

# Art, science education, and politics: plural dialogues

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## **Abstract**

This article sheds light on the relationship between art, education, and politics, focusing on non-formal education actions in the area of scientific dissemination, where the interest for dialogue between art and science is growing. An intertwining of various fields of knowledge poses specific challenges, arranged in multiple layers. Either those related to the status assigned to each field and the consequent influence on policies deployed for them or pedagogical strategies, which should be designed in order to consider their own alphabets in each area at stake; or also to the fact that we live in an age when the dominant paradigm is the scientific one. The background for the discussion proposed here consists of activities conducted by the 'Spaces of Science' linked to the Foundation Center for Science and Distance Higher Education of the State of Rio de Janeiro (Fundação Centro de Ciências e Educação Superior a Distância do Estado do Rio de Janeiro – CECIERJ). It was found that combining art and science can contribute to understanding affections, disaffections, emotions, historical principles, social motives, political interests, partisan inclinations, and so many other determinants of knowledge production.

**Key words** art; science; democracy; scientific dissemination; scientific education.

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## Arte, educação científica e política: diálogos plurais

### Resumo

Este artigo lança luz sobre a relação entre arte, educação e política, enfocando ações de educação não formal na área de divulgação científica, onde o interesse pelo diálogo entre arte e ciência é crescente. O entrelaçamento de diferentes campos do conhecimento propõe desafios específicos, dispostos em múltiplas camadas. Sejam aqueles relacionados ao *status* atribuído a cada campo e a conseqüente influência nas políticas implantadas para eles ou às estratégias pedagógicas, que devem ser concebidas de modo a considerar alfabetos próprios a cada área envolvida; ou, ainda, ao fato de vivermos em uma época na qual o paradigma dominante é o científico. O pano de fundo da discussão aqui proposta consiste em atividades desenvolvidas pelos “Espaços da Ciência” vinculados à Fundação Centro de Ciências e Educação Superior a Distância do Estado do Rio de Janeiro (Cecierj). Constatou-se que combinar arte e ciência pode contribuir para o entendimento de afetos, desafetos, emoções, princípios históricos, razões sociais, interesses políticos, inclinações partidárias e tantos outros determinantes da produção do conhecimento.

**Palavras-chave** arte; ciência; democracia; divulgação científica; educação científica.

## Arte, educación científica y política: diálogos plurales

### Resumen

Este artículo arroja luz sobre la relación entre arte, educación y política, enfocando acciones de educación no formal en el área de divulgación científica, donde el interés por el diálogo entre arte y ciencia está creciendo. El entrelazamiento de varios campos de conocimiento plantea desafíos específicos, organizados en múltiples capas. Ya sea los relacionados con el *status* asignado a cada campo y la consiguiente influencia en las políticas implementadas para ellos o las estrategias pedagógicas, que deben diseñarse para considerar sus propios alfabetos en cada área implicada; o también al hecho de que vivimos en una época en que el paradigma dominante es el científico. El trasfondo de la discusión que se propone aquí consiste en actividades realizadas por los “Espacios de la Ciencia” vinculados a la Fundación Centro de Ciencias y Educación Superior a Distancia del Estado de Río de Janeiro (Fundação Centro de Ciências e Educação Superior a Distância do Estado do Rio de Janeiro – CECIERJ). Se constató que combinar arte y ciencia puede contribuir al entendimiento de afectos, desafectos, emociones, principios históricos, razones sociales, intereses políticos, inclinaciones partidistas y muchos otros determinantes de la producción de conocimiento.

**Palabras clave** arte; ciencia; democracia; divulgación científica; educación científica.

## Art, enseignement scientifique et politique: dialogues pluriels

### Résumé

Cet article met en lumière la relation entre art, éducation et politique, en mettant l'accent sur actions d'éducation non formelle dans le domaine de la diffusion scientifique, où l'intérêt pour un dialogue entre art et science grandit. L'entrelacement de différents domaines de la connaissance pose des défis spécifiques, organisés en plusieurs couches. Soit ceux liés au *status* attribué à chaque domaine et à l'influence qui en résulte sur les politiques mises en œuvre pour eux ou sur les stratégies pédagogiques, qui devraient être conçus de manière à prendre en compte leurs propres alphabets dans chaque domaine concerné; ou au fait que nous vivons à une époque où le paradigme dominant est le scientifique. La base de la discussion proposée ici est constitué d'activités menées par les « Espaces Scientifiques » liées à la Fondation Centre pour la Science et l'Enseignement Supérieur à Distance de l'État de Rio de Janeiro (Fundação Centro de Ciências e Educação Superior a Distância do Estado do Rio de Janeiro – CECIERJ). Il a été constaté que la combinaison des arts et des sciences peut contribuer à la compréhension des affections, des désaffections, des émotions, des principes historiques, des raisons sociales, des intérêts politiques, des inclinations partisans et de tant d'autres déterminants de la production de connaissances.

**Mots-clés** science; démocratie; diffusion scientifique; enseignement scientifique.

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## Introduction

In Brazil, *arts education* is provided for in the National Curriculum Parameters for Art (Parâmetros Curriculares Nacionais de Arte – PCNs) and it should take place from Elementary School, not necessarily focusing on the learning of technical skills, but also contributing to citizen’s comprehensive education and to the understanding of artistic ways of various natures and peoples. Purposes such as encouraging creative readings of the world, as well as the perceptive sensitivity and awareness of the social dimension of arts meet the goals listed in the PCNs. It is worth highlighting in the proposition the formulation of 3 axes: a) production, which involves the suggestion of techniques, themes, and availability of materials; b) fruition, which links the contextualization of works, the understanding of their levels of difficulty and appraisal; and c) reflection, which may be understood as the building of knowledge generated through artistic work.

However, in practice, given the Brazilian reality and the state of the art as a field of knowledge, it is not an easy task to make the precepts of the PCNs come true, either in the formal education context or in the initiatives developed in the domain of non-formal education. Only with Lei n. 5.692 (Lei de Diretrizes e Bases [LDB], 1971) art was included in the school curriculum as ‘educational activity.’ Music became a mandatory subject in the 1990s and only in 2016 did theater, visual arts, and dance enter the primary education curriculum as mandatory subjects. This was a major breakthrough. The obligation contributes to consolidate, little by little, the understanding that the contents of arts are indispensable and crucial for the individual’s overall education.

In turn, in the field of non-formal education there is, increasingly, an association between art and science, especially in scientific dissemination actions, which may be easily found in science centers and museums or in public squares, during thematic events such as the National Science and Technology Week (Semana Nacional de Ciência e Tecnologia – SNCT) and even at schools. As a matter of principle, these actions have as their main goal to make themes and contents related to various sciences palatable to a non-specialized audience. Therefore, it is necessary to dialogue with different languages so that the scientific discourse can be presented in an understandable and attractive way to those who are not fully familiar with the science area. In this direction, multiple forms of art have been explored, such as theater performances, videos, and movies whose themes deal with topics related to the world of science or the biography of scientists, as well as exhibitions that use visual arts, like painting or drawing.

In the scenario where many knowledge and human action areas are exchanged, with distinct characteristics, even considering the many points of contact and the affinities between them, confrontations multiply, focusing the analysis on issues of several categories. Each field of knowledge instills its a mythology of its own, it uses typical signs, explores

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specific operating ways, and proposes questions inherent to its respective study objects. Thus, tensions and sometimes misunderstandings and stereotypes are created that need to be discussed and eliminated, in order to constitute the basis for plural educational processes.

## **The classroom, other places to learn in, art and science**

Learning is an uninterrupted process that occurs throughout life. Either on school benches or on the benches of bars, trains, or households, we learn something every day. The school is one of the sites where we can learn. Learning processes take place at different levels, spaces, and modalities, and such differences should not be ordered on a supposed hierarchical scale. There are several ways to learn and teach that may be complementary, something which does not mean there is sometimes no incompatibility and conflict between them. Some denominations appear in an attempt to categorize things. The so-called 'formal education' is characterized by unfolding in a very structured way, in which a pre-established program follows and where certification is available. Moacir Gadotti (2005, p. 2, our translation) clearly delimits:

Formal education has clear and specific goals and it is mainly represented by schools and universities. It depends on a centralized educational guideline such as the curriculum, with hierarchical and bureaucratic structures, determined at the national level, with oversight agencies of the ministries of education. Non-formal education is more diffuse, less hierarchical, and less bureaucratic. Non-formal education programs need not necessarily follow a sequential and hierarchical "progression" system. They may be of variable duration, and may or may not grant learning certificates.

However, in the quest to define 'non-formal' and 'informal' education, delimitations do not seem so obvious. Maria G. Gohn (2006, p. 28, our translation) explains that often the term non-formal is used by some researchers as a synonym for informal:

We think that it is necessary to distinguish and demarcate the differences between these concepts. At first we can demarcate their fields of development: formal education is that unfolding at schools, with previously demarcated contents; the informal as the one that individuals learn during their socialization process – in the family, neighborhood, club, with friends, etc., loaded with values and cultures of their own, inherited belonging and feelings: and non-formal education is what one

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learns “in the world of life,” saw the processes of sharing experiences, especially in everyday collective spaces and actions.

In an attempt to better demarcate the differences between the education modes, the author goes on to ask who would be the educator in each education field we analyze; where we educate and what would be the territorial space in which the educational acts take place. The questions contribute to pointing out clues that explain differences, but, nonetheless, in relation to non-formal and informal education, there is also a certain degree of dubiety. This study does not aim to deepen the terms that designate different education modes. We seek to discuss the interaction between artistic language and scientific dissemination, which, according to Gohn (2006), may be characterized as non-formal education.

Also in the education field, Freire (1983) postulates that, in a strict sense, no one educates anyone, reaffirming the conviction that it is indispensable to create conditions that favor learning and that such conditions will be more favorable insofar as the person is more capable of looking and to constructing, having her/himself as a basis, the conditions more suited to her/his learning mode and rhythm. It is not a matter of disregarding the external structures and the concrete agents as necessary to make education possible as a public and social project, but we emphasize here the view of Freire (1983) in terms of the need to look into ourselves, as a condition to grasp how educational processes are triggered. Freire (1983, p. 27, our translation) stated: “let us begin by thinking of ourselves and trying to find, in the nature of men, something which can be the crucial nucleus in which the education process is sustained.”

According to Freire (1983), educating implies a route in which a human being must be the subject of her/his own trajectory, and not an object of it. Hence the idea that nobody educates anyone. If we take the words of the author from Pernambuco as a basis, the discussion about learning cannot do without reflection on the emotional factors involved. The questions to be asked are:

- Since emotion must be included in the learning process, when thinking about subjects like science, for instance, how could we conjugate affections and contents?
- How could we stimulate the joy of learning in the midst of so much seriousness, a characteristic of already stigmatized scientific discourses, in spite of some recent initiatives of translation through rather friendly means?
- What may be the possible ways?

## **Art and science education**

Artistic language is, potentially, endowed with the ability to arouse enjoyment, evoke emotions and entertain, which in turn are qualities of extreme importance for educational

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processes. The U.S. psychologist Carl Rogers has dedicated himself to psychopedagogy and his work emphasizes the importance of a globalizing approach that includes feelings and intellect for the promotion of more lasting and comprehensive learning. On this point, in agreement with Rogers, Marco A. Moreira (1999, p. 144, our translation), who devoted himself to the investigation of learning theories and teaching methodologies, explains:

[...] effective learning refers to the person who gets fully involved by her/himself. It is not just a cognitive, “neck up” learning. It is a learning that involves both the cognitive and affective aspect of a person, it is “visceral,” deep, and comprehensive.

Thus, arts associated with science education processes can greatly contribute to deconstructing stereotypes, stigmas, and reductionist views about scientific practice. However, in the mistaken supremacy of the ‘scientifically proven,’ we must take care not to regard arts as a mere tool to convey contents of science, at the risk of diminishing the two. The interaction between art and science will be so much more beneficial insofar as it relies on the dialogue of excellence between the multiple forms of knowledge and the understanding that both constitute points of view and forms of expression. From this perspective, Lopes (2018a, our translation) analyzes:

Like Science, Art is a way of seeing, anticipating, and inscribing. It is an indispensable means to see solutions in an increasingly complex, hostile, and conflicting environment. Feeding the false incommunicability between them, rather than a mistake, is contributing to an unequal society, in which one does not recognize her/himself in the plurality of knowledge, a powerful ally for a full reading of a world so diverse, rich in meanings, and changeable.

The capital question that emerges in face of the proposition of combining forms of knowledge in favor of a pedagogical goal is:

- How could we translate into practical actions the interaction of various knowledge areas, in order to preserve the specificities and not to subjugate one another?

It is a challenge to be understood and faced, which is unfolding in so many others, which has been tackled when planning activities of the Spaces of Science (Espaços da Ciência – ECs) linked to the scientific dissemination sector of the Foundation Center for Science and Distance Higher Education of the State of Rio de Janeiro (CECIERJ), detailed below. First, however, it is necessary to contextualize the scenario in which such actions

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are inserted, since the ECs are established in a larger universe of initiatives aimed at the popularization of knowledge.

## **Art and science in museums and science centers**

The dialogue between art and science has been increasingly explored both in terms of scientific dissemination and in the science education field. The initiatives include different various artistic languages. Science centers and museums are loci where non-formal education is dominant, and often give rise to points of convergence between amateur artists, scientists, museologists, and curators of scientific exhibitions that play the mediating role of the artistic creation process, as indicated by Agostinho e Casaleiro (2015), when referring to the “CosmoCaixa” Museum in Barcelona, whose curator, Jorge Wagensberg (2006), a Catalan physicist-museologist, has coined the concept of *total museology*.

In his conceptualization, Wagensberg (2006) organized science exhibitions that sought to integrate elements based on a set of assumptions in which art and science might occupy two different poles in relation to the way how they operate, but which might dialogue harmoniously in the museological exposition. In the Brazilian scenario, among the actions that aim at the dialogue between art and science, we highlight theater, with more than a dozen scientific institutions (L. M. Moreira & Marandino, 2015) dedicated to the development of activities, among the production of skits, theatrical mediations, and even regular seasons of shows (Gardair & Schall, 2009). “Cultural and Educational Catavento” [Catavento Cultural e Educacional], “National Historical Museum” [Museu Histórico Nacional], “Museum of Life” [Museu da Vida], “Seara of Science” [Seara da Ciência], and “Museum of Science and Life” [Museu Ciência e Vida] are some of the entities that promote multidisciplinary actions involving theatrical language.

There are also actions that associate music and scientific themes, which explore, for instance, aspects of entomology through a repertoire of Brazilian popular music (música popular brasileira – MPB) songs. In this case, the compositions are a starting point for discussing concepts, relationships, and stereotypes about the role of insects in nature and the lay population’s view on small animals (Serpa, 2016). It is also worthy noticing the project “Cyclophonica” – a moving bicycle orchestra, led by Leonardo Fuks, in which music is related to optics concepts.

Science fiction, comics, literature, and cinema have also been getting closer to science. From the early Brazilian comic book initiatives, exploring the scientific universe, such as those developed by Leopoldo De Meis and Diucênio Rangel (1998), to the “Science Comic Strips” [Cientirinhas] by Luiciano Queiroz and Marcos Merlin, produced since 2016 (Caires, 2019), is invested in the combination of visual and textual language and scientific content, aiming to popularize contents and entertain. In the world of literature, the iconic Mary

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Shelley's story, "Frankenstein or Modern Prometheus," is regarded as the first science fiction work. In the plot, Lopes (2018b) observes, "responsibility in the application of knowledge, intellectual arrogance and pride or even excess knowledge, are among the questions raised by the book that has been read over generations for two centuries." Science fiction also extends to the cinema, an art with which science and technology have a special relation:

If we think about the relation between technology and cinema, we may claim that this is an art that only became possible through the development of technological equipment that involves from photographic resources to sophisticated up-to-date projection equipment. Technology in the film industry directly influences the big screen language. Image sonication is an example of this influence, as well as the advent of colors, the visual effects provided by computer graphics or the production of screens that generate the 360-degree illusion (Lopes, 2005, p. 403, our translation).

The history of cinema can be told through the search of human beings to reproduce image in dislocation. Twelve thousand years ago, cave paintings represented animals with 8 legs, in an attempt to illustrate movement. From the primitive interest, the modern man sought to create mechanisms of sequenced presentation of images to produce the sensation of static engravings' movement. In 1833, the British man W. G. Horner conceived the zootrope, an apparatus based on circular succession of images that, when rotated, gave the optical illusion of continuous movement. Between 1876 and 1877 Charles-Émile Reynaud, a professor of science and a French painter, presented the praxinoscope, an invention that performed the same process of animation perception obtained by the zootrope, but replacing the holes with small mirror strips.

Little by little, the equipment was improved until Reynaud conceived the optical theater, a device that combined mirrors and lenses, allowing the projection of complex animations, at a frequency of 15 frames per second, with an average duration of 15 minutes. The *pantomimes lumineuses*, as the presentations were named, reached success with the audience, with crowded exhibition room. The Optical Theater reached an audience of more than 500 thousand spectators. However, it was a handicraft and exhaustive process, and it was necessary to color thousands of sequential images, one by one, in order to consider the synchronicity with the stories' soundtrack, orchestrated live.

It was with the cinematograph, patented by the Lumière Brothers, in the late 19th century that it became possible to film and project scenes on a larger scale. At first, the cinematic technology was limited to the recording of everyday life scenes and the audience's relations to the novelty that registered reality were, naturally, quite different from the current ones in 1895. The low literacy rates, low schooling, and poor understanding



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of the laws of optical physics brought an atmosphere of magic and creed to the cinema. The audience was stunned by the images projected.

When the movie *Arrivée d'un train en gare à La Ciotat* was exhibited, the audience followed the arrival of a train at the station and the disembarkation of passengers. On occasion, part of the audience ran towards the back of the room, fearing to be hit. Those who were filmed waved at the camera. In the brief 60-second duration of the precursor movie, there was no awareness of the coming revolution, in which art and technology were intertwined. At that moment, the nature (or status) of art was not even assigned to cinema.

While the Lumière Brothers learned to explore the new technical-scientific product, Georges Méliès used the 'filming machine' having his experience as a magician and theater director as a basis. Thus, he produced in 1902 the first movie with scenes and dramatic expression. The 12-minute short film, *Le Voyage dans la Lune*, was inspired by one of Jules Verne's novels and it is considered the first science fiction movie. In it appeared the first representations of scientists on the big screen. Since then, the scientific world has been explored in different ways and in dialogue with different periods, because, as Ferreira (2010, p. 265, our translation) observes, "the work of art translates historical conflicts and the political, moral, or epistemic problems of its time."

In the pedagogical actions linking science and cinema, programs such as "VerCiência," an international cinema show on TV, which aims at stimulating the dissemination of scientific culture through different audiovisual technologies, and the "CEDERJ Cineclub Scientific Show" [Mostra Científica do Cineclub Cederj], mainly developed in the SNCT editions. It is a movie exhibition program in the countryside of the State of Rio de Janeiro and in its capital city. The main goal is stimulating the taste for the cinematographic art and the critical eye regarding the arts. The collection consists of titles of varied styles, genres, and epochs.

It is worth highlighting that not all technological production is a fruit of scientific research, but, usually, both are interconnected. In the case of cinematographic language, in addition to the fact that its birth was triggered by technological advances, it has been a vehicle for scientific themes, as well as a way of presenting biographies of characters of science, and it has proved to be an excellent stimulus for the debate on scientific making in a humanized way, contextualized and in dialogue with its time, as corroborated by Oliveira (2006, p. 141, our translation):

Movies express the view not only of the people involved in its assembly, but, indirectly, reveal the imagination of its spectators, because before even contributing to the formation and reinforcement of cultural habits, the production of a certain movie takes into account the view of its target audience, its universe of references, knowledge, and expectations. In this sense, they reveal, more than other artistic productions like a book or a painting, the look of an era or a society.

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In the field of visual arts, a good example of an association between science and art are the exhibitions of the Brazilian Candido Portinari, who left a vast collection of works. Some of them are portrayed in the exhibitions “Portinari: Art and Science” [Portinari: Arte e Ciência] (O Projeto Portinari, 2016) and “Portinari: Art and Environment” [Portinari: Arte e Meio Ambiente] (Casa da Ciência, 2018).

The first one consists of 14 modules, which include 30 replicas of Portinari’s works associated with a set of art, science, and education activities, which include resources and strategies, such as: scientific experiments, art workshops, games, computing, illustrative panel, etc.

The second one gathers digital replicas of 28 works by the painter from Brodowski, São Paulo, Brazil, in which images of Brazilian landscapes, flora, and fauna, crops, and men were selected, constituting an exhibition that, besides showing the artist’s work, aims to thrill and engage visitors, mobilizing them and, through art, awakening them to the importance of turning the world into a space where brotherhood among men is dominant.

This exhibition was organized on the occasion of the United Nations (UN) Conference on Sustainable Development, the Rio+20 (Comitê Nacional de Organização Rio+20, 2011), to join a set of activities to popularize science during the event. The two exhibitions traveled to various science museums, where it was possible to explore interfaces and conduct related activities, such as origami and drawing workshops, providing visitors with the opportunity to exercise and express their creativity, contributing to grasp, in a playful way and through art, scientific aspects. In this way, it was possible to establish relations between Portinari’s works and scientific phenomena, both concerning the pictorial techniques used by the artist and the elements represented in the works, although not necessarily the painter has considered such relations in the original conception of his paintings.

It is also worth mentioning the exhibition held at the Museum of Life, named “Body in African Art” [Corpo na Arte Africana] (ERA Virtual, 2010), whose objects collected by researchers from the Oswaldo Cruz Foundation (FIOCRUZ) who were on a mission in Africa were gathered in 5 modules that addressed the body from various perspectives, namely: a) “Individual Body & Multiple Bodies” [Corpo Individual & Corpos Múltiplos]; b) “Sexuality & Maternity” [Sexualidade & Maternidade]; c) “Body Modification and Decoration” [A Modificação e a Decoração do Corpo]; d) “The Body in Object Decorating” [O Corpo na Decoração dos Objetos]; and e) “Máscaras como Manifestação Cultural” [Masks as Cultural Manifestation]. In this case, the interaction of visual arts resources with anthropology and history – sciences categorized as human and social – is emphasized.

Size is the interest for the conjunction between art and science in the area of scientific education that there are proponents of agglutinating the 2 fields, creating a third and adopting a single term: *ArtScience*. In a manifesto, 4 U.S. authors (Root-Bernstein, Siler, Brown, & Snelson, 2011) postulate principles for synthesizing modes of operation for artistic

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and scientific research and expression, merging subjective, emotional, objective, rational faculties, etc. In Brazil, the term was translated as *CienciArte*. On this aspect, one of the pioneers in the study of this approach, Araújo-Jorge et al. (2018, p. 26, our translation), explains:

CienciArte incorporates the convergence of artistic and scientific processes and skills, and not the convergence of its products. CienciArte is not Art + Science or Art-and-Science or Art/Science, in which the components retain their disciplinary distinctions and compartmentalization. CienciArte transcends and integrates all subjects or forms of knowledge.

However, in practice, the interaction between science and art offers some challenges, since it involves two broad fields of knowledge, which are subdivided into others and apparently are very far from each other. Charles Percy Snow's lecture at the Cambridge University, in 1959 on what he called 'the two cultures,' is a reference for discussing the relations between the areas at stake here. In his speech, he vehemently criticized the split between humanities and natural sciences, warning of the mutual forms of prejudice faced by himself, as he traveled across multiple areas and advocated a better communication between the 'two cultures.'

## **Concretizing relations and public policies: the Spaces of Science linked to the CECIERJ**

At the present time, day by day is crossed by sciences and technologies. At all times, important decisions are made on the basis of scientific argument. The repercussions extend to the most different levels and domains, be they social, economic, or cultural. In this way, sciences cannot be circumscribed to the world of specialists. According to Feyerabend (2011, p. 120, our translation), "lay people can and should overview science." Besides, "in a democratic society, institutions, research programs, and suggestions have [...] to be subject to public control," as Feyerabend (2007, p. 8, our translation) also emphasizes. Thus, it is key to develop strategies aimed at stimulating reflection on the scientific practice and, from this perspective, the association with arts is unique.

The ECs of the CECIERJ are mini-science centers located in the countryside of the State of Rio de Janeiro, where varied scientific activities are carried out, such as interactive exhibitions, planetarium sessions, workshops, science fairs, and activities during the SNCT. The ECs are managed in partnership with local departments of education and the

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CECIERJ's scientific dissemination sector, which, in this relationship, is responsible, as Gardair, Dahmouche e Fiães (2018, p. 519, our translation) explain,

[...] for the training of mediators conducting such activities and the proposition of supplementary programming, such as multidisciplinary events, thematic exhibitions, workshops for teachers and students, which are sometimes partially financed by funding agencies. In physical terms, the ECs have a set of interactive scientific equipment that is exposed in order to facilitate experimentation by visitors.

Most of the funding for the development and implementation of activities comes from the budget of the city halls at stake, also being responsible for preserving the building, resources for infrastructure and maintenance of personnel. Development agencies, such as the Rio de Janeiro State Foundation for Research Support (Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro – FAPERJ) and the National Council for Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq), also play a major role in supporting the design of pedagogical actions. The interface with the visiting audience of the ECs, either spontaneous or scheduled, is carried out by local mediators, trained by the CECIERJ, whose main functions are: a) facilitating the interaction between the audience and the exhibitions; b) holding workshops; and c) mediating the other activities offered by the ECs.

In this scenario, where we see public policies as the set of measures and actions institutionally supported in a systematic way, in various domains and by several entities, we reaffirm the commitment with a public education of excellence, when developing actions aimed at non-formal education, involving multiple social players, varied fields of knowledge, and giving priority to cultural diversity in the teaching of science associated with arts, in a free and unrestricted way. However, some difficulties arise along the route. Often we come across government policies that, unlike State policies, are not necessarily supported by the Constituição da República Federativa do Brasil (1988) regarding the continuity of processes. According to Gardair et al. (2018, p. 519, our translation):

As for the pedagogical objectives to be achieved, we intend to present and discuss themes and contents of the field of sciences in a contextualized, attractive, and accessible way to the non-specialized audience. Providing support for teachers in the region in order to develop and improve their didactic practices is also a goal of the ECs. This is an internationalization action that seeks to promote the popularization of science and technology especially aimed at students and teachers in the regional school network.

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The activities of the ECs are planned in order to present science as one of the knowledge works that man is capable of generating. People seek not to absolutize scientific knowledge, exploring it in a dialogue with other studies, stimulating reflection on the social impact of production in science. Contributing to the deconstruction of stereotypes and stigmas related to scientific practice is also one of the goals to be considered in the formulation of the ECs programming, highlighting the components of subjectivity and affectivity that can constitute the scientific methodology. In this regard, Ferreira (2010, p. 265, our translation) analyzes:

Modern scientific rationality is not characterized by its contemplative nature, it is constituted as a form of knowledge that proposes an intervention in nature in order to dominate it, transforming it, acting on it. Its concepts and assumptions reproduce a mechanistic, dualistic, quantitative, and ordering worldview. That is, it is a type of knowledge that, by interfering, models, constructs reality, organizes things according to its interests, its presuppositions and its methods, it acts in the social sphere, although this is not always clear. In this rationality, subjectivity is a problem to be avoided.

Thus, the ECs activities were conceived by considering the importance of presenting and discussing contents in a contextualized way. In this direction, we highlight two specific actions, in which the association between visual arts and scientific themes was explored in practice, aiming not to incur hierarchization of knowledge and offer multiple points of view on a single theme. It is the itinerant exhibition “The Heaven of Artists” [O Céu dos Artistas] and the workshop “Eating with the Eyes” [Comendo com os Olhos].

## **The Heaven of Artists: an interactive exhibition in dialogue with science**

Heaven arouses the curiosity of men since time immemorial and, as Lexicon (1990, p. 53, our translation) states, “it plays a major role in the mythological and religious conceptions of almost all peoples.” One of the possible explanations for the fascination that heaven exerts on men is the relationship established between heaven and fertility on earth, as well as a rich imaginary about gods and entities who might rule our lives and populate that space above us.

According to Lexicon (1990, p. 53, our translation), there are associated with the celestial world “regular and ordered movements of the stars, the [...] fertilizing rains that are necessary for life, the fear and respect awakened by the phenomena of nature like

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thunderstorm, ray, comets, meteorites, the rainbow.” Perhaps, the mysteries and certain inaccessibility of heaven are also responsible for the interest aroused in human beings. The firmament, the stars, the celestial bodies, the planets, the clouds, the sun, none of this is palpable. We can only contemplate what is visible to the naked eye and imagine what we cannot see. The sky is also a source of inexhaustible inspiration and creation. How many of us do not see hundreds of shapes in the clouds scattered on an afternoon with clear sky? Alvarez (2008, p. 390, our translation) emphasizes that: “the blue sky is unlimited airspace, where a dreamer is lost in that bottomless mirror, without shape and without direction.”

Artists from various eras and styles dedicated themselves to portraying the sky. In visual arts, we may mention Rene Magritte, Edvard Munch, or Vincent Van Gogh, for instance. It is a fact that the themes related to the sky can constitute a great starting point for the articulation of different fields of knowledge, considering the poetic inspiration that this awakens and the immense data set in which it is constituted for science.

The “Heaven of Artists” is an itinerant exhibition, produced with resources from the public notice “Support for the Production and Dissemination of Arts/FAPERJ” [Apoio à Produção e Divulgação das Artes/FAPERJ] and the CECIERJ. With exhibition design by Andréa Fiães and curatorship of Thelma Lopes, it aims to stimulate the discussion of possible relations between science and art through the dissemination of works by consecrated painters articulated to other forms of knowledge and the historical and cultural ambience to which they are linked. There are also, as activity goals, promotion of space for enjoying arts and encouragement to the formation of an audience for visual arts. The exhibition consists of reproductions of works that depict the sky and they are exhibited along with planetarium sessions, aiming to afford artistic and scientific discourse on the same subject.

The research for composing “The Heaven of Artists” was conducted with 3 main contributions: a) contents; b) pedagogical strategies to be developed for presenting the said contents; c) supports and materials fit to the aesthetic and educational purposes, taking into account the feasibility and durability. Seven painters were selected. In total, the exhibition consists of 13 panels, which were grouped into 4 sets: a) an opening panel; b) 7 panels with reproductions of art works; c) 2 panels of mythologies and songs on the sky; and d) 3 interactive panels with magnetic games on the sky.

**Figure 1** Panel of the exhibition “Heaven of Artists”



Source: Prepared by the authors.

The works reproduced were: a) “Lovers in the Sky of Venice” [Os Amantes no Céu de Veneza] (Marc Chagall); b) “Sunset” [Sol Poente] (Tarsila do Amaral); c) “The Fall of Icarus” [A Queda de Ícaro] (Henri Matisse); d) “Blue Sky” [Céu Azul] (Wassily Kandinsky); e) “The Sun” [O Sol] (Edvard Munch); f) “Starry Night” [Noite Estrelada] (Van Gogh); and g) “Constellations” [Constelações] (Joan Miró). The front face of each of these panels contains the reproduction of the work and a sentence by the painter. In the back there is a photo of the artist, biographical information, and space for technical information on the painting, such as: a) size; b) title; and c) museum or private collection where it is located (Figure 1).

Once selected, painters and works, we underline the idea that permeates the whole exhibition: there are different ways of seeing and expressing the world, with arts and science being among them. In this way, we think that, as a pedagogical strategy to highlight the notion of plurality on the same subject, it would be key to include data related to anthropology and even other arts, besides painting. Thus, the panels by the 7 painters are added with 2, named “The Sky and its Meanings” [O Céu e seus Significados], containing brief stories and legends from various peoples about the sky, and “The Sky in the Poets’ Mouth” [O Céu na Boca dos Poetas], with songs that thematize. We also chose to include interactive panels.

Regarding the material supports, the guiding questions were: a) durability; b) ease of assembly and disassembly; c) packing of panels; and d) aesthetic final touch. Thus, we use modular totems and portable displays, to which polyester or canvas banners have

been applied. Several print tests have been performed to provide excellent image quality. The reproductions of selected works were made by having book figures as a basis, treated digitally, in order to obtain a satisfactory aesthetic result. It is worth mentioning that, during the exhibition mediation, we pondered with visitors about the fact that those images reproduced there are only visual references to the originals. We point out differences such as those of tone, texture, and size, for instance.

**Figure 2** Material survey and print test



Source: Prepared by the authors.

A set of actions aimed at the mediators group training was conducted, consisting of students with various undergraduate degrees, in order to work as facilitators of the contents presented and the relations proposed during the exhibition. Such actions included the preparation of a handout and face-to-face meetings in which history of art was discussed, the panels' assembly, audience reception and embracement dynamics, as well as strategies for the association of artistic themes with planetarium visitation.

**Figure 3** Training of exhibition monitors/facilitators



Source: Prepared by the authors.



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Itinerant, from its inauguration in April of 2013 until February 2019, the exhibition was held in localities of Rio de Janeiro, where, we highlight, the number of cultural apparatuses is reduced, such as: a) Duque de Caxias; b) Teresópolis; c) Sapucaia; d) Três Rios; and e) Paracambi. In total, there was an estimated audience of 25 thousand people.

## Eating with the Eyes: an integrated workshop on art and science

The workshop “Eating with the Eyes” [Comendo com os Olhos] was specially designed for the 13th edition of the SNCT, held in 2016, whose theme was “Science Feeding Brazil” [Ciência Alimentando o Brasil]. The main goal was exploring the social and cultural aspects of foods related to contents of various sciences, with the primary notion of seeing that food habit is one of the most important aspects of peoples’ identity and that arts can contribute to grasp the diversity and richness of the food culture of the most distant parts of the world.

**Figure 4** Workshop poster. Detail of the Work “Vermeer”



Source: Prepared by the authors.

In this way, we proposed a virtual tour through the world of painting to participants, by means of works portraying food. A digital material consisted of images of canvases displaying foods painted by artists of many eras and styles. After the exhibition of screens and a debate mediated by a professional in arts, practical activities associating themes of biology, chemistry, and/or mathematics were explored.

In the biology and chemistry areas, we explore the extraction of pigments from food, natural and artificial dyes, their nutritional properties, chemical reactions, and the use of

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these pigments in drawing. In turn, in the domain of mathematics, notions of calculation were related to ideal weight and body mass, for instance. In short, we sought to explore the interaction between various fields of knowledge and offer a plural and multifaceted view of food as a theme. The workshop was held at three main moments (Table 1).

**Box 1 – Description of the workshop “Eating with the Eyes”**

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<b>WORKSHOP EATING WITH THE EYES</b>	
<b>FIRST MOMENT</b> The first moment was common to the two modalities of the workshop: one associated with mathematics themes and another conjugated to contents of chemistry and biology.	Presentation of audiovisual material containing images of works of art depicting food. The selection of paintings was conducted in order to cover various authors, times, and styles. Thus, we think that the discussion on food as a cultural fruit and expression might be facilitated. This step was designed and conducted by Thelma Lopes.  As for mathematics, students participated in a discussion about notions of ideal weight and body mass calculation using collective questions and mathematical challenges. The debate generated through the numbers extended to questions concerning dietary habits, imposed beauty standards, excessive thinness, and eating-related disorders, extrapolating the field of calculations. This step was conceived and developed by Wanda Medeiros Pacheco <sup>1</sup> .  As for the contents of chemistry, the manufacture of natural dyes was explored. Tinctures were prepared at the time of the workshop, in front of the audience, stimulating a rich discussion that, in addition to issues more directly related to contents explored there, expanded to the field of healthy eating habits and food waste. This step was conceived and developed by Célia M. da Silva Santiago and Maria da Penha Macedo Jacobina.
<b>SECOND MOMENT</b>	Dialogical round with the participants about the activity. As a culmination of this stage, students were invited to draw by using the tinctures produced for the workshop, experiencing, in practice, the multiple ways of food use. The stage was designed and developed by Célia Maria da Silva Santiago and Maria da Penha M. Jacobina.
<b>THIRD MOMENT</b>	

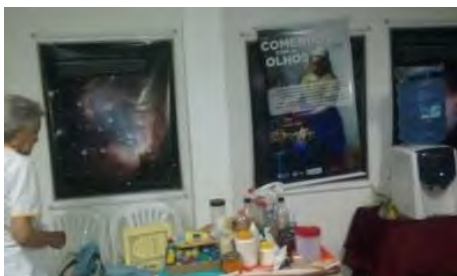
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Source: Prepared by the authors.

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<sup>1</sup> Professors Wanda M. Pacheco, Célia M. S. Santiago, and Maria da Penha M. Jacobina were members of the “Itinerant Science Square” (Praça da Ciência Itinerante – PCI), a program of the scientific dissemination sector of the CECIERJ, since the early years of the project and on the occasion of the workshops. The PCI coordination is in charge of Sônia Simões Camanho.

**Figure 5** Female Chemistry and Biology mediators working with students



Source: Prepared by the authors.

**Figure 6** Drawing made by a student inspired by the work “Verão,” by Giuseppe Arcimboldo



Source: Prepared by the authors.

## Final remarks

The development of plural educational strategies, involving various knowledge areas, distinct social actors, and dialogue with institutions of different origins is a sine qua non condition to ensure citizen's overall education. Much more than stacking content, the leading role of education should lie on enabling a student to select the enormous amount of information available in today's world. The crucial issue is no longer to assert access to information, but to seek dynamics that contribute to the faculty of relating knowledge. The dichotomous view between arts and science, and by extension the misleading associations that may ensue therefrom, are accentuated, despite the growing attempts to detach stereotypes stemming from this misconception. They have historical and cultural roots. We lose much when we dismiss arts as a viewpoint, since we fail to aggregate key meanings to grasp phenomena, be they of a natural or social order.

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However, the effective promotion of dialogue among the multiple fields of knowledge implies a long way to go and involves numerous decision-making bodies, ranging from those that relate to individual affections and interests, going through collective choices, to the performance of institutions and deployment of public policies. There are no ready-made formulas available. Neither is the driving force of the route reduced to a so-called “Renaissance temper,” characterized by interference with knowledge, techniques, and vocations. More than the wish to venture into a universe of various forms of knowledges driven by mere dilettantism, the challenges of this journey require a firm disposition to grasp alphabets and meanings inherent to a profusion of languages and their respective viewpoints. In other words: it consists in taking an attitude in which forms of interpreting, relating, and interacting with the world around us are continually constructed and reconstructed.

It is not, therefore, an easy task, but it is feasible and needed. Today more than ever. We live in controversial times. Ironically, when humanity has at its disposal, as never before, countless communication resources, mainly provided by technological advances, dialogue has been increasingly hard. Entrenched by distorted and polarized views, the capacities to think and ponder have been blunted and they lead us to retroact. In the world of the 21st century, there are those who explicitly started claiming that the Earth is flat and condemning the use of vaccines or Darwin’s theories. With no modesty or reasonable argument, they keep putting into question what has already been thoroughly studied.

In this desolate scenario, the initiatives of scientific dissemination play a major role, as they bring in essence the attempt to promote familiarity with science along with the lay audience, disseminating themes in order to expand the scientific culture and the questions about practices that involve knowledge production. In this context, actions in non-formal education, mainly developed at science centers and museums, stand out. These spaces have been shown to be a substantial dialogical complement to curriculum actions deployed at school, since, not being attached to the student’s approval certificates or to the fulfillment of programmatic contents, they can use rather playful and creative pedagogical strategies.

It is also worth noticing, as final remarks concerning the reflection proposed in this article, some observations: the scientific dissemination actions should operate in dialogue with the school practice, so that, keeping in mind the specificities of each field of action, they complement each other and can propose and reinvent, together, learning dynamics that address learners’ needs. We emphasize that the efforts of both parties mentioned herein have no use if the State does not grasp and undertake joint actions as a public policy.

Another remark is the need to intensify the presentation of scientific contents related to other forms of knowledge. Even in the alternative spaces cited herein, it is not uncommon for the sciences currently classified as ‘human’ to be relegated to the background in activities conducted or even ignored. The misunderstanding of art as a mere instrument

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at the service of science is not rare, either. At this point, the domains of education reflect society as a whole, in which various statuses assigned to arts, sciences, and their multiple modalities are made apparent. That is, even when pluralist and transformative education is attempted, it is possible for us to engage in vices of interpretation and perpetuate mistakes, since cultural change is always gradual. So, there is a need to be on alert and to exercise sensitivity as a form of intelligence.

It is a fact that the chain of issues of the various disciplines has been consolidated little by little. Multidisciplinary pedagogy is a process underway that cannot be abandoned and it must be strengthened through different approaches, among them, the arts, since, in presenting related contents, a contextualization is stimulated – a crucial faculty to understand cause and effect relationships. If we understand all historical, and power, overlaps, which involved, for instance, the old and disconcerted claim that the Sun revolved around the Earth, and not the opposite, the understanding of the astronomical phenomenon itself and that the making of no form of knowledge is detached from its time and social context becomes easier.

Finally, it is worth stressing that uniting art and science in reconciliation, in a non-hierarchical manner, can contribute to understanding affections, challenges, emotions, historical principles, social reasons, political interests, partisan inclinations, and so many other determinants linked to knowledge production. The experiences taking place at the ECs seek to constitute a starting point in this direction, because we believe that such a view favors the contextualization of facts, which in turn is key for citizen's education, plural, and the construction of a society in which indefensible things are advocated.

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