Stand of Science: mobile communication science inquiring about culture and society in schools

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Abstract

The "Stand of Science" is a project of mobile science communication, that uses newsstand-like structures and other simple exhibition materials to bring science exhibitions to public locations as parks, schools, and events. It is driven by three main principles (1) the employment of low-cost and simple materials; (2) the connection of cultural manifestations and social issues to science, mainly by using artistic and media resources; (3) the joy aspect of science, by the use of games, recreation, and entertainment resources. In 2013, we started with initiatives more directly in schools, by involving teachers in the development of school projects with their students. We settled the work in two modalities, JOANINHA (Ladybug), for 4-7 years-old students from kindergarten to elementary, and ALICE for 11-14 years-old students of junior high school. In JOANINHA we perform activities with puppetry, logical games, songs, costumes, handcrafted toys and mockups, approaching themes as space exploration, robots, animal rights, and women in science. It foresees the parents´ participation as well, in workshops and in helping their kids to prepare exhibition materials. In ALICE we approached similar topics adapted to teenager´s interests, with TV series, pop-rock songs, handcrafted robots, simple experiments, role-playing humor sketches, science fiction and fantasy books, and so on. As for JOANINHA, in ALICE we promote a final exhibition to be for the schoolmates, parents, and the school community.

Keywords: Science outreach; early childhood science education; tween science education; science and art; social issues.

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Background and principles

Our current research interests derive from previous experiences of graduate students, from the second half of the 1990's, in two Physics Education projects that existed at the time in the Institute of Physics of the University of São Paulo:

a) The "Experimentoteca-Ludoteca" Project, something like "Playful Library", coordinated by Professor Norberto Ferreira (Ferreira, 1993), which developed low-cost playful experimental resources for science teaching, by using simple and familiar materials to reproduce classical didactic experiments and toys about Mechanics, Electricity, Optics, and so on.
b) The "GREF – Grupo de Reelaboração do Ensino de Física", a project, or "Group for the Re-Elaboration of Physics Teaching", managed by professors Luis Carlos de Menezes and Yassuko Hosoume (Hosoume & Menezes, 1993), which proposed materials and methods for a student's everyday life-based approach to Physics Teaching. As an example, to discuss Mechanics, Thermodynamics, Electromagnetism, based on things students use, see or are interested in, such as electronic gadgets, vehicles, home appliances, etc.

In addition to providing experience to produce didactic material, such activities were the basis of our actions in ongoing training programs for teachers. In terms of the elementary school, programs began in 2005, for example, the "ABC na Educação Científica – Mão na Massa" program. This is a program on Inquiry-Based Science Education (IBSE) intended mainly to elementary school, and it derives from the French program "La Main à La Pâte", and can be linked to the Nobel-Prize physicist Georges Charpak. This led to the implementation of a similar program in Brazil, with three initial poles in institutions of non-formal science education, namely "Fundação Oswaldo Cruz" (Oswaldo Cruz Foundation, known as Fiocruz), in Rio de Janeiro, "Centro de Divulgação Científica e Cultural" (Center for Scientific and Cultural Dissemination, or CDCC), in São Carlos, and "Estação Ciência" (Science Station), in São Paulo, with the two last ones pertaining to the University of São Paulo. The Brazilian Academy of Sciences program supports the program, which is still working throughout Brazil.

One important aspect with which we were concerned, was the role of knowledge sources other than textbooks and the traditional didactic resources usually employed in science teaching. The experiments could be more than a lively way to explain concepts, but it can be a source of real pleasure as well, just like toys, games and other cultural products that children like so much. One of the basis for such wonderings was the work of the French pedagogue Georges Snyders. In the 1980's, he wrote a book entitled "Le Joie à l´École" (Snyders, 1986), in which he states the contradictions that exist between the cultural forms that the school system proposes and those with which the children are so intensely engaged, such as music, sports, concerts, fashion, flirting, among others. He wonders if it would be possible to engage students in an "elaborated culture", which school could provide, as much as they do with their "primary culture", which derive from their spontaneous experiences. In other words, how could the school provide to young people a similar and even deeper joy on knowledge?

There are many possibilities to develop and test those ideas. Since around 2004, based on some personal classroom experience with the use of science fiction to teach science topics, we developed several classroom activities with science fiction films, novels and short stories. We started to use them to discuss not only the products of science – concepts, laws and phenomena – but also the mechanisms of scientific knowledge production and the relationship between science activity and social context.

Based on these practical experiences, we investigated science fiction reflecting classroom experiences (Piassi, 2007). These studies were a basis to develop theoretical analysis instruments to deal with science fiction from the point of view of the science teacher. Classroom approaches to science fiction are often based on identifying science concepts and discussing the distortions on "real" science presented in stories. We consider that a somewhat naïve approach. By considering science fiction as a fictional construction built over a social discourse about science, we were able to deal with such "errors" and "distortions" from another point of view. Instead of distortions, we can think about certain ideological positions about science that we can identify in science fiction works. Most of the time, such positions can be described in terms of polarities, in which each one of the poles represents beliefs or disbeliefs related to the roles that science plays in our lives.

Thus, we obtain some theoretical framework to address not only the application of science fiction itself, but also a broader field of cultural products (possibly) inserted in the science education context, from the playful experiments to toys, films, books, songs, and so on. We were looking for some way to mix it all, considering the pleasure that such things provide to young people in their spare time. However, as Snyders points out, even though such spontaneous joys are real, they are also ephemeral and superficial at the same time. They pose a sort of questions and interests that a more systematic and critical reasoning could address in a more satisfactory way.

Two initiatives have evolved in the past 8 years. The first one was to carry out an ongoing training program for in-service public school teachers, using the IBSE approach, and the elements we were

working with, from playful low-cost experiments to movies, games and other resources. We started with a 30-hour course called "Physics in the K-8 School: Interdisciplinary Activities in a Sociocultural Perspective", as a proposal for ongoing education of science teachers based on Vygotsky's socio-historical theory (Vygotsky, 1978, 2012). This study enabled us to establish the analysis of some criteria to evaluate the choices between different approaches to teaching. Our studies point to the need to examine classroom activity according to multiple aspects that involve not only the conceptual realm and the actions of the teacher and the student alone, but also and mainly, those related to social interactions in the classroom environment (Santos, 2010). On this basis, we planned a second course, a 360-hour course called "Specialization in Astronomy Teaching", in which we proposed to evaluate the model of teachers training teachers in a continuous manner designed to engage participants in the development and the undertaking of didactic activities through social interactions driven by Vygotsky's socio-historical theory. In order to monitor the teachers' didactic production, we developed two instruments: "improvement indicators" and "interaction profiles". The former enabled us to analyze and control the development process activities through formative assessment. Its aim was both to identify and to offer opportunities for correction and improvement by means of descriptive opinion. The latter, in turn, enabled us to analyze the interaction among teachers within their working groups. We observed that the creation and development processes of these activities were directly related to the different ways in which these interactions occurred within the groups (Vieira, 2013). The second initiative was the "Stand of Science", or "Banca da Ciência" in Portuguese, which we will now describe in a detailed manner.

Stand of Science

The scientific diffusion happened to be a particularly interesting object of interest for us, mainly after the previous experiences at the "Science Station". We are interested, however, in ways to decentralize the science centers. The main reason is that there are few museums and science centers in Brazil. It is hard for most children to visit such facilities, even in a large metropolitan area, such as São Paulo. In Brazil, there are some "mobile science" initiatives to bring the experience of museums and science centers to a wider audience. Among them, we can mention the "Mobile Science" itself, a program of Oswaldo Cruz Foundation, which uses a truck as a science center. Other interesting projects are "Art and Science in the Park" (Muramatsu & Robilotta, 2011), which makes science exhibitions in open public spaces and "Truck with Science", which uses a cargo vehicle to carry science hands-on exhibitions to public schools (Souza & Siqueira, 2011).

Our "Stand of Science" fits in this category of projects. It derived from another project called "Ecoteca", from the non-governmental organization Educare, which consists in mobile libraries for children built on structures similar to those used to sell magazines and newspaper. The project coordinator, Mr. Jonar Brasileiro, contacted one of our friends, the high school Physics teacher, Mr. Ricardo Magalhães, who had the idea to adapt the Ecoteca model to mobile science centers. In 2009, that led Educare to hand over a stand to EACH-USP, in order to support researches to develop such idea. Next, we asked agencies for financial support, which made possible, during the 2010-2011 period, to develop both materials and exhibitions, as shown in Figure 1.

Figure 1. (a) The first "Stand of Science" in an exhibition to public kindergarten teachers, in Guarulhos campus of Federal University of São Paulo - UNIFESP (2014). (b) The new stand, designed for transportation by regular car winches, in the Youngsters Exhibition of Brazilian Society of Science Progress meeting, at São Carlos Federal University (2015). Photos: authors.

One aspect we would like to emphasize is the expectation relationship. What kind of experience are the visitors expecting when they come to an exhibition? According to Henning (2006), both museums and exhibitions are not regularly seen as media, nor are they studied from cultural perspectives. Hence, it is rare to think about the implicit messages that certain choices express in the production of materials. As a simple example, we can mention Henning's reflection regarding the glass case often used in museums to display artifacts: "the glass case confers an instant aura of preciousness. It places them in a space and time distinct from that which visitors occupy – protecting it from deterioration, pollutants, and changes in

temperature" (Henning, 2006, p. 8). Henning gives this example when she discusses the well-known Marxist concept of commodity fetishism and she applies it to the museum case. Commodity fetishism is a phenomenon where people attribute essential value to the thing itself, instead of the human labor necessary to make it up. In other words, the focus is on things, rather than on people.

We do not want the visitor to see the "Stand of Science" as a consumption place, despite the "point of sale" metaphor implicit in its constitution. When we think of a stand or a stall, the acts of selling and buying comes automatically to our mind. We go to a newsstand, or a fair stand, or a juice stall to buy something or, at least, to get informed about things (or services) to acquire or consume. However, what we offer instead is a knowledge experience, with some bit of humor and a kind of entertainment or leisure that implies a non-passive attitude to the visitors. They have to decode situations, wonder about phenomena and ask for answers to their questions.

In some way, that is a kind of expectation break, in the sense that, at first glance, the visitor sees the "Stand of Science" as a point to sell something, but instead what he gets is a learning situation, which requires direct engagement, handling things, social interactions, and so on. Thus, it is not a consumption relationship after all. The very constitution of the things they will find at the stand is not that of a mass-market industrialized product we can find in stores. On the contrary, what they will find is simple handicraft things that suggest they could replicate them by their own means. That is the implicit message we want to convey. You are not going to buy something tricky to show to your friends, such as in a magic stall. You are not even going to quickly and passively watch a performance done by someone. If you want to replicate that experience, you will be able to do that, because the necessary things to do that are simple, manageable, and accessible.

Additional funding helped us to improve both the action model and the overall design model to the Stand of Science. We set standards in visual communication, materials, dimensions, exhibition devices formats, monitors´ uniforms, and so on. One of the main developments was to plan strategies and materials in order to take small exhibitions to locations where it was impossible to carry the stand itself. However, when we tried to move the stand from one point to another, we realized that its specific structure required a lot of specialized (and expensive) work to make it mobile. A redesign was necessary for transportation – such as wheels, a more robust steel frame, dimensions similar to an automobile, and handles designed to attach it to a truck body. Therefore, we could haul it in regular vehicle winches, a much cheaper service, available everywhere (Figure 1b). In addition, this new mobile stand is designed to remain outdoors, also relying on a system to capture rainwater.

Even with this better designed stand, it was not that simple to use it to make exhibitions in every location we wanted or were asked for. In some situations, it would be more effective or suitable to have more portable equipment. So we adopted two strategies. The first one was in some way maintaining the idea of a kind of "point of sale" for science, but in a smaller scale, something like a fruit stall that offers science instead of fruits. Other strategy we adopted to carry science exhibitions clearly associated with the idea of a "Stand of Science" was to create a visual identity that resembled a "point of sale for science", just as the stands do. With that in mind, we chose standards for materials for exhibition devices that could follow the reproducibility and the simplicity of the ideas. We projected displays as a kind of 3-D posters, by using boards of perforated eucalyptus wood shavings. This is a cheap and versatile eco-friendly material, which could accommodate both exhibition artifacts and small explanation posters.

The focus of the project is not to reach the widest possible audience, nor is it to disseminate the "Stand of Science" on a large scale. Although such aspects are desirable, our main interest is to produce knowledge that schools, non-formal educational spaces, municipalities, universities, and other institutions can duplicate at the local level.

Among the schools that visit the Stand of Science or that are visited by it, we work currently with some fixed pilot schools in which one or more teachers directly integrate with the project team, attending regular meetings and developing, under our guidance, specific interventions. Its structure allows not only the necessary evaluation of the actions in the school space, but also the individual subprojects to find room for systematic research. We understand such kind of actions as non-formal interventions in the school space (and other educational spaces), which is, by definition, a formal education environment. We are especially concerned about this interaction between non-formal and formal education mediated by the university- school relationships since it promotes several research possibilities.

Ladybugs in wonderland: The non-formal interventions

Based on our former experiences with science fiction and its possible uses to teach science, we started to research in this field. Things went a little broader than science fiction itself, extending to other similar cultural expressions that include several kinds of media and materials. In general, we assumed it is adequate to label such investigations by the more general term "fantasy". Therefore, we can say that we started a research line on fantasy studies applied to science education.

Fantasy narratives are present all over the education since early childhood, from fairy tales to modern cartoons feature films. They depict the natural and social world by means of fantastic

representations of phenomena, beings and situations, involving things like dragons, talking animals, magic, extraterrestrial beings, robots, enchanted forests, animated toys, and so on. Children build an important part of their worldview through those representations in books, puppets, games, toys, comics, films and other media, including the one relative to nature and society. With the development of the graduate program on cultural studies at EACH-USP, we started to undertake systematic research in this area, seeking to investigate the relationships between the socio-political dimensions of science, the civilizing process and media for youngsters and children represented in cultural industry products of audiovisual fiction, printed and musical expression. With the parallel development of the "Stand of Science", since then we have been trying to make connections between these two streams of researches concerns. On one side, the exhibitions actions with the playful experiments, handmade toys, among others, and in the other all that media stuff, which, despite being interesting for science teaching, was not simple to configure in terms of the classical itinerant science center proposal.

In 2010, we obtained resources from a federal agency for our project "Reading Science", so that we could explore the use of fictional works in classrooms. Initially, this work included such things as "Teaching the Theory of Relativity with Novels", "Using Fantastic Tales to Teach Physics" or "The Use of Comics to Teach Science", among others, which derived from master´s degree works. We consider that the teaching of science should incorporate socio-cultural and political themes related with the sciences, including approaches to the arts and social sciences. Our proposals were precisely about that. All these works, however, concentrated mainly in analyzing some materials and formulating possible didactic activities, while there were only occasional practical and systematic classroom applications.

For the results to be more effective, we decided to perform regular actions to ensure organized data gathering, which led to two projects. The first one is called JOANINHA (Joy, Observe, Analyze, and Narrate: Inquiries on Nature, Humanities, and Arts), intended to early childhood (between 2 and 6 years-old) and it focuses on how children use literature, puppetry, toys, games and playing. Currently, it has three kindergarten schools involved. The other project is ALICE (Arts and Ludicity on Inquiries of Science Culture on Educational Environments), directed to pre-adolescents (tween) audiences It is intended for 10-14 years-old students, and it is based on extra-curricular activities, which involved music, cinema, robotics, role playing, TV series, debates and so on. We are performing it in two public schools. The acronym JOANINHA forms the word for "ladybug" in Portuguese, as that animal is a commonly present figure in several media and products targeted to early childhood. The second acronym refers to the well-known character from Lewis Carroll´s juvenile fantasy stories.

The first systematic application of that took place in 2011, based on two undergraduate investigations, which focused on illustrated children's books in an action directed towards younger children. The interventions occurred in public elementary schools, where we explored possibilities and educational applications of children's books, puppet theater, cartoons, toys, among other resources. For example, from children books like "While Mummy Hen Was Away" (Young-so; Byeong-ho, 2013) and "Rosie´s Walk" (Hutchins, 1971), which tell stories about hens going to walk outside her fowl run (or "home") and things gone bad, a wolf threatening her eggs in the first one or a fox chasing her in the second one. By using books like these to address critical inquiries and to promote playful and didactic activities about such themes, we believe we can fulfill important goals to teach science concepts, to discuss social issues, and to develop both language and artistic skills.

None of these books were written as a resource to teach science, but clearly several concepts could be explored, such as food chain, predator-prey relationships, and others that were less obvious, deriving from such questions as "Why does the hen live in the farm while the fox lives in the forest?", "Why don't the wolf stay at the forest? Isn't there food him out there? Why?", or even "Is it true that when a hen leaves her home bad things always happen? Why?" Such simple questions may address environmental issues, animal rights, and gender relationships, among others. It was explored as a puppetry show.

The activities involve text production, research and the use of art and media for expressions of scientific content: panels, foldings, paintings, performances, installations, videos, toys, music, fiction texts, among others. Teenagers produce their work and exhibit them, not only in school, but also in non-school settings, such as fairs, exhibitions, and other events. The team includes graduate and undergraduate students from various courses. The activities proposed in this scenario intends to encourage critical observation and to wonder about the natural world, as well as to think about social relationships and practices. For this to happen, we develop recreational activities for children that try to provide real opportunities for sociocultural interaction, while enabling contact with subjects related to science in connection with humanities and arts. It drove not as a curricular content, but as an amusement intervention in the school context. The project as a whole included six fronts, performed by different teams, according to Figure 2.

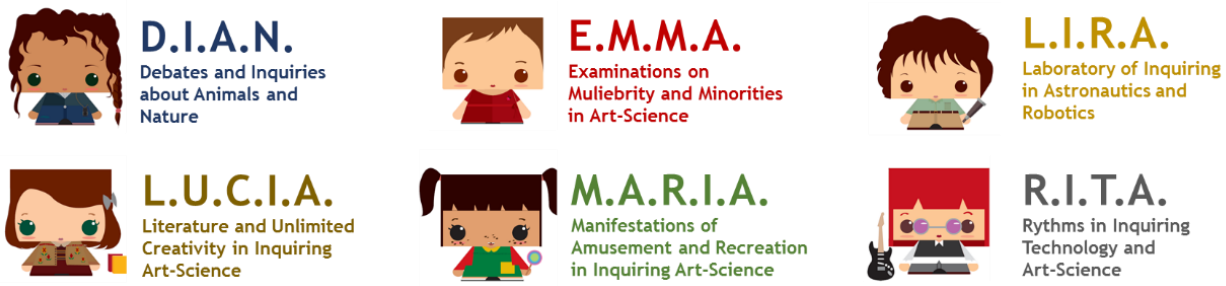

Figure 2. The six "Stand of Science" teams. Each one is named with an acronym that honor a woman whose work relates to the respective team proposal. Illustration: Alina H. Paradiso, from the LUCIA team.

The names of the teams are references to prominent women: Dian Fossey, zoologist and primatologist who was murdered for defending the gorillas; Emma Watson, actress and UN Women Goodwill Ambassador; Jacqueline Lyra, Brazilian Aerospace Engineer at NASA; Lucia Machado de Almeida, Brazilian writer of children literature; Maria Antonieta de las Nieves, Mexican actress of humor for children; and Rita Lee, Brazilian rock star. Because of the interdisciplinary character that we propose, any teacher interested can undertake those activities, regardless of their discipline or training, as well as other school professionals whose expertise or interest can be met.

Conclusions and research developments

The project "Stand of Science", with "JOANINHA" and "ALICE", and the close interaction among them, contribute to several research fronts. We can split them into three main categories:

1. Questions about the production and strategies of science education/dissemination. These questions involve reasoning about the materials and messages and their effectiveness, in a broad sense.
2. Questions about the agents involved (school students and/or visitors, their teachers, undergraduate monitors, graduate students). Here the focus is on educative interactions and on the professional training.
3. Questions about the role of the institutions and the possible results to public policies in several instances, such as school extracurricular projects, science dissemination programs, university school relationship, ongoing teacher training, and so on.

Therefore, our focus is not only on the children themselves. Beyond the basis of the children-oriented work, the Stand of Science program constitutes a professional training process and a laboratory to test possible educational policies in micro scale. We consider the project as a study to contribute to public policies, not only to government instances, but also to the university actions in society. The professional training process has two fronts: (a) the in-service (and in-local) training, directed towards the teachers' work in the school, and (b) the initial training, because university students do all the hard work, and that is part of their professional training as teachers or other careers.

We also believe that key research results derived from the material work, so that the project foresees, at all stages, systematization and dissemination of this material in such a way as to permit its reproduction and adaptation in other contexts. In relation to the participant teachers, discussing suggestions and proposals over the activities and the possible results that they can collect in their classes also integrate the dissemination effort to wider audiences.

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