

Behold the Sky: bringing Astronomy to public schools of Rio de Janeiro, Brazil

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Abstract

In this paper, we present novel strategies and actions to engage the general public into liking Astronomy, such as the lending of high quality astronomical material to perform observations and hands-on activities (the Astrokit). This is of greater relevance, in environments with less resources like public schools or institutions in Brazil. Moreover, we show the importance of Science Museums as centres of non-formal education and the benefit resulting from the relationship museum-school. Worthy to note is the special synergy with teachers, who constitute an essential link within the astronomy education process and induce a multiplying effect derived from the direct access they have to a great number of students and other colleague teachers.

1 Introduction

Astronomy is a science which has great visibility in mass media, being this, perhaps, the reason why children and young people show such a huge enthusiasm about it. Curiosity about the Universe might be easily stimulated without the need of sophisticated laboratories or state-of-the-art telescopes. No wonder that the International Year of Astronomy celebrated in 2009 in about 150 countries was the largest education and popularization of sciences event in history, with a share of 815 million people. Among the justifications presented by [3] for the presence of Astronomy in elementary school, it is emphasized that this science offers the opportunity to realize our insignificance in front of the Universe. And that, according to [1], would result in more people aware of its place in the world and their responsibilities to the planet.

There are other arguments that can be considered to justify the teaching of astronomy in schools. Considering that many astronomy concepts are included in the school curriculum in various disciplines, we must pay special attention to teachers working with these topics

since it is known that they face a number of difficulties, which undermines the realization of empirical activities on the subject. According to [5], in Brazil, these difficulties comprise a “personal insecurity and fear in the topic” as well as a lack of infrastructure in schools; and the “difficulty in carrying out visits to observatories and planetariums”, especially in schools located in the countryside. These reasons justify the promotion of outreach activities in astronomy and teacher trainings.

Museums and science centers are spaces that promote the visitors interest in scientific knowledge, encouraging them to learn more about science and its construction process [8]. The museum, while non-formal education space, has the potential to promote intrinsic motivation to study science [7]. Yet the school can be thought of as one of the most democratic spaces of a country where the formal education system is mandatory, for all citizens passed or will pass through this environment. In the collaboration museum-school lies, therefore, an opportunity to reach a greater number of subjects exposed to the scientific issues, especially when non-formal education spaces can provide these stimuli through ongoing actions [6].

The Museum of Astronomy and Related Sciences (MAST) is a center focused on astronomy outreach where a well-integrated team of astronomers, educators and museologists works together to develop educational material and promote outreach activities, as well as conduct impact studies to assess the efficacy of those actions.

2 Behold the Sky

The project “Behold the Sky” is run by the MAST and the Nacional Observatory in Rio de Janeiro, and lends observing equipment to schools to promote astronomy outreach activities. The main goal of the project is to assess whether these astronomy outreach initiatives contribute to the pedagogic practice of teachers in their classrooms and how this mechanism works. Moreover, a secondary aim is to test the alleged use of astronomy as a inspiring tool in the area of science education and the collaboration established between museum-school.

Every year, hundreds of thousands of students from all over the country take part in the Brazilian Astronomy and Astronautics Olympics (OBA). This has the aim of both spreading astronomy and astronautics-related concepts and training teachers about these topics [2]. After being marked some of the exams are sent by participant schools to the Organizing Committee to select candidates for the international competition. The OBA exam archive thereby offers an unique opportunity to evaluate the teaching of astronomy in Brazil in relation to school level and content, as well as over time. Understanding the common-sense conceptions about astronomical phenomena unraveled by the exams is of utmost importance to planning successful outreach activities. This is exactly what the MAST is doing in parallel to the development of the Behold the Sky project: we are conducting an independent analysis of OBA exams as to understand which astronomical contents bring more difficulties to the Brazilian students. This analysis is helping us to plan all astronomy-related activities promoted by the Museum as well as the planning of the Behold the Sky material project, such as the Astrokit.

“Behold the Sky Carioca” is a branch of the project which targets teachers and public

from the metropolitan area of Rio de Janeiro, whom usually have difficulties observing the night sky due to light pollution and safety issues. Therefore, it focuses on daytime astronomy and solar observations, giving teachers the possibility of carrying out the educational activities while their students are at school.

2.1 The AstroKit

For Behold the Sky Carioca, we have designed an Astrokit composed by daytime astronomical and didactic material, essentially, a solar telescope, solar filters and a handbook of activities adapted to the Brazilian scholar curriculum (Fig. 1). The handbook comprises six practical activities compiled from various educational sources and adapted to a common format. Each activity conveys one physical concept through an experiment, while providing the background theoretical framework. The covered concepts are: localization and orientation (compass), counting of time (sundial), the orbits of planets, the seasons of the year and the real size of the Sun. These hands-on experiments mostly rely on low-cost materials and resources to demonstrate that science is accessible to everyone. The activities can be performed with both primary and secondary education students.

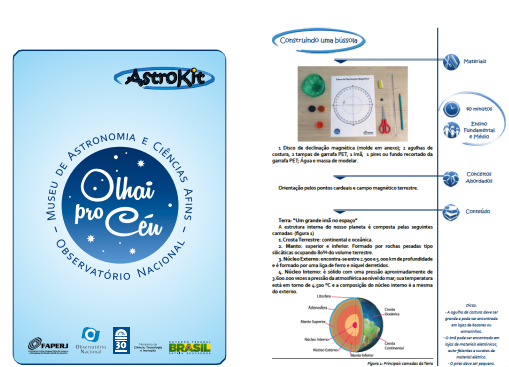


Figure 1: The front cover and first page of the activity "Building a compass" of the handbook.

The interested teachers may borrow the material after completing a specialised training, given by astronomers from the Museum (see Sec. 2.2). When returning the kit, teachers are requested to fill a questionnaire to give their impressions on several aspects, such as the utility of the didactic material, the adequacy of the training, and whether the before-hand expectations were fulfilled.

The associated research project is focused on optimizing the Astrokit, so that it becomes a material which teachers can use to improve their practice, as well as evaluating the use of such material. Our long term wish is that, the Astrokit may serve as a model for other Science Museums, Planetaria, or even Universities Outreach Departments, interested in developing similar lending materials to cooperate closer with schools and teachers.

2.2 Teacher Training (ECAP)

The training aims to present the AstroKit to the teachers and, above all, enable them to handle the telescope, so they feel confident to perform the activities and observations by their own at their schools. It happens in the last Tuesday of the month from 14:00 to 17:00 in the auditorium of the headquarters building of the MAST, and its design is heavily based on the Teacher Advisory Meetings (EAP) promoted by the Coordination of Science Education of MAST.

Along the process we learned that the best format for the realization of the training is to divide it into the following steps: 1) Collection of teachers' expectations (written) of participation in the project Behold the Sky and, if necessary, collecting the missing documents necessary for the loan of the AstroKit; 2) Oral presentation via slides of the history and goals of the project, astronomical topics covered in the handbook and concepts about the Sun; 3) Practical training on the mounting and use of the solar telescope; 4) Small workshop on one or two of the activities contained in the handbook.



Figure 2: Two moments of the teacher training: (left) teachers learn how to mount and use the solar telescope; (right) workshop to present the activities of the handbook.

3 Evaluation methodology

The evaluation of the Astrokit has been conducted using two instruments: (1) a questionnaire with an open question given to the teachers prior to the loan of the material, where they write their expectations towards the Astrokit; (2) a questionnaire with open and closed questions about the teachers' experience with the AstroKit, after they have used it. These two instruments are allowing us to conduct a qualitative and quantitative analysis of the kit and the pedagogical practices of Behold the Sky.

To analyse the open questions' responses, which basically contain the discourse of the teachers about the Astrokit, we are using the theoretical framework introduced by [4] so that we can capture the central ideas of each question in a single discourse. This is a methodological approach of tabulation and organization of qualitative data to analyse open



Figure 3: Students of several public schools of Rio de Janeiro using the materials of the AstroKit.

questions' responses containing the discourse of a collectivity, so it allows one to understand thoughts, beliefs and values of a community on a given topic (self-expression of collective thought or opinion).

The preliminary central ideas from the built discourses on the teachers' expectations are listed here, in order of importance: 1) Enhance knowledge on Astronomy; 2) Transmit Astronomy to students (both motivation and scientific content); 3) Learn new didactic and pedagogical approaches; 4) Learn how to use the telescope and the material; 5) Interest in knowing the Museum. Once all the discourse analysis has finished, we will use the results to improve the Astrokit and release the material publicly.

4 Results

Since its beginning, the project Behold the Sky has reached around 12,000 people (students of different ages, teachers, public school servants) and trained 60 teachers in the use of high quality astronomical material. Only during the year 2016, we have made 21 material loans to schools and institutions of the metropolitan area of Rio de Janeiro (see Table 1).

Table 1: Numbers of the project Behold the Sky.

Participation	2015	2016
Teachers at the Training Sessions (ECAP)	34	26
Loans	27	21
Number of Students	5782	5471
Form of Expectations	27	23
Evaluation questionnaires	20	16

It should be noted that since 2015, the project has reached 11,253 students from public

schools of Rio de Janeiro, through the work carried out with the 60 teachers who attended the training. This yields in ~ 188 students reached per trained teacher, somewhat much larger than the typical number of participants in the Sun's observation activity that takes place at the Museum headquarters. Based on these numbers, we can infer that empowered teachers become independent astronomy outreach agents, engaging a great number of people into astronomy outreach activities. Once equipped with the adequate resources and necessary materials, they induce a multiplying effect that derives from the direct access they have to vast number of students and other colleague teachers. This one of the most important results that we are being able to measure within the research project.

5 Conclusions

We have presented an astronomy outreach project named "Behold the Sky", which seeks to engage the general public into liking Astronomy by lending high quality astronomical material to perform observations and hand-on activities to schools. Moreover we have proved the special synergy with teachers, who constitute an essential link within the Astronomy education process facilitating a multiplying effect of the impact of these actions. This result highlights the importance of Astronomy Museums as centres of non-formal education and the benefit resulting from the relationship museum-school.

Acknowledgments

Behold the Sky has been funded by the Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ). Sandra Benitez Herrera thanks the Brazilian agency CNPq for financial support through the Institutional Formation Program (PCI - 313114/2015-3).

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