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INSIDE THE BLOOD WITH ARTSCIENCE AT *CHAGAS EXPRESS XXI* - INNOVATION FOR SCIENCE EDUCATION AND HEALTH PROMOTION

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Abstract: present a pedagogical scenography model, *Inside the Blood*, discuss aspects of the circulation and blood elements in healthy and disease conditions. The visitors walk inside an ArtScience installation as if they were “inside a blood vessel” through the immersive and sensorial experience. The visit was mediated by an educator discussing some aspects of the acute phase, when the parasite called *Trypanosoma cruzi* is found in the blood of infected people, attracting attention of distinct ages and scholar levels. To understand and evaluate the construction of knowledge through the eyes of visitors, they created models in a modelling clay art craft workshop. More than 80% of the clay models expressed information about scientific content and 66% presents association between scientific information and subjective messages with personal meanings. We concluded that the model is a useful tool for science and health education, aiming to create artistic expressions that potentialize learnings and communication.

Keywords: ArtScience; Scenography Art Installation; Chagas Disease; Science education.

Introduction

The project *Inside the Blood with ArtScience* was approved in a public re-search call (Fiocruz Scientific Divulgation Projects) and was then developed in partner-ship with the ArtScience research group at the Laboratory of Innovations on Therapies, Education and Bioproducts (Liteb/ IOC/Fiocruz). Blood and its components, the heart and the circulation are marked by great cultural, social, and affective symbolism (Meyer, 2005). However, there are rare opportunities for people to see and interact with explanatory models on this theme, or even to visualize the elements and blood components (Christensen et Al., 2015; Rocha & Marandino, 2017).

For more than a decade we have been working with scenography models to foster science education (Araujo-Jorge et Al., 2004). Based on a previous model named *Giant Artery* Art-installation conceived for a science museum (Oliveira et Al, 2020), we developed a new project *Inside the Blood with ArtScience*, to build a blood vessel model to be inserted in research field expeditions coupled to education interventions. In this work we present and describe the development of *Traveling Artery*, an immersive Art Installation of a giant blood vessel three meters long and two meters wide and high aiming to ensure mobility and traveling to different locations and to promote knowledge about the blood elements and properties. Both the museum and the portable models represent a blood vessel where participants can enter and imagine themselves into the bloodstream. During the art installation "visit" the participants may note, and discover by themselves, some modelled anatomical and molecular blood elements created to propose discussions about health and blood issues. Our objectives in the present study were (1) to describe the concept and design of the art installation named Inside the blood and (2) to approach the educational potential of the con-tents presented in the model through the eyes of visitors expressed in the clay models.

The model could be adapted to any blood-related subject and in this study. We conveniently choose the subject of bloodstream circulating parasites (*Trypanosoma cruzi*) due to the opportunity to insert *Inside the Blood - Traveling Artery* as an education module in a Chagas disease re-search and education expedition conducted in 2019, in the state of Minas Gerais, Brazil (Araujo-Jorge et Al., 2021). Then, besides the inner models of normal red and white blood cells and platelets, we also modelled trypomastigote forms of the parasites, and specific antibodies, to present the *causal agent* of the infection and the molecular basis of the diagnosis. Model representations are based on the natural analog process of the human being (Root-Bernstein; R. & Root-Bernstein, 1999). Mental, conceptual, and artistic models are characterized as representations of real-world processes or objects, constructed primarily through the establishment of analogical relationships and comparisons that are related to artistic materials and conceptions to promote the association and fixation of new information (Marandino, 2009). The representation by artistic models is characterized in objects, shapes and structures constructed through analogies. Dimensional scale changes to enable the communication of different conceptions and is used as a strategy in science dissemination to illustrate and exemplify elements restricted to human observation (Oliveira et Al, 2020).

An *imaginary museum* can be built on each person's imagination: this is the main idea spread by Jorge Colli in his book *What is Art* (Coli, 1995). The author refers to a collection of memories of art pieces that come together through subjectivity, embedded in multiple connections, imprinting meanings over the objects. Learning meaningful content mobilizes the left lower prefrontal cortex of the brain by giving meaning to information, making it much easier to learn (Blakemore & Frith, 2009).

Scenography language acts through visual communication and, in this context, con-tent information is linked directly to physical form. The main message is structured by realistic words, symbols and observations, a composition designed to direct interpretation (Urssi, 2006). The final understanding of a visual experience depends on the interaction of meaning and form, articulating the content and the observer. The message is interpreted and modified by the content. The technique used for this process will allow the observer's abstraction. The pictorial or imaginary thinking is determined by visual information, the totality of data and comprehension (Manovich, 2011). Could an *imaginary museum* with the imagens of blood elements be built in the imagination of each person that visit *Inside the Blood - Traveling Artery*? To address this question, we based the model conception and the modelling workshop mediation activities in the ArtScience principles. The interdisciplinary field, ArtScience integrates human knowledge through creativity, innovation, and investigation (Root-Bernstein et Al., 2011).

The integration of art and science education educates the look, enables the development of perception, sensitivity, and creativity (Araujo-Jorge et Al, 2018). Both science and art are structured through investigative, analytical and intuitive processes. When articulated or united, they allow the universal understanding of all things, as elucidated in the ArtScience Manifest, *"ArtScience enables us to achieve a more complete and universal understanding of things "* (Root-Bernstein et Al., 2011). Another item in the ArtScience Manifest articulates the convergence of artistic and scientific processes and skills (Root-Bernstein et Al., 2011). Such processes and skills are part of the STEAM movement (Science, Technology, Engineering, Arts and Math's), where through interdisciplinarity the human-world relationship is approached, integrating creativity, communication, and scientific curriculum to enable the construction of meaning in a concrete situation (Henriksen, 2014).

Among the different conceptual and pedagogical fields, ArtScience has been consolidating a partnership with positive results for science education (Araujo-Jorge et Al., 2021; Araujo-Jorge et Al, 2018; Sawada, 2019; Edwards, 2008; Zambrana-Ortiz, 2011; Mast et Al., 2016), both in formal and in non-formal modalities (Oliveira et Al, 2020). Formal and non-formal education have educational environments, but the main differences between them are in the relations of dialogue between experts/educators and individuals, as well as in the real space where communication and learning processes take place. The non-formal education environments, science centers and museums, squares, fairs, parks, are somehow detached from school (even if they occur in school yards), and the dissemination of scientific knowledge happens freely and autonomously: the individual can choose what to learn and with who to learn (Lee, 2018).

The activities presented in these spaces deal with the senses. The series of stimuli provided seeks to enable the participants to identify the elements used to communicate scientific knowledge present in the objects and concepts presented to the public. Moreover, non-formal education meets dissemination of scientific knowledge in many ways, especially science centers and museums, vacation camps, public squares, and malls. Science dissemination and understanding is a challenge that received important inputs from the ArtScience approach (Siler, 2011), opening a field of educational research and practices. Siler highlighted that the success of the integration between ArtScience and Science Communication derives from the fact that they both promote action and contact through perception, producing sensations and emotions, and enabling individuals to connect into sensory, cognitive, and abstract dimensions (Siler, 2011). Then, through imagination and memory, participants can create hypotheses and associations that structure their under-standing of natural phenomena. Visual expression is understood

within the ArtScience concept: content is revealed through form, language, and perceptual events. When a scientific content is processed by means of artistic visual expression, it allows the interpretation of signs structured in forms and patterns, transforming them into new associations and metaphors connected to human values and issues with a profound impact on their consciences (Siler, 1999).

Inside the Blood with ArtScience activities were developed at *Chagas Express XXI (CEXXI)* that was designed to introduce Chagas disease education in Brazilian endemic (Araujo-Jorge et Al., 2021). *CEXXI* is a social educational technology developed by Fiocruz researchers together with the people affected by the disease, which is caused by the infection with a flagellate parasite called Trypanosoma cruzi and affects more than 6 million people worldwide (Araujo-Jorge et Al., 2021). In Chagas disease, as in other infectious diseases involving blood sucking insects as vectors, the blood is the central link between host, reservoirs, vectors, and the affected people. The main scene for Chagas disease development is the insect dependence on blood as the main food, parasites dependence on blood for its transit to target organs and/or nutrition metabolism, and warm blood mammals as a variety of parasite hosts (Araujo-Jorge et Al, 2018). *CEXXI* is an ArtScience participatory and itinerant exhibition to talk about Chagas disease in cities where there is a risk of Trypanosoma cruzi parasite contamination. We conveniently choose the subject of bloodstream circulating parasites due to the opportunity to insert *Inside the Blood - Traveling Artery* as an education module in a special Chagas disease research involving an education expedition *Chagas Express XXI* that was conducted in 2019 by our laboratory (https://expressochagas.com; Araujo-Jorge et Al., 2021).

Materials and Methods

Inside the Blood - Traveling Artery: concept, design and setup

In *Inside the Blood - Traveling Artery*, the blood vessel, the components of circulating blood were represented with both analogy and symbology, which provide communication with the visitor through the association caused by perception and emotions, as previously described (Oliveira et Al, 2020).

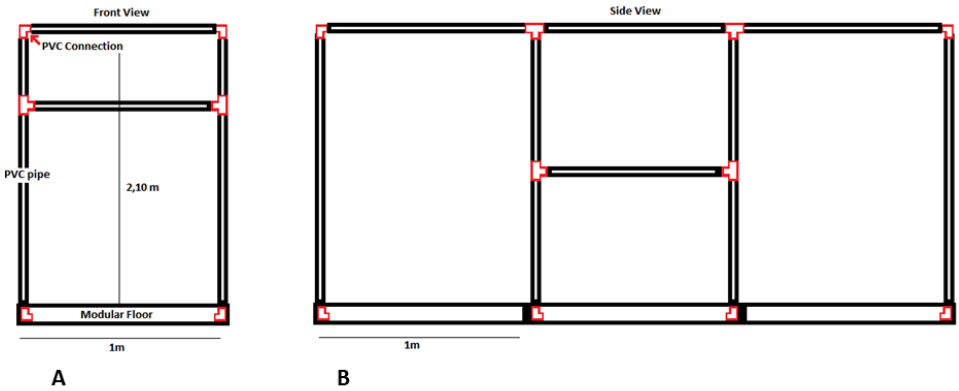

Figure 1. General scheme of *Inside the Blood - Traveling Artery*. Dimensions in front (A) and side (B) views. Source: Self-authorship.

The general scheme of the art installation is shown in Fig. 1 with the dimensions and pieces (Fig. 2). A corridor was structured with a modular plastic floor, PVC pipe and

covered with vinyl canvas where up to five people can enter and an adult fit vertically (2.10 meters high).

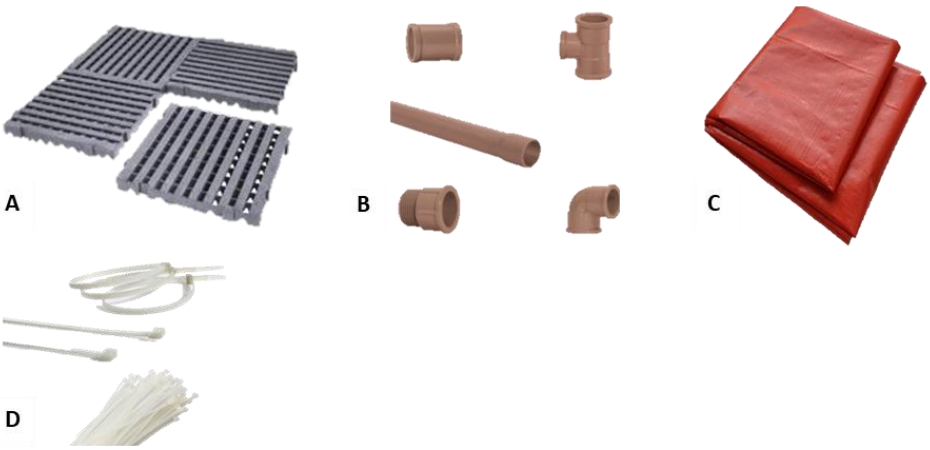

Figure 2. Model Pieces. A - Modular floor, B - supporting rods and connecting/fitting pieces, C - vinyl canvas - analogy to camping tent and D - tent rod supports and assembly pieces. Source: pisoplastic; deflash; imperiolonas; leroymerlin.

To enhance the interactivity of the model we decided to enlarge 55,000 times the model of red blood cells (mean diameter of seven µm) to fit in an adult´s hand with about 40 cm. All the other elements, including white blood cells, platelets and parasites were sculptured in paper maché keeping the relative scale as compared to the enlarged red blood cells. We used the analogy that in the 55,000 times magnification a 7 mm push pin head diameter would correspond to 385 meters, an extension of about 3 to 4 blocks of 100 m each. Preparing, modeling, drying, and painting the paper maché models was the subject of another previous *BioArt* modeling workshop, not related to the exhibition (data not shown). We also tried to make an analogy with the distance from the place of the exhibit to the central square or the main city church. These analogies were necessary to open the visitor´s mind to the nanoscale dimensions. *T. cruzi* infected blood smears were available for the participants to look directly in a light microscope (Fig. 3,); videos showing blood cells movement were available in portable screens for the participants that were somewhat interested in a deeper discussion.

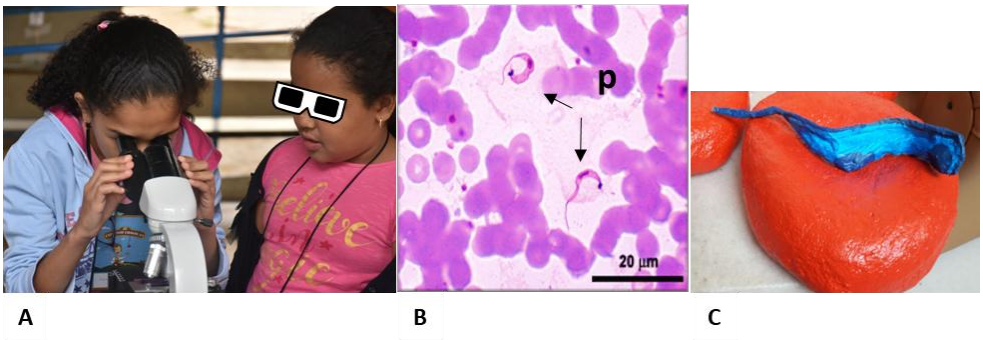

Figure 3. Figure 3. Observation in the microscope and model of red blood cell/T. cruzi. A and B - Light microscope with stained infected blood smear slides were available in another educational module of the exhibition, as well as C - printed micrographs presenting blood cell elements so that many different correlative images could be presented to the visitors. Source: Self-authorship.

The complete list of materials to take on the expedition for *Inside the Blood - Traveling Artery* installation included: (1) two large size suitcases (76 x 48 cm) for the pieces representing the cell elements; (2) one medium size suitcase (67 x 45 cm) for the electric material (cables, connectors and 10 m circuit of led bulbs), (3) the tissue panel indicating the place of the exhibition (in this case, in the form of a train wagon – see below), (4) the proper red rubber canvas for the model, (5) one 12,000 BTU portable air conditioner with dehumidifier, exhaustion tubes and remote control unit; (6) a standard export carton with the floor mod-ules, PVC tubes as supporting rods. The number of parts may vary, as the modules can be assembled in a large or small size, reconfiguring the PVC fittings according to available space to assemble the whole model. Fig. 4 show a typical setting of the installation with PVC pipes that were assembled with proper connectors.

Figure 4. Assembly of the scenography model structure. The model could be assembled/ disassembled in 60 - 120 minutes. Source: Self-authorship.

To facilitate assembly, disassembly and transportation, the bases were made on modular plastic floors. The floors were adapted to fit the PVC tubes at their ends, forming a corridor of a blood vessel, where the modules fit together through PVC connections. The rods were covered with a waterproof vinyl tarpaulin (Fig. 4) and the paper maché models of the previously prepared blood elements were hung on the rods. The entry and exit were made by a cut at each end, closed with adhesive tape *Velcro*. If the visitor needs to leave during the journey, the vinyl tarpaulin was also modular, allowing an exit every meter.

The Art Installation scenography had two types of illumination, the first with red led mini bulbs, referring to the color of blood, and the second with black led bulbs, referencing to the methylene blue dye which marks membranes and cell nuclei under microscopy. We also inserted a mini red portable audio speaker to deliver the sound of normal blood flow (doppler carotid artery record donated by a university colleague). The blood cell elements were handcrafted sculptured with paper maché and painted with plastic paint. For a corridor of three meters long and two meters wide we prepared thirty erythrocytes, 15 leukocytes, 10 platelets, and 20 parasites that were randomly hanged (Fig. 5). These were hung and distributed throughout the *Artery* model, making it difficult for the visitor to pass (Fig. 6), favoring his/her interaction with various components during the walking tour through the installation space.

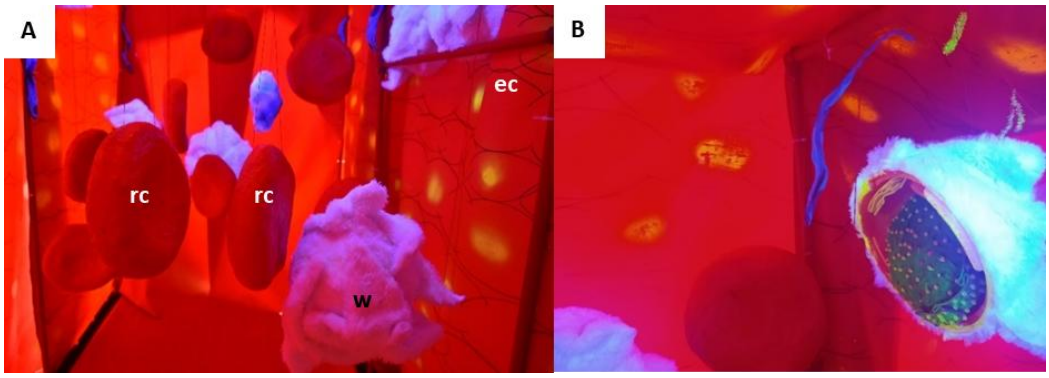

Figure 5. The blood elements of the *Inside the Blood - Traveling Artery*. Scenography model showing the representations of the blood elements (A) and the parasite T. cruzi (B) in the Chagas Express XXI. Source: Self-authorship.

Figure 6. Entering *Inside the Blood - Traveling Artery*. Chagas Express XXI audience interacting with representations of elements within the model. Source: Self-authorship

These components needed to be replaced and frequently reviewed by the team as they were used for the visitors´ interaction with the model. Their durability was low, as they could be touched and transported depending on the context. The size scale between the components was not strictly followed, due to an earlier decision to approach molecular and cellular structures in the same environment, making scale equivalence impossible. Among other things, the scenography has the role of imagining situations and adopting a dialogue with real space (Araujo-Jorge et Al., 2021). Visits within *Inside the Blood - Traveling Artery* lasted an average of 15 to 20 minutes each varying from one to five people at a time.

The mediation with the public: ArtScience as a theorical-methodological basis for a transdisciplinary approach

To assess the impacts of *Inside the Blood with ArtScience* for science teaching, we investigated the occurrence of learning of the specific contents presented in the scenography model in the construction made by the public in the clay models. For this investigation, the Triangulation of methods was used. Data triangulation requires the combination of multiple re-search strategies capable of apprehending the qualitative and quantitative dimensions of the object, meeting both the requirements of the qualitative method, by guaranteeing the representativeness and diversity of positions of the social groups that make up the re-search universe, and to the ambitions of the quantitative method, by providing knowledge of the magnitude, coverage and efficiency of the program under study (Minayo, 2005). The triangulation of the data obtained from the following methodologies was then performed: 13 thinking tools / cognitive categories described by the Root-Bernstein couple (Root-Bernstein & Root-Bernstein, 1999); Isomorphism (Arnheim, 1997); Establishment of Bardin's identifying categories (Bardin, 2009).

Inside the Blood - Traveling Artery mediation activities are founded in the 13 thinking tools / cognitive categories, described by Robert and Michèle Root-Bernstein (Root-Bernstein & Root-Bernstein, 1999): (1) Observing, not simply watching, in a way to go beyond the visual aspect of seeing; (2) Imaging, evoking images, creating visual representations in the mind; (3) Abstracting to take something and to simplify it to its most important single element; (4) Recognizing patterns, identifying what is common and what is unique; (5) Forming patterns, creating something different by combining two or more elements together; (6) Making analogies, finding a relationship in size, function, form, or other; (7) Thinking with the whole body, moving the body through space to let imagination flow (in this case, the small intravascular space offered by the model); (8) Empathizing, changing the perspective and the point of view; (9) Thinking in a dimensional way, moving from 2D to 3D, 4D (including sensorial inputs, in this case the visual, tactile and sound sensing), or 5D (including symbolic representations), scaling, or altering the proportions and symbols; (10) Modeling, creating representation of something in a physical (and even functional) form; (11) Playing, simply for the fun and for the joy of doing something (*entering into the bloodstream*); (12) Transforming, altering some thing or some tool into another thing or another tool; (13) Synthesizing, describing a complex and whole idea in few words, in a picture, or in a movement or sound. These categories are important to promote and to consolidate creativity (Root-Bernstein & Root-Bernstein, 1999; Arnheim, 1997; Siler, 1990).

The Isomorphism (Arnheim, 1997) - simplification of the concept in the form represented in the artistic expression is based on *the visible configuration of the content,* where two perceptual concepts, Eidetic Images of Memory and Isomorphism must be included to allow the evaluation/understanding of the idea or concept presented. Eidetic images of memory allow projecting a replica of a scene seen on an empty surface through intellectual abstraction. Isomorphism (Iso = equal; Morph = form; ism = science) is the structural kinship between the stimulus pattern and the expression it conveys in the object or composition. An artistic expression is based on visual perception, where the task of symbolizing the universal content is performed by a formal pattern and the proposed theme. The relationship between the properties of the forms that make up the visual expression requires a structural correspondence between meaning and pattern, thus enabling its visual and conceptual understanding (Arnheim, 1997).

The choice of Chagas disease for *Inside the Blood with ArtScience* testing and the local field exhibitions

The exhibition featured an imaginary train with thematic wagons and an old train station, making an analogy to the story of the discovery of Chagas disease by the Brazilian scientist Carlos Chagas in northern Minas Gerais, inside a laboratory/train wagon in 1909 (Araujo-Jorge et Al, 2021). The field test of *Inside the Blood with ArtScience* was adapted to *CEXXI* and the main inclusions were the modelled parasites and the antibodies that are the molecular basis of laboratory diagnosis. *Inside the Blood - Traveling Artery* participated in this expedition in *Discoveries & Play*, the 3rd education module (*wagon*), with the theme *Trypanosoma Who? The Acute Phase of Chagas Disease*. A characteristic feature of acute Chagas Disease is positive parasitemia, the finding of parasite in the blood, microscopically by direct blood smear examination, or amplified trough blood culture or parasite DNA amplification. Parasitemia is low and intermittent in chronic phase.

Inside the Blood - Traveling Artery installation was presented in five cities that were visited by *CEXXI* expedition in 2019 in the Brazilian Northern Minas Gerais (MG) state. Four of them are endemic for Chagas Disease (Grão Mogol: 15,667 inhabitants; Espinosa: 31,624 inhabitants; Montes Claros: 404,804 inhabitants; Lassance: 6,490 inhabitants). Lassance is the municipality where Carlos Chagas identified Chagas Disease (Araujo-Jorge et Al, 2021). In the capital of the state of MG (Belo Horizonte), the presentation was during the Joint Congresses of Brazilian Societies of Tropical Medicine and Parasitology, allowing the visit of specialists in science to the installation.

Ethics statement

The project and all the consent forms and questionnaires were previously analyzed and approved by the Ethical Committee of Research in Humans (CAAE 15584119.4.0000.5248) according to Brazilian laws and regulation of research in humans. During the expedition, all the participants were identified by filling registration and authorization of audio and video image use for communication and research items, as well as some objective questionnaires. A written formal consent was obtained from each participant or from his/her parent/guardian in case of under the age of eighteen.

Modelling clay workshop to access the perceptions of the *Inside the Blood - Traveling Artery* visitors: their own arteries

After experiencing the sensation of entering inside the *Inside the Blood - Traveling Artery* model into the *bloodstream*, the participants were invited to an ArtScience activity (Fig. 7) to construct their own blood vessel models using modeling clay (plasticine) and a tube-like curved cardboard, to the workshop *Building your own Artery*. They were asked to represent something they learned or liked, or a sensation/feeling perceived while visiting the scenography model). They were also asked to give a specific and proper title to their handcrafted work. We stimulated modeling activities and analyzed them to understand how visitors perceive the contents presented within the scenography model. The single motivation to participate in the workshop was curiosity and experiencing an

art-driving activity, since no other stimuli were proposed, such as win free gifts, or candies or cookies. In mean, each person stayed 20-30 minutes in the modeling clay workshop, and many returned the other day, when the exhibition was available.

Figure 7. *Building your own Artery* Workshop. With card paper to represent the endothelial cell support and modeling clay of different colors, adults and children are invited to (re)construct their mental models of the blood vessel and its elements. Source: Self-authorship.

We did not register the exact number of persons entering *Inside the Blood - Traveling Artery*, opting to focus on their production of their clay models, which were numbered and analyzed categorically. However, full exhibition quantitated at the entry all the visitors, and at the end all those who wanted to evaluate the activities and to sign the consent form to participate in the research projects. They evaluated the activities of each module using a 5 grades Likert scale: “I love it” /5; “I liked it very much” /4; “I liked it more or less” /3; “I didn´t like it” /2; “I hated it” /1. The percentage of answer in each grade was then calculated to describe the general perception of the participants. These data were published elsewhere (Araujo-Jorge et Al., 2021). For qualitative studies we also registered in a field notebook the visitor´s oral expressions. When they consented, we audio or video recorded their speeches.

To perform a categorization analysis, we classified the forms that were modeled, as well as the content they express, as well as the given title, aiming at unravelling patterns of reasoning and at perceiving the proposed contents (Arnheim, 1997). The evaluation through artistic expression is currently included in the formal disciplines of artistic and plastic education in Brazil. It focuses on the development process, where the result is not the main object of study.

> "Evaluating implies knowing how the contents of Art are assimilated by students at each moment of schooling and recognizing the limits and flexibility necessary to give opportunity to the coexistence of different levels of learning in the same group of students” (Brasil, 1997).

All the models were photographed and were then classified into three categories: Forms and Proposal, as related to the modeled elements and the title choose for the model and Content, as related to the semantic analysis of the title. The purpose of the analysis was to understand if the participants captured the main message presented in the *Inside the Blood - Traveling Artery* Art Installation (the main blood elements and the presence of a parasite when a parasitic disease occurs), and how this message was structured through their artistic expressions represented in their models (Root-Bernstein & Root-Bernstein, 1999; Minayo, 2005; Bardin, 2009).

Results

Inside the Blood with ArtScience in the Chagas Express XXI exhibition

During the nine days of exhibition in 2019 Chagas Express XXI received more 2,117 visitors mostly (62%) females, from all age ranges (Araujo-Jorge et Al., 2021). They registered at the entry and authorized the use of their images, before exploring the forty thematic ArtScience workshops. Considering the four cities where the *Building your own Artery* workshop was open to public participation, children (1 to 11-year-old) accounted for 11%, teenagers (12-17-year-old) for 7%, adults (18 to 59-year-old) accounted for 65% and seniors (60 to 89-year-old) for 17%. To enter *Inside the Blood - Traveling Artery* was one of the activities of education module # 3, named *Discovery and Play*, that was followed by two other ArtScience activities: the *Building your own Artery* workshop and another workshop named *Portinari & Health*, related to art pieces of the Brazilian artist Candido Portinari.

After entering the exhibition, the visitors could walk among all the 6 education modules and chose what to see and what to do. The *Discovery and Play* module attracted visitors from all age ranges, from 4 to 79-year-old persons, but the percentage of children (30%) and teenagers (11%) almost doubled in relation to the general visitors. During opening hours for visitation of the *Inside the Blood - Traveling Artery* it was rarely seen a moment without people waiting on the line to enter inside the installation. At the last module of the full exhibition (*wagon 6*) participants were asked to evaluate each wagon and to sign the consent forms. Wagon 3 activities got 285 evaluations for that were stratified as: 57% loved, 38% liked it very much, 4% liked it more-or-less, 1% I didn´t like it, and no one *hated it*. So, a large majority approved the proposal of Wagon 3 workshops, including the visit at the *Inside the Blood - Traveling Artery* and the *Building your own Artery* Workshop: 95% liking very much or loving it, this validating the proposal of this ArtScience portable installation in its first field test.

Participants Impressions

Only one visitor agreed to record a video explaining the model he produced, and this is what he says: *"So this is the vein, the inside of the vein. Inside there are red and white blood cells. Then when the Trypanosome cruzi gets there, the white blood cells, they re-lease antibodies that go there in the Trypanosome cruzi and they will try to defend the body and there are many, you know, and they will try to defend the body."* This is an example of his perception, when trying to explain to the mediator what he saw and felt while entering the *Inside the Blood - Traveling Artery*. Since part of the adult participants in this endemic area (Araujo-Jorge et Al, 2021) were seropositive for Chagas disease, sometimes they reported their own feelings related to the disease. Moreover, they had also memories related to family members that were infected or that died Chagas Disease (Araujo-Jorge et Al, 2021). Death in this illness is related to heart insufficiency, to heart rhythm alterations that induces sudden death, or to gastrointestinal disorders. Those perceptions were better evidenced during the creation of their own mini-artery clay models.

Expression in the modeling clay activity: an art methodology

During the nine days of the *CEXXI*, the participants in the *Building your own Artery* Workshop got free access to the modeling clay workshop materials (Fig. 7) and produced 160 models (Fig. 8), their own arteries, produced in four of the five visited cities: Grão

Mogol with 77 models produced, Espinosa with 47, Montes Claros with 25 and Belo Horizonte with 11 models. The interest in participating on the modeling clay workshop depended on the available time, which was higher in the first two cities. The workshop table setup included modeling clay of distinct colors, paper, coloring pens and glue (Fig. 7). Most of the children spent about 10 to 20 minutes modeling in the workshop, with interest and visible satisfaction expressed in their face. A friendly conversation usually started between the participant and the mediators (Fig. 7).

Figure 8. Some models clay produced in *Building your own Artery* Workshop. (A) A representative model entitled: "dangerous parasite" (*parasita perigoso*, in Portuguese); (B) A representative model entitled *inside the blood*; (C) A conceptual model entitled *Didn´t want to contaminate the blood*; (D) A representative drawing of a 5-year old boy (Felipe); (E) A conceptual model entitled *Fear* (*medo*, in Portuguese); (F) A conceptual model with content expressions; (G) Forms associated to blood elements. Source: Self-authorship.

To understand the messages communicated by visitors, the 160 models were photographed (Fig. 8) and classified as Forms (e.g. a form referring to a red or a white blood cell, or to a parasite) and Proposal (representative or conceptual), as related to the modeled elements and the title choose for the model and Content, as related to the semantic analysis of the title. The synthetic frame is shown in Tables 1 and 2.

Table 1. Frequency distribution of the Forms and Proposal categories observed in the models build by the participants of the *Building your own Artery* Workshop.

Category of the Models produced. (n=160)	**Parasite**	**Red Blood Cells**	**White blood cells**	**Parasite + Red + white blood cells**	**Inside a white blood cell**	**Plasma**	**Anti-bodies**	**Total (n=160)**

Forms	81%	82%	89%	69%	24%	17%	19%	100%
				Proposal				
a. Representative	36%	38%	37%	35%	14%	0	13%	39%
b. Conceptual	44%	44%	51%	34%	7%	16%	6%	61%

The artistic manifestation of knowledge or information consists of content and form. By observing, thinking, questioning, and understanding, the subject is expressing and associated understanding between new and old knowledge (Ostrower, 2010). When developing a visual model, the person/the artist chooses elements such as words, shapes, symbols, and colors, so that through the total composition he/she conveys his/her main message (Urssi, 2006; Bardin, 2009). The Forms category (Table 1) was created to relate the main forms presented within *Inside the Blood - Traveling Artery* (red blood cells, white blood cells, antibodies, and *T. cruzi* parasite) to the shapes modeled with plasticine in visitors' representations. It was then subdivided into Parasites, present in 81% of the models, red blood cells in 82%, White blood cells in 89%, Antibodies in 19% and Three Shapes in 69%, the latter considering the models that present the three forms together. It was also observed the representation of the interior of white blood cells in 24% of the models, also present in the scenography model, and the representation of plasma in 17% of the models.

The Proposal category aimed at separating the models by titles, since we asked the participants to write a title on their models; however, the proposal also considers the representation in the artistic expression of visitors (Fig. 8). The mini-artery models that expressed a representative proposal (presenting a specific knowledge on the theme), accounted for 39% of the total and those that expressed a conceptual proposal, sensations and feelings associated with the theme, accounted for 61% of the total (Table 1). In the Figure 8A-8B it can be seen examples of representative models: *dangerous parasite* (*parasita perigoso*, in Portuguese), and *inside the blood*. Figure 8C a conceptual model, entitled *I didn´t want to contaminate the blood*. Out of the 160 models, six had no title, and we embedded them between conceptual or representative based on the identification per-formed just by modeling interpretation (Arnheim, 1997).

The Forms category was associated with the Proposal conceptual subcategory, forming a new category: Forms + Conceptual, searching for expression of connections be-tween ordering and content representation through forms that clearly showed conceptual and subjective expression. Models with concept titles and the three forms account for 34% of total production, concept titles + parasite shape appear in 44% of the models, concept titles + red blood cell form appear in 44% and concept title + white blood cell appear in 51% of the models (Table 1). In some models, the participants decided not to use the modeling clay but to draw their impressions (Fig. 8D). The Content analysis of the titles enabled to the identification of seven subcategories shown in Table 2, considering that only 154 models that were entitled.

Table 2. Frequency distribution of the Forms and Proposal categories observed in the models build by the participants of the Artery ArtScience Workshop.

Content category	**Number of titles**	**Percentage**
A-Blood/Artery/Heart	46	30%
B-Blood elements	23	15%

C-Contamination by *T. cruzi* parasite	28	18%
D-Chagas Disease/ Acute phase	12	8%
E-Feeling	22	14%
F-Action	15	10%
G-Art	8	5%
Total	154	100%

Information related to cardiovascular/blood vessel structure and function was present in 45% of the titles (categories A+B, Table 2), calling the public attention more intensively. Concepts related to specific content concerning Chagas Disease emerged in 25% of the titles (categories C+D, Table 2). Interestingly, minor categories related to feelings, action and even art, also emerged in the titles chosen by the public (categories E, F and G). Figure 8E show a conceptual model entitled *Fear* (*medo*, in Portuguese), prepared by a 10-year-old girl. Another conceptual model (Fig. 8F) that express feeling: it was prepared by an old woman that explained she modeled a person (a human body) to put inside the card scene, using grey color for its head and writing: *grey is the color of our pain*. In the Figure 8G we simulated the three main forms associated to blood elements.

Some productions drew attention during data analysis. A drawing made by a 5-year-old child (Fig. 8D), considered as a representative model, communicates essential aspects about the context observed when visiting *Inside the Blood - Traveling Artery*, such as the difference between the elements that circulate through the blood, the perspective of distance between the elements and the floor and the child's size scale in relation to de model's cell representations, which shows that the artistic expression communicated some visual understanding of the blood learned in the visit. Figure 8E shows a model of a 10-year-old child who was having difficulty to write a title, and the mediator suggested that she de-scribe a feeling through the activities of Chagas Express XXI, and she said *fear*. It can be observed the presence of two main forms, the parasite, and the circular shape, which is probably representing the red blood cell, by the format used. The model in Figure 8E portrays the child's understanding of the severity of Chagas Disease, the fear expressed in its title reflects the feeling of the reality of the place where he lives and the people, he knows who may have the disease. Participating in the expedition's activities and being presented to scientific studies and research, she expressed feelings about this new knowledge in a personal way, possibly afraid of receiving a positive diagnosis and feeling fear due to the memories related to friends and family having the disease.

More than half of the models were made in the cities Grão Mogol and Espinosa, however, comparing the results with the cities Montes Claros and Belo Horizonte, it is possible to notice that in the first two cities the visitors produced many models with conceptual proposals. In Grão Mogol 78% of the models are in this category and in Espinosa 60%, in Montes Claros 36%, less than half, and in Belo Horizonte only one model was considered conceptual. The relevance of the theme to the population of the first two cities may be related to this result. Moreover, in Montes Claros and Belo Horizonte the public was specialized, most of them health agents, university students and

researchers. Another relevant fact is that 71% of the models with titles show knowledge about the content presented within the model (subcategories A, B, C and D) and only 29% of titles show words that represent sensations, such as feelings, actions and art. Models with conceptual titles that are also associated with subcategories that present content information on the theme (A, B, C and D), represent 66% of the total, stating that the development of a multidimensional artistic expression activity as an evaluation tool. The construction of meaningful learning resulted in the visitors' creations with scientific information associated with subjective messages with personal meanings related to the theme.

The participant who produced an mini-model represented in Figure 8F reported having a diagnosis of Chagas Disease, which can be seen in the written information and modeled representations. It is observed the representation of the human body in the center of the model, and different forms composing this body. Because she could not write, she asked her to identify the elements she produced instead of putting a title. The colored elements represent the *defense* of this body and the parts where the white plasticine is mixed without a definite color are representing the *color of the pain we feel*, expressing the physical pain her feel from having the disease and empathy with other people also with the disease. The major form of pain representation is in the position of the head of the human figure, an essential member for survival, intensifying the significance of disease in this representation. It can also be observed the representation of the three main forms associated with the main element shapes of the giant model, red blood cells, white blood cells and *T. cruzi* parasite (Fig. 8G).

The identification defense was associated with the content presented that the body has defenses, which will act in the case of an infection, as occurs in the Chagas Disease. The elements associated by the word *defense* and the forms are represented with colors, which apart from each other, differentiates them from the conceptual part, the pain related part caused by the disease. This example of a conceptual model contains artistic expressions related to the scientific contents addressed in the model, such as the circulation of different elements in the bloodstream and the body's defense against an element that causes a disease. There is also a main message of a subjective nature, the disease causes a physical pain, represented with an *ugly* color, unlike the colors of healthy blood. The visitor presented in her model a content related to a person life, full of meanings associated with scientific information. Intelligence does not act alone, thinking, observing, creativity, understanding and abstracting are part of the construction of new knowledge. To learn content in a meaningful way is to perceive language as a new way of perceiving, added to previous knowledge and the relevance of new knowledge and capacity of transference, the subject perceives and represents the world around (Bardin, 2009; Perkins, 1994).

During the exhibition, many participants asked for a written folder that could help them remembering the immersion experience they had both in by entering *Inside the Blood with ArtScience* and by playing and creating artistic models in the *Building your own Artery* Workshop. We then prepared the folder (Fig. 9) that started to be delivered in the successive presentations in non-formal events for science and blood education.

Figure 9. Publicity Folder of the *Inside the Blood with ArtScience*. Part of the folder with the logo, developed after the *CEXXI*. Source: Self-authorship.

Discussion

Authors should discuss the results and how they can be interpreted from the perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted. The two objectives of the present study were accomplished: (1) the concept and design of *Inside the Blood with ArtScience* Art Installation proved to be interesting to attract the public attention and interest, and (2) it´s testing in field conditions confirmed its high education potential, as judged by the concepts, feelings and proposals embedded in the mini models created by the public after visiting the installation. The model can be adapted to other blood-related subjects, such as diverse virus that are trans-mitted through infected blood (HIV and Hepatitis B, for example), blood and bone marrow donation, blood transfusion, leukemias, or others.

The evidence for public approval of *Inside the Blood - Traveling Artery* installation was the high rate of attraction of visitors to participate in the activity, and the 95% *excellent* and *very good* evaluations received in 285 answers. However, the most interesting results emerged from the analysis of the models prepared in *Building your own Artery* Workshop, showing that more than 80% expressed the information shared in the installation and in the mediation. Studies on Gestalt, the psychology of form, address the main theme of making explicit what is implicit: understanding and analyzing any subject requires recognizing that any system, as a whole, is made up of parts acting among themselves. A visual artistic work is conceived by integral parts to exist as a totality, and one way of analyzing it is to decompose the visual elements that constitute it, for a deeper knowledge of its specific qualities. The blood vessel models created by *Inside the Blood with ArtScience* visitors were broken down primarily into Form, Proposal and Content to understand how the participants captured the main message.

The result of the analysis of the forms category showed that in 94% of the models at least one of the three main forms appears, and the form that most appears is that which

represents the white blood cells in 89% of the models. This result may be due to the content presented throughout the *Inside the Blood - Traveling Artery* mediation about white blood cell acting in defense of the organism. The main theme addressed during the visit was the infection of the parasite *T. cruzi*, an invader in the bloodstream, the incidence of white blood cell shape in 89% of the models may be indicative of the understanding of this function in the blood. The representations of the interior of the white blood cell in 24% of the models point to the understanding that these elements are cells that have distinctive characteristics. In addition to the three main forms, plasma was represented in 17% and antibodies in 19% of the models, antibodies were represented in Art Installation, plasma was not, but was part of the content covered in mediation to the visitors.

The three main forms are present in 34% of the conceptual models, the parasite shape in 44% and the white blood cell shape in 51%, the defense function content also featured in the conceptual models, association this content to the subjectivity in every unique message. This result corroborates with the effectiveness in communicating scientific content through the artistic expression, acts in the ordering of forms, by means of which one aims at content, the form converts the subjective expression in communication of the learned scientific information. The artistic expression of scientific information needs to define perceptual patterns to represent content, seeking connections between imagination and logical reasoning, which can be defined by *transformation of quantified data which is not visual is into a visual representation* (Manovich, 2011). A scenography installation, when used for research and teaching needs to involve the visitor in the narrative of the scientific content.

> "Science outreach must strike a delicate balance between public accessibility and scientific accuracy. On the one hand, science outreach must truly reach out, engaging and entertaining the public. The most effective outreach impacts minority groups that are sometimes excluded by society from understanding the latest advances of science and experiencing current contemporary art. On the other hand, science outreach must also be deeply rooted in accurate scientific concepts. In particular, the all-too-common propagation of scientific misconceptions must be prevented and corrected." (Mast et Al., 2016)

Looking at an artistic representation is a temptation to find meanings, it is to create *a particularly supportive platform for building thinking devices* (Perkins, 1994). In the case of a nonformal teaching environment, learning can go beyond acquiring new knowledge, skills to change attitudes, values, fun and abstraction on a given subject, inspiration, and creativity, learn in that context, it is more than information acquisition (Pegram, 2016). Allowing the public to get involved with the scenography environment is to enable them to make associations with their previous experiences, building new meanings for the content presented, cognitive, social, cultural, and personal meanings. Peter Slavenburg (2012) developed in his article *Seven commandments* seven steps for a scenography exhibition to reach the public in an effective and empathic way. He says that when the public is invited to action, the information is better absorbed and better understood.

> “An exhibition is about telling stories.
> An exhibition is about real stuff, about authenticity.
> An exhibition is about creating action, about mental and physical.
> An exhibition is about focus, about making clear choices.
> An exhibition is not about me, but about we...
> An exhibition is about sparking inspiration.

An exhibition is about love and passion." (Slavenburg, 2012)

An experience of scenography immersion works within space and three-dimensional forms, where the visitor can experience a series of perceptual events (Arnheim, 1997). An artistic expression is based on the visual perception of an idea or concept obtained by intellectual abstraction. At the basis of artistic expression is form, which *is the visible configuration of the content*, where two perceptual concepts, Eidetic Images of Memory and Isomorphism must be included to enable the evaluation of the artistic expression of different contents.

Conclusions

Subjectivity and meaning are characteristics developed by Art, by artistic making, resulting in creativity and action. To learn meaningful content, the subject captures new meanings by making relationships with meanings that he/she already has, building his/her new knowledge through a reorganization of his/her old knowledge. This capacity of transference and connection of meanings will depend on the predisposition to learn, the language, words, signs, instruments, and analogical processes acting through the person´s perception, attracting him/her to the new knowledge in search of meanings and relevance of the content for his/her life (Moreira et Al., 2019). The pictorial or imaginary is determined by the visual information, the totality of data. Knowledge structuring is the result of the individual´s mental state or mood, type of need that motivates research and how he/her perceives what it is observing (Ostrower, 2010).

It is interesting to note that some negative feelings and perceptions were expressed by the participants, as they talked about *fear*, or *pain*. Dealing with a condition that has the stigma of causing death and of not having cure is a permanent and actual challenge for Chagas Disease (Sanmartino, 2019). COVID-19 pandemics raised similar feelings of fear and a recent study has shown that *the only predictor of positive behavior change* (e.g., social distancing, improved hand hygiene) *was fear of COVID-19* (Harper, 2021). There is some evidence that art therapy activities even help people to control fear (Sezen, 2019). In fact, for Chagas Disease, aware-ness of the environmental risks as well as engagement in activities for increasing knowledge and population empowerment towards the collective fight for health rights (access to diagnosis and integral care) are the associated to the feelings of fear and to the attitudes of facing and overcoming fear.

The process of developing the model from analogical relationship with previous and personal knowledge and with *Inside the Blood with ArtScience* is characterized by the use of the 13 cognitive categories, the tools for the development of creative capacity (Root-Bernstein & Root-Bernstein, 1999) can be perceived from the visit in scenography model, observing, recording, evoking images and abstracting; throughout the dialogue process, recognizing and forming patterns, establishing analogies and thinking dimensionally, modeling, playing, transforming and synthesizing until the completion of the models with a title. It is important to understanding this process, where at all stage's participants make use of these categories simultaneously, assisting in the process of creativity and communication, by structuring the learning of meaningfully learned knowledge.

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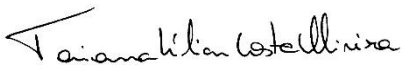
Declaração de Conflito de Interesses

Eu, Taiana Lílian Costa de Oliveira, autora do artigo Por Dentro do Sangue com ArteCiência no Expresso Chagas XXI - Inovação Para a Educação Científica e Promoção Da Saúde “Declaro não haver nenhum conflito de interesse que pudessem influenciar de forma inadequada o desenvolvimento ou as conclusões do trabalho, seja de origem financeira, política, acadêmica ou comercial



Assinatura

DECLARAÇÃO DA CONTRIBUIÇÃO DOS AUTORES

Declara-se que todos os autores listados nesse estudo contribuíram intensamente para a elaboração, realização, manipulação dos dados, escrita do trabalho e leitura crítica. Segue o detalhamento:

Taiana Oliveira – contribuiu na Conceitualização, Curadoria de dados, Análise formal, Aquisição de financiamento, Investigação, Metodologia, Administração de projeto, Recursos, Software, Supervisão, Validação, Visualização, Escrita – rascunho original, Escrita – revisão e edição;

Thallyta Vieira – Validação, Visualização, Escrita – revisão e edição;

Rita Machado - Validação, Visualização, Escrita – revisão e edição;

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