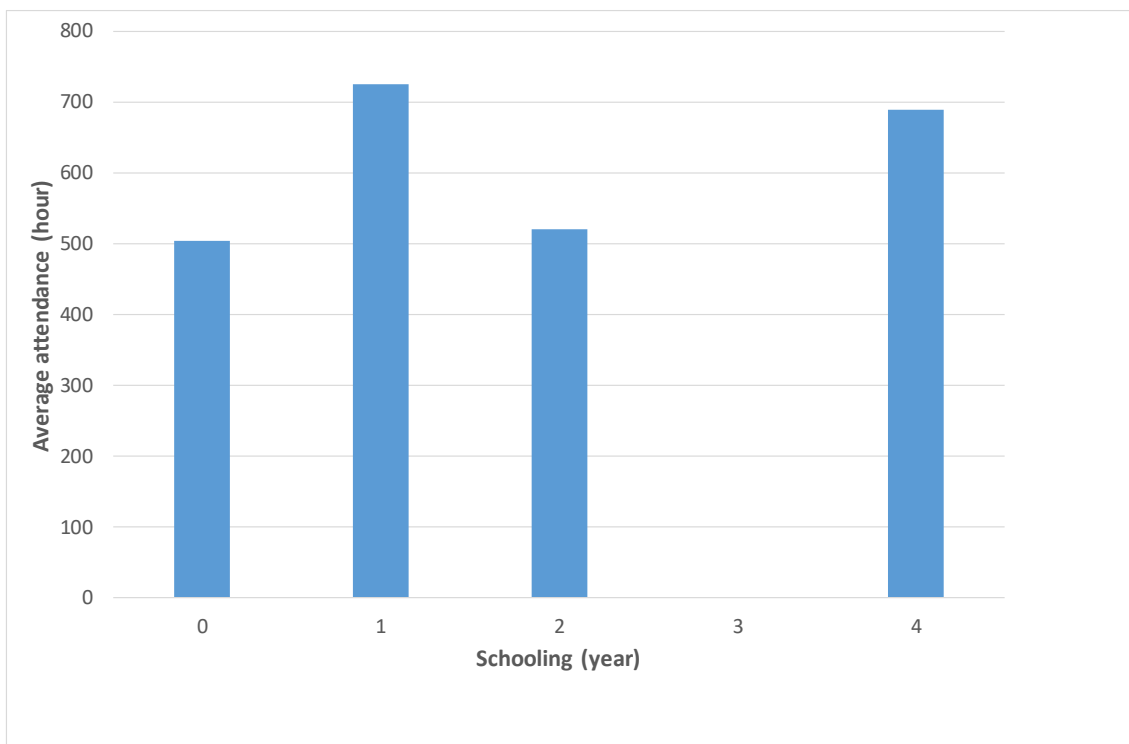
Figure 11 - Distribution of schooling versus attendance of the community members (anonymized from 1 to 14).

Table 5 – Framework of project evaluation impact category: Social inclusion
Note: all quotes are free translations of Portuguese language.

Impact category: Social inclusion		
Objective	**Indicator**	**Evidences that impact was attained/not attained**
Provide cultural experiences	Attendance record	+ The mutual reliance between the community, the boundary spanner and the science communicator, gained during the development and implementation of the project, gave them trust to participate on the visits to the museum and the IGC's laboratories. Evidence: 93% of community visited the museum, and 86% visited the laboratories.
	Project evaluation & Project presentation & Sessions notes	+ The community participated and enjoyed cultural experiences provided by the project. All the community participants entered a museum and a scientific institution for the first time. Evidence: 1) On session 6, one of the participants stated: "The museum is full of love". 1) During project evaluation, a participant stated (about the museum): "I can't even speak about the museum. I loved everything." 2) During project evaluation, a participant stated (about the museum): "We found many new things, beautiful things, that we don't have here around us". 3) During project evaluation, participant 10 stated (about the museum): "It was a landmark. We will remember this visit for long years. 4) During the project presentation, one of the participants stated: "I enjoyed the Gulbenkian [museum]. I would like to go there again".
Encourage closer relationships with a new public of science	Project narrative & Project presentation	+ The community felt that they learned new things, enjoyed the visit to the laboratory and were able to self-express about scientific objects or instrumentation. Evidence: 1) During project narrative, participants were able to describe a number of things they observe at the laboratory, e.g.: "fish brains, the study about zebra fish and flies, a foetus, a heart". 2) During project evaluation, when asked about what they liked the most, all participants mentioned the visit to the laboratories (particularly the fishes on aquariums and the microscope).

Overall, taking into account the evaluation indicators described above it can be considered that the project promoted some increase in awareness of science, moderate increase in knowledge about scientific topics related to neuroscience, some stimulation of curiosity, abstraction and self-expression, high engagement with the project, some to moderate engagement with science, high to very high encouragement of community willingness to participate in new cultural experiences, very high participation in cultural experiences, and moderate encouragement to became a new public of science. Considering an overall qualitative assessment, the project can be regarded has having a moderate achievement.

3. Discussion

3.1. Insights and limitations from the project "Embodying Memories"

Projects of science communication may encounter many barriers identified in previous studies of accessibility and social inclusion/exclusion from science (e.g. Dawson, 2018), such as: age, gender, schooling, ethnicity, social status, income, geographic location, and job profile. The project "Embodying memories" was undertaken with a community apart from science due to a greater or lesser degree of all exclusion factors mentioned above. A project with such target audience can provide insights into positive outcomes and negative aspects of exploratory methods of engagement through Science & Art.

One of the project achievements was the fluidity and fruition of the project itself. At first, all actors had reservations and did not know what to expect. On the community side, there was a scepticism about what Science & Art would have to do with them. On the science communicator and neuroscientist's side, there were questions about how the community would accept, react, and engage with the project. On the social worker's side, there was reluctance and reservation about the adequacy of a Science & Art project to this audience. Ever since the development of the boundary spanner, during the pre-sessions period, reciprocal confidence increased with mutual acquaintance and shared occasions.

An important asset of the project was the work-pair science communicator/boundary spanner, inspired by the observations of the art education projects pedagogical pair. This was important in more than one way. Firstly, to assure someone was available for recordings and field notes, to increase the chance of acknowledging diverse responses, and also as a backup and safety measure for unforeseen and unavoidable situations. Secondly, when shyness hindered session's flow because proposed activities by one of the work-pair were out of participants "comfort zone", the other work-pair was used to break-the-ice or exemplify. Thirdly, because the work-pair shared between each other the knowledge of group dynamics, discussed session's activities and structure, thus improving session's efficiency.

To achieve a high level of engagement, a dynamic balance was constantly in a trial between the six axis of the project, and respective institutions. Considering each session individually, there was a likely unbalance of the axes. For example, session 2, where the brain functions were addressed, although other activities such as movement, mimic, self-expression were made, an unbalance towards the science education occurred (Figure 12). During sessions 5 and 7, there was an unbalance towards the institutional advertising, whilst on session 6 the mental health promotion though memory exercise, was the focus. The project axis wide range addressed different interests thus increased the likelihood to reach diverse people. Additionally, the topic 'Memory' allowed continuity between spaces and subjects, while maintaining the desired multitude of perspectives: evoked emotions and stimulated self-expression by the community, triggered curiosity about the brain and from there to brain science, connected to the collective memories inside the museum and from there to art forms, and from the brain functions to all human movement, mundane activities and cultural creation.

Likewise, the several institutions from a variety of fields: research, academy, art, social, and participants had different goals, practices and individual profiles. The variety is undoubtfully an asset that can potentiate time and resources, and make use of a variety of professional

expertise. However, the diversity can also be a challenge. Whilst the social worker was more interested on cultural animation and social inclusion, the scientist was committed to engage the community in neurosciences; some members of the community faced the project as a mental exercise, whilst others where interested in learning about art. Each partner was forced to contribute or participate to a part of the project that did not directly address its own agenda, and therefore an extra investment was required. The role of the boundary spanner was crucial, yet challenging to balance between how much would be desirable for each partner to stay in and out of their comfort zones and territories, and deal with some resistance (most of all from time constraints) of each partner.
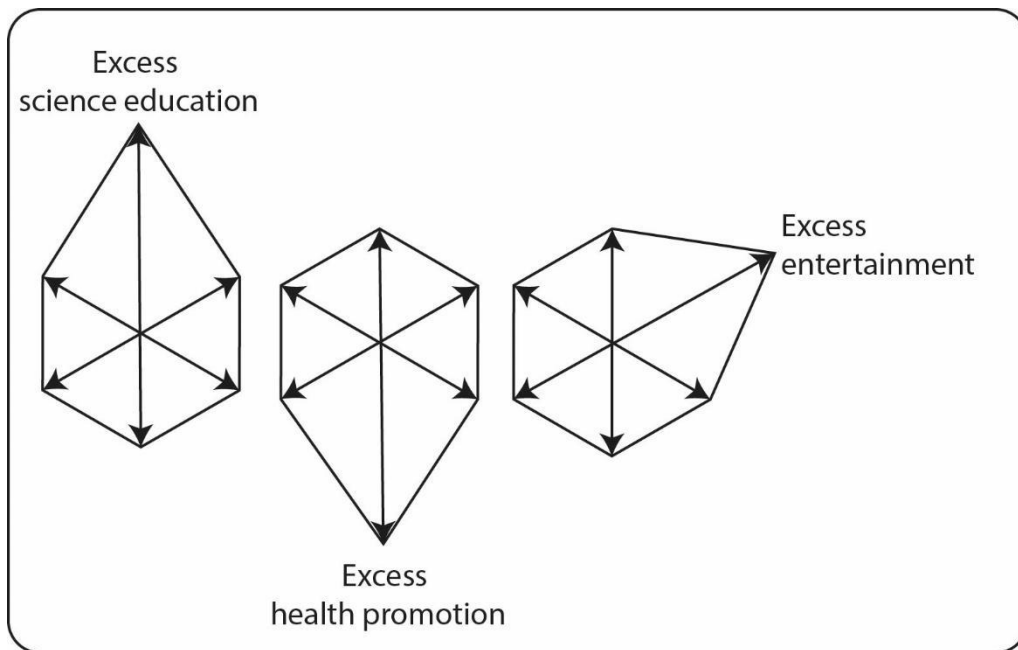

Figure 12 - Examples of unbalance of the project axis, towards science education, health promotion and entertainment.

When sessions started, there were constant interruptions to solve personal issues, the community's concentration span was limited, children (grandsons at their care) interrupted or distracted their attention, and an overall dispersion was noticed. Through time, almost all of this disappeared or was limited, with the last session tacking place smoothly and in a focused way. This achievement was important on its own because session's efficiency improved over time; but more importantly if this community engages in new future projects where intellectual stimulation is required, they will be a better prepared to profit from those projects. As evidenced in other projects, in a practicing culture of science learning, it is not just science that is produced but the environment for learning (and learning science) (Fusco, 2001).

The community was not built for the project, rather the societal actors were consulted to identify the group. Several options were considered, all within migrant communities inhabiting the vicinities of the research institute, however due to time limitations this was considered as the most "structured" by the social worker. The municipality task of community identification was very useful, in the one hand because the project benefitted from previous work on social inclusion and from the municipality knowledge of vulnerable communities; and on the other

hand, it valued the municipality role, therefore straightening institutional bonds. The municipality was also important for resource availability. The municipality assured transportation for visits, supported the public presentation/party, provided a venue for sessions and was responsible for the community contacts.

The distance from the neighbourhood to cultural centres within the municipality or even to Lisbon cultural spaces is not great (e.g., 10 km or an hour of public transportation to the FCG museum). Geographic distances certainly pose difficulties to the community that does not drive and have mobility difficulties; however, this was not the main issue. They take greater distances for medical appointments. In the same way, the sea is less than 5 km from the neighbourhood and still the community would not take advantage of it. After a municipality programme to promote the beach accessibility, with the incentive of the social worker and devoted transportation, the community started to go together to the beach (see section 3.1.2). Interestingly, the community motivation to go to the beach during summer was not as a leisure activity, but some sort of a medical treatment. They sea bathe, even if the water is cold and they cannot swim, because they were told that it is good for their health. For some members of the community, the participation on the "Embodying Memories" project had the same rationale. It was taken as a mental exercise, thus good for their health.

On a short-term perspective, the opportunity given to participants to engage with Science & Art, to visit the museum and laboratories, to meet scientists and science instruments, was a social inclusion achievement on its own. Given the personal histories and professional careers, this was a unique experience, as stated by participant 10. Participant 9 actually used the word "courage" to express what it took her to participate. One of the main outcomes of the project was an increased openness of the community to participate in cultural activities, such as a visit to another museum or a visit to the institute on "The Open Day" event. Nonetheless, the medium-term repercussions of the project are more questionable as there is no guarantee that they will feel motivated and empowered to take own initiatives. Community members may be more receptive, but limitations in transportation, limitations of access to culture programmes, physical limitations, financial limitations, as well as decades of exclusion and isolation may delay or inhibit such individual (or family) initiatives.

The community empowerment is limited in a short duration project such as this. In this sense, in the immediacy of the project, the continuing of participation in cultural activities, even if sporadic, depends on the social worker. The social worker had a very important role on the project execution. The community contacts were limited to face-to-face or telephone, as no texting or e-mail was possible. This implied that for session agenda, the project was dependent on verbal communication by the social worker, which she done diligently. Nevertheless, the involvement of the social worker in the project could have been more significant, had her role in the project been better discussed. Besides concerns with the community legal issues, social conditions, well-being, etc., the social worker is aware of the group limitations, thus protects them from experiences that she believes will make them fell diminished. For that and other reasons, the community is very grateful and trustful in her judgement. The social worker finds activities such as gymnastic or strolls that benefit the community members' health and social interactions. However, the protection also entails a certain withdraw from activities that promote intellectual stimulation.

Another difficulty encounter during the project was the impossibility of written materials. This was limiting because constrained activities such as gaming or exercises that use words, letters, numbers for role-play, sequencing, matching, amongst others. The group did not only have

literacy issues; the lack of intellectual stimulation and mental health promotion was pervasive, which occasionally compromised activities. This was observed when a 6-piece puzzle was offered, and only some could complete it. The puzzle was not used to check the community's competences, quite the opposite, it came out as an afterwards observation. The group needs additional resources to address this issue, which was outside of the project scope. Even so, project implementation could have included in the beginning an additional couple of sessions to exercise creativity, self-expression, and abstraction. Even though the theme was not set at this stage, these exercises, including exploration of artistic techniques, could had also foster trust, acquaint, and disinhibition. However, there was also the possibility that these free sessions could have mislead the community to a different type of project.

In relation to the project evaluation, several issues were detected, namely the previously referred impossibility of use of questionnaires. Interviews and focus groups inhibit the participants expression of negative opinions, or aspects that could be perceived as negative by participants. A key problem is courtesy bias where respondents tend to tell researchers what they (are perceived to) want to hear (e.g., Camfield *et al.*, 2014). Another issue was that some evidences for evaluation were recorded as field notes on the project log-book, during or after the sessions. Field notes, i.e. the written recording of observations, had limitations: the session activities themselves were the main focus, thus it was not possible to fully perceive each participant verbal and non-verbal contribution; and field notes were sometimes particularities, cherry picked citations that were therefore biased by the observer/participant perspective. However, audio recordings, but especially photographs and video recordings were intimidating and unpleasant to some members of the community that expressed their uneasy with cameras. Because of this, only two videos, two audio-recordings and sample photographs were taken. Towards the end of the project, participants became more open to recordings, and for the final presentation all were photographed by the boundary spanner. Though by the time video recordings were viable, most sessions had taken placed. Here there was a question of weighing the disadvantage of participants feeling uncomfortable and thus less participative; and the advantage of accurate project recording. A better compromise may be more audio recording that enhance the project data and only require feasible support of written annotations.

The community's problems with memory and mental plasticity, related to aging, poor stimulation or disease, affected the impact category "Knowledge of scientific topics related to neuroscience". Some participants tended to forget what occurred during previous sessions, namely participant 4 who developed a neurological condition that compromises the memory; and participant 2, that showed clear evidences of engagement with the project but failed to self-express project topics or activities and stated "My head is not the same. My memory is failing me[2]". The scarcity of offer to this community, even less activities that promote intellectual stimulation and enrichment, generated a feeling of gratitude towards the science communicator, the boundary spanner and the social worker. When asked to identify negative aspects about the project during the last session, participant 1 stated "How can you ask us to say something negative if we would have nothing if you didn't come here?[1]". Although this statement presumes the participant valued the experience offered by the project, it makes impossible the identification of elements/issues that could have been improved, valued, neglected.

---

[2] Free translation of Portuguese language.

3.2. Model proposal for engaging vulnerable communities

Social media provide examples of public engagement with science "going broad", reaching large audience, particularly webpages, blogs, documentaries, TED talks (e.g., the Neuroscientific Diagnosis of the "Zombie Brain": a humorous blog post that turned into a popular science book and over 700'000 YouTube views, by Bradley Voytek). However, these may not be effective channels for inclusion of vulnerable communities. Many traditional approaches to public communication about science (science web sites, traditional science documentaries, and similar outreach efforts) may inherently favour elite audiences (Nisbet and Scheufele, 2009). Moreover, with so much focus on media strategy and education, it is important not to forget that perhaps the most effective strategy for connecting with difficult-to-reach audiences is face-to-face conversation and other interpersonal channels (Nisbet and Scheufele, 2009). The project "Embodying memories" fits the small budget projects, as "Urban Garden" (Fusco and Barton, 2001) or "Scientific Racism" (Foggett, 2008), described in section 1.3.1, since it did not involve the creation of an exhibition or science centre. It was designed specifically for adults, which are the less common social-inclusive projects, more similar to the "Creative Canals" project (Science Museum Group, 2019), but mostly taking place on the community spaces as the "Questioning Workshops" (Perié *et al.* 2014) and addressing a community interest such as the "Urban Garden" project. Moreover, "Embodying memories" project adds to the practice-based research body of knowledge of engagement with science by the use of art, artistic techniques and artistic institutions, in an approach aligned with the concept of "culture capital".

The insights gained with the development of the project "Embodying memories", its evaluation and critical reflexion in light of practices of social inclusion in science, nurtured the development of a model for vulnerable communities' engagement with science, using Science & Art approaches. The project entails the following phases (adapted from the phases of model of outreach of Varner, 2014): Phase 1 - Design, plan and collaboration; Phase 2 - Implementation; and Phase 3 - Evaluation (Figure 13). Within each phase, this work proposes both well-established and innovative tasks, described below.

During Phase 1, when the design of the project is set, several tasks are undertaken: definition of partners, establishment of collaborations and relationships, development of boundary spanner, establishment of specific topics and goals, and development of an evaluation plan. Projects of science communication may have a variable number of partners, unwisely only one to more than four, such as the "Native Waters" project. For this project native and non-native informal educators joint efforts with tribal youth and adults of the Missouri River Basin, the Montana State University and the Science Museum of Minnesota with the support of two foundations, a charitable trust, and a bureau (Sachatello-Sawyer and Cohn, 2005).
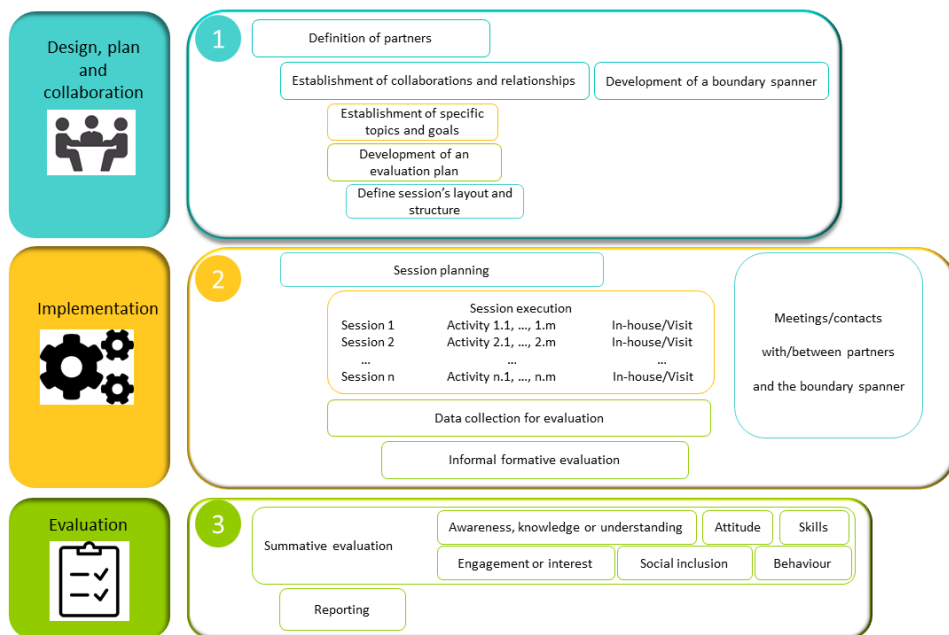
Figure 13 - Proposed model for projects of science communication using Science & Art to promote social inclusion.

In multi-sessions projects involving Science & Art approaches, the number of partners necessarily increases. Partners for these projects preferably cover a wide-variety of areas, not only traditional institutions that endeavour engagement with science. Moreover, for social inclusion cross-sectoral collaboration is desirable. These individuals or institutions can be within the sector of:

- Science. For example, researchers, research institutes, universities, laboratory facilities.
- Arts. For example, art museums, art galleries, theatre companies, edified heritage, opera houses, dance companies.
- Education (formal and non-formal). For example, high schools, science centres, art schools, botanical gardens, libraries, craft schools.
- Industry. For example, pharmaceutical industry, telecommunication industry, ceramic industry,
- Public organizations. For example, municipalities, governmental offices, social security services, hospitals, military institutions.
- Communication. For example, institution communication offices, science journalists, national broadcast.
- Civil society. For example, charities, Non-Governmental Organisations, religious institutions, sponsors.
- Entertainment/Leisure. For example, aquariums, zoos, sport clubs, circus companies, shopping centres, fairs, festivals.

Projects involving significant interdisciplinary and multiple partners, need to bring into the arena people and organizations with different backgrounds, practices, languages, purposes, that may be misaligned, or even compatible. Strategic alliances, joint working arrangements, networks, partnerships and many other forms of collaboration across sectoral and organizational boundaries currently proliferate (Williams, 2002). A science communicator with a broad-range education may endeavour such task; however, limitations will probably arise. To

address these issues it is important to have individuals who mediate between the different social groups - the boundary spanners, which are key agents managing within inter-organizational theatres (Williams, 2002). These individuals must effectively inhabit multiple social entities, and allow the distinct cultures to communicate successfully without the need for either to adapt culturally to the other. Many science communicators act in the role of boundary spanner within their groups or organizations to bridge boundaries and to ensure their maintenance (Kirby, 2008).

At this point, the specific nature of the collaborative work, specific topics and goals are designed during meetings, join activities, workshops, and visits. The boundary spanner role is pivotal at this stage, managing relationships, expectations, complexities, interdependencies, negotiating and influencing. The project's central topic needs to meet the following criteria:

- Interesting to all partners;
- All partners are able to contribute;
- All partners envisage benefits from the topic exploration;
- All partners' knowledge/awareness/engagement improves after the project.

This phase brings partners together, generates empathy, and more importantly partners take time to acknowledge each other's interests, resources, availability, and potentialities. Besides science communication or engagement, social inclusion, and art engagement, project goals can also include community building, entertainment, health improvement, environmental behaviour change, art education, fund raising, and institutional marketing. After setting the objectives, a session's layout and structure should be defined. Finally, an evaluation plan should be developed, identifying qualitative and quantitative indicators, and other characterizations parameters, some of which need to be gathered before or during the early stages of the project implementation.

For phase 2, when the project is implemented, tasks consist in: session's planning, session's execution, data collection for evaluation, and informal formative evaluation, all accompanied with meetings and contacts between partners and the boundary spanner, and eventually informal formative evaluations (Figure 13). At the beginning of the implementation, having the topic selected it is necessary to design and plan the number, duration and type of sessions. At the minimum end, the project implementation is a couple of sessions and for longer projects, the layout can consist of a number of sessions occurring over multiple years. The sessions progress should follow a narrative arc, i.e., the way sessions evolve should on the one hand tell a story and on the other hand, should increase in intensity and complexity. The project implementation specific attributes are dependent upon, amongst others:

- Ambition of goals;
- Interest and level of engagement of the several partners;
- Complexity of the topic and degree of depth into it;
- Human resources availability and profile;
- Space availability, quality and features;
- Equipment and materials availability and quality;
- Transportation means;
- Type of artistic techniques to use;
- Financial support.

For the project to develop in a collaborative way, sessions planning and executions needs to be at the same time loose enough to accommodate the adjustments proposed by the several

partners, but straightforward enough to make good use of available resources, and keep the story on track. Even considering all the above constraints or assets, the experimental research from the project "Embodying Memories" suggests **minimum** conditions for these projects, which are: two-person team for session's execution; one cultural visit outside the community space; one session devoted to stimulate creativity, abstraction, curiosity; contact with two art forms during session's execution; one direct contact with a science professional; one activity demonstrative of the relation between the scientific topic and an issue of everyday life; and two months project implementation. Some of the issues contribute directly to the approach of science capital, as defined by (Archer *et al.*, 2015)

To evaluate if the scientific-artistic approach used in the project serves the purpose of engagement with science of socially-vulnerable communities, several evaluation methods can be adopted. Literature on project evaluation can be found in e.g. Margoluis *et al.* (2009), Carleton-Hug and Hug (2010), Bryman (2012), Moss *et al.* (2014), Kennedy *et al.* (2018). The evaluation of science communication projects is neither an easy task nor a consensual one. Providing the causal effect of one particular intervention (over and above other experiences) and thereafter claiming impact is extremely difficult (King *et al.* 2015). King *et al.* (2015) draw a distinction between "evaluation studies" that focus on immediate questions of what and how something works on the one hand and "impact analyses" on the other hand. For these authors, impact analyses are longitudinal, large-scale, involving control populations, with both quantitative and qualitative elements. On the contrary, Wagoner and Jensen (2015) question whether control groups are at all needed or useful for impact evaluation in informal learning or public engagement settings, and Jensen (2015) states that there is no reason to assume that impact evaluation must be large-scale or include both quantitative and qualitative elements. According to Jensen (2015) there is no achievable science communication goal that is impervious to robust measurements using social scientific tools.

Given the specific nature of these projects, the Framework for Evaluating Impacts of Informal Science Education Projects (Allen *et al.*, 2008) is particularly useful. The framework for evaluation need to be defined case-by-case including several (not all) of the following six impact categories: 1) Awareness, knowledge or understanding; 2) Engagement or interest; 3) Attitude; 4) Behaviour; 5) Skills and 6) Social inclusion. When dealing with social inclusion, evaluation should consider the diversity of publics. Therefore, it may be necessary to use evaluation tools other than written questionnaires, to include the opinion and perception of, for example, illiterate participants and foreign language participants, persons with visual impairment, motor impairment, reading or writing difficulties. Tools such as interviews, focus groups, ethnography and participant observations, language analysis, and video recording analysis, may overcome challenges in evaluation by written materials.

4. Conclusions

The project "Embodying memories" was an innovative exploratory project by the way it combined science, art and communication to engage with a vulnerable community, apart from most culture events. It was a small budget project, comparable to a few science communication projects designed specifically for social inclusion of adults found in the literature; however, it adds to the practice-based research body of knowledge by the use of art, artistic techniques and artistic institutions, in an approach aligned with the concept of "culture capital". The selected community for the project embodies many of the barrier factors identified in social exclusion from science/culture: age, gender, schooling, ethnicity, social status, income, and job profile. On a short-term perspective, participants' engagement with Science & Art, the visits to the museum and laboratories, the acquaintance of scientists and contact with science instruments, was a social inclusion achievement on its own.

The project involved a number of partners from a variety of fields: research, academy, art, and social. It developed in a collaborative way, giving voice to all partners, giving value to all contributions, making use of diverse know-how and sharing resources. The variety was undoubtfully an asset that potentiated time and resources, and made use of a variety of professional expertise. However, the diversity of objectives and practices was also a challenge. The role of the boundary spanner was crucial to evaluate and balance each partner's availability, openness and agenda.

One of the project achievements was the fruition of the project itself, experienced not only by the community participants, but also by the science communicator, boundary spanner, neuroscientist, art specialist and social worker, attained from motivated partners in a positive, participative and respectful atmosphere. The topic of the project – Memory - allowed continuity between spaces, permitted diversity of perspectives, evoked emotions, stimulated self-expression, and connected science to everyday life. Throughout the project development it was possible to identify other positive and negative choices and outcomes, that may provide useful insights to others seeking this type of approaches. The project was set as a balance of six axes – science education, cultural animation and entertainment, social inclusion, mental health promotion, institutional marketing, and art education. The six-axes approach permitted multiple drivers and practices to reconcile.

Overall, taking into account the selected evaluation indicators it was considered that the project promoted some increase in awareness of science, moderate increase in knowledge about scientific topics related to neuroscience and some to moderate engagement with science. Given the evolution noticed along the project, a possible improvement of these indicators could have been possible with one or two more sessions of practical activities and debates about science. It was considered that there was only some stimulation of curiosity, abstraction and self-expression. These are probably more ambitious and sophisticated goals that are more adequate for a project follow-up or to a second project, taking advantage of what was achieved with this first project.

One of the main social goals of the project was to increase openness of the community to participate in cultural activities, such as visitations to other museums or a visit to the institute "Open Day". It was qualitatively assessed on the project evaluation, a high level of engagement with the project, a high to very high encouragement of community willingness to participate in new cultural experiences, and a very high participation in cultural experiences. Nonetheless, the medium-term repercussions of the project are more questionable as there is no guarantee

that they will feel motivated and empowered to take actions. Community members may be more receptive, but several logistical and financial limitations, over decades of social exclusion may hinder such initiatives. In the immediacy of the project, the participation in cultural activities, even if sporadic, will probably depend on the social worker.

The insights gained from the development of "Embodying memories" project, its evaluation and critical reflexion in light of practices of social inclusion in science, was the basis for model of science communication using Science & Art approaches to promote social inclusion. The model has three phases: Phase 1 - Design, plan and collaboration; Phase 2 - Implementation; and Phase 3 - Evaluation. Within each phase, well-established and innovative tasks are proposed. Hopefully the model has sufficient guidance and freedom to be used as a guideline, not a restrictive corset for future projects of science communication. The model also highlights areas of desirable/required expertise for training scientists and science communicators in engagement with Science & Art, and social inclusion.

Acknowledgements

References

Aguirre, C. (2014). "Which role can they play to participate in a city social reconstruction?". *Journal of Science Communication* 13(2): C04.

Allen, S., Campbell, P.B., Dierking, L.D., Flagg, B.N., Garibay, C., Korn, R., Silverstein, G., Ucko, D.A. (2008). *Framework for evaluating impacts of informal science education projects*. (ed.) A.J. Friedman. The Division of Research on Learning in Formal and Informal Settings, 114 pp.

American Association for the Advancement of Science (2019). "Center for Public Engagement with Science Technology". Retrieved 28 January 2019 (https://www.aaas.org/programs/center-public-engagement-science-and-technology).

Archer, L., Dawson, E., DeWitt, J., Seakins, A., Wong, B. (2015). ""Science Capital": A conceptual, methodological, and empirical argument for extending Bourdieusian notions of capital beyond the arts". *Journal of Research in Science Teaching* 52(7): 922–48.

Archer, L., DeWitt, J., Willis, B. (2014). "Adolescent boys' science aspirations: masculinity, capital, and power". *Journal of Research in Science Teaching* 51(1): 1–30.

Atkinson, R., Siddall, K., Mason, C. (2014). *Experiments in engagement: engaging with young people from disadvantaged backgrounds*. London, UK, 14 pp.

Ballantyne, R. and Packer, J. (2005). "Promoting environmentally sustainable attitudes and behaviour through free-choice learning experiences: What is the state of the game?" *Environmental Education Research* 11(3): 281–95.

Batts, S.A., Anthis, N.J., Smith, T.C. (2008). "Advancing science through conversations: bridging the gap between blogs and the academy". *PLoS Biology* 6(9): e240.

Bauer, M.W. (2008). "Paradigm change for science communication: commercial science needs a critical public". In D. Cheng, M. Claessens, T. Gascoigne, J. Metcalfe, B. Schiele, and S. Shi (Ed.), *Communicating science in social contexts*, Springer, pp. 7–25.

Bauer, M.W., Allum, N., Miller, S. (2007). "What can we learn from 25 Years of PUS survey research? Liberating and expanding the agenda". *Public Understanding of Science* 16(1): 79–95.

Belfiore, E. and Bennett, O. (2007). "Rethinking the social impacts of the arts". *International Journal of Cultural Policy* 13(2): 135–51.

Bell, P., Lewenstein, B., Shouse, A. W., Feder, M. A. (2009). *Learning Science in Informal Environments: People, Places and Pursuits*. Vol. 8. National R. Washington, DC: The National Academies Press.

Berendsen, M. (2005). "Conceptual astronomy knowledge among amateur astronomers". *Astronomy Education Review* 4(1): 1–18.

Boeren, E. and Whittaker, S. (2018). "A typology of education and training provisions for low educated adults: Categories and definitions". *Studies in the Education of Adults* 50(1): 4–18.

Borun, M., Chambers, M.B., Dritsas, J., Johnson, J.I. (1997). "Enhancing family learning through exhibits". *Curator: The Museum Journal* 40(4): 279–95.

Bourdieu, P. (1986). "Forms of Capital". In J. Richardson (Ed.) *Handbook of theory and research for the sociology of education*. New York, USA, Greenwood Press, pp. 241–58

British Science Association (2016). *A changing sector: where is science communication now?*. British Science Association, 33 pp.

Brown, B.A., Reveles, J.M., Kelly, G.J. (2005). "Scientific literacy and discursive identity: A theoretical framework for understanding science learning". *Science Education* 89: 779–802.

Brown, K., Eernstman, N., Huke, A.R., Reding, N. (2017). "The drama of resilience: Learning, doing, and sharing for sustainability". *Ecology and Society* 22(2): 8.

Bryman, A. (2012). *Social Research Methods*. Oxford, Oxford University Press, 766 pp.

Bultitude, K. (2011). "The why and how of science communication". In: P. Rosulek (Ed.) *Science Communication,* European Commission, Pilsen, pp 1–18.

Camfield, L., Duvendack, M., Palmer-Jones, R. (2014). "Things you wanted to know about bias in evaluations but never dared to think'. *IDS Bulletin* 45(6): 49–64.

Carleton-Hug, A. and Hug, J.W. (2010). "Challenges and opportunities for evaluating environmental education programs". *Evaluation and Program Planning* 33(2): 159–64.

Chang, M. (2015). *Communicating environmental science through art: scope, applications, and research agenda*. MSc Thesis, University of Washington, 44 pp.

Cornwall, A. and Jewkes, R. (1995). "What is participatory research?" *Social Science and Medicine* 41(12): 1667–76.

Curtis, D.J. (2009). "Creating inspiration: the role of the arts in creating empathy for ecological restoration". *Ecological Management and Restoration* 10(3): 174–84.

Curtis, D.J., Reid, N., Ballard, G. (2012). "Communicating ecology through art: what scientists think". *Ecology and Society* 17(2): 3.

Dawson, E. (2014a). "Equity in informal science education: Developing an access and equity framework for science museums and science centres". *Studies in Science Education* 50(2): 209–47.

Dawson, E. (2014b). "Reframing social exclusion from science communication: Moving away from "barriers" towards a more complex perspective". *Journal of Science Communication* 13(2): C02.

Dawson, E. (2018). "Reimagining publics and (non) participation: Exploring exclusion from science communication through the experiences of low-income, minority ethnic groups". *Public Understanding of Science* 27(7): 772–86.

Dawson, E. and Jensen, E. (2011). "Visitor studies towards a contextual turn in visitor studies: Evaluating visitor segmentation and identity-related motivations". *Visitor Studies* 14(1): 127–40.

Desjardins, R., Rubenson, K., Milana, M. (2006). *Unequal Chances to Participate in Adult Learning: International Perspectives*. Paris: UNESCO: International Institute for Educational Planning, 312 pp.

Dierking, L.D. (2008). "Evidence and categories of ISE Impacts". In A.J. Friedman (ed.) *Framework for evaluating impacts of informal science education projects*. The Division of Research on Learning in Formal and Informal Settings, pp. 17–27

Donghong, C., Claessens, M., Gascoigne, T., Metcalfe, J., Schiele, B., Shi, S. (2008). "Introduction: Science Communication - a Multidisciplinary and Social Science". In C.

Donghong, M. Claessens, T. Gascoigne, J. Metcalfe, B. Schiele, S. Shi (Ed.) *Communicating science in social contexts*, Springer Netherlands, pp. 1–3.

Donghong, C. and Shi, S. (2008). "The more, the earlier, the better: science communication supports science education". In C. Donghong, M. Claessens, T. Gascoigne, J. Metcalfe, B. Schiele, S. Shi (Ed.) *Communicating science in social contexts*, Springer Netherlands, pp. 151–63.

Elder, J., Coffin, C., Farrior, M. (1998). *Engaging the public on biodiversity: A road map for education and communication strategies*. The Biodiversity Project, Wisconsin, USA, 118 pp.

European Commission. 2004. *Europe needs more scientists.* Report by the High Level Group on Increasing Human Resources for Science and Technology. Brussels, Belgium, 191 pp.

Eveland, W.P. and Dunwoody, S. (1998). "Users and Navigation Patterns of a Science World Wide Web Site for the Public". *Public Understanding of Science* 7(4): 285–311.

Falk, J.H. and Dierking, L.D. (2012). "Lifelong learning for adults: The role of free-choice experiences". In B.J. Fraser, K.G. Tobin, C.J. McRobbie (ed.) *Second international handbook of science education*, London, Springer, pp. 1063–79.

Falk, J.H., Storksdieck, M., Dierking, L.D. (2007). "Investigating public science interest and understanding: Evidence for the importance of free-choice learning". *Public Understanding of Science* 16: 455–69.

Falk, J.H., Osborne, J., Dierking, L.D., Dawson, E., Wenger, M., Wong, B. (2012). *Analysing the UK science education community: The contribution of informal providers*. The Wellcome Trust, London UK, 80 pp.

Fenichel, M. and Schweingruber, H.A. 2010. *Surrounded by Science*. National Research Council. Washington, DC USA, The National Academies Press, 220 pp.

Fischhoff, B. (2013). "The sciences of science communication". *Proceedings of the National Academy of Sciences* 110(3): 14033–39.

Foggett, M. (2008). *Community consultation at the Dana Centre: An audience-led project between London' s African-Caribbean community and the Science Museum*. Audience Research & Advocacy Group, Learning Unit, The Science Museum, London UK, 16 pp.

Friedman, A.J. (2013). "Reflections on communicating science through art". *Curator: The Museum Journal* 56(1): 3–9.

Fusco, D. (2001). "Creating relevant science through urban planning and gardening". *Journal of Research in Science Teaching* 38(8): 860-877.

Fusco, D. and Barton, A.C. (2001). "Representing student achievements in science". *Journal of Research in Science Teaching* 38(3): 337–54.

Grand, A., Davies, G., Holliman, R., Adams, A. (2015). "Mapping public engagement with research in a UK university". *PLos ONE* 10(4): e0121874.

Hayes, J.C. and Kraemer, D.J.M. (2017). "Grounded understanding of abstract concepts: The case of STEM learning". *Cognitive Research: Principles and Implications* 2(1): 7.

Heras, M. and Tàbara, J.D. (2014). "Let's play transformations! Performative methods for sustainability". *Sustainability Science* 9(3): 379–98.

Hooper-Greenhill, E., Dodd, J., Creaser, C., Sandell, R., Jones, C., Woodham, A. (2007).

Inspiration, identity, learning: The value of museums – Second study. Research Centre for Museums and Galleries and University of Leicester, 361 pp.

Jensen, E. (2014). "The Problems with Science Communication Evaluation". *Journal of Science Communication* 13(1): C04.

Jensen, E. (2015). "Highlighting the value of impact evaluation: Enhancing informal science learning and public engagement theory and practice". *Journal of Science Communication* 14(3): Y05.

Jensen, E. and Wright, D. (2015). "Critical response to Archer *et al.* (2015) "Science Capital": A conceptual, methodological, and empirical argument for extending Bourdieusian notions of capital beyond the arts". *Science Education* 99(6): 1143–46.

Jovchelovitch, S. (2002). "Re-thinking the diversity of knowledge: Cognitive polyphasia, belief and representation". *Psychologie et Société* 5(1): 121–38.

Kennedy, E.B., Jensen, E.A., Verbeke, M. (2018). "Preaching to the scientifically converted: evaluating inclusivity in science festival audiences". *International Journal of Science Education* Part B(8:1): 14–21.

Kim, H.-S. (2012). "Chapter 18. Engagement: The key to the communicative effectiveness of science and ideas". In B. Schiele, M. Claessens, and S. Shi (Ed.), *Science communication in the world: practices, theories and trends*, Springer, pp. 269–79.

King, H., Svalastog, A.L., Hobson, M., Robinson, A., Clipson, H. (2015). "Highlighting the value of evidence-based evaluation: Pushing back on demands for "impact"". *Journal of Science Communication* 14(02): A02.

Kirby, D.A. (2008). "Hollywood knowledge: Communication between scientific and entertainment cultures". In C. Donghong, M. Claessens, T. Gascoigne, J. Metcalfe, B. Schiele, S. Shi (Ed.) *Communicating science in social contexts*, Springer Netherlands, pp. 165–80.

Koo, A. (2015). "Arts and education for underprivileged people: Community-based art projects case study". *Procedia - Social and Behavioral Sciences* 174: 64–68.

de la Garza, A. and Travis, C. (2019). "Introduction". In A. de la Garza and C. Travis (Ed.) *The STEAM Revolution*, Springer, Cham, pp. 1–10.

Lopes, M. M. (2015). "Intertwined artistic practices: Critical remarks on collaboration across fields of knowledge". *MIDAS* 5.

Margoluis, R., Stem, C., Salafsky, N., Brown, M. (2009). "Design alternatives for evaluating the impact of conservation projects". In M. Birnbaum and P. Mickwitz (Ed) *Environmental program and policy evaluation: Addressing methodological challenges. New Directions for Evaluation*, Wiley-Blackwell, pp. 85–96.

Massarani, L. and Merzagora, M. (2014). "Socially inclusive science communication". *Journal of Science Communication* 13(2): C01.

McCallie, E., Bell, L., Lohwater, T., Falk, J.H., Lehr, J.L., Lewenstein, B.V., Needham, C., Wiehe, B. (2009). *Many experts, many audiences: Public engagement with science and informal science education*. A CAISE Inquiry Group Report. Washington, D.C., Center for Advancement of Informal Science Education, 83 pp.

Mendes, M. M., Brígido, P., Candeias, P. (2011). *Diagnóstico da população imigrante no concelho de Oeiras: Desafios e potencialidades para o desenvolvimento local*. In I. Évora

(Ed.), *Diáspora Cabo-Verdiana: temas em debate*, CEsA/ISEG, Lisboa, pp. 227-258.

Metcalfe, J., Riedlinger, M., Pisarsky, A. (2008). "Situating science in the social context by cross-sectoral collaboration". in *Communicating science in social contexts. New models, New practices*, In C. Donghong, M. Claessens, T. Gascoigne, J. Metcalfe, B. Schiele, S. Shi (Ed.) *Communicating science in social contexts*, Springer Netherlands, pp. 181–97

Moss, A., Jensen, E., Gusset, M. (2014). *A Global Evaluation of Biodiversity Literacy in Zoo and Aquarium Visitors*. World Association of Zoos and Aquariums (WAZA), Gland, Switzerland, 37 pp.

Nisbet, M.C. and Scheufele, D.A. (2009). "What's next for science communication? Promising directions and lingering distractions". *American Journal of Botany* 96(10): 1767–1778.

Opermanis, O., Kalnins, S.N., Aunins, A. (2015). "Merging science and arts to communicate nature conservation". *Journal for Nature Conservation* 28: 67–77.

Peltola, T. and Arpin, I. (2018). "Science for everybody? Bridging the socio-economic gap in urban biodiversity monitoring". In S. Hecker, M. Hackay, A. Bowser, Z. Makuch, J. Vogel, A. Bonn (Ed.) *Citizen science: Innovation in open science, society and policy*, UCL Press, London, pp. 369– 380

Perié, L., Riboli-Sasco, L., Ribrault, C. (2014). "Straight into conflict zones, scientific research empowers the minds". *Journal of Science Communication* 13(2): C05.

Pinto, B. and Riesch, H. (2017). "Are audiences receptive to humour in popular science articles? An exploratory study using articles on environmental issues". *Journal of Science Communication* 16(04): A01.

Pool, R. (1991). "Science literacy: The enemy is us". *Science* 251(4991): 266–267.

Von Roten, F.C. and Moeschler, O. (2007). "Is art a "good" mediator in a science festival?" *Journal of Science Communication* 6(3).

Rounds, J. (2004). "Strategies for the curiosity-driven museum visitor". *Curator: The Museum Journal* 47(4): 389–412.

Rowe, G. and Frewer L.J. (2005). "A typology of public engagement mechanisms". *Science, Technology & Human Values* 30(2): 251–90.

Sachatello-Sawyer, B. and Cohn, T. (2005). "Native Waters: integrating scientific and cultural ways of knowing about water". *Curator: The Museum Journal* 48(2): 134–40.

Schwartz, B. (2014). "Communicating science through the performing arts". *Interdisciplinary Science Reviews* 39(3): 275–89.

Science Museum Group. 2019. "Project Archive". Retrieved 28 January 2019 (https://group.sciencemuseum.org.uk/our-work/learning/projects-and-partnerships/project-archive/).

House of Lords (2000). *Science and Society*. Report of the House of Lords Selected Committee on Science and Technology, third report, London UK.

Shein, P.P., Li, Y.Y., and Huang, T.C. (2015). "The four cultures: public engagement with science only, art only, neither, or both museums". *Public Understanding of Science* 24 (8): 943–56.

Snow, C.P. (1959a). "The two cultures". In *Rede Lecture at the University of Cambridge*. Cambridge.

Snow, C.P. (1959b). *The two cultures and the scientific revolution*. Martino Fine Books, 66 pp. 2013 Reprint.

Stiller-Reeve, M. and Naznin, Z. (2017). "The artistic process nurtures collaboration and a sense of community in a climate project in Bangladesh'. *Bulletin of the American Meteorological Society* 99(3): 491–97.

Streicher, B., Unterleitner, K., Schulze, H. (2014). "Knowledge rooms - science communication in local, welcoming spaces to foster social inclusion". *Journal of Science Communication* 13(2): C03.

Tavares, M.A. (2016). *Marias. Um Projeto Para a Qualidade de Vida de Mulheres Idosas Imigrantes*. Projecy Report of Câmara Municipal de Oeiras, 8 pp.

Varelas, M., Pappas, C.C., Tucker-Raymond, E., Kane, J., Hankes, J., Ortiz, I., Keblawe-Shamah, N. (2010). "Drama activities as ideational resources for primary-grade children in urban science classrooms". *Journal of Research in Science Teaching* 47(3): 302–25.

Varner, J. (2014). "Scientific outreach: Toward effective public engagement with biological science". *BioScience* 64(4): 333–40.

Wagoner, B. and Jensen, E. (2015). "Microgenetic evaluation: Studying learning as it develops". In G. Marsico, R. Ruggieri, S. Salvatore (Ed.), *Reflexivity and Psychology.* Information Age Publishing, Charlotte NC, pp. 293-310.

Warden, R. (2010). "The internet and science communication: Blurring the boundaries". *Ecancermedicalscience* 4: 203.

Wigfall, M. Z. (2015). *The Arts: Building a foundation to increase science literacy skills for urban youth*. PhD Thesis, University of Missouri-St. Louis, 199 pp.

Williams, P. 2002. "The competent boundary spanner". *Public Administration* 80(1): 103–24.

Annexes

Annexe 1. List of acronyms

CLAIM – Centro Local de Apoio à Integração de Migrantes

CMO – Câmara Municipal de Oeiras

FCG – Fundação Calouste Gulbenkian

IGC – Instituto Gulbenkian de Ciência

ISE - Informal Science Education

PES - Public Engagement with Science

PUS - Public Understanding of Science

STEM - Science, Technology, Engineering and Maths

STEAM - Science, Technology, Engineering, Arts and Maths

Annexe 2. Structure and plan of the project sessions

PROJETO "DAR CORPO ÀS MEMÓRIAS" – 1ª SESSÃO

SESSÃO/ TEMA	1ª – O objeto/órgão das memórias
DATA/HORA	11-09-2018 / 15h00
ORIENTAÇÃO	Ana Matias, Ana Mena, Cláudia Gonçalves

MATERIAIS
● Questionário base de avaliação de perceção da ciência (3);   ● Gravador áudio;   ● Máquina fotográfica com cartão de memória;   ● Molde físico do cérebro;   ● Computador portátil;   ● Diário de bordo.   Nota: as participantes precisam de trazer os seus objetos.

DURAÇÃO	ATIVIDADE	ORIENTAÇÃO	DESCRIÇÃO
10 min.	Receção do grupo		Conversa inicial, disposição das pessoas na sala.
40 min.	Avaliação de base	Ana Mena	Conjunto de perguntas a realizar-se em "focus group", de forma descontraída. Documentação por gravação áudio.
30 min.	Memórias na palma da mão	Ana Matias	Cada participante e interveniente conta a memória associada ao objeto que trouxe. Documentação escrita e fotográfica.
15 min.	Apresentação do cérebro	Cláudia Gonçalves	Apresentação do objeto/orgão das memórias: o cérebro. Pequena descrição do órgão, através das suas características físicas principais, apoiada pelo molde físico. Documentação fotográfica.
10 min.	Coleção de palavras	Ana Matias	É pedido às participantes que escolham 3 palavras que descrevam a sessão. Documentação escrita.
1h45			

PROJETO "DAR CORPO ÀS MEMÓRIAS" – 2ª SESSÃO

SESSÃO/ TEMA	2ª – As funções do cérebro
DATA/HORA	02-10-2018 / 15h00
ORIENTAÇÃO	Ana Matias, Ana Mena, Cláudia Gonçalves

MATERIAIS

- Máquina fotográfica com cartão de memória;
- Computador portátil (Música);
- 2 imagens A4 de cortes do cérebro, com as principais áreas coloridas e numeradas;
- 2 puzzles de 6 peças com a mesma imagem do cérebro;
- Lista das funções do cérebro com as funções numeradas de acordo com a imagem;
- Diário de bordo.

DURAÇÃO	ATIVIDADE	ORIENTAÇÃO	DESCRIÇÃO
10 min.	Receção do grupo		Receção do grupo, disposição das pessoas na sala.
20 min.	Resumo da sessão anterior, memórias na palma da mão e puzzle do cérebro	Ana Mena	Relembrar que o projeto se debruça sobre as memórias e sobre o cérebro. Resumir a sessão anterior, mencionando os objetos das memórias e quem os mencionou. Dar lugar a novos objetos. Distribuir os 2 puzzles e as imagens de cortes de cérebros e relembrar o aspeto do orgão.
40 min.	Representação de objetos	Ana Matias e Cláudia Gonçalves	Para cada um dos objetos das memórias, propor que as participantes façam uma representação corporal do objeto ou da sua finalidade. Se necessário exemplificar. No final de cada representação, interagir com a Cláudia. Documentação escrita e fotográfica.
	O cérebro e as suas funções		Localizar na imagem e na cabeça a área responsável pela função que pode ser associada ao objeto/finalidade. Relatar casos reais de lesão e comprometimento da função.

40 min.	O cérebro e as suas funções	Cláudia Gonçalves e Ana Mena	Descrição da função do cérebro não abordadas anteriormente (em associação com os objetos da memória) e sua localização na imagem do cérebro.
	Representação de lesões do cérebro		É pedido às participantes que representem, através de mímica ou teatralização,) uma pessoa com comprometimento da área do cérebro associada a essa função. Documentação escrita.
10 min.	Coleção de palavras	Ana Matias	É pedido às participantes que relembrem as palavras já existentes na coleção e que escolham 3 novas palavras que descrevam a sessão. Documentação escrita.
2h00			

SESSÃO/ TEMA	3ª – O desenvolvimento do cérebro
DATA/HORA	08-10-2018 / 15h00
ORIENTAÇÃO	Ana Matias, Ana Mena, Cláudia Gonçalves

MATERIAIS
● Máquina fotográfica com cartão de memória; ● 2 imagens A4 de cortes do cérebro e 2 imagens A4 com o desenvolvimento do cérebro durante a gestação; ● Caixa com pequenos cartões que têm atividades que demonstram as várias funções do cérebro; ● Lista das funções do cérebro com as funções numeradas de acordo com a imagem; ● Diário de bordo.

DURAÇÃO	ATIVIDADE	ORIENTAÇÃO	DESCRIÇÃO
10 min.	Receção do grupo		Receção do grupo, disposição das pessoas na sala.
20 min.	Resumo da sessão anterior e imagens das zonas do cérebro	Ana Mena	Resumir a sessão anterior, mencionando os objetos das memórias e quem os mencionou. Dar lugar a novos objetos. Distribuir as imagens de cortes de cérebros e relembrar que há várias zonas do cérebro, com diferentes funções.
40 min.	O cérebro nas várias fases da vida	Cláudia Gonçalves	Caracterização das várias fases de desenvolvimento do cérebro: gestação, infância, adolescência, vida adulta. Incluir fatores que favorecem e prejudicam o desenvolvimento do cérebro. No final de cada fase interagir com a Ana.
	Representação das fases de desenvolvimento	e Ana Matias	Representar com gestos ou movimento, as várias fases do desenvolvimento. A ideia é responder a "O cérebro durante a ….. é…..: gestação – crescimento/ explosão, infância – estímulos e caminhos, adolescência – social e emocional vida adulta – ginástica e stress. Documentação escrita e fotográfica

40 min.	Auto representaçã o do cérebro	Ana Matias e Ana Mena	É pedido às participantes que representem, apenas com uma palavra e mímica ou teatralização, os seus próprios cérebros respondendo à pergunta: O meu cérebro é……. Documentação escrita e fotográfica.
10 min.	Coleção de palavras	Ana Matias	É pedido às participantes que relembrem as palavras já existentes na coleção e que escolham 3 novas palavras que descrevam a sessão. Documentação escrita.
2h00			

PROJETO "DAR CORPO ÀS MEMÓRIAS" – 4ª SESSÃO

SESSÃO/ TEMA	4ª - O cérebro em pormenor: neurónios e ligações
DATA/HORA	14-10-2018 / 15h00
ORIENTAÇÃO	Ana Matias, Ana Mena, AndreiaDias, Cláudia Gonçalves

MATERIAIS

- Máquina fotográfica com cartão de memória;
- 2 imagens A4 de neurónios e 2 imagens A4 de neurónios em rede;
- Imagens A4 de células da pele e de vários tipos de células do corpo humano
- Modelo artesanal de neurónio (vela e fio elétrico)
- Novelo de trapilho laranja
- Diário de bordo.

DURAÇÃO	ATIVIDADE	ORIENTAÇÃO	DESCRIÇÃO
10 min.	Receção do grupo		Receção do grupo, disposição das pessoas na sala.
20 min.	Resumo das sessões anteriores	Ana Mena	Resumir as sessões anteriores, mencionando os objetos das memórias, coleção de palavras; as zonas e funções do cérebro e o desenvolvimento do cérebro. Usar expressão corporal quando possível
20 min.	Os neurónios	Cláudia Gonçalves	Apresentar as células como unidades básicas da vida, como os tijolos da casa. Apresentar vários tipos de células do corpo humano. Mencionar as ligações entre neurónios.
15 min.	As ligações entre os neurónios	Andreia Dias	É pedido que as participantes se juntem em grupos de 3 e que coloquem uma mão de cada pessoa em frente. O exercício consiste em cada uma adicionar uma mão, com movimentos ondulantes e alguém tem que tirar a mão para que sejam sempre só 3. Documentação fotográfica.

25 min.	As ligações entre os neurónios	Andreia Dias	É pedido que as participantes se coloquem em circulo viradas para dentro. Ata-se o trapilho numa pessoa e essa pessoa dirige o seu fio para outra (pelo ar ou através da Andreia). No final obtém-se uma rede que representa as ligações entre os neurónios. O que é reforçado na explicação. Documentação fotográfica.
10 min.	Coleção de palavras	Ana Matias	É pedido às participantes que relembrem as palavras já existentes na coleção e que escolham 3 novas palavras que descrevam a sessão. Documentação escrita.
1h40			

PROJETO "DAR CORPO ÀS MEMÓRIAS" – 5ª SESSÃO

SESSÃO/ TEMA	5ª – As memórias, as migrações e as culturas
DATA/HORA	22-10-2018 / 10h00
ORIENTAÇÃO	Ana Matias, Andreia Dias, Cristina Campos, Maria da Conceição Tavares

MATERIAIS
● Diário de bordo; ● Máquina fotográfica com cartão de memória; ● Consultar: https://gulbenkian.pt/descobrir/atividade/entre-lugares-entre-culturas-em-180/

DURAÇÃO	ATIVIDADE	ORIENTAÇÃO	DESCRIÇÃO
10:00-10:15	Reunião do grupo na Outurela	Ana Matias	Receção do grupo e entrada no autocarro.
10:15-10:45	Transporte Outorela - Lisboa	Conceição Tavares	
11:00-11:15	Reunião no museu	Ana Matias	Reunir o grupo no átrio do museu e enquadrar a visita no âmbito do projeto "Dar corpo às Memórias", fazendo a ligação com os objetos da memória, que num museu, se tornam memórias coletivas. Documentação fotográfica.
11:15-12:15	Visita "Entre lugares, entre culturas em 180º"	Cristina Campos	A visita pretende ser uma viagem do Oriente ao Ocidente, da Antiguidade ao século XX, entre lugares e entre tempos, num percurso por diferentes culturas. Documentação escrita e fotográfica.
12:15 – 12:30	Coleção de palavras	Ana Matias	É pedido às participantes que relembrem as palavras já existentes na coleção e que escolham 3 novas palavras que descrevam a sessão, ao mesmo tempo que é feita uma rede com trapilho. Documentação escrita e fotográfica.
12:30 – 13:00	Transporte Lisboa - Outurela	Conceição Tavares	
3h00			

PROJETO "DAR CORPO ÀS MEMÓRIAS" – 6ª SESSÃO

SESSÃO/ TEMA	6ª – Ligação entre tópicos e sessões
DATA/HORA	13-11-2018 / 15h00
ORIENTAÇÃO	Ana Matias, Ana Mena

MATERIAIS
● Máquina fotográfica com cartão de memória; ● Novelo de trapilho; ● Papelinhos para palavras; ● Marcadores de feltro; ● Diário de bordo.

DURAÇÃO	ATIVIDADE	ORIENTAÇÃO	DESCRIÇÃO
10 min.	Receção do grupo		Receção do grupo, disposição das pessoas na sala.
15 min.	Coleção de palavras	Ana Mena	Relembrar as palavras da coleção de palavras.
15 min.	Resumo da sessão 5: Museu Calouste Gulbenkian	Ana Mena	É pedido às participantes que contem o que se passou na sessão 5 (visita ao Museu Calouste Gulbenkian). Para que haja participação das várias pessoas vai-se usar a rede com trapilho para que falem à vez. Documentação fotográfica e escrita.
25 min.	Resumo e ligação das sessões 1 a 4	Ana Mena e Ana Matias	Começando na rede gerada pela atividade anterior, é pedido às participantes que se recordem da rede de neurónios – neurónios – outras células – cérebro – desenvolvimento do cérebro – funções do cérebro.
25 min.	Máquina de Poesia	Ana Matias	Com base na coleção de palavras do projeto, criam-se categorias de palavras: nomes, verbos, lugares, estados do ser, adjetivos. Pede-se às participantes para dizerem mais umas inspiradas no projeto. Colocam-se as palavras no chão nos espaços criados dentro da rede de trapilho. Pede-se às participantes que retirem 5 palavras e faz-se 1 verso com elas. Repete-se até haver 4/5 versos para obter o poema do projeto. Documentação escrita e fotográfica.
1h30			

SESSÃO/ TEMA	7ª – O laboratório de investigação
DATA/HORA	19-11-2018 / 15h00
ORIENTAÇÃO	Ana Mena, Ana Matias, Cláudia Gonçalves, Maria da Conceição Tavares

MATERIAIS
- Diário de bordo.   - Máquina fotográfica   - Preparações nos laboratórios

DURAÇÃO	ATIVIDADE	ORIENTAÇÃO	DESCRIÇÃO
14:30	Reunião do grupo na Outurela	Conceição Tavares	Receção do grupo e entrada no autocarro.
14:30-15:00	Transporte Outorela - IGC	Conceição Tavares	
15:00 -15:30	Visita ao laboratório de	Ana Mena e Rita Nunes	Observação de imagens de cérebro e neurónios. Observação microscópica de lâminas (onde não se consegue distinguir nada a olho nu) para observação de estruturas celulares. Se houver experiências a decorrer, será permitida a sua observação. Documentação escrita e fotográfica.
15:30-16:30	Visita aos laboratórios de microscopia e histopatologia	Ana Mena Gabriela Joana	O grupo é dividido entre os laboratórios de microscopia e histopatologia e dá-se oportunidade a que se possam sentar e mais facilmente ver o que se pretende mostrar. Documentação escrita e fotográfica.
16:30– 17:00	Visita aos aquários	Claudia Gonçalves	Será explicado o papel deste modelo (peixe-zebra) e suas características. Documentação escrita.
17:00	Lanche na cantina		Convívio e momento de partilha de impressões.
17:30– 18:00	Transporte IGC - Outurela	Conceição Tavares	
3h30			

SESSÃO/ TEMA	8ª – Avaliação do projeto
DATA/HORA	28-11-2018 / 15h00
ORIENTAÇÃO	Ana Matias, Ana Mena

MATERIAIS
- Questionário base de avaliação de perceção da ciência;   - Gravador áudio;   - Máquina fotográfica/vídeo;   - Tripé;   - Molde físico do cérebro;   - Imagens de: - corte do cérebro com as principais áreas coloridas e numeradas   - desenvolvimento do cérebro durante a gestação,   - vários tipos de células do corpo humano,   - neurónios,   - neurónios em rede,   - quadros preferidos ("retrato de Helena Fourment" e "sagrada família e doadores");   - Puzzle de 6 peças com a imagem do corte do cérebro;   - Lista das funções do cérebro de acordo com as funções numeradas na imagem;   - Caixa com pequenos cartões que têm atividades que demonstram as várias funções do cérebro;   - Novelo de trapilho;   - Modelo artesanal do neurónio;   - Papelinhos com palavras do projeto;   - Poema do projeto   - Diário de bordo.

DURAÇÃO	ATIVIDADE	ORIENTAÇÃO	DESCRIÇÃO
10 min.	Receção do grupo		Conversa inicial, disposição das pessoas na sala.
20 min.	"Focus group"	Ana Mena	Conjunto de perguntas a realizar-se em "focus group", de forma descontraída. Documentação por gravação áudio.
30 min.	Narrativa do projeto	Ana Mena Ana Matias	As participantes são convidadas a falar sobre os tópicos/temas do projeto tendo como ponto de partida o objeto/imagem à disposição sobre a mesa. Documentação por gravação vídeo.
30 min.	Avaliação do projeto	Ana Matias	É pedido a cada participante que enumere 3 coisas que correram bem, 3 coisas que correram mal e 3 coisas que aprenderam. Documentação por gravação áudio e fotográfica.
15 min	Preparativos para a apresentação	Ana Matias	Discussão com o grupo do que será concretamente a apresentação (disposição em palco, ordem de intervenção, conteúdo da apresentação, figurinos, música(?)). Documentação escrita.
1h45			

Annexe 3. Questions of the focus groups

AVALIAÇÃO DA PERCEÇÃO DA CIÊNCIA

Este questionário, a realizar-se em "focus group", visa perceber as opiniões, perceções e expetativas face à ciência de uma comunidade sénior, utente do Centro Local de Apoio ao Acolhimento de Imigrantes da Outurela, Carnaxide. Este "focus group" terá lugar antes do início das sessões/visitas programadas no âmbito do projeto e repetido no final do projeto.

Esta é uma conversa descontraída orientada por um conjunto de perguntas, para se saber a vossa opinião acerca de algumas questões da ciência. Não é um teste com respostas certas ou erradas. Todas as respostas são certas se refletirem a vossa opinião. Seria interessante para a nossa conversa ir ouvindo a opinião de várias pessoas.

1)   O que acham que é a ciência? O que vos vem à cabeça quando pensam em ciência? Conseguem lembrar-se de 4 ou 5 coisas que associem com ciência?

2)   Acham que a ciência é importante? Porquê?

3)   Acham que a ciência faz parte do vosso dia-a-dia? Em quê?

4)   Acham que a ciência pode melhorar ou piorar a vossa vida?

5)   Se tivessem de dizer a alguém, diziam que a ciência é uma coisa boa ou má? Porquê?

6)   Acham que Medicina é ciência? Acham que História é uma ciência?

7)   Acham que um computador, telemóvel, televisão, ou micro-ondas, têm alguma coisa a ver com ciência?

8)   Acham que os cientistas são pessoas mais inteligentes que as outras?

9)   Recomendariam aos vossos netos seguir um curso de ciência e tornar-se cientista?

10)   Gostam de ver programas sobre animais e a vida selvagem na televisão?

11)   Se a situação surgisse, acham que gostavam de voltar a estudar?

12)   Já ouviram falar em células? Sabem o que é?

13)   Já ouviram falar em genes? Sabem o que é?

14)   Já ouviram falar do cérebro? Sabem o que é que ele faz?