STEM Education Hub

Science Education in Schools: connections between Brazil and the United Kingdom

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British Council

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INTRODUCTION

STEM EDUCATION AND INTERNATIONAL COOPERATION

ANDREW NEWTON

The STEM Education Hub is a joint initiative of the British Council and King's College London. It was launched in 2020 and aims to promote high quality education for everyone, with a focus on the teaching of the STEM (Science, Technology, Engineering, Mathematics) subjects in schools. The project is founded on partnerships – with schools, research institutions, and representatives of other formal and non-formal education spaces – as well as the sharing of experiences and practices, all with a strong focus on international cooperation. The connection between the United Kingdom and Brazil is one of the programme's strongest assets.

That connection is reflected in the topics chosen by the speakers, such as citizen science, inclusion (especially girls and black girls), critical pedagogy, avoiding a Euro-centred approach, a concern for the role that informal educational spaces can play, and the role that science communication and information have in promoting the aims of the project. All this results in educational activities and methodologies that can be replicated by teachers in their schools.

This publication also highlights the STEM Education Hub's concern with mutuality: the two-way collaboration and sharing of experience between the United Kingdom and Brazil. This can be seen clearly in the experience of the Brazilian researcher who is enthusiastically building scientific and cultural connections with the United Kingdom and in that of the schoolteacher who is taking advantage of their educational research projects in Brazilian higher education institutions to train teachers in the United Kingdom. Also included is the experience of a science communicator from the United Kingdom, who show us some exciting web-based platforms that support the study of science, and of the science education experiences of UK museum managers that resonate with the museum education studies of a Brazilian researcher. What do these narratives demonstrate? They reveal that there is space to strengthen and widen international collaboration in the field of school education to match the level that already occurs in higher education.

As the STEM Education Hub enters into its third year and the British Council and King's College London actively seek new collaborative and financial partners, it has already clearly demonstrated the opportunities it offers for STEM education mobility, reflection, study and collective experiments between the two countries, while strengthening the culture of using research-based evidence in support of reflective educational activities which promote citizenship, equality, and sustainable development.

SCIENCE TEACHING FOR A BETTER WORLD

ARTHUR GALAMBA
DIRECTOR OF THE STEM EDUCATION HUB
AND LECTURER IN SCIENCE EDUCATION

The scientific education of citizens has been increasingly indispensable for society, in order for it to understand and participate in decisions on socio-scientific issues. In the educational and professional spheres, an understanding of the STEM (Science, Technology, Engineering and Mathematics) fields is recognized for its cultural and economic value and for its ability to develop critical thinking. As a result, STEM education has recently received significantly more investment to democratize access.

It is in this context that the STEM Education Hub has been formed as a partnership between King's College London and the British Council to bring together STEM educators from Brazil and the United Kingdom. The STEM Education Hub organises various events for educators from both countries, such as seminars, round tables and workshops.

The decolonial agenda is integral to the Stem Education Hub, questioning the predominance of the Eurocentric world vision and thinking while valuing cultures, stories, the ways things are done and thought about, and the relationship with nature of other parts of the world. It pays special attention to issues such as social justice, democracy, citizenship, inclusion and racism. In addition, it aims to help teachers in schools understand and use innovative educational approaches and research results in the classroom.

A major international challenge in teacher training is to educate teachers to develop critical thinking, that is, to help them reflect critically on their educational practices, as well as on classroom activities that encourage a desire to learn. To do this, it encourages them to experiment with alternative approaches to teaching and learning.

Critical thinking is necessary, for example, to enable the educator to develop a range of extracurricular activities that allow both teachers and students to go beyond what is set in the national curricula or what is included in textbooks. It also allows teachers to plan their classes to meet the educational needs of each student, always taking into account their environment and socio-economic conditions, thus creating a more inclusive education, with a special focus on actions that encourage girls and, more specifically, black girls, to discover and take ownership of all their potential for action and creation.

In recent years, both the United Kingdom and Brazil have developed specific pedagogies that educators from these two countries have perceived not only as necessary, but also as more powerful in the face of local challenges.

Modern life has become profoundly dependent on science and technology, a fact that has made scientists from around the globe work together and seek to extend access to scientific achievements to the entire population. The collective effort by the international community to make a vaccine against Covid-19 is the most striking of recent examples of this situation. Children are curious about the world surrounding us, about the laws that govern nature and this can help us build a better world for everyone, one which is more equal. There are many ways of attracting them to learn about science. From laboratory work to discussions about themes related to science, technology and society, as well as questions about the philosophy and history of science.

This publication brings together a series of reflections and experiences of science teachers and scientists from both countries to encourage leaders and teachers to immerse themselves in new experiences, in harmony with schools and society, in such a way that scientific knowledge expands its boundaries. And that it is possible for everyone to explore and discover, not only the school laboratories, but also museums, observatories and the very environment in which the students and their families live. Let this open the door to new solutions, to improving the quality of life and to the taste for knowledge.

SCIENCE AS A PARTNERSHIP

A concept focused on the participatory aspect of learning in society and schools

Learning points

- The importance of partnerships in citizen science
- The evolution of the partnership concept
- Different models: co-creation, collaboration, or contribution
- Learning through experimentation in schools
- Student engagement
- Experiences with citizen science in Chile and the United Kingdom
- Project platforms

From a lecture by

Natália Pirani Ghilardi-Lopes

is an Advisor to the Post-graduate Programme in Evolution and Diversity and to the Post-graduate Program in Teaching and History of Science and Mathematics, Federal University of ABC (UFABC). She coordinated the citizen science and environmental conservation research group at UFABC and is currently the supervisor of the Citizen Science Programme at the Brazilian National Atlantic Forest Institute. She is the founder of the Brazilian Citizen Science Network and an associate professor at UFABC.

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Covid-19, climate change, and managing energy resources are clear examples of the kind of issue that contemporary societies and their citizens are concerned with, needing to understand their impact at every scale, from local to global. At the end of the last century, a movement emerged to bring scientists and society closer together. The resulting mechanism brought science actively into partnership with schools and the whole teaching/learning process, helping it become more interesting and real to the students, who become partners in the observation and analysis of the phenomena which are part of our normal lives.

To show how scientists work with schools and the general public, the STEM Education Hub organised a seminar in August 2021 in conjunction with the British Council and King's College London, entitled "Citizen Science and School Education: How to Create Projects for Schools to Participate in Scientific Research."In addition to practical experiments to promote a conversation between science and citizenship, the concept, application and dimensions of Citizen Science were also explained.

Natália Pirani Ghilardi-Lopes introduced the subject, first defining what citizen science is, then going on to discuss what distinguishes it from known scientific practices and enables it to operate in conjunction with

those practices. According to Natália, the key characteristic is the partnership between professional scientists and people who are interested in science.

"There is enormous potential in these partnerships to promote public engagement in different stages of the scientific process, such as scientific and technological education, collaboration and introducing policies on issues of social and environmental relevance."

The breadth of the present-day concept is one of its features, partly due to the concepts underlying its origins, which incorporates two key studies:

· **Democratic citizen science**, proposed in 1995 by **Alan Irwin**, hen a professor at the Department of Human Sciences at the University of Brunel, United Kingdom, where he examines the responsibility of science toward society and the need for citizens to embrace scientific knowledge, as well as making use of that knowledge to demand social change.

· **Participatory citizen science**, as defined in 1996 by **Rick Bonney**, Director of Public Engagement in Science and a researcher at the University of Cornell's Ornithology Laboratory in the USA, is a practice in which people contribute observations or their time and energy to the scientific process.

Some forms of citizen science are also derived from these broader concepts, which can be introduced into the school. What defines these approaches are the differing degrees of participation in the scientific process. The classical stages of the scientific approach are:

- Definition of the research question
- Obtaining information
- Developing hypotheses
- Planning the study
- Data collection and sampling
- Interpretation of data
- Drafting of conclusions
- Dissemination of results
- Definition of new questions on the basis of the results.

In school or society, these forms of citizen science are given specific names, according to the type of participation:

· **Co-creation Citizen Science** – the citizen scientist participates in all stages of the scientific process.

· **Collaborative Citizen Science** – participation is more limited, with an emphasis on citizen data collection and analysis.

· **Contributory Citizen Science** – participation is limited to citizen data collection, and sometimes to its dissemination.

"Citizen science projects produce genuine scientific results. They are not just simulating an interest in science – they are not theoretical. The science is practical and genuine."

THE DIMENSIONS OF CITIZEN SCIENCE

Whatever space it occupies, citizen science is a scientific approach like any other, with limitations and biases, like any other aspect of science, which need to be considered. It has two major focuses, the first being its concern with pure science, the second being its educational role. In relation to the scientific endeavour, a partnership with professional researchers is vital to ensure constant scientific rigour. Insistence on applying the rigour of the scientific method enables new knowledge to be produced, or an improved understanding of certain issues, as well as relevant results.

CITIZEN SCIENCE IN SCHOOLS

Citizen science encourages student-centred learning, that they actively experiment using their own skills and knowledge. As Professor Ghilardi-Lopes says, it is "learning about scientific concepts, attitudes, and procedures, as well as about science itself, how it is produced and done, using technology and within a real context."

This active involvement of the student in relation to the object of the study can even encourage them to follow a scientific career. It can also bring the individual student a feeling of personal fulfilment, self-confidence, physical and emotional well-being and sense of belonging to their working group. It is a social activity that paves the way for collective learning.

From a social point of view, it stimulates a sense of co-responsibility in relation to the scientific problems investigated, such as the environment and health, problems that are relevant to both individuals and society in general. It can be a means of action or activism towards global health, when we consider a broad health picture, for example. It has a direct relationship with experiential learning.

STUDENT ENGAGEMENT

In order to ensure the maximum involvement of students, teachers need to follow some principles. Among them, the following are key:

- Assess and plan the degree of difficulty of the projects, so that the students feel challenged but are capable of achieving the objectives. For this, the teacher needs to have a good understanding of their class.
- Ensure that the age of the students is compatible with the skills they are expected to acquire during the learning process.
- Ensure that the appropriate protocols are in place, especially

in relation to safety in both natural environments and the virtual world, as well as the issues of sharing information and data privacy.

• Establish communication channels and trust between teachers and students, so that they feel at ease about reporting difficulties, giving feedback to the teacher, and reflecting on the process so that changes can be made during the ongoing project if necessary.

PROCESS, CONTEXT AND DATA

In science in general, and also in citizen science, processes are of great importance. Therefore, you need to look at each moment of the activities, not just the results. This look is closely linked to the planning of citizens' science proposals.

Two aspects are very important in this regard:

• That research issues are relevant and make sense to learners, encouraging their participation. For ensure this, they must be well contextualized. They may be local, regional, national, or global in scope, but they must resonate with the students' area of interest.

"The idea of science as a process that has rules, which is rigorous, is also part of learning about the nature of science, and it is very important that the teacher takes this into account."

• That the data generated are of high quality, resulting from adhering to clear research protocols, and that they are usable by science. Its collection must be in accordance with the skills of each age group and with the curricular objectives, so that they have scientific rigour.

LOCAL AND GLOBAL: EXAMPLES

Citizen science projects in schools can be quite varied and include both local and global issues. Some concrete examples:

LOCAL ISSUES: monitoring of solid waste disposal; food waste; biodiversity in gardens, parks, and the school grounds; air quality; the use of energy in the school or students' homes; the impact of agriculture (especially, but not only, for rural schools); beneficial ecosystems provided by natural environments.

ISSUES RELATING TO MORE DISTANT LOCATIONS (TO BROADEN THE STUDENT'S WORLD VIEW): penguin monitoring in Antarctica; African biodiversity; air quality in the most polluting countries.

GLOBAL ISSUES: climate change, deforestation, land use changes; agriculture; livestock farming; urbanisation; water pollution, etc.

EXTRAPLANETARY ISSUES: the form of galaxies; black holes; astrobiology.

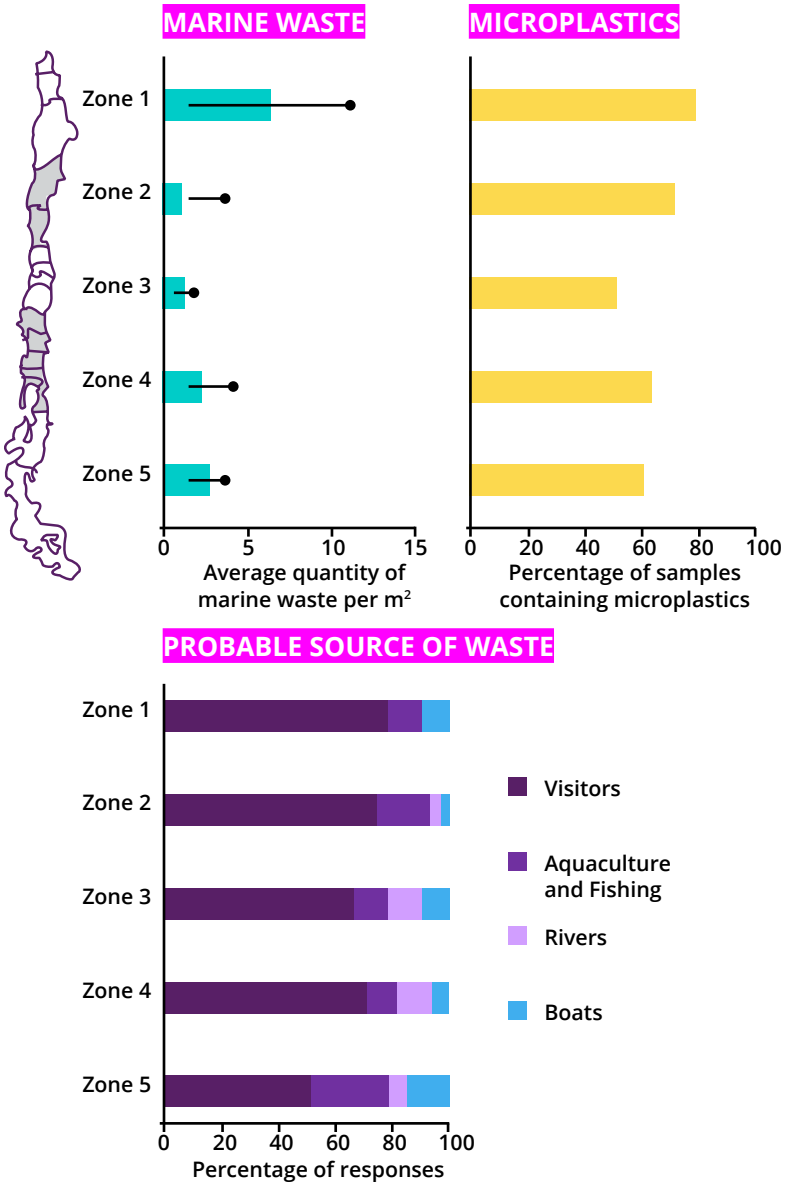
EXAMPLES OF PROJECTS

From the themes, we move on to citizen science projects in other countries, which may inspire Brazilian schools and students.

The first is the Chilean **"Cientistas de la basura"** (Garbage Scientists), who monitored the presence of microplastic along the long Chilean coast. In a partnership between schools and universities, a protocol was created for children and adolescents to study the presence of plastic on the beaches. The field work was preceded by an in-depth study of plastic and its effects on the environment, and then the students collected data on the beaches, delimiting specific areas and sifting the sand to count the number of fragments of microplastic present. The project protocol was not very complicated but was not made over-simple for the students.

The data supported a diagnosis of plastic pollution on the country's beaches. The reliability of the data was considered high, close to that of the data produced by scientists. The conclusion reached on the basis of the differences found between different regions, was that the plastic found was tourism-related.

Another example was carried out in London and involved handing out air quality measuring devices to the students. They received sensors to be placed in their backpacks to monitor air quality three times a day: on the way to school, during classes, and on their way home. The measurements they made showed a greater concentration of particulate material in the air when they were going to the school, when more polluting vehicles were on the roads.



“There are projects that can be carried out at no cost, based on the use of data that already exists on citizen science digital platforms.”

SCIENCE PLATFORMS

The two cases above illustrate different choices in terms of financial investment in projects. While the English project used more sophisticated data collection devices – the air quality sensors – the Chilean experiment used simpler means – sieves and a plastic container.

There are, however, other projects, such as biodiversity surveys studies, that can be carried out at no cost, based on the use of data that already exists on citizen science digital platforms

ONLINE RESOURCES FOR TEACHER INITIATIVES

International citizen science platforms designed to promote and support initiatives, where there are various projects available.

- **INaturalist** (www.inaturalist.org)
- **Zooniverse** (www.zooniverse.org)
- **Anecdata** (www.anecdata.org)

Bird watching, with a section for Brazilian species

- **eBird** (www.ebird.org and www.ebird.org/brasil).

Platforms listing projects that can be used for comparative purposes or serve as a basis for teachers’ proposals, making it possible to check research questions and results.

Projects from around the world

- **Scistarter** (www.scistarter.org)

A collection of Brazilian projects, such as BeeKeep, on bees.

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- **SiBBr** (www.sibbr.gov.br)

Soon, the Brazilian Network of Citizen Science will take on this role of sharing Brazilian initiatives.

STUDENT EVALUATION

1 What should the teacher take into account when evaluating student performance in citizen science activities?

2 There are different models for this, depending on whether the projects take place at school or not. Six points are suggested for analysis:

INTEREST: The degree of relevance attributed by the individual to science, a scientific topic or environmental undertaking, for example. It can help establish future motivation for scientific careers.

SELF-EFFECTIVENESS: the belief in the ability to learn or perform a task itself. In citizen science, the ability to perform or participate in a scientific activity.

MOTIVATION: there are several motivational indicators, such as helping others, learning, developing social motivation; professional motivation; protection; of being part of a group.

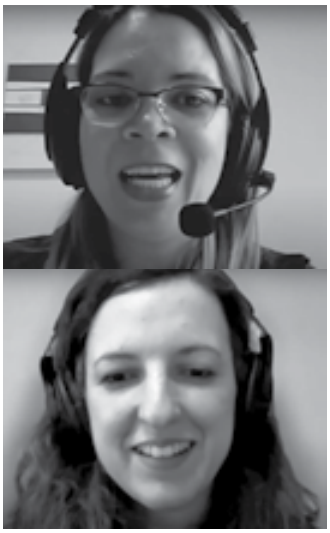
KNOWLEDGE: of content, of science processes, about the nature of science
.

SKILLS: asking and answering questions; collecting data; developing and applying models; planning and conducting investigations; reasoning; to analysing and interpreting data (data literacy); constructing explanations; communicating information; using evidence to support an argument, among others.

BEHAVIOURS AND ATTITUDES: Participation or activism. This aspect is more linked to the result of the project after it ends, such as change of lifestyle, habits, etc.

USING CITIZEN SCIENCE IN SCHOOLS

School projects from teacher-researchers



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Learning points

- Partnerships between university and school
- Scientific projects in response to tangible problems
- Sustainable food curriculum and education
- Curiosity about the stars drives scientific education
- Platforms to support scientific learning
- Interacting with those who make science

From the talk by

Jussara Almeida Bezerra and Diana Ribas Roque

Jussara Almeida Bezerra is a headteacher in the city of São Bernardo do Campo in the state of São Paulo, after working as a primary teacher in a number of schools in the region. She lectures on primary education, literacy, and active learning methodologies in higher education institutions. She is studying for an M.Sc. in the teaching and history of science and mathematics at the Federal University of ABC (UFABC). She researches into the link between citizen science and education.

Diana Ribas Roque is a graduate in Biological Sciences from the Catholic University of Brasilia and teaches primary school Science and English. She has an M.Sc. in Teaching and History of Science and Mathematics from UFABC. She is a member of that university's citizen science research group.

Two Master's projects supervised by Professor Natália Pirani Ghilardi-Lopes on different areas of science were presented at the seminar on citizen science, a STEM Education Hub initiative supported by the British Council and King´s College London. The cases also illustrate possibilities of partnership between university and school.

Master's students Jussara Almeida Bezerra and Diana Ribas Roque presented science education concepts for primary schools on the topics of healthy eating and astrobiology, respectively. The differences between them show the possibilities of citizen science in the school environment. The two researchers developed their projects as postgraduate students in the Teaching and History of Sciences and Mathematics at the Federal University of ABC (UFABC) and introduced them to the schools where they were working, or where they had worked. The research involved two distinct phases. Diana Roque has completed her M.Sc. while Jussara Bezerra continues her studies.

"The change in the school menu and the perception that there was considerable waste of food was the key to using citizen science to address the problem at global level."

HEALTHY EATING

Headteacher Jussara Bezerra was introduced to the concept of citizen science during an in-service training course. The course included material on the application of didactic sequences to different scientific themes. She saw the possibility of using the concept in her primary school in São Bernardo do Campo.

The school was in the process of changing the menu for its school meals. As the new lunch menu was introduced, she observed that there was a considerable amount of food waste involved.

AN OPPORTUNITY

She then prepared a didactic sequence focused on the theme she wanted to address, entitled "From waste to sustainability: Challenges and possibilities of food education through citizen science."

The sequence was introduced after previous attempts to raise awareness of children and teachers through dialogue, trying to encourage everyone to avoid waste. For the children, however, it was also a time when they were getting used to a new menu and changes to their eating behaviour. The conversations were, however, not very effective at raising awareness in the school population.

"The study showed that the argument against waste has no scientific basis and is limited to common sense ideas. "

In order to understand the topic better, Jussara and her team researched into food wastage in general – the size of the problem, the reasons behind it and bottlenecks in the food cycle. They found that it is an issue that affects the whole world, and that it is not restricted to schools. Far from it. Their research found that 1/3 of all food produced round the world is wasted along the different stages of the food chain: production, distribution and consumption.

The study also showed that the argument against waste lacks a scientific foundation, limiting itself to common sense ideas, often encouraging feelings of guilt. Some of the phrases illustrating this behaviour:

BEFORE: A NON-SCIENTIFIC VIEW OF WASTE

"Wasting food is a sin"

"Do you think money grows on trees, to be throwing food in the garbage?"

"Do you throw food away when so many people are going hungry?"

OPTING FOR SUSTAINABLE FOOD

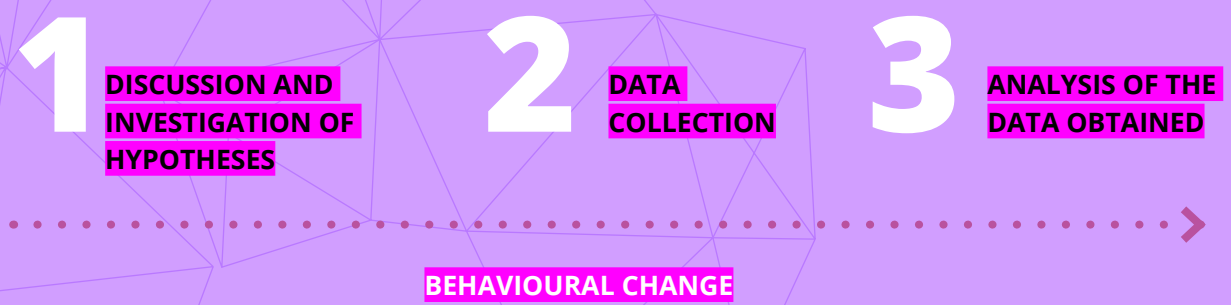
Jussara Bezerra notes that there is an opportunity to address the subject in the Brazilian National Curriculum (BNCC). "In the curricula of different education systems, we see a gap, a lack of emphasis on sustainable food education. The content and the abilities being developed generally focus on the issue of nutritional education, there are no guidelines or anything more explicit which mention the importance of sustainable food education," she observes.

The following didactic sequence aims to eliminate food waste in the school environment, with the active participation of students in all stages of the process. Its application also serves to measure the transformative potential of citizen science applied to education, verifying the change in the behaviour of students as a result of the activity, with their active participation throughout the process.

In the protocol for this sequence, the students have the opportunity to: collect data; analyse the data and, by participating in the process, consciously change their behaviour on the basis of scientific evidence.

"There is a gap, a lack of emphasis on sustainable food education. The content generally focuses on nutritional education, there are no guidelines or something more explicit which mention the importance of sustainable food education."

SYNTHESIZED SCIENTIFIC METHOD



QUESTIONNAIRES AND CHANGES

The first stage involved weighing discarded food. Two students were responsible for weighing the food and recording the data. The idea was not to reveal the purpose of this data collection to everyone, as it could result in people behaving changing their behaviour before the weighing.

"Students took part in thematic classes on food waste, planetary health, environmental conservation, and sustainable consumption."

THEN A SURVEY WAS HANDED OUT WITH QUESTIONS SUCH AS:

"Have you ever thrown food out?"

"Why do you think people waste food?"

"Do you think wasting food is a problem?"

"Have you noticed any wasted food at school?"

The answers for this first stage included the common-sense responses about the theme already mentioned above: "It's a sin", "The cook gets upset".

The next step was to present the previously collected data, along with photos of food left on the plate to be thrown out.

Then the students had lessons on the topic of food waste, the United Nations Sustainable Development Goals (SDGs), and global health, environmental conservation, sustainable consumption, and ethical attitudes towards consumption. The data from the first stage were looked at again, and the students then calculated correlations between expenses, waste and food quantity, or how much water was used to produce 100 grams of rice. They also analysed the use of water in livestock farming and were able to scale the problem in terms of economic, social and environmental impact.

The students also calculated how many people could be fed with what was wasted. After that, they discussed the topic, made decisions and carried out a new weighing session, re-applying the questionnaire. By the end of the project, food waste was eliminated from the school. The initial weighing found that 2,450 kg of food was set to be discarded. By the final weighing, the amount was zero.

Jussara Bezerra compares the answers to the initial and final questionnaires by the same student to assess the change of behaviour and the respondee's approach to the question. The response to the question "Why do people waste food?", changed from "They don't like school food" to "They don't care for the environment and water."

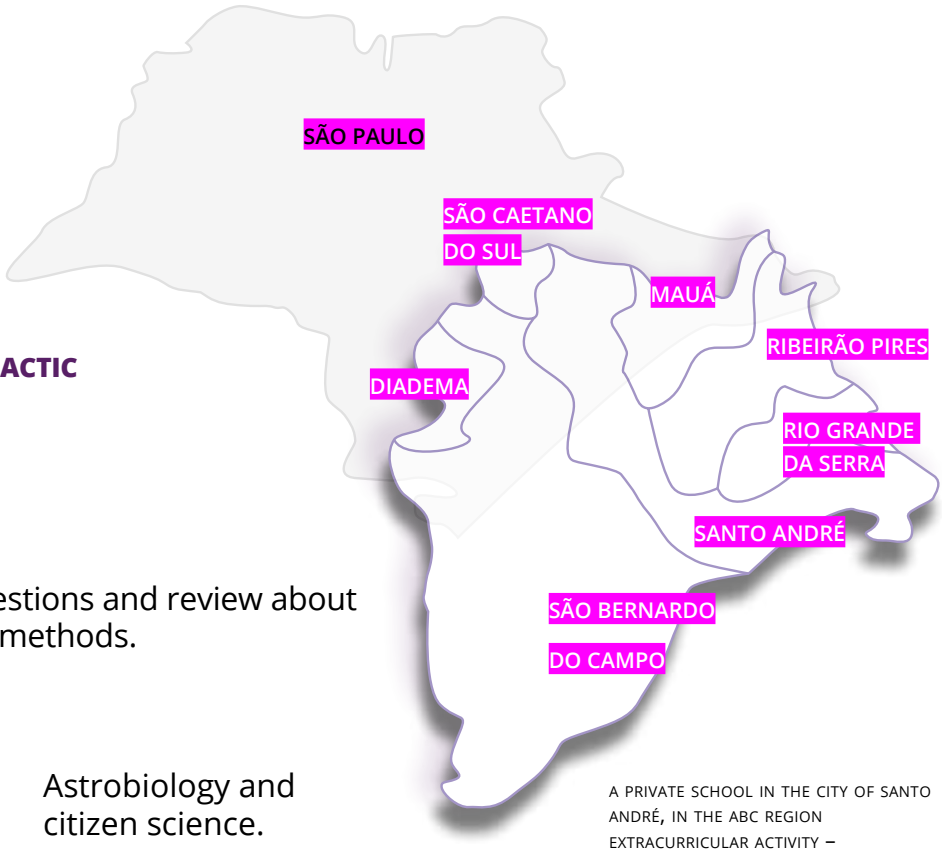
THE FASCINATION OF ASTROBIOLOGY

Understanding the stars and their mysteries, the relationships between the galaxies, the Earth and ourselves and how we fit into all this, has been an object of curiosity and fascination by mankind since immemorial times. Taking advantage of the power of this theme to mobilise engagement, biologist and teacher Diana Ribas Roque investigated the relationship between astrobiology, scientific literacy and citizen science in her M.Sc. thesis.

She included some of the results of her investigation in her talk "Astrobiology and Citizen Science: Possibilities for Scientific Literacy for Primary School Students".

The motivation for her research came from her constant questioning about the cosmos. Diana Roque listed some questions she considers to be very motivating, such as: "Where does life come from?"; "How has it evolved?"; "Is there life elsewhere than Earth?"

These are questions that concern not only scientists and the adult world in general, but also young students. This choice of theme encouraged and stimulated both her own work and that of her students. The addition of citizen science led to a methodology that brings people together, whatever scientific knowledge they bring with them, because it leads to the active participation of all in the scientific process. "And it contributes to breaking down the stereotypes in science, such as that of the untouchable scientist. Working in science, you realize that it is part of everyday life and that you can contribute to it," says Diana Roque.



A PRIVATE SCHOOL IN THE CITY OF SANTO ANDRÉ, IN THE ABC REGION
EXTRACURRICULAR ACTIVITY – SCIENCE CLUB
PREPARATION OF DIDACTIC SEQUENCE TO BE USED IN THE SCIENCE CLUB

THE FIVE-LESSON DIDACTIC SEQUENCE COVERED:

1. Initial questions and review about scientific methods.
2. Astrobiology and citizen science.
3. Putting citizen science into practice.
4. Getting to know a scientist.
5. Final project.

DIDACTIC SEQUENCE AND THEMATIC DIVISION

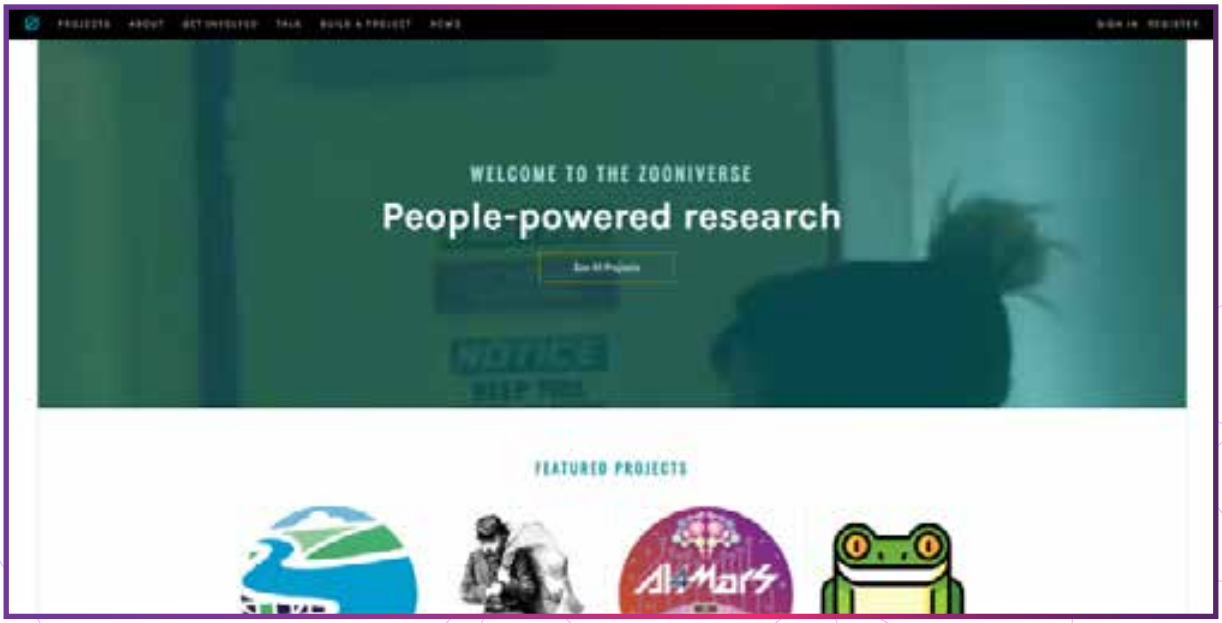
The research was carried out and put into practice in a private school in the ABC region in the state of São Paulo. As with the research on sustainable food, a key step was to produce a didactic sequence for the theme. In this case, it was intended for students participating in an extracurricular group in Year 6 of primary school.

Diana, who acted as an observer/participant, points out that student participation was voluntary and the group was already motivated to study science.

MARS AND THE ZOONIVERSE PLATAFORM

The second lesson introduced astrobiology and citizen science to the students, as well as an overview of the planet Mars, which would become part of the citizen science project to be pitched to the students. Another novelty for the students was the Zooniverse citizen science platform (www.zoouniverse.org), which supports a range of projects which are open to anyone to participate. All the projects involve data analysis. The participant can choose a project from a menu and learn how to use the tool to contribute to it. There is a tutorial, for example, where they learn how to analyse images of Mars on the site. All the projects have a clear and specific tutorial, enabling even those who do not have specific knowledge of the area to contribute.

The project selected for the students to contribute to was COSMIC (Content-based Onboard Summarization to Monitor frequent change), from NASA's Jet Propulsion Laboratory. Among other information, the participant can see how many others are involved in the project. In this case, 3,891 citizen scientists had taken part in the project by the time it finished, including some of Diana Roque's students.



INTERACTION AND STIMULATED QUESTIONING

The third lesson required the students to prepare questions to ask the scientist they were to meet in the fourth lesson. The questions demonstrated how varied were the students' interests. Some examples:

> "If there was no food left on the planet, would any animal survive?"

> "If we were to plant something on Mars, how would that work?"

> "How did life come about on Earth?"

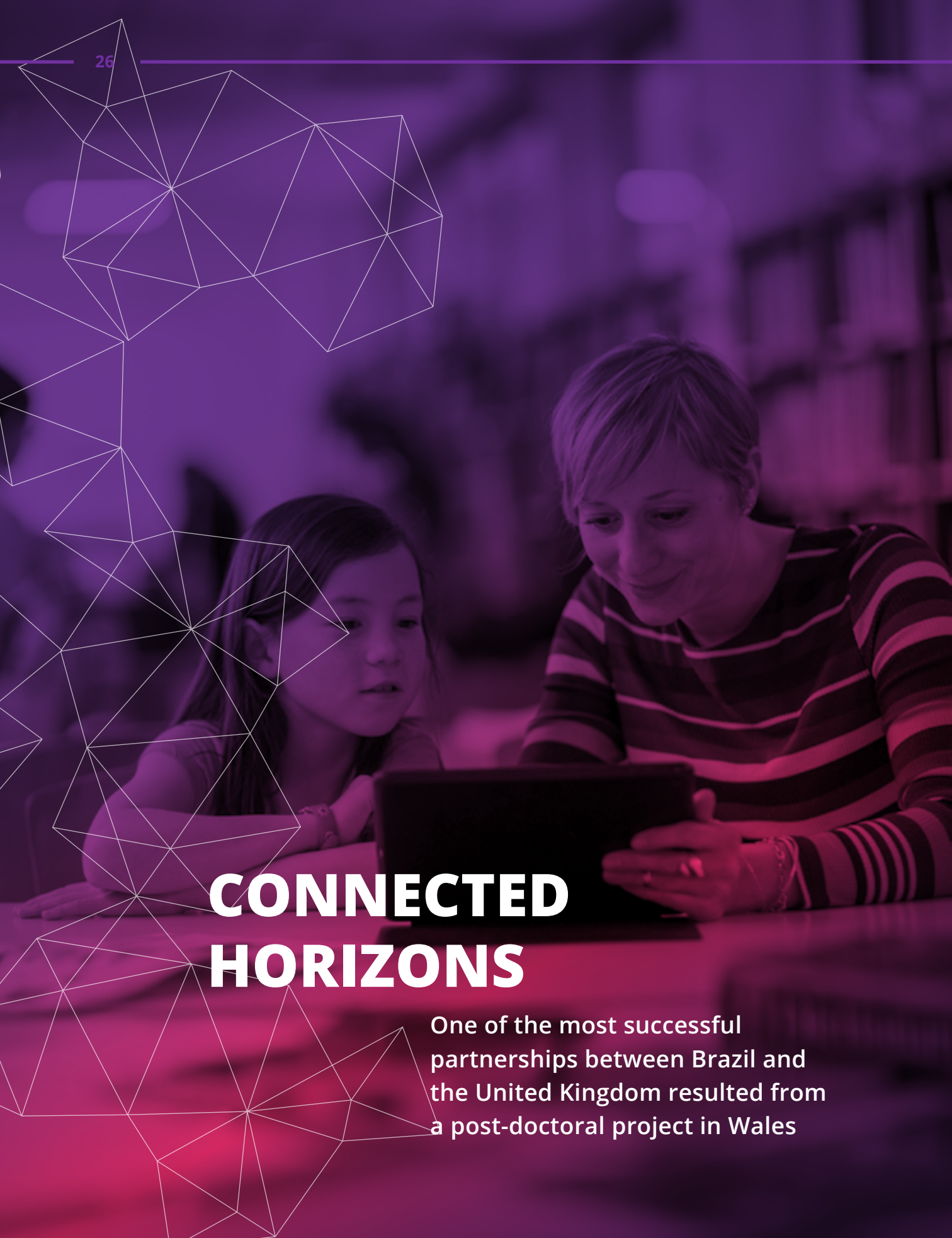
The fourth lesson saw the students interacting with the scientist, discussing the topics they had studied. That encounter took place before the pandemic took hold.

The fifth, and final, lesson involved the students in a project where they used a stop motion animation to show what they had understood and the highlights of the didactic sequence from their point of view.

Basing herself on a transcript of the third and fourth classes, Diana Roque listed some aspects which struck her in her perception of the students' view of the experience.

The main ones were:

- **Motivation to participate in the Science Club**
- **Notions of citizen science**
- **Concept of self-effectiveness**
- **Family support**
- **The stereotype of the scientist**
- **Issue of gender in science.**



CONNECTED HORIZONS

One of the most successful partnerships between Brazil and the United Kingdom resulted from a post-doctoral project in Wales

From a talk
by **Ronaldo Christofoletti**

A lecturer and researcher at the Institute of Marine Sciences of the Federal University of São Paulo, Dr Christofoletti is a science enthusiast, committed to science education and working together with those who transform society, He coordinates the Maré de Ciência (Tide of Science) programme, is an educator for the British Council's Core Skills, Active Citizens and Researcher Connect programmes, co-chair of the Communications Advisory Group for the UN Ocean Decade and is a member of UNESCO's Ocean Literacy with All programme.

WHEN **11/08/2021**
WHERE **Live**
AUDIENCE **228**
PRODUCED BY **STEM Education Hub, British Council and King's College London**

Learning points

- Scientific partnership between Brazil and the United Kingdom
- Science as a bridge between cultures
- The importance of science communication
- Citizen science and public policies
- Raising awareness of local and global issues
- United Nations Decade of Ocean Science for Sustainable Development

CONNECTED HORIZONS

One of the events marking the launch of the STEM Education Hub was a talk by biologist Ronaldo Christofoletti, a lecturer and researcher at the Federal University of São Paulo, when he spoke of his experiences in the area of academic collaboration between Brazil and the United Kingdom, from project concept to implementation, as well as the impact of these initiatives. One of the most effective partnerships he has been involved in was concerned with his institution's Tide of Science programme, which aims to build connections between universities, schools and society under the overall umbrella of Citizen Science.

CITIZEN SCIENCE

A broad concept, which involves different forms of partnership between scientists and members of the public interested in science, supporting:

1. public engagement with different stages of the scientific process
2. science and technology education
3. collaboration with and implementation of public social and environmental policies

*Ghilardi-Lopes, 2021

“The most important part of the learning process is what does not actually work. These small challenges open up the way towards success in the future.”

Christofoletti, who works at UNIFESP’s Institute of Marine Sciences, which is based on the university’s campus in the coastal city of Santos, focused on his long history of partnerships with the United Kingdom, above all with Bangor University on the northern coast of Wales. In his introduction, he emphasised that he would be speaking frankly about what went on behind the scenes of these projects, and not just speaking about the successes. It was necessary to speak openly about them, as there are different issues involved in building a partnership and often the most important part of the learning process is what does not actually work. These small challenges open up the way towards success in the future.

THE THREE STAGES OF A PARTNERSHIP

The partnership started in 2008 and began with fundamental research in the area of marine sciences, where he worked with the British researcher Stuart Rees Jenkins. At this stage, Christofoletti was a post-doctoral student under the supervision of Jenkins. His research involved investigations in the area of biodiversity – how the marine environment functions in the face of climate change and the impact of human activity.

His objective was to observe the impact of these forces on a larger scale, comparing the coast of Brazil with that of the United Kingdom by examining more how factors that emerge at local scale, such as the presence of seaports, the localised impact of a range of pollutants and of the sewage and rubbish disposed of in the sea and large scale environmental factors as seawater temperature. How did they affect the biodiversity of the coastal regions and the species present in those areas? For instance, in the United Kingdom there is the dog whelk (Nucella lapillus), a shellfish which is normally white, while in Brazil there are sea snails and small mussels.

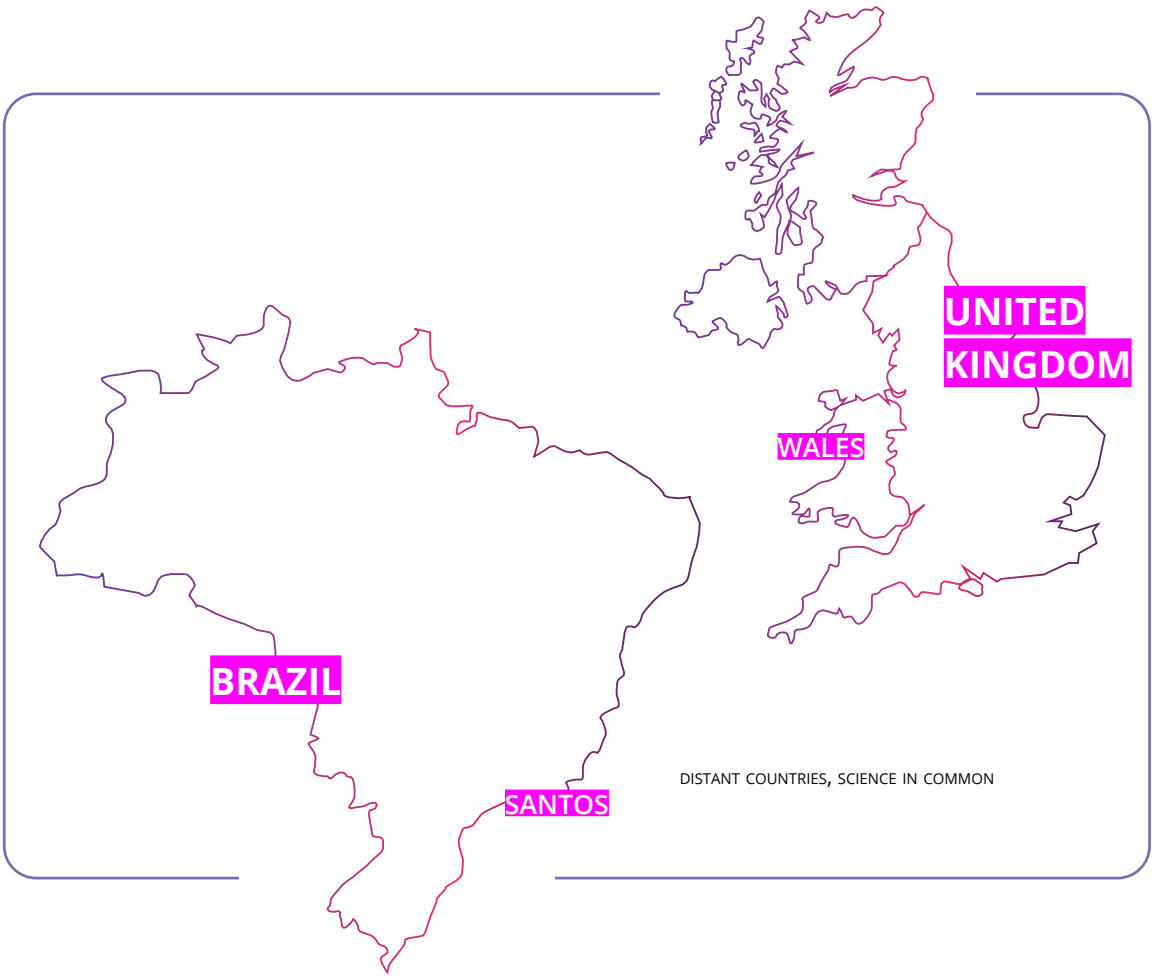
More than 20 projects have been financed over the 13 years since this partnership was first formed, including research and events, and exchange programmes for students and researchers. All this has taken place during a period where the internationalisation of science and universities in Brazil has become much more valued, with an emphasis on innovation and academic mobility.

Nucella lapillus/Wikimedia Commons

The first years of the partnership, between 2008 and 2015, saw a focus on research staff exchanges. Christofoletti spent 2008 and 2009 in the United Kingdom and then returned to Brazil, going back to Wales at least once a year thereafter. Meanwhile, Stuart Jenkins had research visits in Brazil few times, including a 10 months period in 2014.

As related by Christofoletti, his experience is encouraging for those who want to break down international frontiers but are somewhat hesitant about what is involved. "When I moved to Wales in May 2008, I had not been to Europe before. My travels had never taken me beyond South America".

As I prepared for the move, I wanted to get to know who I would be working with. I started by reading scientific articles and then met their author personally when I arrived. The two researchers soon found common ground and got along well, sharing the same approach to science and values.



DISTANT COUNTRIES, SCIENCE IN COMMON

"A good understanding of the marine sciences in Brazil cannot skip steps. It is necessary to follow in the footsteps of someone who already knows the issues, while making these steps of interest to researchers in countries which have advanced further."

It soon became clear to both researchers that, despite being in different hemispheres and having different climates, the United Kingdom and Brazil actually had similar coastal ecosystems, especially those of sandy beaches and rochy shores, the two ecosystems with which they were most familiar.

CULTURAL DIFFERENCES

While both researchers discovered that they were patient and resilient, they also actively focused on finding the differences – in their plans, in their countries, and in their personal natures.

One of the obvious areas where they differed was that they were at different stages of their scientific careers. Christofoletti was at the start of his career, while Jenkins was already further along on the road. This meant that their experiences and rate of progress were different. Where the research environment was concerned, this different was also evident and needed to be taken into consideration.

The United Kingdom, as is the case with other countries, was and is ahead of Brazil in scientific knowledge. This meant that where a question might appear very innovative to Christofoletti, it would be trivial to Jenkins. They considered, however, that just because certain observations and conclusions had already been made some time ago in the United Kingdom, it was not a given that the answers would be the same in Brazil. This required that new ways of tackling old questions had to be found. From Jenkins' point of view, he needed to accept that collaborating in research which would have an impact in Brazil would not necessarily lead to wider discussion internationally.

On the other hand, it was important that the process of broadening knowledge in the ocean sciences in Brazil did not jump steps. In other words, it would be necessary to follow in the footsteps of someone who already knew the issues while facing the challenge of making these steps in the journey also interesting to researchers in countries which had advanced further in their research.

There was also the question of differing cultures and research processes which the researchers needed to adapt to, such as the extrovert nature of Brazilians in general and British objectivity and punctuality. There are also periods in each location when the productivity will be greater or lesser than the other. In January, for example, the summer holiday period in Brazil, things slow down, as many Brazilians are on holiday. Meanwhile, in the United Kingdom, the same period is one of the most productive in the academic area. The position is reversed in August.

This was an important learning point when planning projects involving countries in the northern hemisphere. The initial idea was that the peak activity period would be January and that the project would end in August. This would have been difficult for the Brazilian team.

It is clear that the way in which Brazilian funding agencies handle project management is different from those in the United Kingdom. The good side of this is to look at the differences in a positive light and aim to find solutions to problems like this.

MOVING TO THE NEXT STEP

While the first stage of the partnership saw Christofoletti being hired by UNIFESP in 2012 and Jenkins coming to Brazil in 2014, the years 2015 and 2016 gave an opportunity to rethink some aspects of the partnership. While the researchers felt that things were going well, they also sensed that they were moving in different directions.

“Scientific communication is a vital link between researchers and society, and also between institutions. Failures in communication can result in issues which affect the whole process.”

While the first stage of the partnership saw Christofoletti being hired by UNIFESP in 2012 and Jenkins coming to Brazil in 2014, the years 2015 and 2016 gave an opportunity to rethink some aspects of the partnership. While the researchers felt that things were going in the right direction, they also sensed that they were taking different directions.

Christofoletti continued to focus on climate change, biodiversity and the marine sciences but also started to teach scientific method at UNIFESP and work in the area of science communication.

The British Council brought its global programme Researcher Connect to Brazil in 2014 to help researchers develop their science communication skills. After he participated in a workshop for c. 25 researchers, Christofoletti was one of six Brazilians selected as multipliers for the programme, training peers in Brazil. More than 100 Researcher Connect workshops were held in Brazil between 2015 and 2017, covering the whole country. Christofoletti participated in about 30 of them, from one end of the country to the other.

The experience made him realise the importance of science communication as a key link between researchers and society, as well as between institutions.

During this period, Stuart Jenkins was participating in a large project to monitor the entire coast of the United Kingdom. The project was rooted in the principle of citizen science and brought together citizens and society to collect the data. There are many advantages to the concept, including spreading knowledge beyond the academic world, helping citizens become part of the research, as well as enabling data to be collected across many different locations.

This really increased the volume of data collected, to an extent that would have not been possible if only the scientists had been involved. Clearly, the non-academic participants were trained and instructed beforehand. Christofoletti emphasises that this clearer view of the scientific process by the population in general not only helps understanding but gives value to science itself. This is highly important during the Covid-19 pandemic, for example, when so much fake news is around.

"With the Ocean Decade, society is invited to look at the ocean sciences. This is because most of the world's population lives in the coastal regions, and the environmental degradation and transformation of these regions and the oceans are a major threat to the planet."

IN FAVOUR OF THE TIDE

In 2017, a solution to the mismatch between the different research paths being taken by Christofoletti and Jenkins appeared when the British Council put out a call for proposals in partnership with Brazilian research funding agencies under the umbrella of the Institutional Links programme, which aimed to support social innovation in the areas of rural development and biodiversity. One of the nine projects approved

INSTITUTIONAL LINKS

Managed by the British Council, accepts proposals for a range of cooperation activities between Brazilian and British institutions, including workshops, missions, lectures and other interchange activities over a period of up to two years. The programme is funded by the Newton Fund.

was a project put forward by the two researchers: "Coastal biodiversity and public policies: methodologies and actions to integrate stakeholders", supported by FAPESP, the São Paulo State research funding agency.

It was an opportunity to bring together experiences involving science communication, citizen science, work on biodiversity and proposals for public policies. An invitation to the Environment Secretary of the city of Santos in the State of São Paulo was the key step towards building a joint programme to monitor the coastal biodiversity of the municipality, using citizen science as a tool. The data produced supported the local authorities in their efforts to establish a conservation policy. Approved in November 2017, the project began in 2018 under the name Maré de Ciência (Tide of Science), in partnerships with the University of Bangor, the Santos branch of the Instituto Arte no Dique (Art on the Dike Institute), as well as the British Council, UNIFESP and FAPESP.

The name of the project, Tide of Science, is related to the ebb and flow of the sea during the tides caused by the gravitational attraction of the sun and the moon.

Coincidentally, in 2017 the United Nations had resolved to declare the period between 2021 and 2030 as the Decade of Ocean Science for Sustainable Development (https://ioc.unesco.org/ocean-decade), or 'Ocean Decade', supporting the UN's 14th Sustainable Development Goal (SDG 14), a set of 17 goals to be met in support of the 2030 Agenda.

The Ocean Decade initiative invites all areas of society to look at the ocean sciences. The intention is to shine a light on the threat posed by the environmental degradation and transformation of the coastal regions of the planet, where most of the world's population lives.

While the researchers were thinking about how to include different sectors of society (local government, academia, and civil society) in the project and build awareness of a topic that was both local and global through Tide of Science, the Decade appeared as an opportunity. What was being proposed at the global scale was, in essence, what was emerging in Santos.

THE IMPORTANCE OF VALUES

An important aspect of this partnership was that it was rooted in shared values built during prior experiences, such as the British Council's Active Citizens programme, which is focused on leadership in civil society and based on the three pillars:

1. Intercultural dialogue
2. Social development
3. Community-led social change

In other words, the programme aims to build global connections while looking at and engaging with local issues. In order to develop the leaderships skills required, so that those involved were equipped to deliver the activities, the Core Skills programme was also introduced, which includes the skills and abilities which are essential to the 21st century.

These include key learning areas such as digital literacy, critical thinking and problem resolution, citizenship, collaboration and communication skills.

When Tide of Science was pitched to the British Council, it was rapidly seen that the spirit behind the concept of Citizen Science was close to that of Active Citizens.

While the first stage of the partnership with Jenkins was more focused on monitoring the coast of the United Kingdom, the project was never intended to be one way. It was, in fact, always intended that with the experience

gained in the United Kingdom, citizen science with a local flavour would take root in Brazil, influenced by and adapted to local culture.

At the same time, a discussion was taking place internationally which questioned the fact that in some projects involving citizen science, the scales weighed heavily in favour of the science, leaving the whole citizenship aspect as a secondary issue. Some articles have pointed out the danger of "Uberizing" science, where many members of the public help with the research while the scientists are not really concerned with what these lay people are learning.

Aware of these concerns, Christofoletti opened a door through which knowledge could flow in the opposite direction, with the Brazilians helping their UK counterparts, demonstrating how it was possible to achieve a balance between the citizens and the scientists when it came to benefiting from the project. This exchange of experience between the two teams identified two key learning points from the point of view of the partnership:

1 The process is more valuable than the final result. It is necessary to invest in building the project together, taking into account the position and interest of each stakeholder, from identifying the nature of the problem to be investigated and the proposed solution. This is what happened in Santos.

2 The information should be examined from the perspective of citizenship. In order to do this, it is necessary to associate current skills and abilities in the population with the technological resources available, so that citizens participating are able to identify the information and reaffirm ethical values. As well as understanding that the time needed to build scientific knowledge is not the time required by the researcher, but the time that the entire group of participants requires.

With respect to these different time frames, international collaboration helps emphasise the point that, depending on the situation, either of the parties may need to speed up or slow down its activity.

TIDE OF SCIENCE WORK FRONTS

There are some clear lines of action in the Tide of Science project's work when it comes to citizen science. One of them is the activity names Maré com a Comunidade (Tide with the Community), which is a set of activities involving communities which are disadvantaged in the socio-environmental or economic sense, a reality which many Brazilians face which is much less noticeable in the United Kingdom.

This line of action expanded to embrace a partnership with the project Women in Science, aiming to emphasise the importance of gender issues and the role of women.

Another line of action is Maré com a Escola (Tide with the School), which collaborates with the STEM Education Hub project and introduces a very important question: how to bring together formal educational spaces with the informal ones in the community.

In addition, there is the Science-Policy actions, which matches scientific knowledge with the needs of civil society, where decisions are taken on the basis of research data and its understanding within the community.

SCIENCE COMMUNICATION

Tide of Science also gained visibility through a series of events aiming to demonstrate and enhance the public nature of the project. For example, during the first half of 2018, the Tide Science Festival took place, involving four months of science activities and actions in various places, including related cultural activities. The festival programme included:

- A piano recital at the Pinacoteca do Santos to mark the publication of a book about the activist Bárbara Veiga, who travelled around the world on various vessels for 17 years.
- A series of activities at the Coffee Museum, such as Women and the Sea, which focused on girls and women in science and involved tours for them to get to know the museum and its collection.
- Open discussions in partnership with the city of Santos authorities where topics which generate conflict between social groups were discussed, such as fishing and maritime pollution.
- Pint of Science: a special edition of this science communication initiative, started in the United Kingdom, which brings scientists into contact with the general public in bars, restaurants and other social spaces to discuss topical themes.
- Chats with children in socially deprived areas, such as those in the north-east of Santos, where many people live in shacks supported on stilts in low-lying areas. These children are also invited to a weekly session with the Arte no Dique group, where they are taught scientific literacy.
- Ocean Day, the closing event of Environment Week. This event took place on the beach and brought together about 1,000 people.

SUDDENLY, THE PANDEMIC

With all this going on, a new phenomenon appeared in March 2020, first in the United Kingdom and then in Brazil – the Covid-19 pandemic, something with was unimaginable to everyone, perhaps with the exception of scientists and others with an interest in science. At the beginning, no-one knew how long it would last, imagining that it would be for a few months, a belief that was soon challenged by the facts.

Then, according to Christofoletti, those involved in the project decided that their responsibility went beyond the scientific into the social area. Various institutions had already participated in the project before the pandemic. So the idea emerged of the 1st Ocean in Education Challenge. How to organise it?

The solution was to ask the teachers for suggestions on how the schools could discuss the theme "The Ocean" remotely in the classroom. There were two requirements only: that the student was at the heart of the project and that more than one subject area was involved.

For four months, from July to the end of October, 2020, stories were collected and activities designed. In November, the 1st Young Ambassadors Forum was held virtually, with a range of activities, including streamed events, workshops and presentations. All the material was

collected and licensed for use by those interested. During the challenge, 60 schools and 11 informal educational spaces in 11 Brazilian states, from the north to the south, from the remote Fernando de Noronha archipelago in the Atlantic to Minas Gerais, a landlocked state, took part. More than 130 teachers from different disciplines, about 2,000 students, and more than 6,000 others were involved in or directly impacted by the project.

THE THIRD STEP

This example of the path followed from the first by Ronaldo Christofoletti and Stuart Jenkins, who have continued to involve a number of other people in their plans, even in the midst of the pandemic, is, in essence, very closely linked to the ideas behind the STEM Education Hub. A project which started with the specific aim to map and monitor the coasts of the two countries went on to gain new directions, as it involved various schools and a range of organisations, including the British Council and King's College, as close partners.

As Christofoletti says: "The STEM Education Hub opens doors, windows and gates. It brings opportunities for shared creativity, research, innovation and citizenship. It supports advances by building a project structure that is multi-sectoral from the start". He also recalls the valuable learning experience he had: "it is important to look at what is different, because diversity is very important."

11 States

60 Schools

11 Non-formal teaching spaces

Child education, Middle School, Young people and Adults

+130

Educators from Different Knowledge Areas

+2.000

Students Directly Involved in the Projects

+6.000

People Indirectly Impacted by the Projects

THE ART OF ATTRACTING YOUNG PEOPLE TO SCIENCE

Specialists from the Science Museum Group talk about what they do to engage the public and show that science is much more than what they learn at school

WHEN **25/05/2021**
WHERE **Live**
AUDIENCE **100**
PRODUCED BY **STEM Education Hub, British Council and King's College London**

Learning Points

- What is the Science Museum Group?
- The level of scientific engagement in the UK
- The importance of personal choices
- The need to support those who feel excluded
- The museum as a welcoming space
- The engagement points
- The difficulty of measuring results

From a talk
by **Karen Davies and Beth Hawkins**

Karen Davies is Head of Learning Research and Resources at the Science Museum Group and has spent 25 years developing new ways to communicate scientific and technological ideas and concepts to a wide range of audiences through interactive exhibits and innovative programming.

Beth Hawkins, Academy Manager at the Science Museum Group, has been working with formal and informal scientific education for more than 20 years. Since joining the Science Museum Group, she has developed materials and delivered training to STEM teachers and professionals in the UK and internationally. She has also led learning research projects.

Those who accept the challenge of attracting the interest of more young people to science and technology should try, first and foremost, to understand what they think and what they really are looking for, rather than just relying on the specialised literature and research. They should also focus on showing that science goes beyond what they learn at school and has practical applications to everyday life, which is different from what many of them think.

These are some of the suggestions made by Karen Davies, Head of Research and Learning Resources, and Beth Hawkins, the Science Museum Group Academy Manager, which brings together five museums in different regions of the United Kingdom – the Locomotion, in Shildon; the National Railway Museum, in York; The National Science Media Museum in Bradford; the Science and Industry Museum in Manchester; and the Science Museum in London.

“It is a question of stimulating discoveries through the interaction and active participation of young people.”

According to Karen Davies, eight years ago the group developed a project that brings together the concept of science capital and the relationship between young people and science, aiming to understand the audience better. Beth Hawkins pointed out that, at its heart, the work consists of arousing curiosity in science, engaging connections and stimulating discoveries through the interaction and active participation of young people. “It’s not a question of wanting to teach and give lectures, but of stimulating discoveries through the interaction and active participation of young people. Science capital is really important to us at the Science Museum Group, it’s something we’re incorporating into everything we do.”, she said.

ONLY 5% ENGAGE ACTIVELY

Beth Hawkins explained that one of the underlying aspects of the group's work is the level of public engagement with science capital in the UK: only 5% of the British population is actively engaged (mostly male and middle class) – meaning that they are regular visitors to the museums, feel very comfortable in these environments and love science. About 68% are less engaged – they are occasional visitors who are interested in science but do not make a special effort to get involved – while the remaining 27% have low science capital, only visit museums when arranged by their school, are mostly female and come from socially disadvantaged backgrounds. They think: "Science is not for me").

"Science capital is really important to us at the Science Museum Group, it's something we're incorporating into everything we do."

SCIENCE CAPITAL IN THE UNITED KINGDOM

5%

have **high science capital** (fully engaged). Most are males in socially privileged positions.

68%

have **average science capital** (casual visitors)

27%

have **low science capital** (not interested in science)

“A museum represents the possibility of a change of attitude, the creation of a “spark of inspiration, pleasure and creativity.”

These data opened the eyes of the researchers, helping them understand in detail those who visit the group’s museums. In the case of the public with low science capital, the data highlighted the importance of visits by groups of students, as this segment would probably not be taken to a museum in a family outing.

As well as being an important force in increasing science capital, when it comes to the engagement ecosystem, the school is also the place where young people have more opportunity to come across science when the school arranges a visit to a museum, according to Beth Hawkins. In turn, museums have a responsibility to show that science is not only a compulsory subject at school, but a factor in practical development.

“We help make that connection, showing that science is more than something you learn at school. We have the opportunity to show the applications and relevance of science in everyday life and the benefits that science brings to us. In reality, what we do is much more than just passing on knowledge. It’s about showing that science skills can be transferred to many opportunities in personal life,” said Beth.

A museum, therefore, represents the possibility of changing attitudes, of creating a “spark of inspiration, pleasure and creativity” – in other words, a hunt for objects that actually matter, the search for something beautiful and useful. In fact, “the Great Object Hunt is an activity developed by the Science Museum Group to encourage people to look around and identify what actually attracts their attention, among so many interesting items.”

OPPORTUNITY FOR PERSONAL CHOICES

The simple act of looking around you carefully is, according to Beth, an enriching exercise at any time, from the winter sun low on the horizon to the details of the plants in the garden. "It is really emotional to just look at the world about us. It is one of the reasons why we like to say that there are no wrong answers, it all depends on someone's viewpoint. I can't say what you find beautiful, that is completely up to you. It's a personal choice. In a museum, people can feel overloaded with information, with so much around them, and we need to say to them that they are allowed to just look around and find things they think are interesting."

Beth Hawkins' observations are directed particularly at teachers and others who take young students to museums and assume a responsibility which, sometimes, is a bit beyond them. She says that the role of cultural institutions is to help these teachers feel comfortable, welcome, and supported, so that they don't become lost amongst the thousands of objects on show, with a fixed idea that they should focus the attention of the students all the time on what they should look at. The idea is that a visit to a museum should be a shared experience and full of discoveries.

SUPPORTING THOSE WHO FEEL EXCLUDED

Karen Davies reminded us that anyone who deals with science and culture should also understand the real connection that people have with objects in their surroundings, and that this is a resource that could be used by both families and schools. “One of our most important values is that we are open to everyone, and obviously this is not limited just to people who love science and are happy to visit a museum. There are many people who feel uncomfortable or anxious when they are in contact with science and then think that they are not welcome in places like ours.”

According to Karen, many of the strategies used by science centres seem to favour those who are already engaged with science and exclude people who face the wider inequality of society. “That is why the science capital approach should be applied equally to all, so that there is a wider range of people who engage with science, participate and feel welcome. This requires a change in the way we approach our work. It’s not the audience we need to change, but the way we deal with it. We need to support the educators, who are very important to us. We recognize that not all teachers are equal and this public should be segmented.”

A survey by the Science Museum Group showed that there are different types of educators, one of which is very anxious about visiting the museum and not sure how to behave. On the other hand, there is the group of experienced teachers who know the museum well and know what to do in it. The important thing, Karen says, is to support all types of visitors and focus on improving their journey in all possible ways, not just in relation to the museum’s collection on show.

LANGUAGE

Think of the visual and verbal language used, and how it can help everyone feel part of science – rather than feeling that science is something “other people” do. Use gender-neutral personal pronouns, visual and verbal language, and explain any jargon used.

SKILLS

Think about how to help people recognize that they actually have and use a wide variety of scientific skills. Give examples of where and how scientific skills are used by different people in their daily lives. Emphasize how such skills can be useful for their hobbies and jobs, whether in the scientific field or not.

In this sense, the science capital approach needs to involve people working in the museum and be based on the different level of audience needs, beginning with the basic details. Karen suggests a few questions: "For example, is the museum clean and safe? Is it accessible to everyone? Do we have access ramps suitable for people with specific needs? Do we have appropriate facilities? Do we have toilets for people with disabilities? Do we offer appropriate information? Are the cafes accessible and affordable?"

These details can determine whether or not the visitor is motivated to return to the museum and, according to Karen, an engaging, memorable and inspiring experience should be offered – one which connects to the visitor's expectations and contributes to increasing their science capital: "These things are important and should be taken into account. Everyone in the organisation really has a role to play, to make the museum much more welcoming for every visitor."

EXTEND THE EXPERIENCE

Help people continue to connect with science in their day-to-day lives. Extend experiments by giving them simple ideas and activities they can do later, such as questions for them to think about or investigate further, or challenges to do at home, school, or anywhere else.

POINTS OF ENGAGEMENT

The learning environment in a science museum covers the STEM, (Science, Technology, Engineering and Mathematics) concept perfectly, showing how it is relevant and applicable to everyday life. As points of reflection to increase the engagement of young people, the speakers suggest initiatives such as the use of inclusive language, the stimulation of themes for discussion, the use of everyday examples, building a climate of trust and partnership, expanding the visitor's experience and knowledge of STEM content to highlight skills and broaden their perception of how science and technology can benefit people.

Beth said that the information collected in the surveys needs to be put into practice, and the changes needed to convey to the public the idea that museums are welcoming, useful and necessary environments have to be implemented. To do this, we need to constantly re-evaluate what is done daily by the team members.

“There is a lot of trial and error. Don’t know what to do at any given time? So don’t keep doing the same thing if it doesn’t work. If it works, you can make it even better, so that next time others can use your learning. That’s the idea.”

The Science Museum Group team also spoke of other initiatives aimed at engaging young people, such as experiences which demonstrate how dry ice is used in special effects in the cinema, theatre, and TV shows. “These are examples of the resources we use to make the visitor more confident and more at ease, by showing scenarios they recognise and are interested in, stimulating further visits to the museum and showing teachers what they can do in the classroom,” explained Beth Hawkins.

This approach simplifies the concept of science capital and brings it closer to the real life of young people. This is why it becomes a key issue in the search for more engagement, as it shows the potential for the practical application of science and the improvement of individual skills. With this thought in mind, the Science Museum Group has created a special web page to show how parents and teachers can become multipliers of scientific knowledge.

At the same time, Karen and Beth emphasised the importance of focusing on the diversity involved in life sciences and working beyond the stereotype of “white lab coats.” This includes scientists specialising in sports and various other areas who can be called upon to talk to visitors and school groups, helping them understand what is on offer in museums in a way that is different and more accessible.

As an example, they reported a very different experience a few years ago, in which visitors were invited to dress up as cockroaches to explore the risks of climate change. According to popular belief, cockroaches would be the last living beings left on Earth in the event of a global apocalypse. They also mentioned that the museums in the group also include works of art in their exhibitions, in order to show the connections that exist between all areas of human knowledge and their different representations.

HOW TO MEASURE THE RESULTS

And what was the objective benefit provided by these initiatives, which go beyond the conventional approach? How do you measure your success in terms of strengthening the science capital of young people and, as a result, the engagement efforts of the science and technology museums? Their conclusion is that there are no really effective metrics in this area. Karen Davies said that it is simply impossible to objectively measure the personal changes that occur in science capital, due to the lack of consistent means of evaluation and previous parameters. The expectation is that changes will occur over the long term, gradually: "What we are measuring is the engagement of people with science through what is observable and the indicators available in the education system and informal learning spaces."

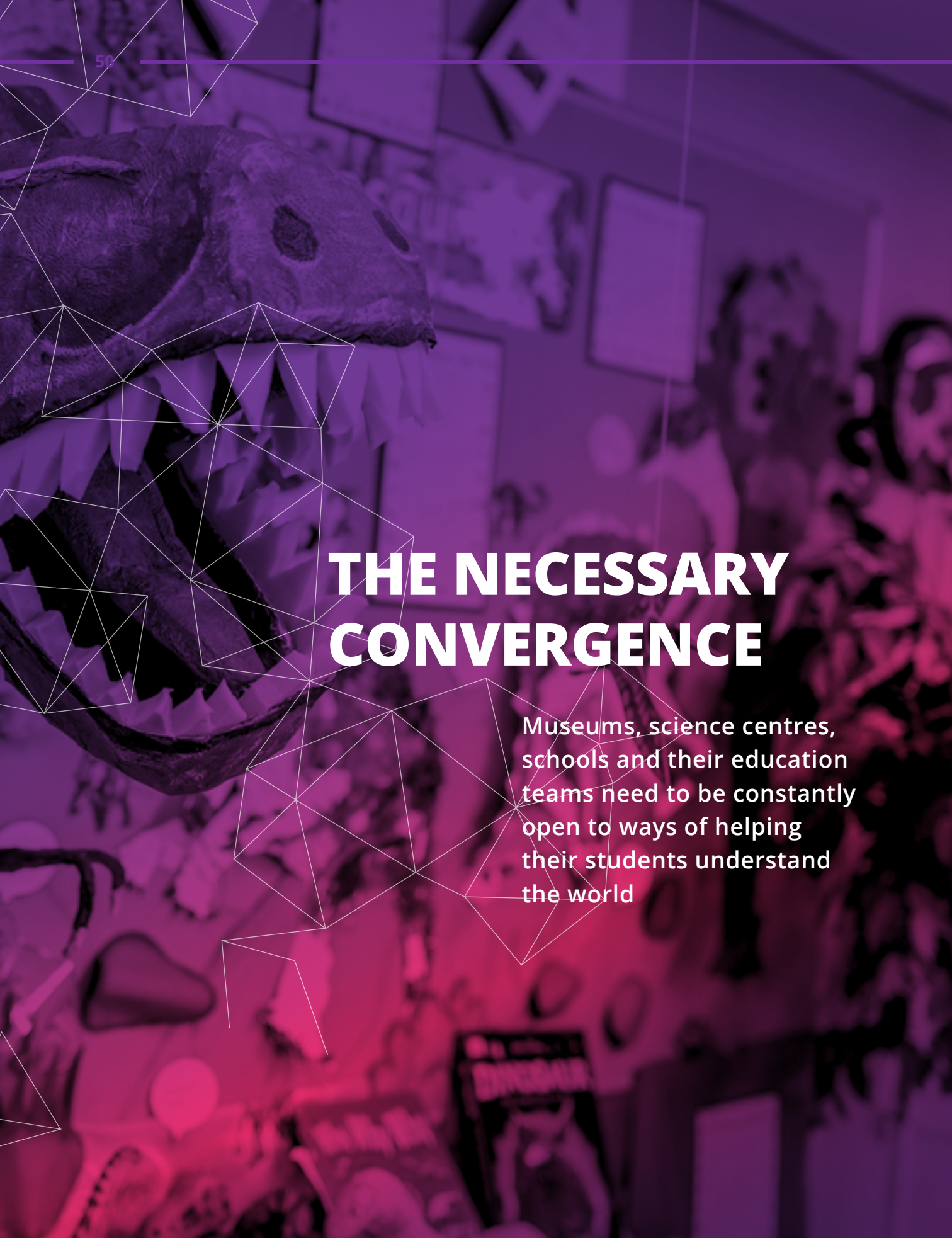
According to Karen, what is being done is to assess how young people have a significant connection to science in the Science Museum Group spaces, and with that they can really say afterwards: "Yes, science is for me." It is about providing connections with what they know and with their daily lives and creating a sense of belonging. "We want them to feel welcome when they go to a museum or a science centre such as our own, that they can see that people just like them are there too, that they have a positive emotion about the experience. In the end, it is a matter of feeling, of how they see science."

PEOPLE

Think about how to broaden perceptions about those who do science, showing examples of the diversity of individuals who use it and benefit from it in their work. Help people realise that they actually know someone who uses science, and that it is shaped by everyone in society.

POSITIVE REINFORCEMENT

Think about how to help people believe that science is something they can do. Value and reward people when they behave scientifically using scientific knowledge or skills. Leave them with the feeling that they "can do this" and that they "want to discover or learn more."



THE NECESSARY CONVERGENCE

Museums, science centres, schools and their education teams need to be constantly open to ways of helping their students understand the world

From the talk
by **Ana Carolina de Souza Gonzalez**

Currently studying for her doctorate in Health Information and Communication at Fiocruz (PPGICS/ICICT), including a sandwich period at the University of Exeter (United Kingdom) supported by the Capes/Print Fiocruz Programme (2021). She has an M.Sc. in Morphological Sciences from the Federal University of Rio de Janeiro (UFRJ) (2006), a diploma in Science Education from the Federal Institute of Education (IFRJ) (2011), a B.Sc. in Biological Sciences (Medical) (2003) from UFRJ and a Teacher's Degree in Biological Sciences from IAVM (2009). She was a Technical Assessor at the National Department of SESC (Social Service of Commerce) between 2007 and 2012, responsible for coordinating the national SESC Science programme. Since 2012 she has been a Public Health Technologist at the Fundação Oswaldo Cruz (Fiocruz). Between 2017 and 2020, she led the Mobile Science Section, setting up Fiocruz's Museum of Life/Oswaldo Cruz House Touring Department, overseeing the Art and Science on Wheels project. She is a member of research groups concerned with Education, Science Museums and their Publics, and Studies into Information and Evaluation in Science, Technology and Health. She is experienced in promoting and popularising science, with a focus on science museums and centres, exhibitions and touring museums, museum communication and education, training museum educators for touring programmes, public communication of science for social inclusion, art and science, audience research and evaluation.

WHEN **11/08/2021**
WHERE **VIRTUAL EVENT**
AUDIENCE **100**
PRODUCED BY **STEM Education Hub, British Council and King's College London**

Learning points

- The Brazilian perspective on educational spaces
- The role of educators in museums
- The National Museum Education Policy (PNEM)
- Science capital and the fight against inequality
- The museum goes to the school and the school goes to the museum
- The importance of extending the experience beyond the physical visit

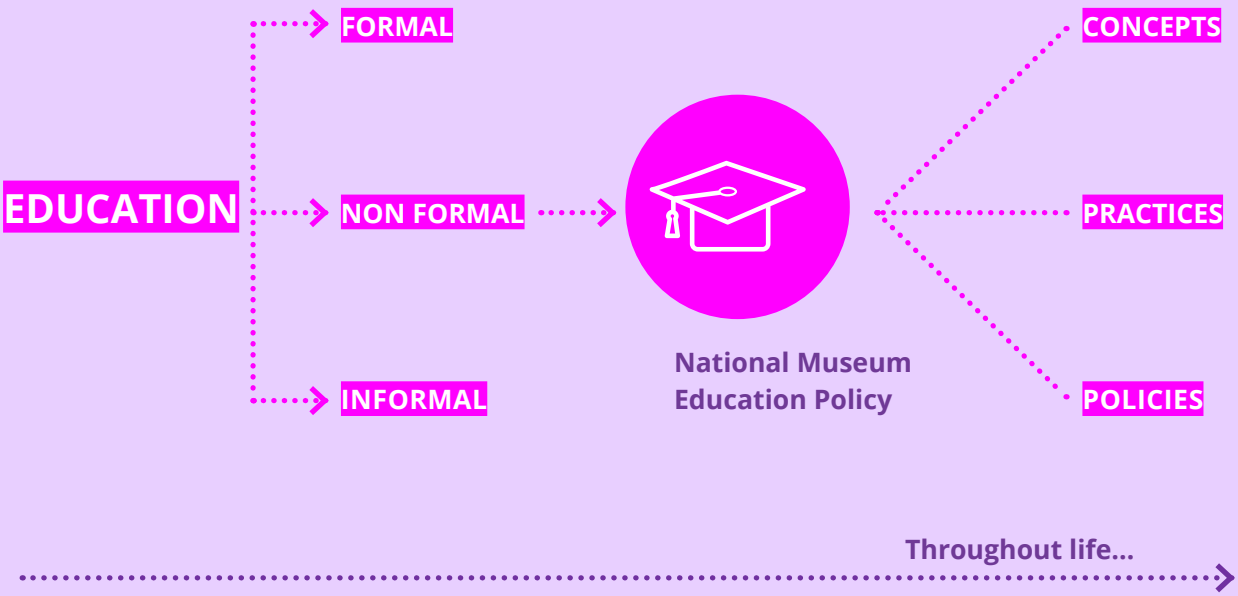
Outside their school, children and young people can be attracted to science in many different ways and places. Museums are a space that lend themselves well to this. They are places that make many scientific processes and events visible through interactions of different types. Researcher Ana Carolina de Souza Gonzalez, a Ph.D student in Health Information and Communication at Fiocruz, addressed the issue of science capital from the perspective of the encounter between museums and schools. She pointed out that not only are such encounters are not only possible they are essential.

A starting point in this discussion is to look at how different educational moments and spaces are seen from a Brazilian point of view. In general, one can classify the way both science and other subjects are taught as: formal, non-formal and informal.

In Brazil, as in Spain and other countries, informal spaces are those where learning takes place without the clear intention of teaching and learning. Such spaces are social spaces, where friends and family socialise, such as the theatre or cinema, which can be fixed forever in our memories and experiences but were not intended as teaching and learning spaces. However, obviously, it is possible for teaching and learning to take place in such spaces.

Formal education, however, takes place in situations where places such as schools and universities are charged with delivering knowledge. They are characterised by well-defined and conceived timetables, in which they certify the extent of knowledge gained by those who pass through them.

We consider non-formal spaces of education to include museums, science centres and other institutions - places that have a more flexible spacial and temporal logic, but with the intention of teaching and learning through their educational practices, which usually systematise knowledge.



CASTRO, et al., 2021; FREIRE, 1997; GADOTTI, 2012; TRILLA; GHANEM, 2008.

https://pnem.museus.gov.br/

THE BRAZILIAN EXPERIENCE

In the Brazilian case, since the turn of the century these practices have resulted in what we call museum education. At the beginning of this century, educators working in museums formed a network focused on the discussion of their practices, concepts, and challenges, where they can reflect on how to make this field take a more central role within museums and similar institutions.

To emphasise the importance of educators working in museums, Ana Gonzalez makes a parallel between them and teachers in formal schools: "If schools do not exist without their teachers, museums do not exist without their educators either. Because it is the museum educators who further the encounter between exhibitions, museological objects, the collection and the public."

In summary, it is these educators who give new meaning to what the institution signifies to its, by buiding connections with what this public already knows, helping this connection to generate new meanings.

These discussions progressed and culminated in the publication of an institutional document which was transformed into policy by the Brazilian Institute of Museums, becoming the National Policy for Museum Education (PNEM), whose introductory paragraph sums up its intention well:

"The PNEM is a set of principles and guidelines aimed at guiding the realisation of educational practices in museological institutions, strengthening the educational dimension in all spaces of the museum and supporting the activities of educators."

And, more than anything, it recognises and emphasises the importance of museums reaching their audiences and being open to every type of public.

MUSEU DA VIDA

Reception center - Museu da Vida Fiocruz (Life Museum)

SCIENCE CAPITAL FOR EVERYONE

When looking at these three educational approaches, we have a perspective of something that will be present throughout the lives of citizens. These are issues with which we will be confronted in the different social spaces we interact with, and which need to count on the commitment of a permanent, emancipatory vision, which will help in the fight against any kind of oppression and violence.

A brief analogy which explains the concept of science capital is that it can be thought of as a container, a bag, for example, in which all our science-related resources, such as habits, attitudes, and the way of thinking, are collected together. Throughout our lives, we will add elements to this bag by reflecting on and studying some topic, and through our actions, as well as the interactions we have – with people and through networks.

However, the act of adding elements to this bag is not fortuitous. The science capital of each of us has different motivations, linked to other types of capital: economic capital, social capital, cultural capital. All of these things condition the additions of each one to the bag.

What does that mean? That when we provide spaces and promote opportunities for all people, without distinction, to fill their bags, we are working to combat inequalities and inequities.

"When we provide spaces and offer opportunities for everyone, without distinction, to make the most of themselves, we are working to combat inequalities and inequities."

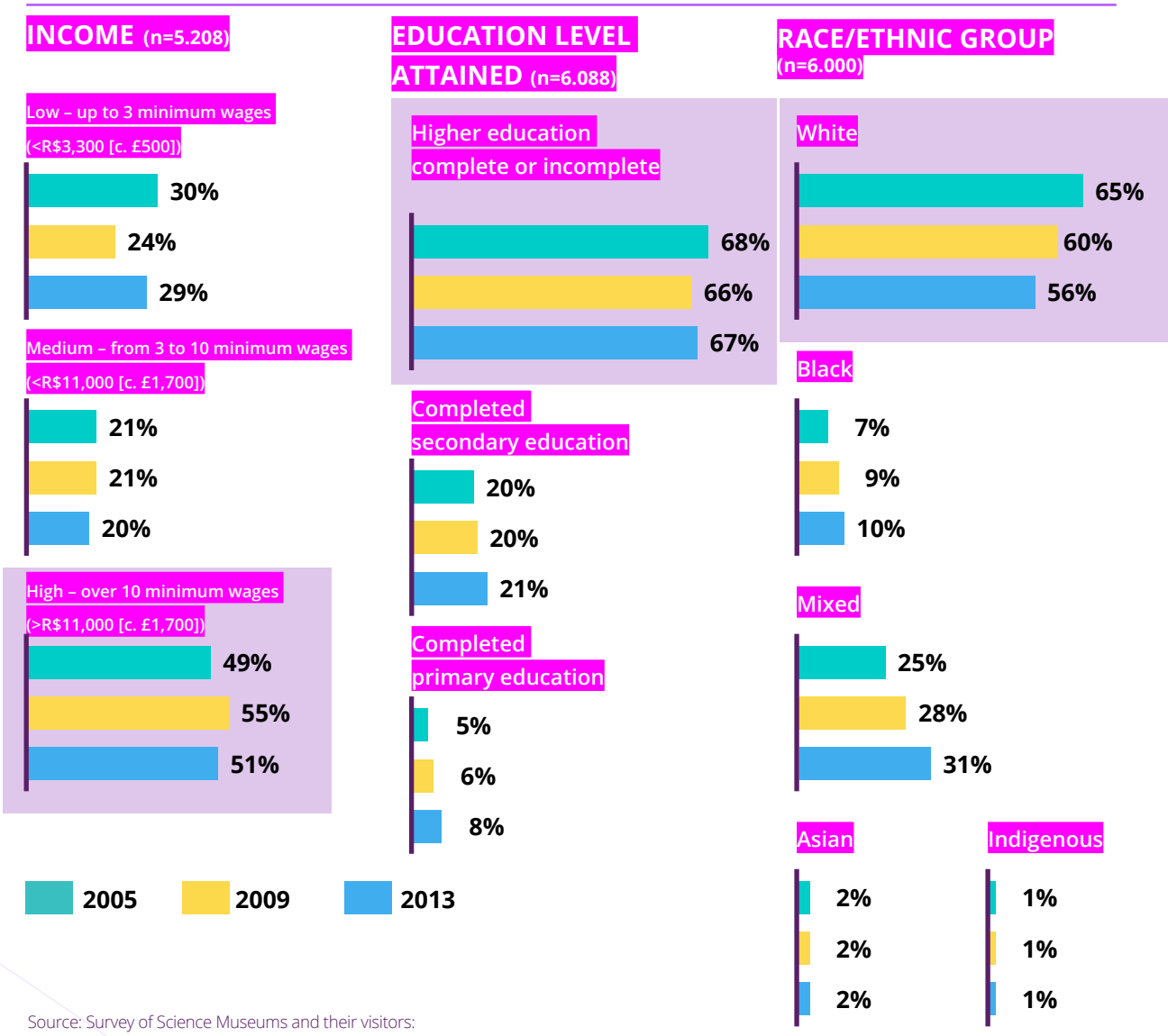
SNAPSHOTS OF BRAZIL

When things happen this way, we move towards greater social justice. And this question is pertinent, as we see in some general studies about Brazil that allow us to see how this appears in practice. A longitudinal survey was carried out by the Observatory of Science Centres and Museums, coordinated by Fiocruz. The data presented here are not the most recent, the results of a later survey are yet to be published. But this data take includes some very interesting elements.

This survey was carried out in five different museums and had more than 6,000 participants and enabled us to build a profile of the visitors to each of these spaces was established. In the graph, we see that most visitors are from high income families, have university degrees and are white. Most of them were visiting these museums for the first time during the three years in which the survey was carried out.

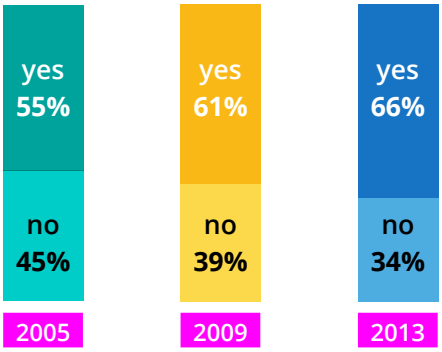
It should be emphasised that when the respondents spoke about how they heard about the museum, they said that the main source of information was their teachers, followed by friends and relatives. This reinforces the importance of relationship networks as a defining factor in the habit of visiting science spaces.

Another survey, called "Culture in the State Capitals" (available online at: **CIDADES — cultura nas capitais**), interviewed 33 million Brazilians. It should be noted that the public in the state capitals, on average, has a profile quite different from that of more remote regions, outside the metropolitan areas.



Source: Survey of Science Museums and their visitors: Longitudinal study 2005, 2009, 2013 / OMCC&T (2017)

IS THIS YOUR FIRST VISIT TO THE MUSEUM?



n = Consolidated total of all museums per year of data collection

HOW DID YOU HEAR ABOUT THE MUSEUM?

Source: Survey of Science Museums and their visitors: Longitudinal study 2005, 2009, 2013 / OMCC&T (2017)

In this survey, 56% of respondents said they had an interest in visiting museums and science centres; 30% had never been to these spaces and 40% had visited them more than a year ago at the time of the survey. In the last 12 months, 30% of these Brazilians have said that they had gone to science museums.

In the next page is a graph that correlates social class and education. In the socioeconomic classes C, D and E, the visitation is low (between 11% and 32%). When a correlation is between educational level and visitation, the percentage of those with degrees who went to museums is much higher, regardless of the social class to which they belong.

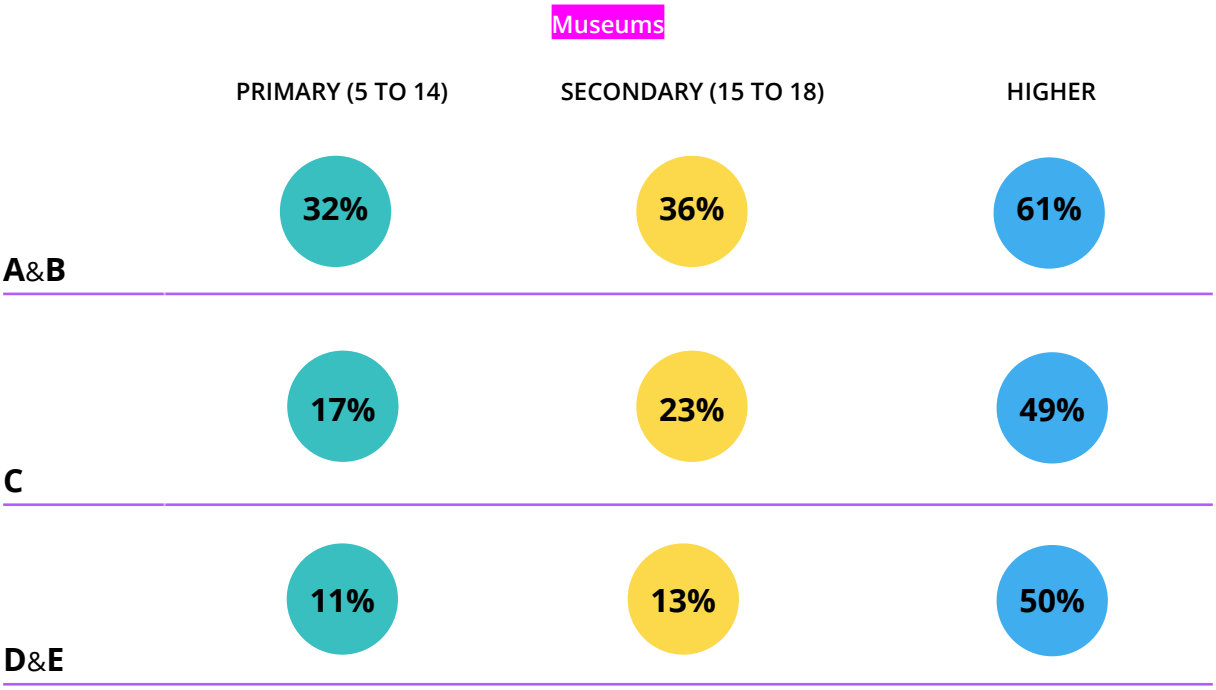
This shows that educational level is a great differential in decision making or in the habit of visiting non-formal education spaces or spaces such as science centres and museums.

In a third survey about the public perception of science, carried out in 2010, 2015 and 2019, more than 60% of Brazilians declared that they had a strong interest in science and technology. Which suggests that many people visit museums of this nature. But, on the contrary, in the last survey, conducted over the calendar year 2019, 93% did not visit any space of this type. Among those who earned from zero to a minimum wage, the percentage rose to 97%. If we look at the illiterate or those who did not finished elementary school, the percentage is even higher: 99%. That is, education and income are very important factors when it comes to opting to visit science centres and museums.

EDUCATION X INCOME

Education encourages access to culture, even amongst those in the same economic class

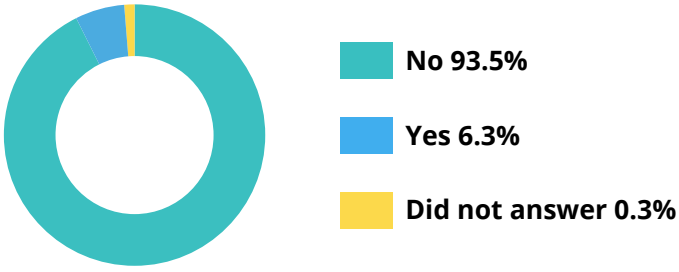
Museums



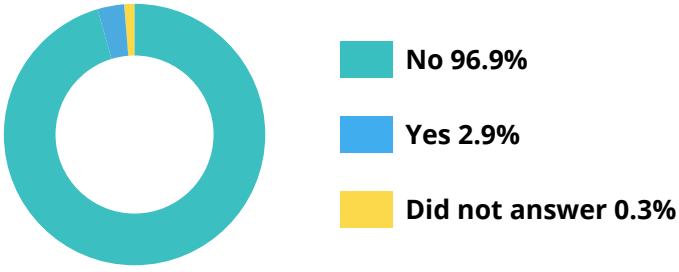
Source: Culture in the State Capitals Survey, 2018. J. Leiva.

Visited a Science and Technology Museum or Centre over the last 12 months

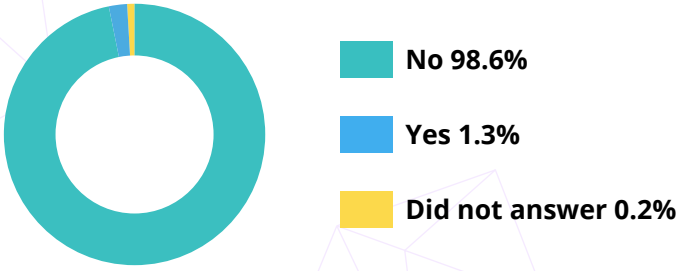
Year: 2019 **Total:** 2.200



Year: 2019 **Income:** Zero to 1 total minimum salary: 383



Year: 2019 **Education Level:** Illiterate/Did not complete elementary education (1st to 5th year) Total: 553



Source: Perception of S&T. https://www.cgee.org.br/web/percepcao/

“These spaces give us knowledge, things to do, stories, debates, conflicts – all with the aim of helping individuals develop their critical skills and citizenship.”

THE NECESSARY CONVERGENCE

The joint actions of two types of institution – schools and museums – which have a responsibility for social transformation, represents a vital convergence from the point of view of assuming joint responsibility for the education of individuals. These spaces give access to knowledge, actions, stories, disputes, conflicts – and all of this is intended to help individuals learn to exercise their critical skills and citizenship.

The joint actions of these two educational spaces needs, of course, to consider the potential of each space, at what can pass across the historical barrier between them and what must be done to overcome those barriers. All of this should include an emphasis on the function of each educational institution and the formation of scientifically literate citizens.

This definitive approach depends on movement - on being dynamic. It requires perspectives to shift, from the most concrete to the most symbolic. The museum needs to go to the school and the school to the museum. And the educators in the two spaces are those mainly responsible for developing this mutual and supportive listening exercise.

An important aspect: the visit to the museum cannot be an end to itself, it cannot be a one-off action, it needs to transcend those moments. The teacher needs to know the museum, participate in activities that the museum frequently offers, such as meetings between teachers, seminars on educational practices. In turn, the museum has to know about the school that is going to visit it. What learning are these visitors bringing, regardless of age? What do they want to know? What are they curious about? Questions that help value each person’s personal knowledge and beliefs to build something new.

These environments are able to help us form a new view of the world if they recognise all the knowledge that is in motion within them, without establishing a hierarchy. By achieving this, it may become possible that the students who remain silent in the classroom speak out, express themselves, interact. After the visit, other interactions and engagements can be offered, such as Tik Toks, or through a hashtag, so that students can create content after their visit.

In such cases, it is important to be aware of, for example, what the students report and talks about when they return to their homes, what got their attention, what doubts they brought to their teacher, and what this teacher can take to the museum. It is an alliance that needs to include everyone. "This should be done without losing sight of the need to be open to, to hear, to recognise, to welcome the knowledge of the other and to build new knowledge from there. This is a way for us to build social impact that is greater than the mere sum of a museum and a school", observes Ana Gonzalez.

Finally, it is important to stress that even in the midst of the pandemic, schools and museums had to create new approaches and activities to remain in touch with their audiences, find a way to reposition themselves so that they could fulfil their mission, which is to educate. For this reason, the theme of the 19th Brazilian National Museum Week, which took place in February and March 2021, was "The Future of Museums: Recovering and Reimagining", in which it was very clear that there was a shared concern that social inequalities should not widen as the result of a lack of access to digital technologies. This is a major challenge not only for schools and museums, but for Brazilian society as a whole.

MARIA BUZANOVSKY

The century-old "Moorish Castle", the distinctive building housing Fiocruz's Museum of Life

THREE WAYS OF ENGAGING WITH TEACHERS AND THEIR STUDENTS

1 Provocations

- Meeting with teachers (pedagogical workshop/ meetings about the student journey)
- Courses on the themes to be covered
- Support material
- Initial teacher training

(subjects covered in teacher training courses)

2 Activities during the visit

- Teacher/researcher/explorer
- Personal memories and visitors' own experiences
- Other knowledge gains legitimacy
- Participation of students who usually don't take part in classroom activities

3 Other activities

- Students remember discussions and debates for longer
- Collaborative projects
- Dramatizations, games, models
- Surveys of these groups and teachers
- In-service teacher training

(workshops, courses, seminars)

Sources: ALMEIDA, 1997; MARANDINO, 2001; PEREIRA; CARVALHO, 2010; REQUEIJO, 2009; SOARES, 2015.

FROM LOCAL TO GLOBAL – CITIZEN SCIENCE PROJECTS FROM THE OPEN UNIVERSITY

Ways to engage students with the environment and build their knowledge

DIVULGAÇÃO

WHEN **11/08/2021**
WHERE **VIRTUAL EVENT**
PUBLIC **228**
PRODUCED BY **STEM Education Hub, British Council and King's College London**

Learning points

- Citizen science in schools
- Technology-based learning
- Digital platforms at the service of science
- Evolution Megalab
- iSpot
- Treezilla
- X:PolliNation
- Cos4Cloud
- Citizen observatories

From the talk
by Janice Ansine

Senior Project Manager – Citizen Science, The Open University (OU), United Kingdom. She is responsible for projects that use innovative education technology to involve the public in participating in and learning about biodiversity and nature using tools and resources made easily available on the web (www.iSpotnature.org and Treezilla). She also helps teach citizen scientists with accessible and innovative techniques (www.open.ac.uk/citizen-science-and-global-biodiversity) and researches in her field: https://citsci.kmi.open.ac.uk. With a B.A. (Hons) and Diploma (Hons) in Media and Communication (University of the West Indies, Jamaica), an MSc in Environmental Change & Management (Oxford), and an MSc in Science & Society (OU), she is currently studying for a Doctorate in Education (EdD) in Technology Enhanced Learning (OU). She has experience in media, environmental management and science and society, and has extensive experience leading initiatives in communication, public engagement, dissemination, informal learning, and behavioural change in the areas of sustainability, science and the environment.

Janice Ansine, leader of citizen science projects at The Open University (OU), was another participant in the seminar organised by the British Council and King´s College London. Her talk focussed on her findings from her experiences in the area, using the concepts of citizen science. These activities were created with the support of several communities and schools, and Janice presented a panorama of the actions which have been used to generate or share ideas on how to promote learning inside and outside schools using the principles of citizen science, show the work of The Open University in the

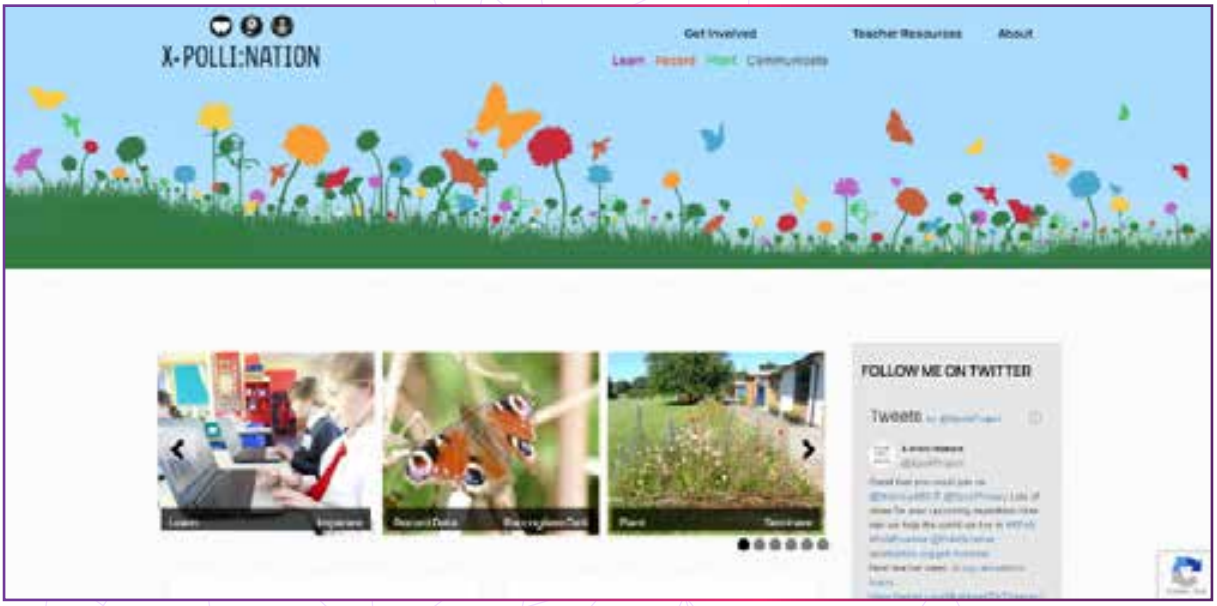
area.

The presentation took the following form:

• An overview of some of the projects she has participated in, such as: Evolution Megalab, iSpot, Treezilla, X-Polli:Nation, Cos4Cloud.

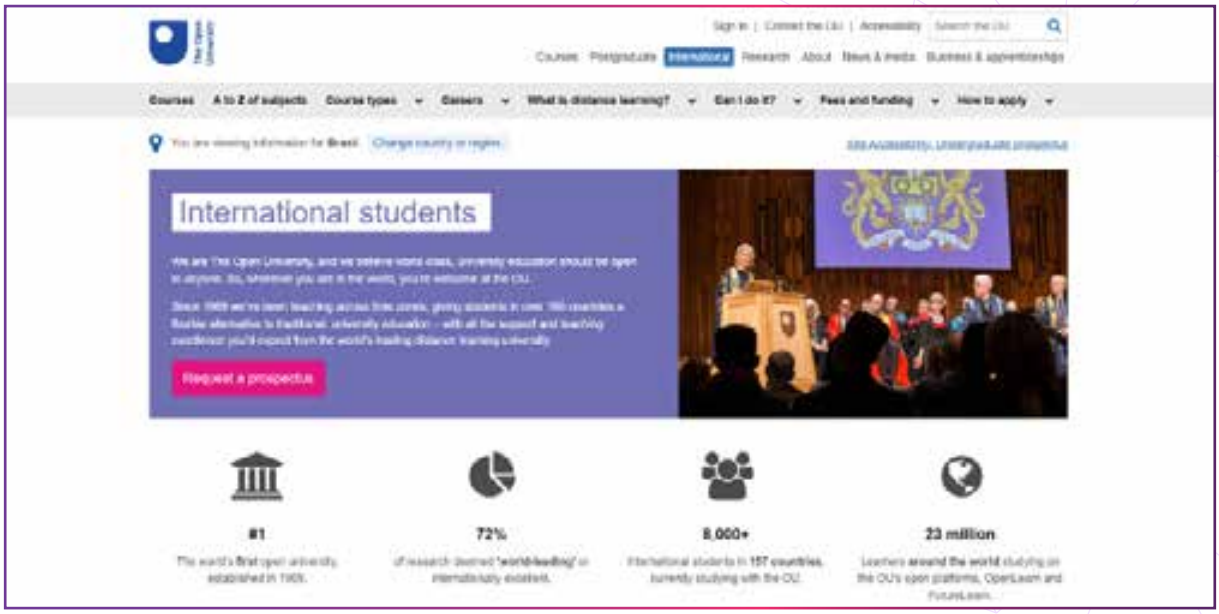
• An explanation of the learning model and some ideas and opportunities for learning through citizen science.

www.opensciencelab.ac.uk
https://www.ispotnature.org/
https://treezilla.org/about
https://xpollination.org/
https://cos4cloud-eosc.eu/



The Open University (OU) is the leading British distance learning institution and focuses on developing innovative education technology.The OU integrates citizen science into its teaching and learning while using the concepts of open science and practical science, this is part of the online content offered as part of STEM pedagogy.

Janice's research activity includes public engagement around the monitoring, classification, collation, and analysis of data at scale, in addition to establishing the infrastructure for this purpose. This makes it possible to structure citizen science actions directed toward public policies and community actions, in a design that favours the strengthening of citizenship in the practice of citizen science. As part of this work the OU's citizen science-based learning and teaching model emphasises objective-based learning and results.



Collaborative learning opportunities are supported and encouraged, both formal or informal, by encouraging students themselves to conceive, create and contribute to projects. This is supported by the integration of citizen science into some of its teaching. This approach can be successful and is promoted in projects of citizen science and acted as an incentive for other partners to use this methodology as well. The Open University has engaged in projects to better understand how the general population can participate in research and collaborate in scientific practices, as well as teach students to use skills related to the formal scientific method.

In addition, Janice Ansine also emphasised institutional investment in broader knowledge exchange, public involvement, and the building new collaborations. She spoke of her experience in the scientific field, saying that this has influenced the way in which she practices, manages, and communicates citizen science concepts and activities. She stressed the fact that she was a science communicator, not a scientist, an opportune distinction which demonstrates how science takes place at various levels.

"I communicate the science we do, particularly with regard to biodiversity and citizen science. I've been at The Open University for 13 years and have been responsible for a wide range of projects."

She is currently focused on technology-based learning. She is enquiring into the learning journey through a case study of iSpot Nature and The Open University, both members of the European Citizen Science Association. Janice Ansine is also a member of the Citizen Science Association, a global entity based in the United States.

SOME THE OPEN UNIVERSITY PROJECTS

Evolution Megalab was one of the first Europe-wide citizen science projects. It introduced Charles Darwin's theory of evolution to students through the observation of variants, adaptations, and distribution of snails in different locations, such as gardens and open public spaces.

"The Open University has engaged in projects to better understand how the general population can participate in research and collaborate in scientific practices, as well as teach students to use skills based on the scientific method."

These observations are a means of showing evolutionary trends in species, using the snail as an example. The public contributes by collecting data on their habitats, and the colour and form of their shells. Snails are an interesting example of adaptation to the environment over time.

iSpot (https://iSpotnature.org) is a citizen observatory which shares experiences and learning about nature, which helps students, or anyone, develop species identification skills.

The OpenScience Lab (https://opensciencelab.ac.uk) is a space that presents practical science, online experiments, and citizen science activities.

Treezilla (https://Treezilla.org), the monster map of trees, catalogues trees and their species in the United Kingdom and calculates ecosystem service values.

X-Polli:Nation (https://xpollination.org/) works directly with schools to cross-pollinate ideas, methods, and technologies for pollinating insect citizen science.

The Open University is one of the main partners in a European initiative called **Cos4Cloud** (https://cos4cloud-eosc.eu/), which is developing technological services for citizen observatories for use in citizen science projects. The main focus of this project is to to improve citizen observatories by helping them to increase the quantity and the quality of observations.

DECIDE (https://www.ceh.ac.uk/our-science/projects/decide), a project based in the United Kingdom, records nature where it matters, providing tools and techniques to those who are able to go to places where there is a wide diversity of species which, until now, have been recorded less frequently.

Finally, there is a new project called **SENSE**, – Sensory Explorations of Nature in School Environments – which explores all the senses and connects them via artificial intelligence. The intention is to encourage children to share and appreciate nature around them in more depth.

Evolution Megalab is one of the first Europe-wide citizen science projects. It introduces Charles Darwin's theory of evolution to students through the observation of variants, adaptations, and distribution of snails in different locations, such as gardens and open public spaces.

EVOLUTION MEGALAB

A European project involving 14 countries. Running over 2009 and 2010, the project marked the 200th anniversary of the birth of Charles Darwin, the English naturalist (1809-1882), and the 150th anniversary of his book **Origin of the Species**, which was first published in London in 1859.
The focus of the project was a public survey of banded snails. A wide range of resources were made available to help the public get involved. At the core of the

project was an aim/scientific hypothesis to examine evolutionary responses to climate change. A website was built to make available historic records covering the period 1930 to 1980. The challenge was for people to post new data about snails which would identify places where they lived. A range of tools were developed, including quizzes, ID guides, and books with school activities. This project was supported by the British Council, whose support at the strategic level enabled it to expand to other European countries and for it to be translated into other languages.

The school activities were key to the successful engagement with the project. Tools were made available for the teachers to participate and work with their students. It had a significant media outreach, reaching more than 5 million people in the UK alone. The website had more than 71,000 hits, more than 6,000 registered users and more than 2,400 records submitted. A large number of schools, universities and scientists participated. Schools from all over Europe participated.

ISPOT: IDENTIFYING SPECIES SINCE 2009

iSpot is a citizen science platform for identifying and learning about biodiversity. One of the main functions of iSpot is allowing the user to upload a photo so that the members of the community can help identify what is shown in the image. The platform helps all types of

users – from experts to beginners – to engage with biodiversity. It was developed in the United Kingdom but is scalable and has global in coverage. Different user communities help each other with identification. Individual participation, growth and development is demonstrated through a unique reputation system.

iSpot was launched by The Open University in 2009 and continues in full operation, over 12 years later. It is intended to make it easier to identify species. This can be a challenging task, which makes it more difficult for people to engage with science and topics involving nature. It is, however, important that these topics are accessible and open to all. To build a new generation of naturalists it is necessary for young people to get involved in the practical side.

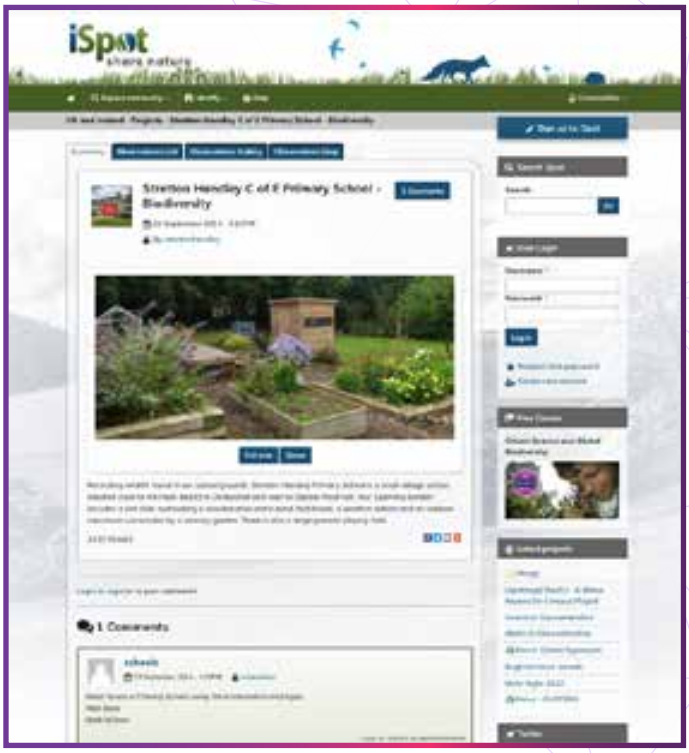
It is also important that they are involved in recording biological data, as their experience in this type of group can ensure that the species are identified and the community spirit kept alive.

The site includes various resources. Some of the most important resources are the species dictionaries, which are integrated into the site and cover both United Kingdom and international species. The website also feature innovative technology and integrated tools. A large part of the effort dedicated to the site is due to its emphasis on learning and teaching. Over the years this has been supported by joint initiative by The Open University and the BBC supporting increased engagement and learning about biodiversity, with the help of social media and activities involving schools and community groups.

The iSpot site is open for everyone to look at the latest observations, without registration.

You can click on the groups to see what is happening. Registration is essential if the user wants to help or be helped by other users. Registration also allows the user to post, to use the species dictionaries, contribute, give ideas, comment, read the comments of others, and to take part in forums. iSpot users also gain reputation points as the system monitors the user's progress in recognising species such as invertebrates, birds, fish, etc. The user can also personalise the site using filters and by grouping subjects, as well as adding resources such as quizzes, assessments, and courses.

The following is an example of how a school in the United Kingdom used iSpot, creating filters to collect and share information on biodiversity. The school set up a project to record the wildlife observed in its



Stretton Handley Primary School – Biodiversity project

surroundings. Observations are posted regularly. The slide shows an outline of the project, as well as a gallery of images with just some of the observations posted. It is an example of an effective way of cataloguing the data. The site also shows the students what is happening in the area around the school in real time.

iSpot is also integrated into a free OU course citizen science and global biodiversity, which can be a useful resource for teachers. It is free and available on The Open University's learning site, OpenLearn. Hundreds of schools, teachers and others regularly contribute to iSpot.

A LARGE CATALOGUE OF TREE SPECIES

Treezilla is another platform which has an impact. It recently succeeded in getting new funding as part of Branching Out (https://www.uktreescapes.org/projects/branching-out/) under the Future of UK Treescapes programme funded by UK Research Innovation (UKRI). Treezilla is part of an initiative supporting new ways of mapping, predicting, and communicating social and cultural values by understanding past present and future valuations.

Treezilla was developed as a platform to engage citizens in the subject of trees, becoming aware of the value of these species and providing information that can be used to monitor them.

It is one of few platforms that engages the public in recording this type of data. It also includes information from various public bodies that house data about trees. More than 1 million trees have been recorded by more than 1,000 registered users. It is used by public authorities, Tree Wardens, schools, and other organisations.

A range of resources is available on the site. The guide can be used to identify trees found in the United Kingdom.

The platform can also be used for teaching. Treezilla collaborated with the Institute for Research in Schools (IRIS) to develop opportunities for secondary school students and those over 16 from all backgrounds. IRIS Treezilla was set up with the support of the project, offering a practical way for young people to uncover the impact of climate change and make a contribution to the United Kingdom's tree canopy survey, by adding data to Treezilla.

The experience builds identification and classification skills. One of the main ideas behind the project is for the schools themselves to take on the project, adapt it as necessary and incorporate it into the classroom activities. The following is an example of how a science teacher at a girls school encouraged students to set up their own project to reduce their impact on the environment surrounding the school.

It is interesting to see how they incorporated the activity and returned regularly after normal school hours to observe the changes and map their impact. It is a practical way to apply the tools to a local situation.

Enter https://treezilla.org/. click on the filters Select Record Status and then on Excellent to see a map with species which have been recorded recently.

It aimed to bring together young people, educators, technologists, and scientists to learn about how we can protect pollinating insects. The project is run by The Open University in collaboration with partners throughout the United Kingdom.

CREATING SPACES FOR POLLINATING INSECTS

Janice Ansine also presented the X-Polli:Nation project, which focuses on the science of pollinators, that is, insects that pollinate flowers. The core idea is to improve and expand pollination citizen science tools and approaches across different geographic boundaries and stages of the actionable citizen science cycle.

It aimed to bring together young people, educators, technologists, and scientists to learn about how we can protect pollinating insects. The project is run by The Open University in collaboration with partners throughout the United Kingdom. It also operates in Italy. One partner school is the St Alban's Church of England Aided Primary School in Hampshire.

The cycle works as follows:

- learn about pollinators
- create or modify habitat in school grounds
- record data about pollinator visits

This information is shared on X-Polli using a Polli-Promise.

The X-Polli:Nation cycle works as follows: learn about citizen science, create or modify research models in the school environment and record data about the pollinators identified.

More than 2,000 schools signed up for the Polli-Promise, which enabled a little less than 5,000 m2 of pollinator-friendly habitat to be created or improved, demonstrating the power of this type of initiative. Supporting schools carried out experiments using a range of tools and resources, free courses, and materials to support learning. These are available for download on the site.

NETWORK OF OBSERVATORIES

Janice then talked about a European project – Cos4Cloud. The focus is to boost citizen science technologies to increase the spread of citizen observatories throughout Europe and the world. There are more than 15 partners in Europe and Colombia, including The Open University, which also leads a work package focused on training, education, and capacity building.

THE MAIN OBJECTIVES OF COS4CLOUD ARE:

1 

Integrate citizen science into society, using the European Open Science landscape as a framework to provide innovative services to the citizen observatories.

2 

Facilitate networking and knowledge management between organisations and people, including schools which work directly with citizen observatories.

3 

Contribute to ensuring the sustainability of the citizen observatories.

This includes how to use citizen observatories in different school experiments and an assessment process is part of this.

WHAT ARE CITIZEN OBSERVATORIES?

They are community-based monitoring and information systems which can be oriented to the environmental or biodiversity areas, using several types of devices and tools to increase engagement and participation. Their focus is on improving the management of natural resources such as flora, fauna, and land.

Citizen observatories and partners from different organisations and countries are working closely together. They include: Artportalen (Sweden), Natusfera (Spain), iSpot (United Kingdom) and Pl@net (France), all of which are focused on biodiversity. Other organisations focus on environmental quality and monitoring, such as KdUINO, for freshwater monitoring, and OdourCollect, while CanAir.io and iSpex are concerned with air monitoring.

These projects involve significant experiments in the educational sectors and some are working directly with schools. One of the project's partners, NKUA University of Athens, is working with teachers and schools in Greece to integrate citizen science and develop different approaches.

The Open University identifies opportunities for school-based learning for this scientific sector, focusing on data and research, teaching and learning, engagement and collaboration.

The training looks at how to use citizen observatories in different school experiments and include the assessment process as part of this. In the United Kingdom, experiments introduced through the work of NKUA are being included in the English-language training material. They are available in Greek on NKUA's site and resources will be made available in English on the online Toolkit that The Open University is developing, which is linked to the university's free teaching resources.

Join the Cos4Cloud community to receive updates on progress made and find out about other ways to get involved. Cos4Cloud is funded by the European Union's Horizon 2020 research and innovation programme under grant agreement no 863463.

FOCUS ON LEARNING

To end her presentation, Janice spoke of the learning design for iSpot, which is integrated into the university's citizen science project. An extract from an article co-authored by Janice some years ago sets out the key approaches:

"By focusing on learning, iSpot not only helps participants generate valid scientific observations, but it also trains them to become the biological recorders on whom future data collection will depend."*

There is a cycle, a learning curve, where people collect data, make identifications, and learn through the process. Some of the different approaches are being looked at in order to build a wider involvement and a better understanding of the learning process through citizen science, which should be available for analysis in the near future.

In summary, The Open University identifies opportunities which include school-based learning for this scientific sector, focusing on data and research, teaching and learning, engagement, and collaboration. This involves innovations, new technologies, taking on all sorts of projects (schools and community) and building collaborations to facilitate this kind of involvement, as well as creating learning opportunities and training opportunities to support teachers' activities. So that they become involved with their students, and that both take home some of these ways of working and learning, participating in citizen science for the good of the natural world.

SCIENCE AND RACIAL REPRESENTATION

Narratives in the history of science have omissions that must be addressed in curricula and classrooms

From a talk
by **Anna Canavarro Benite**

With a doctorate in Science, an M.Sc. in Inorganic Chemistry, a PGCE in Chemistry and a B.Sc. in Chemical Technology, all from the Federal University of Rio de Janeiro, Benite is currently an Associate Professor and Coordinator of the Initial Chemistry Teacher Training Programme (PIBID) at the Federal University of Goiás (UFG). She is a member of the Dandara no Cerrado Black Women's Group, coordinates the Chemistry Education and Inclusion Research Laboratory (LPEQI) at UFG and also coordinates the Goianía Interdisciplinary Group for Inclusive Education (RPEI). She is a member of the Brazilian Association of Black Researchers and the Brazilian Association of Research into Science Teaching, as well as an advisor to the Goiás State Research Funding Agency. Her interests in Chemistry Education include African culture and history in the teaching of science; the teaching of science in the African context; science teaching and special needs students; cyberculture in inclusive education; and research into the initial and in-service training of chemistry teachers.

WHEN **10/06/2021**
WHERE **VIRTUAL EVENT**
AUDIENCE **100**
PRODUCED BY **STEM Education Hub, British Council and King's College London**

Learning points

- The relationship between science, racism, and colonisation
- Does science have a colour?
- An inclusive curriculum
- A new use for palm oil
- Paths to inclusion in science teaching

Professor Anna Canavarro speaks of her work in the **Chemical Education and Inclusion Research Laboratory**, at the Federal University of Goiás (UFG), where they are examining the thesis that science as it is taught in universities reproduces the norms of society, in which scientific knowledge and modernity lead to racism and colonisation.

She relates episodes in the mainstream narrative of history of science in which recognition overlooks initiatives linked to black scholars, advocating new approaches in classrooms that embrace an inclusive curriculum capable of bringing black people, particularly black girls, closer to science learning.

SCIENTIFIC KNOWLEDGE AND OTHER OPTICS

“In a technological society such as the one in which we live, scientific knowledge is used as a validator, it has the status of truth and subjugates the other forms of reading the world”

According to Anna Canavarro Benite, the Chemical Education and Inclusion Research Laboratory sees scientific knowledge as one among other optics when reading of the world, such as religion, common sense, and traditions. From the dialogue between these visions emerges a world more integrated than that revealed only by the modern science taught and produced in university research institutes.

For Benite, modernity unveils not only the nation-state as a dichotomy between the modern and the untamed, the man and the woman, the black and the white, the colonised and coloniser.

In her view, scientific knowledge, and language – a synergistic integration of words, diagrams, and graphics – reproduce the norms of a society where scientific knowledge and modernity open the way to racism and colonisation.

SCIENCE AND REPRESENTATION

“Curricula reproduce interdiction mechanisms. What happened with the history of science, if one of the first records of the evolution of the species has colour and this colour is not the colour that appears in the curricula and is not the same as that of the universal subject?”

HISTORICAL OMISSIONS

Scientific knowledge includes studies of the evolution of species in which monkeys become white men, despite all mitochondrial studies supporting the dating of the origin of the human species leads to the conclusion that we originate from a woman, probably African, argues Benite. One of the first records supporting this reading of scientific knowledge comes from the ancient Kemet, the name originating in

Egypt (it is the Greek version of the word) which means "black land". The invention of the balance scales, an essential device in chemistry, is recognised as a great moment in the history of the subject and has been credited to the French scientist Antoine Lavoisier. However, these scales had previously been described in the mythology surrounding the black Egyptian goddess Ma'at. The "black earth" is, therefore, a record marked by colour, also by gender.

Benite believes we need to talk about this theme to give a future to black children studying in Brazilian schools. When one tells them that, in addition to a past linked to a perfidious, sordid slavery, the records of which have been deleted from history, our past includes ancestors actively investigating science and technology, we are looking forward to a future.

When examining the Solvey Conference on Physics and Chemistry in 1927, one of the first modern science meetings, what we see is the portrait of the universal subject, except for the presence of the female scientist Marie Curie. Today, 15 editions of the conference later, an image of the participants shows a steep increase in the presence of women, especially white women, who are still part of the perspective of the universal subject. What has happened to the black population, why is it not represented?

“Images of black women are invisible”

An examination of photographs of Chemistry Nobel Prize winners from 1902 to 2014 repeatedly shows the image of the universal subject. For Benite, this shows that the science which is taught has colour and gender. Science, therefore, is shown as a succession of successful facts involving white men, representing an interdiction of bodies in a country like Brazil, where most of the population is self-declared as female – black women. This discourse is repeated in the schools and results in a reasoning such as: “since I don’t see myself, I don’t buy into it, and I can’t see myself there.”

In another, more recent, example, Benite examines a study given prominence on the cover of the renowned scientific journal **Nature** that links the first humans to the African continent. The work was based on temporal markers found in the remains of the oldest humans, which generates data which dates their origin. While the celebration of the discovery is justified, Benite argues that it does not differ significantly from that of the black scientist **Cheikh Anta Diop** who, in 1979, traced the migratory flow from Africa using technological artifacts. By questioning the absence of Diop from the cover of Nature, Benite argues that there is a past in science and technology that needs to be recovered in the classroom and told to students.

CHANUTH

IN SCHOOLS THIS DISCOURSE IS REPEATED AND RESULTS IN A REASONING SUCH AS: “AS I DON’T SEE MYSELF, I JUST CAN’T SEE MYSELF THERE.”

Along the same lines, Benite argues that it is important not to accept certain pathogenics as innate to the Brazilian black population, which has a much lower life span than the white population. Many diseases, such as hypertension and diabetes, are due to the social condition of black people in Brazil, with lower-paid jobs and long working hours, housing in under-resourced districts, with a lack of access to basic health and education and poor eating habits. These are the factors that explain the lower life span.

ACADEMIC INEQUALITY

"Science is increasingly disconnected from reality. Even before the pandemic, science had already produced few responses, it had very little dialog with the population."

Productivity time, the time that should be optimized over a number of products.

The distribution of research grants in Brazil shows that black women, a segment which, according to Benite, interests her, "especially because I am part of it", are the beneficiaries of 31.6% of the grants distributed, a proportion which decreases as we progress up the career hierarchy, where the proportion of black women scientists receiving research productivity grants, the main funding source for senior researchers, is considerably lower. This logic of production is marked by the logic of meritocracy, which establishes mechanisms of competence, time served and competitiveness, is therefore inefficient, according to Benite. .

In another indicator of academic inequality, recent research in Brazil produced a word cloud highlighting the expectations of black scientists and white scientists. A comparison between them reveals that in the case of black scientists, the prospect is always one of difficulty, of a conquest, of a challenge to be overcome. The white scientist, the universal subject, is always associated with normality, technologies, the expectation is that they will have a successful career.

MORE INCLUSIVE CURRICULA

“When it comes to innovation, what is required is a science that does not exclude the labour, intelligence, and creativity of more than half the population”

Technological and scientific development are fundamental to national sovereignty. When a curriculum excludes the ability of some, the future of students in the classroom in this nation is impoverished. More than half of the Brazilian population is being excluded from technological discovery, and that is why we talk of a curriculum that is inclusive of the contribution of researchers and researchers of an African background, especially those from the African diaspora.

AN OPEN DOOR FOR BLACK GIRLS IN SCIENCE

It is from these concerns identified by Benite that the **Investiga Menina!** (Investigate, girl), scheme came into being. It is a weekly classroom-based educational support programme established in 2016. It is the result of collaboration between a black feminist arm of the social movement Dandaras do Cerrado, an NGO for black women in which Benite is an activist, the UFG, and the Sólion Amaral State High School, a secondary school with 1,500 students in a socially deprived district in the city of Goiânia. It serves an area of 40 km2 situated between the university, the poor outskirts of the city, and the NGO. Its goal is to encourage black girls to pursue careers in the STEM area.

Once a month, Investiga Menina’s partner schools host scientists from within and outside the state to speak about their research. As an example, instead of teaching particle physics by listing the historical achievements of white men by date, the first female Brazilian Harvard-graduate physicist, who works with national sovereignty technology – missile-head laser guidance – talks about particle physics using her research into semiconductors as the starting point. She has already been part of the programme for 15 years. Now girls who studied at the high school are accepting invitations to come back and speak about their own experiences as scientists.

"The school curriculum is a legal obligation of the state and is, above all, a mark of the dispute for state power in all spheres. But we build our own curriculum for the STEM area, based on the expectations of girls. We examine black identity, the chemistry of strands of hair, makeup and sunscreen for black skin, and nutrition."

BLACK CULTURE DRIVES SCIENCE

Benite finished by speaking of another example of her work to encourage a more representative curriculum: the use of palm oil as a case study in general chemistry classes for the engineering undergraduate course at UFG.

The oil palm is a sacred fruit for the oracular religions of African origin. Benite explains that the fruit did not originate in Brazil and arrived in the country not as a dietary element of enslaved Africans, but to increase the value of black bodies in the slave trade market, used as a lubricant to give these bodies a healthier appearance. "Not only do we exploit these arriving bodies, but we also grant their descendants a subservient future ", she says.

According to Benite, 46% of the population of Goiás self-declares as black. Indeed, unlike what some may believe, the state's largest expression of popular culture is a black traditional festival, the congada, and not the sertanejo (country music) festival, she explains. There are a huge number of candomblé terreiros (spaces for the sacred practices of the religion) in the state, its adherents being considered a traditional community for the respectful way with which they relate to nature, and other aspects.

PALM OIL IS COLLECTED IN PLANTATIONS AND USED TO REABSORB METALS USED IN CHEMICAL PROCESSES

It is in this context that Benite started to collect the fruit in terreiros and use them in the classroom. "We collect and extract the pulp from the shell of the fruit, which is very rich in lignin and highly absorbent". She explains that the product is used to absorb and recover metals used in chemical procedures. Instead of sending the waste from the classes to the incinerator, or selling it for use in recovering these metals, the classes themselves carry out the procedure. Benite also points out that a patent application has already been filed for the pulp-based metal recovery route. She goes on to say that the use of palm oil has become a way of highlighting not only knowledge of the diaspora, but of its practice. In addition to an epistemology that is markedly white, it is placed in a more respectful relationship with nature and with people who are part of the educational area.

"If there had been racial quotas (for university entrance) at the time I studied, if I had studied with a black teacher, I would probably have reached positions which I haven't reached, because I have yet to encounter my peers. Today we have the chance to do this within the schools."

FROM STUDENTS TO SCIENTISTS

"The search for a more significant curriculum, especially for the black population of Brazil, requires action on several fronts"

TO LEARN MORE

Access the panel **Cientistas Insubmissas**, and meet the black Brazilian scientists who work with **Investiga Menina!** and collaborate to uncover a past in science and technology of the people of the diaspora. See also Tia Ciata.

COLONIALISM AND SCIENCE EDUCATION

Science teaching has much to gain if it adopts a more critical stance, inspired by Paul Freire's concepts

WHEN **10/06.2021**
WHERE **ONLINE EVENT**
PRODUCED BY **STEM Education Hub, British Council and King's College London**

Learning points

- Paulo Freire and colonial perspectives
- Global North and Global South
- Coloniality
- Epistemic injustice
- Science and traditional curricula

From a talk
by **Haira Gandolfi**

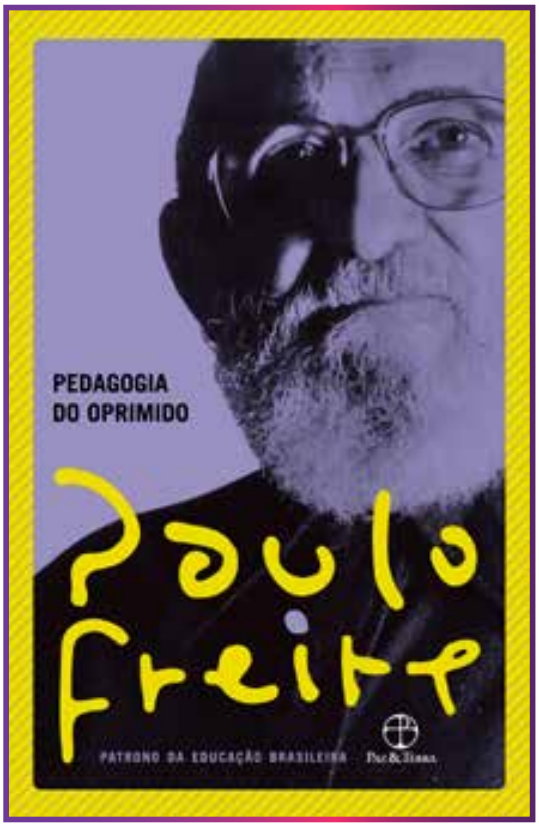
A University Lecturer at the University of Cambridge, United Kingdom, Haira Gandolfi has a Ph.D. in Education (Teaching of Sciences) from the Institute of Education - University College London. M.Sc. in Science and Mathematics Education from the State University of Campinas (Unicamp), São Paulo. Her experience includes lecturing on technical courses in Chemistry and Environment at the Paula Souza Technological Education Centre (Ceeteps) and as a Chemistry teacher at the Technical College of Campinas/ Unicamp. She has a B.Ed. in Chemistry and a B. Sc. in Technological Chemistry from Unicamp, including an exchange year at the Universidad de Córdoba, Spain. Her professional and academic career in chemistry is concerned with the teaching of science, the teaching of chemistry, the history of science, analytical chemistry and food science and technology.

Haira Gandolfi's raw materials are the intersections between Paulo Freire, critical pedagogies, coloniality and science education. Her career has taken her from Unicamp in the city of Campinas, São Paulo, to the University of Cambridge's Faculty of Education, where she is a lecturer. Her doctoral project is based on a perspective which looked from the Global South to the Global North.

According to Haira, one of her greatest challenges is to be working in an institution that is the cradle of many colonial projects, where many spaces, names and stories are founded on a colonial project. "The legacy is always present, throughout the university," she says. "There, talking about colonial studies may seem extravagant, given that the view of coloniality that emerged with **Rhodes Must Fall**, the 2015 movement, is something very new in the Global North, but in the Global South this discussion has been going on for some time."

Haira explains that the theme has been on the agenda since the 20th century in the United States, also part of the Global North, where critical pedagogies and Paulo Freire have been known for some time, especially in the context of counter-culture, anti-racist struggles, civil and decolonial rights, with the schools of the Black Panthers in Oakland, or with the writings of intellectuals such as psychiatrist and philosopher **Frantz Fanon**, the historian and activist **W.E.B. Du Bois** and feminist activist **Bell Hooks**, who died recently. According to Haira, Hooks identified points in common with Paul Freire's thinking in an attempt to defend against segregation in the United States.

In the Southern Hemisphere, Haira identifies similarities in the inspiration in Paulo Freire of the Movimento sem Terra (Landless Movement) schools in Brazil, in the work of South African activist **Steve Biko** and in anti-apartheid schools in South Africa, or in Lumad schools in the Philippines. All, in some way, also deal with colonial thinking and critical pedagogies, somehow alluding to ideas contained in the book *The Pedagogy of the Oppressed*, by Paulo Freire, in particular the **banking concept of education**.



PAULO FREIRE AND COLONIALITY

According to Haira, Freire's concept of a fragmented vision of reality is powerful and, in some way, very similar to the ideas about coloniality discussed today.

According to her, students in schools around the world only have access to a partial view of ways to understand reality. And because they do not have access to a wide variety of knowledge they do not engage more significantly with this reality. The notion of knowledge is where Paulo Freire and coloniality can unite in different ways, including in terms of scientific education.

“The critical reading of reality, the idea that building knowledge is not just about facts – which we find in the curriculum and especially science – but about understanding the norms, values, and interests underlying what we call facts.”

Haira argues that it is not the case of denying science or knowledge, but of seeing differently, understanding what is behind it. “When Paulo Freire brings us the concept of **awareness**, it is a deep understanding of how the world works, how the more people understand this challenging reality, the more critically they can enter this reality.”

Fragmentation and partial access to understanding reality, understanding how the world works, how standards, values and interests, all reinforce the idea that knowledge has a historical and social context of production. The critical reading of reality is somehow associated with colonial studies, for example, when they bring the idea of visibility or invisibility, with the obscuring of certain contributions and realities. From the Portuguese colonial perspective, only the colonisers had a history, beginning with their ‘civilising’ arrival and presence. Only the colonisers had culture, art or language, and they were civilised citizens. In a way, Haira argues, Paulo Freire is an inspiration for colonial studies.

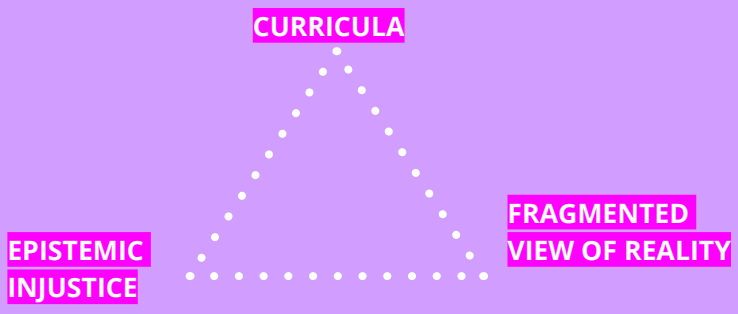
SCIENCE EDUCATION

When we talk about the historical social cultural context of knowledge production, this also affects science education. STEM curricula do not escape what we call epistemic injustice or a fragmented vision of realities, the result of the production of scientific knowledge based on complex links between different groups, with historical and social bias.

For Haira, it is not enough to understand, it is also necessary to deconstruct the traditional narratives about the development of scientific and technological knowledge and to reconstruct their plurality, casting light on cultural and social trajectories that have been erased, which are complex, involve interesting and also oppressive stories, in the midst of colonial projects.

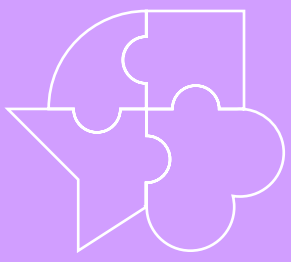
PRODUCING KNOWLEDGE

Situation



Paths

Deconstruct traditional narratives about knowledge



Reconstruct plurality

Throw light upon cultural and social trajectories that were erased

"This Is the case of recognising that the science we talk about, which we teach, the technology we teach, mathematics, all were built in intercultural, sometimes oppressive, sometimes non-oppressive encounters, but most of the time of an oppressive nature."

"Science itself was built on a global repertoire of wisdom, information, and living specimens and materials collected from various corners of the colonial world. The extraction of raw materials from mines and colonial plantations went hand in hand with the extraction of scientific information and specimens from colonised peoples."

Rohan Deb Roy, 2018

According to Haira, the teaching of science must incorporate questions concerning coloniality, the fact that it results from a meeting between cultures, which was partly erased, with merit only given to the tales of the coloniser. For her, science was built from a global record of information on specimens and materials extracted from various corners of the colonial world, Latin America, and many countries of the global south. When studying history, it is possible to understand colonial legacies, but it must also be understood that it is not only about history and geography – it also involves science. Science education needs to make it explicit that science was built through these intercultural encounters.

SCIENCE EDUCATION IN THE GLOBAL NORTH

Haira explains that part of her work in the UK is directed at science teachers in secondary schools, bringing discussions about how science works in scientific development through a decolonial lens into the national curriculum, focusing on very traditional curriculum topics in England, such as medicine, magnetism, evolution and biodiversity and natural resources, among others, trying to uncover the hidden stories of scientific development. Her work focuses on the 11 to 13 age

group, "because they are not yet oppressed by the UK education evaluation system."

In the Global North, how to approach these legacies by speaking to white, British teachers – in some places in England there are many multicultural schools, but the teaching professionals are predominantly white, generally working with multicultural students. How to establish these connections?

According to her, this situation leads to the following thought: Even in the Global North, even far from indigenous communities, even living in places far from environmental disasters, how can we deal with these issues if we cannot see these oppressive situations closely? Lives in the Global North still depend on natural resources coming from the exploitation of cheap labour in the Global South. So how can we understand the global situation of oppression created by living in neoliberal capitalist societies, in some cases very rich? What are the connections between these students and teachers and what happens in the Global South?

"As a chemist, I am always thinking about natural resources and their exploitation. What are the connections between the colonial history of the exploitation of natural resources and what we have today in Brazil in terms of technological development?" she asks.

“Environmental justice issues and scientific education must go together.”

QUESTIONS ABOUT SCIENCE IN TRADITIONAL CURRICULA

Darwin

“Why was Charles Darwin able to travel around the world at that time collecting specimens which became the basis of his Theory of Evolution? What was he doing in South America? What allowed him to be able to travel like this, who supported his voyage financially? What was the cultural and social context?”

Metals and chemistry

“South Asia has a legacy of extensive metal production and development. In the history of South America and Latin America, there is a strong tradition of exploitation of natural resources. This is the history of our chemistry in South America. States were named after mines, universities were created around them. There are cobalt mines in Africa: Why there and why in those conditions? What drives this and what drives technological developments today. Science education needs more than ever to talk about it.”

Geopolitics and neocoloniality in the natural sciences

“Many people speak of the natural sciences and nature as something universal, which always apply equally, and all knowledge is the same. We also talk about socio-scientific issues from the point of view that they are very specific. These traditional concepts in the application of science need to be rethought, taking into account the idea of citizenship, scientific injustice, and environmental injustices.”

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