Boletim da Sociedade Astronômica Brasileira, **37**, no. 1, 334-338

Legacies of the Moonlight Outback Caravan project to demystify conspiracy theories about Astro(nomy/nautics) in Northeastern Brazil

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Abstract. In this work, we compile the main results of the project Moonlight Outback Caravan, dedicated to the dissemination of Astronomy and Astronautics in the countryside of Northeastern Brazil in an inclusive manner. We organized a network of six hubs of the National Professional Master's Program in Physics Teaching (MNPEF) in the states of Alagoas, Bahia, Maranhão, Pernambuco, Piauí, and Sergipe. All interventions revolved around telescopic observations and were divided into modules, in which we taught Astronomy and presented refutations of conspiracy theories. The participating hubs were equipped to reproduce the actions in their own regions. We report here the successes and failures of the project, which reached 50 cities far from major urban centers, collected macrodata from more than 450 interviews, and recorded children's expressions in approximately 850 drawings.

Resumo. Neste trabalho, compilamos os principais resultados do projeto Caravana do Luar do Sertão, dedicado à divulgação da Astronomia e da Astronáutica no interior do Nordeste do Brasileiro de forma inclusiva. Para isso organizamos uma rede de seis polos do Mestrado Nacional Profissional em Ensino de Física (MNPEF) nos estados de Alagoas, Bahia, Maranhão, Pernambuco, Piauí e Sergipe. Todas as intervenções giraram em torno de observações telescópicas e foram divididas em módulos, nos quais ensinamos Astronomia e apresentamos refutações a teorias da conspiração. Os polos participantes foram instrumentalizados para reproduzir as ações em suas próprias regiões. Relatamos aqui os sucessos e falhas do projeto, que alcançou 50 cidades afastadas dos grandes centros urbanos, coletou macrodados em mais de 450 entrevistas e registrou manifestações infantis em aproximadamente 850 desenhos.

Keywords. Moon – Teaching of Astronomy – Techniques: 3D Printing – Virtual observatory tools

1. Introduction

Conspiracy theories and "fake news" are terms that have become highly popular in recent years (Allcott & Gentzkow (2017); Goertzel (1994); Korta (2018); Vermeule & Sunstein (2009)). These share, in essence, the same origin: the belief that some authority, or trusted mediator, holds privileged information, which leads to some form of collective control or influence for self-interest, and which is sustained by the degree of reaction they demand, the consequences they imply (Retief et al. (2013)), the emotions involved (Ferreira & Acioly-Régnier (2010)), and especially the inherent difficulties in verifying information with the necessary degree of care (Dörner (1980)).

Although in many cases the dissemination of conspiracy theories may seem relatively harmless, there are cases in which the collective resonance of individual misinformation can produce potentially harmful social consequences, such as the famous case of the "Vaccine Revolt" (Sevcenko (2018)) and the recent resistance to adherence to vaccination programs (Barata et al. (2012); Zorzetto (2018)).

In particular, topics related to Astronomy have always been part of popular imagination, arousing curiosity and sympathy among the general public (McCurdy (2011)), but also becoming the target of numerous speculations that stray from a rigorous scientific conception. Examples include the confusion between Astronomy and Astrology, "fake news" associated with imminent collisions between meteors and planets, or conspiracy theories

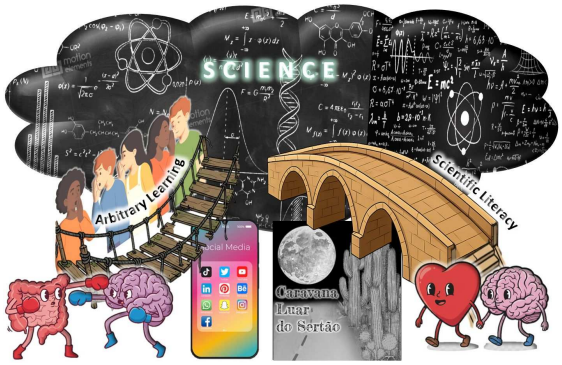

Figure 1. Cartoon on the arbitrary learning and scientific literacy. The symbol of our project is under the solid bridge.

such as claims that the Earth is flat, the Sun and planets revolve around the Earth, and that humans never set foot on the Moon (Briggs (2019); Eversberg (2019)).

From a historical perspective, misinformation and the distortion of knowledge have often served the interests of groups that promoted enormous atrocities based on prejudice and the segregation of people and groups (Plous (2003)).The effects of this are reflected in marks in the low educational indices of Basic Education, impacting vulnerable groups.

Data from IBGE (PNAD, 2021) reveal that in northeastern regions the fraction of the self-declared Black population exceeds the Brazilian average by 20%, and the same region suffers from Basic Education Development Index (IDEB, 2015) scores below the national average. In the digital world, misinformation spreads without limits, while science remains confined to physical institutions, creating fertile ground for pseudoscience, prejudice, and "useful ignorance."

For this reason, itinerant exhibitions, interiorization, and popularization initiatives take on the challenge of meeting the human need for quality education (Dominici (2014); Kuhn (2016); Rocha (2018)) and, in addition to occupying digital spaces, promote actions that bring scientists and science closer to the population, filling a typical gap promoted by the illusion of digital connectivity: the awareness that the quality of what is human is learned through human connection (MacMahon (2020)).

Since 2011, the Astronomy undergraduate program at the Federal University of Sergipe has established itself as the first of its kind in Brazil's North and Northeast regions. In 2013, we were designated as Polo 11 within the National Professional Master's Degree Program (MNPEF), where topics in Astronomy, Astrophysics, and Astronautics are regularly offered in Contemporary Physics course to train teachers as multipliers. In addition to its work in Education and Research, our Astronomy Program it is also committed to Outreach.

In response to the CNPq/MCTI/FNDCT Call No. 36/2022 – "From the Science Park to Space Exploration, Astronomy and Astronautics: Traveling Exhibitions, Popularization, and Interiorization of Science" – together with other Northeastern MNPEF centers (06 - Bahia, 08 - Piauí and Pernambuco, 11 - Sergipe, 36 - Alagoas, and 63 - Maranhão), we submitted the project "Moonlight Outback Caravan: 50 Years of the First Step on the Moon and Beyond....", which was ranked in first place and approved for a two-year regional funding line to promote telescopic observational experiences and non-formal educational initiatives, seeking to demystify conspiracy theories among populations in the Northeastern countryside. The project aimed to celebrate two historic milestones: the 50th anniversary of the last time humanity walked on the Moon and the beginning of the Artemis Program, which marked a symbolic achievement by sending the first woman and the first Black person to the Moon, reconciling scientific progress with representativeness.

2. Objetives

The general objective of the project was to promote itinerant telescopic observations and didactic exhibitions on Astronomy and Astronautics in the Northeast region, in a collaborative network (O0). For this we followed the specific objectives

O1: Compose a Network associated to teacher formation hubs (multipliers);
O2: Create multimedia resources and telescopic observations strategies;
O3: Establish the proper plans to choose places, public, materials and suitable training for the events;
O4: Favor events far from the larger centers, considering regional characteristics;
O5: Provide the suitable equipment to the multiplier hubs;
O6: Establish scientific literacy strategies between those involved and the public;
O7: Generate teaching sequences for simulating space exploration modules with drones and using the telescopic for observational measurements;
O8: Generate resources and models in 3D printers;

Figure 2. Skeatch of the event setup in perspective.

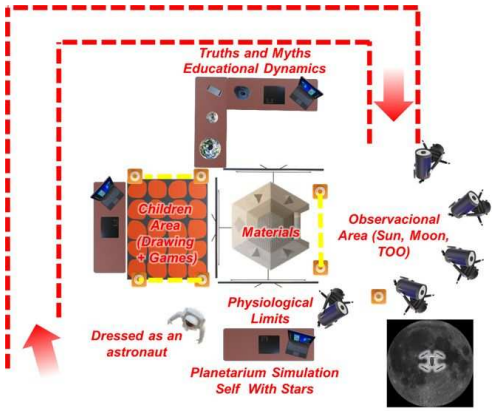

Figure 3. Skeatch of the event setup from above.

O9: Produce videos for dissemination, training and exhibition;
O10: Investigate spontaneous concepts of the audience;
O11: Use dialogic and interview techniques in our research;
O12: Analyze audience productions;
O13: Publish results and methods.

Each of these indices will be revisited when referring to the achievement of the associated objective in this work.

3. Methodology

In line with the criteria for regional projects outlined in the aforementioned call, we sought partnerships among the hubs of the National Professional Master's Degree in Physics Teaching (MNPEF). In 2022, there were 24 hubs in the Northeast region, of which we established connections with six. Each represented different states among the nine in the region: hub 6 (Bahia), hub 8 (Pernambuco, Bahia, and Piauí), hub 11 (Sergipe), hub 36 (Alagoas), and hub 47 (Maranhão) (O1)."

Although these hubs include professors who teach Astronomy within their respective courses, Sergipe is the only one that offers a degree in Astrophysics. Consequently, this hub coordinates the management of the project and allocates scholarships to up to 12 undergraduate and postgraduate students who serve as our operational staff. In addition, we established a partnership with the State Department of Education in Sergipe, under process number 018000.97186/2022-9, to ensure the necessary resources for teachers and students to participate of the events and receive training in their own cities.

The events consisted of four modules: 1-) Sky Projections, simulations and explanations; 2-) Movies and Children Area; 3-) Truth or Myth and 4-) Observational Area, following the Figs. 2 and 3. Since the modules are relatively independent, they were rearranged in reason of local circumstances and available staff.

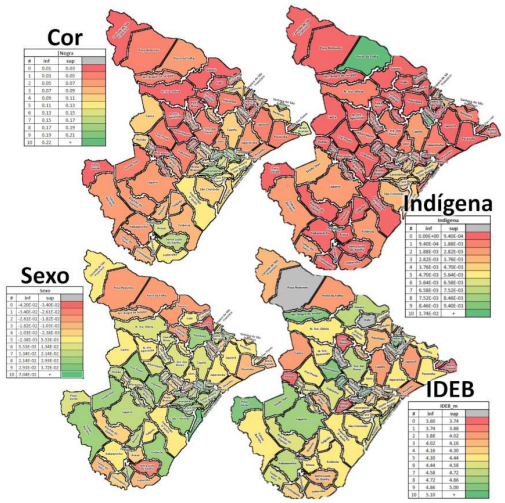

Figure 4. IBGE 2015 indexed map used to choose cities with social/economic/cultural of interest in our research.

Figure 5. Observational and instrucional kits (at left) were delivered to each hub involved in the project (at right). It includes 3d printed material, such as our game on the Moon's phases Rodrigues et al. (2025)

To carry out the events, we studied the ephemerids that would favor the observation of the Moon for at least 4 hours after sunset (O2). In two years of project, we were limited to 113 possible nights to promote the events. Due to limitations in staff, financial resources, and transportation budget restrictions, 70% of the surveyed cities were located within Sergipe, where the main research on spontaneous conceptions on Astronomy and Astronautics (O10) (based on interviews) and children's drawings, were conducted (O11, O12). In Sergipe we selected the cities according to socio/economic/cultural criteria (Fig. 4), such as racial predominance (black and indigenous), gender (male and female) and results in the Basic Education Development Index (best and worst IDEBs) (O3, O4).

4. Results and Discussion

Kits with equipment (O5) were delivered to all hubs that organized and conducted observational events in at least 2 cities under their responsibility (Fig. 5).

We have reached 50 cities and more than 7500 people (Fig. 12), which is 40% more than the minimum required in the CNPq call. Note that we covered 13 cities in the far outback, or approximately 20% more than the number of MNPEF hubs. We covered

Figure 6. Photographs taken during public telescope observation sessions and teacher training events.

Figure 7. Resources produced by the Teaching Group include: materials designed to establish strategies for scientific literacy in accordance with the BNCC, aimed at teachers and the general public (O6); original subtitled videos ASTUTOS-UFS (2025) (O9); and a module for simulating space exploration with drones, as well as the simulation of telescopic observations under adverse weather conditions (O7).

almost 50% of SE municipalities, providing us a fair enough sample to our researches.

We shared the tasks into the following groups:

I. Observational Events (Fig. 6), which includes logistics and dissemination;
II. Teaching, that involves inclusion, accessibility, videos and films (O7, O9), (Fig. 7);
III. Research, for educational and scientific purposes, including the observation of certain targets of opportunity (TOO).

The study of parallaxes was effectively conducted within this network (Fig. 8). For further details, see the paper "Lunar Distance with Parallax during Occultations in the Context of the Caravana Luar do Sertão" in this proceedings. Within the research group, there are also members engaged in 3D printing and modeling (O8) (Fig. 9). One example of their activities is presented in the paper "Lunar Craters Modeled from the LROC Database for 3D Printing with Inclusive Educational Proposals" also included in this proceedings.

Taking into account the entire audience, we collected more than 450 responses to our dialogic interviews (Fig. 10), which aimed to investigate:

1. The contrast between Science and Pseudoscience;
2. Neo-geocentrism, Flat Earth and popular misconceptions;

Linha de Base	Objeto Ocultado	Distância Terra-Lua na Data [km]	Paralaxe [arcsec]	Distância Obtida [km]	Erro Percentual [%]
Aracaju - São Cristóvão	Antares	382727	5,6104	389464,9	1,76
São Cristóvão - N. Sra. Dores	Saturno	354398,7	30,8124	344244,4	2,87

Figure 8. The distribution of our observational network for research. The blue markers indicate the locations of the observers. This network was articulated to record occultation events and to determine the Moon's parallax and its distance. The attached table presents a selection of our results.

Figure 9. Image composition of some of our modeling activities, materials, and training for 3D printing, tactil Astronomy and instrumental techniques.

3. Elaboration on physical phenomena and celestial perceptions;
4. Conspiracy theories, such as the denial of humanity's journey to the Moon;
5. How people explain the Moon's phases;
6. Popular notions of astronautics and identity-related issues.

For further details, see the paper "Scientific distortions assessed in non-formal learning environments and their effects on conceptions about Astronomy and Astronautics in the Brazilian Northeast" in this proceeding.

We also accumulated over than 850 children draws (Santana et al. (2025)), for which the results are presented in this proceedings in the paper "Analysis of children's drawings in non-formal learning environments: an extensive study in astronomical observation activities in Northeastern Brazil" (Fig. 11).

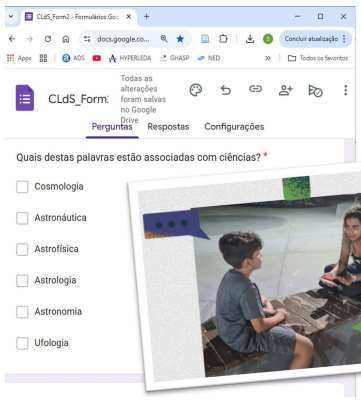

Figure 10. Part of our interview form, along with one of our collaborators dialogically engaging a participant during the event carried out in Simão Dias.

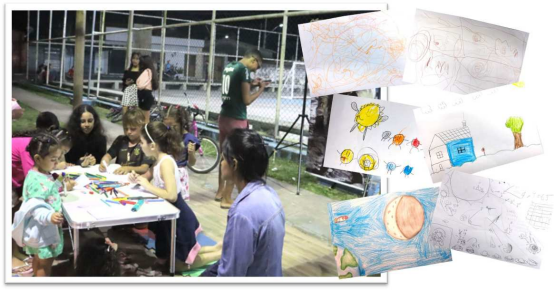

Figure 11. "Children's Area" at one of our events, featuring examples of children's drawings corresponding to different Piaget developmental stages

5. Conclusions

Although our project faced a 33% budget reduction, we not only achieved but also exceeded the anticipated impacts, as demonstrated by the following numbers:

1. More than 20 kg of observational and instructional material delivered to each hub, including telescopes, oculares, projectors, graphics tablet, computers, planetary models, etc;
2. Almost 8000 people reached directly in 50 cities in 6 states and over than 165000 by social media;
3. A network with over 40 collaborators and 70 mutipliers formed in MNPEF hubs;
4. Interviews and drawings collected from nearly 10% of the attending public;
5. Observational training in Astronomy, Astronautics and Astrophotography conducted at 6 MNPEF hubs;
6. Over 48 hours of newly released content distributed across 60 videos, with more than 150000 views on YouTube and Instagram, with more than 3500 followers;
7. Twelve scientific works presented at national events, with the potential to generate four high-impact papers (O0, O13).

The Northeastern regions not included in our project was a consequence of two main reasons: the absence of MNPEF hubs and the implementation of "competing projects" funded under the same call in these states. Paraíba did not present any MNPEF hub with which we could establish a partnership during the formation of our network. In Rio Grande do Norte, two independent projects were approved under the same call (CNPq408611/2022-7, 408272/2022-8), which hindered the possibility of partnerships in that state. For the same reason, partnerships were not

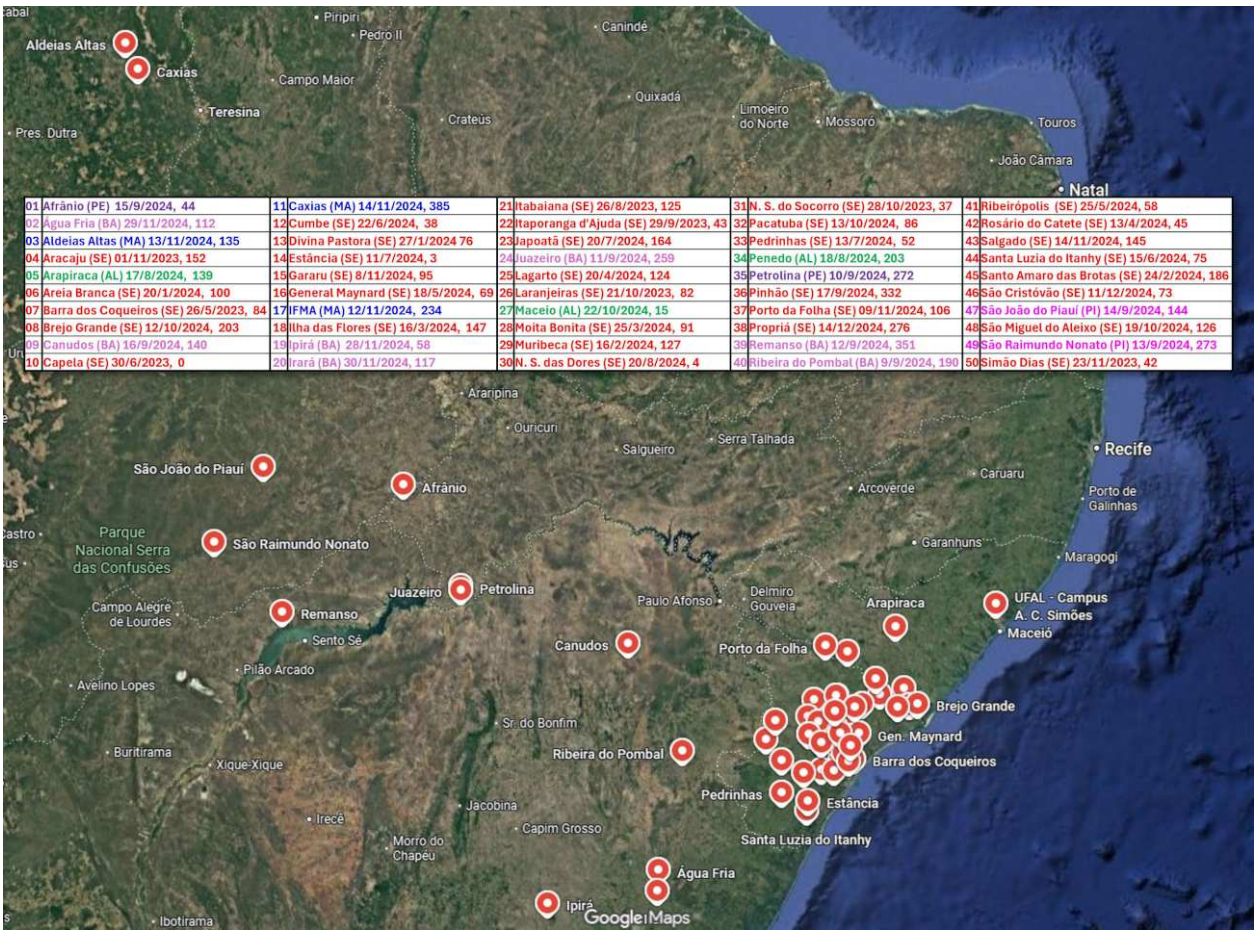

Figure 12. Geographical distribution of the cities where the events took place.

feasible in Ceará (CNPq407872/2022-1) and south of Bahia (CNPq408672/2022-6), where the UEFS hub withdrew to conclude the project due to disagreements regarding its execution in the region.

We are in negotiation with researchers in other regions to expand this project throughout Brazil.

Acknowledgements. The authors acknowledge the financial support provided by the National Council for Scientific and Technological Development – CNPq (grant 408662/2022-0).

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