

SCIENTIFIC DISSEMINATION IN NON-FORMAL SPACES: A CASE STUDY INVOLVING GENERAL RELATIVITY AND THE ECLIPSE MUSEUM

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ABSTRACT

This qualitative work aims to investigate the potential of non-formal spaces in complementing school education. The research is focused on a case study regarding a scientific event involving the general relativity theory which took place at the Eclipse Museum, in the city of Sobral, Ceará. The study was carried out through field research supported by interviews and questionnaires, in which were involved local citizens, the director and the former director of the Eclipse Museum, as well as former employees of the institution. The results point to the importance of commitment to the city, its education, and its memory; to the necessity of permanent investments

of continuous flow in the multiple educational spaces, increasing the efficiency of school education. On the other hand, it is worth highlighting that the local school curricula have not properly honored regional scientific and cultural knowledge, leading to a deficient basic education. Due to this deficit, it has been noticed that citizens have not been acquiring the necessary knowledge to understand relevant facts concerning the scientific explanation of the phenomenon observed in the skies of Sobral for just over a century, which notably contributed to the confirmation of the general theory of relativity.

KEYWORDS: Sobral, Interviews, Disclosure environment.

DIVULGAÇÃO CIENTÍFICA EM ESPAÇOS NÃO FORMAIS: UM ESTUDO DE CASO ENVOLVENDO A RELATIVIDADE GERAL E O MUSEU DO ECLIPSE DE SOBRAL

RESUMO

Este trabalho investiga qualitativamente o potencial dos espaços não formais na complementação de uma educação escolar forjada nas instituições formais e nas contribuições prestadas para a divulgação científica, tomando como referência um estudo de caso envolvendo, a teoria da relatividade geral e o Museu do Eclipse de Sobral. O estudo foi concretizado numa pesquisa de campo subsidiada por entrevistas e questionários, nos quais foram envolvidas pessoas que compõem a população sobralense, diretores do Museu do Eclipse e ex-funcionários da instituição. Os resultados apontam para a importância do comprometimento com a cidade, educação e memória; para a necessidade de investimentos

permanentes de fluxo contínuo nos vários espaços educacionais, aumentando a eficiência da formação escolar. Por outro lado, observa-se que os currículos escolares locais ainda não têm prestigiado devidamente os conhecimentos científico-culturais regionais, levando a uma formação básica deficitária por parte dos cidadãos. Em função desse déficit, percebeu-se que os cidadãos não têm adquirido os conhecimentos necessários para a compreensão científica do fenômeno observado nos céus de Sobral há pouco mais de um século, e que contribuiu notoriamente para comprovação da teoria da relatividade geral.

PALAVRAS-CHAVE: Sobral, Entrevistas, Ambiente de divulgação.



1 INTRODUCTION

Notoriously, contemporary science teaching faces several difficulties that, gradually, have generated in Brazil high rates of scientific illiteracy (Nunes et al., 2023). In parallel to this, society itself struggles to preserve its memory and make its history “alive”. Within this context, several educational institutions coexist with a common objective: the propagation of scientific and cultural knowledge. Such institutions constitute the so-called formal and non-formal spaces of education. Examples are, respectively, schools and museums.

The importance of formal educational spaces for society is unquestionable, since they depend on each other, including the technical proficiency of those who undertake activities essential for the development of society itself. For Guimarães, Roriz and Teixeira (2015), if the school reproduces a simplistic view of science, knowledge can be acquired as something unquestionable, as knowledge is concentrated on technical issues. As an expansion of the vision of science and the construction of knowledge, we can deeply engage with non-formal educational spaces, which in this work will specifically address the role played in the city of Sobral by the Eclipse Museum.

Regarding museums, Marandino et al. (2003) state that these spaces, while active in the context of heritage conservation of history, culture and science, contribute to the awareness of this heritage, acting within the cultural dimension and establishing a distinct form of non-formal education separate from traditional teaching.

The participation of the city of Sobral, situated in the northern region of the state of Ceará, in one of the most significant astronomical events in the history of science—the observation of the total solar eclipse on May 29, 1919—is widely recognized in international scientific circles. Photographic records contributed to the proof of one of the scientific theories that revolutionized science in the 20th century: the general theory of relativity, formulated by the German physicist Albert Einstein. As a result of this significant episode, which heightened the city's visibility and underscored its importance as a historic landmark in science, the Sobral city council constructed a museum monument in 1999. The main objectives of this monument are to preserve the memory of the city and its contribution to the dissemination of the general theory of relativity. It is important to highlight that this theory has been gaining more and more space in society with the most recent discussions, such as the discovery of gravitational waves and the first photo of the accretion disk of a black hole, which were widely disseminated on social networks and television.

Through qualitative research supported by interviews and questionnaires, we aim to find out how the population of Sobral perceives the Eclipse Museum—a non-formal space for education—and what sense of value they attribute to general relativity.

2 METHODOLOGY

To conduct this study, qualitative field research was undertaken, resulting in an analysis of the current status of teaching and dissemination of the general theory of relativity in Sobral, Ceará, with a particular focus on the role played by the Eclipse Museum.

When choosing an investigative approach for the work, we opted for qualitative research, taking into account some characteristics highlighted by the authors Ludke and André (2017), among which the fact that the direct source of data be obtained in a natural environment and have the researcher as their main research instrument. The investigation is therefore focused on direct contact with the object of study, allowing for the simultaneous description of data and monitoring of gestures and actions that occur during the research. Such behaviors are relevant, since the individuals involved are susceptible to external influences and every detail can be described as a result of observation. As Bogdan and Biklen (1994, p. 48) state, “qualitative researchers attend study sites because they care about the context. They understand that actions can be better understood when they are observed in their usual environment.”

As a research location, the city of Sobral, in the northern region of Ceará, was chosen due to its relevance within the international scientific community, since it was in Sobral that the most significant data that led to the confirmation of the general theory of relativity was obtained.

The subjects involved in the research included 28 members of the Sobral population, two former employees of the Eclipse Museum, its first director, and the current director. Initially, the research was designed to include only the former employees and the director who was in office at the start of the study. However, upon beginning the investigation, it was discovered that the Eclipse Museum had an inaugural director who served from 2000 to 2004. Consequently, it was decided to also incorporate his insights about the institution. These subjects were selected based on the following criteria/justifications:

- Being able to position the institution within the community context, highlighting its main objectives and potential;
- Being able to describe from their perspective the current situation of local scientific dissemination, with a particular focus on the general theory of relativity;
- Being able to assess society's perception regarding the functioning of the institution;
- Possessing knowledge about the 1919 experiment and the implications of general relativity for science and technology.

To carry out the field research, it was decided to use interviews and questionnaires as a data collection method. Interviews, as intentional conversations, provide an opportunity to obtain the intended information and collect descriptive data directly from the interviewees. This approach allows for the intuitive development of an understanding of how the subjects interpret aspects related to the investigated theme. The interviews were conducted as dialogues, with the research's justification explained beforehand. Each conversation lasted approximately five to eight minutes, and, with permission from the interviewees, audio recordings were made and later transcribed. A

questionnaire was administered to former employees of the Eclipse Museum, which was sent to them electronically to facilitate completion.

The sampling of residents was carried out randomly, taking into account the age range of those involved from 12 to 58 years old, chosen within the main neighborhoods of the city of Sobral. Thus, a more in-depth perception of the situation studied becomes possible, since a variety of data can be collected and analyzed by the researcher. This resonates with what Ludke and André (2017, p. 22) state when referring to this multiplicity of information: “with this variety of information from different sources, [the researcher] is able to cross-reference information, confirm or reject hypotheses, discover new data, rule out assumptions or raise alternative hypotheses.”

In total, 28 people from the general population were interviewed, chosen randomly from seven neighborhoods, so as not to influence the results of the research. The interviews were carried out in homes, squares and other parts of the city. The neighborhoods covered include the low, middle and upper social classes.

The former employees involved in the research were those closest to the researchers, aiming to facilitate the application of the research. In the interview with Director B, we sought to find out general information about the institution and its operation. With Director A, the main objective of the questionnaire was to recover some of the work carried out at the Eclipse Museum during his tenure from 2000 to 2004..

About the research host city, Sobral, located in the northern region of the state of Ceará, 235 km from the state capital (Fortaleza), connected by BR-222, which connects the state of Ceará to the states of Piauí, Maranhão and Pará. Sobral has a population of 188,233 people according to data from the latest census by the Brazilian Institute of Geography and Statistics (IBGE) in 2010. However, its estimated population currently exceeds two hundred thousand inhabitants.

The municipality boasts a rich cultural collection, including the Dom José Museum, the São João Theater (the second oldest theater in Ceará), the House of Captain Mor, the Arc de Triomphe, the Eclipse Museum, and others. The Eclipse Museum, a monument built in 1999 to celebrate the 80th anniversary of the confirmation of the general theory of relativity, stands as one of the city's main attractions.

Affiliated with the World Astronomy Association, the Eclipse Museum boasts a diverse array of apparatus and exquisite equipment. Among them is the most advanced telescope in the North and Northeast regions of Brazil, the LX 200-Schmidt-Cassegrain 16”. Additionally, the museum houses photographic records of the expedition that visited Brazil to observe the 1919 eclipse, along with documents containing news reports from that time, highlighting the significance of the event.

3 RESULTS

3.1 Interview with Sobral residents

28 individuals from various neighborhoods across Sobral were interviewed, providing a comprehensive perspective on the function of the Eclipse Museum. These interviews shed light on

its role in complementing formal education and elucidating the relationship between formal and non-formal educational institutions.

When questioning residents about their knowledge of the Eclipse Museum, as well as their frequency and the manner of their introduction to the institution, it was found that 75% of residents know about and have visited the museum, with only approximately 14% visiting on multiple occasions. Furthermore, residents highlighted the relationship between schools and the museum, generally identifying schools as the intermediary between residents and the Eclipse Museum. Dutra and Nascimento (2016) mentioned the role of schools in bridging the gap between people and museums.

Two interviewees made noteworthy statements, indicating that students were initially introduced to the Eclipse Museum through a technical visit program at their schools. Subsequently, these students returned to the museum independently, demonstrating their own initiative:

I1: Yes, I have, more than once. Once it was through a school trip and the other times on my own.

I2: Yes, yes, twice. One by the institution Dr. João Ribeiro Ramos and another by my free will.

These statements demonstrate the significance of the relationship between formal educational institutions, i. e., schools, and non-formal educational institutions, such as the Eclipse Museum. This observation resonates with Felício's (2011) plea for the integration of formal and non-formal educational institutions in order to provide students with comprehensive training rooted in community interaction and cultural immersion.

When asked what marked them most during their visits, residents cited, in their entirety, the possibility of observing the stars through the technologies present at the Eclipse Museum.

I3: To learn more about astronomy and see the technological capacity that the museum provides to the population.

I4: To be able to observe the planets, to have a better view, curiosity.

The arguments presented by these residents demonstrate the relevance of astronomy content in motivating individuals' pursuit of knowledge. The curiosity to discover, visualize, or recognize celestial bodies and phenomena highlights the need for greater investment in presenting this content within basic education. Kemper (2008, p. 8) underscores the importance of including this or similar content in high school courses:

The inclusion of astronomy content in high school physics courses becomes pertinent as they are of great interest to the young audience who attends them. This interest is evidenced by the doubts and questions that students bring to classes, as well as by their active participation and motivation when these topics are covered.

Some of the reports collected indicate that museum visitation is not exclusively tied to educational institutions or other local organizations. When asked about their visiting, some residents expressed curiosity about exploring the city's heritage on their own initiative.

15: When I visited the museum, it was not through any institution or educational program, but of my own free will.

16: I visited the museum a long time ago and the visit was not planned. It was out of curiosity, and I went and visited it.

It is possible to notice, through the residents' statements, that the popularity of the Eclipse Museum in the city is undeniable. While residents claimed to "know it", not everyone had the opportunity to visit it. This indicates the need to further extend the museum-school and museum-society relationship in order to expand the public outreach of the institution and enable more visits.

When asked why an Eclipse Museum was built in the city of Sobral, residents associate the construction of the place with physicist Albert Einstein, the father of the theory of relativity. However, they do not demonstrate clarity regarding the scientific rationale for the existence of the museum. The main answers obtained to this question were:

17: Because Albert Einstein's people came here to Sobral together to see the eclipse pass here at that time.

18: I heard about it was because of Albert Einstein.

19: Because of Einstein's research that his students came to prove.

110: I believe it was because of Albert Einstein, who proved the theory of relativity in that same place.

111: I know it was because Einstein discovered the theory of relativity here in Sobral and then the museum was built based on this theory, this discovery.

The reason for the type of responses obtained seems to point to the fact that the interviewees do not understand the nature of the experiment that was carried out in Sobral on May 29, 1919. They were not adequately introduced to the basic principles of the general theory of relativity, nor even considering the historical foundations of the experiment carried out in the city. This is certainly justified by the fact that, according to Oliveira et al. (2017, p. 33):

The special theory of relativity is typically covered in high school classrooms; however, the content of general relativity is notably absent. Its historical approach is closely linked to the history of the city and is generally accessible only to students who have the opportunity to participate in a visit to the Eclipse Museum.

According to Oliveira et al. (2017), the content of general relativity is absent in high school classrooms in the municipality of Sobral. However, works by Aringhieri and Silva (2017) and Oliveira et al. (2019) suggest the viability of conceptual approaches to topics related to the general theory of relativity even in basic education. Therefore, while students receive some information about the 1919 experiment during their visits to the Eclipse Museum, particularly regarding the local observation of the phenomenon, they may not be able to assimilate that much information within

the short period of time allotted for visits. Additionally, discussions on the topic are not consistently brought back to the classroom in a pedagogically appropriate manner.

The subsequent question aimed to explore the level of understanding people from Sobral have about the theory of relativity, and the responses obtained reaffirm the findings of Oliveira et al. (2017). The results indicated that the general theory of relativity still occupies a limited space in the school curriculum. Among all those interviewed, only three were able to articulate their perceptions on the subject:

I12: It establishes relationships between masses and energy of a body.

I13: The theory is associated with the speed of light and certain questions posed by Einstein. However, I am unsure how to apply the theory, as I do not recall its specifics.

I14: What I grasp from it is that it involves the study of time and space, where it becomes evident that they are relative and that everything relies on the observer's viewpoint.

The speeches of Sobral residents indicate a limited understanding of relativity, particularly regarding the general theory of relativity. While the special theory of relativity is often covered in high school curriculum, its treatment remains constrained due to various factors. These include the limited time available for physics instruction, with some schools offering only one physics class per week. Additionally, schools tend to prioritize content aligned with the National High School Exam (ENEM), further restricting the depth of coverage. Furthermore, irregularities in teacher training contribute to the challenges; many physics teachers lack specialized training in the subject, reflecting a broader national reality.

Before posing the final question, the interviewer provided definitions of formal education, informal education, and non-formal education, following the framework outlined by Santos and Germano (2015). This was done to ensure that these terms were clearly understood by the interviewees, as it was assumed that they might otherwise be interpreted inconsistently or not well assimilated. The investigation revealed that Sobral residents also frequented other non-formal educational spaces. Some of the answers were:

I15: I've already visited the museum, the São João theater, the old Madi Museum, there's the art gallery, the municipal library and ECOAS, and what can I say? The youth houses that are in the neighborhoods...

I16: I think the Dom José Museum—you can learn a lot there. The São João theater too...

I17: I also believe that there is another non-formal space that is quite interesting to visit, which is the House of Captain Mor, where you can have a guided visit, an explanation about certain contents, certain objects that exist inside the house.

I18: Only the museums, the Dom José Museum, the Eclipse Museum, that planetarium they built now near the Eclipse Museum, the house of culture are non-formal spaces, the House of Captain Mor, right, the issue of Sobral's historical heritage.

I19: In Sobral, there is another museum, the Dom José Museum, which delves deeper into the history of Sobral, spanning back to ancient times and addressing historical aspects related to

the Sun and other relevant topics. Similarly to the Eclipse Museum, it serves as a non-formal educational space. Additionally, the São João Theater, besides hosting plays, also showcases dance and music performances. The House of Culture and various other institutions contribute to the dissemination of knowledge among the population. Collectively, these institutions and events can be regarded as non-formal educational spaces.

The analysis of these statements leads to the perception of a variety of non-formal educational institutions existing in the city of Sobral. It is worth highlighting that all the institutions listed by the interviewees were established by the municipal government and have since been maintained by it, which certainly emphasizes the appreciation of historical, scientific and cultural heritage, as well as local investment in spaces of non-formal education.

3.2 The research with the directors of the Eclipse Museum

As previously mentioned, the Eclipse Museum was founded on May 29, 1999, and since then its directors have been: Saulo Machado Filho (Director A), from 2000 to 2004, and Emerson Ferreira de Almeida (Director B), who served from 2005 to 2019.

The key information gathered from the interview with Director B is outlined below:

Interviewer: What was the motivation for creating an Eclipse Museum here in Sobral?

Director B: The establishment was motivated to preserve and elucidate the memory of the events surrounding the measurement of the Einstein effect, which occurred in Sobral on May 29th, 1919. Until that point, there existed a popular culture surrounding the eclipse, with various legends and narratives about the event. The museum aimed to solidify this historical account and establish it authentically, thereby providing a foundational resource for science education in Sobral. Thus, over the years, the Eclipse Museum has evolved into a laboratory for local schools in Sobral, equipped with devices suitable for educational purposes, spanning from geography to natural sciences.

Interviewer: Who were the creators of the Eclipse Museum?

Director B: The idea for the museum originated from the city's public administration at the time, spearheaded by the then-mayor Cid Ferreira Gomes, and garnered support from universities.

Interviewer: How is the Eclipse Museum subsidized?

Director B: The Eclipse Museum is sustained by the municipal government of Sobral through its own funds. While it primarily operates under municipal jurisdiction, it also relies on the assistance of scholarships provided by Acaraú Valley State University (UVA) for its functioning.

Interviewer: What is the composition of the team at the Sobral Eclipse Museum?

Director B: The museum has a local administrator and three or four interns who work during the museum's opening hours.

Interviewer: What are the museum's opening hours?

Director B: The Eclipse Museum is open to the public from Tuesday to Friday, from 8 a.m. to 11 a.m., and on Saturdays from 8 a.m. to 12 p.m.

Interviewer: Where do most visitors to the Eclipse Museum come from, and what is your estimate of the total number of visitors during its nearly 20 years of operation?

Director B: Most visitors are from Sobral and the surrounding region [the northern region of the state of Ceará]. We also receive visitors from other parts of Brazil and from abroad. The museum's primary audience consists of public and private schools within the city of Sobral. While individual visitors and resident groups also come, these visits are less frequent. Most visits are scheduled by schools as part of our educational program. Our scholarship recipients are specifically trained to engage with schoolchildren. Regarding the total number of visitors, I don't have the exact figure on hand, as it's managed by the cultural department in Sobral. However, I estimate that it exceeds 40,000 visitors.

Interviewer: Could you tell us a little about the importance of the museum in terms of non-formal education and dissemination of science?

Director B: The Eclipse Museum has been recognized by the Brazilian Institute of Museums (Ibram) as a prominent space for non-formal education. Since its inception, the museum has been equipped to facilitate educational and enlightening experiences related to astronomy, the solar system, and the universe. We offer various models and interactive materials to enhance this non-formal educational process. Thus, the museum was built not only to commemorate historical events but also to serve as a hub where people could learn more about the universe.

Director B's statements highlight the use of municipal funding to preserve historical memory and promote scientific dissemination in the city. The museum serves as a supplementary non-formal space of education. The school-museum partnership has remained active, with hosting public and private schools being the primary program at the site, as noted by the interviewee.

Below are the responses provided by Director A in the interview:

Interviewer: Could you tell us a little about your experience as director of the Eclipse Museum of Sobral?

Director A: I served as the museum coordinator from July 2000 to May 2004. Upon its opening in 1999, the museum lacked coordination, resulting in limited activities and precarious services. Regarding the telescope, only a municipal secretary possessed the technical knowledge to operate the equipment, albeit without the ability to identify celestial objects. Thus, the appointment of an astronomer and coordinator became imperative.

Interviewer: During your tenure, could you describe the team composition at the Eclipse Museum, including the number of staff and their respective roles? Additionally, how was the institution sustained during this period?

Director A: To the best of my recollection, the team consisted of university interns from UVA and individuals recommended by acquaintances within the City Hall. The institution was consistently funded and maintained by the City Hall, although their level of interest in its upkeep

varied over time. The team comprised four attendants, who worked on a rotational basis to cover service hours from Tuesday to Sunday, 8:00 am to 10:00 pm. As for the Observatory, I personally oversaw its operations from Wednesday to Saturday, contingent upon favorable weather conditions.

Interviewer: What specific activities were carried out at the Eclipse Museum, and who were the primary recipients of these activities?

Director A: The audience consisted of individuals of all ages and social backgrounds. Upon assuming the coordination role in July 2000, I introduced the "Night of the Stars" program in September, featuring observations of planets, the moon, stars, and deep sky objects. Starting from 2002, during the rainy season, we offered discounted or free admission to students from Sobral's public school system to ensure consistent attendance at the museum. Additionally, during eclipses, we utilized local media for publicity, encouraging observation of the phenomenon both inside and outside the museum premises.

Given that local schools do not incorporate the general theory of relativity into their curricula, how do you perceive this situation? Would it not be essential for schools to impart this knowledge, especially considering the significance of the phenomenon observed here, which contributed to the confirmation of one of the most revolutionary theories in science and consequently led to the establishment of the Eclipse Museum? Shouldn't formal educational institutions, rather than non-formal ones like the museum, be responsible for transmitting such knowledge?

Director A: I don't know how it is now, but at the time, many public schools visited the place simply as a tour option, making use of the discounts on admission. Few teachers connected the museum's theme with something that was learned in the classroom. Only university students visited the place to better understand the general theory of relativity. Public elementary and high school students went to the museum because they knew that something historic happened there, without involving topics about relativity. I think it is the school's duty to transmit this, but the museum needs to provide support so that this transmission has a satisfactory effect.

Interviewer: What measures could be taken to enhance the museum's effectiveness and attract more visitors? Is there an established culture in Sobral of visiting the museum for entertainment or personal enrichment?

Director A: In the initial year, locals frequented the museum primarily to "enjoy the air conditioning," as admission was free. However, after the introduction of an entrance fee (R\$2.00), visitation from the local population significantly declined. Efforts were then made to raise awareness and encourage visits for educational purposes.

Interviewer: What are your expectations for the future of the institution?

Director A: Emerson has been doing a good job, and the museum has obtained more equipment thanks to joint efforts with universities over the years.

3.3 Interview with former employees of the Eclipse Museum of Sobral

The interviews conducted with former museum employees shed some light on how the space contributes to the training of its staff, the operational routine of the museum, and its future prospects as seen through the eyes of those who have worked there. The three virtual sessions lasted approximately 10 minutes each.

The first question aimed to uncover the primary motivation that led them to work at the museum. All interviewees stated that their passion and interest in astronomy were the driving forces behind their involvement in the museum's activities.

"My motivation stemmed from a desire to delve deeper into the realm of astronomy..."

The following question aimed to gain a deeper understanding of the daily experiences at the museum, including how programming was organized during visits and the primary activities conducted. One former employee's response highlights this aspect:

"During museum operations, the primary activity involves hosting visits from both public and private schools. They typically schedule their visits in advance, specifying the time and day through a formal request. The visitation session lasts approximately 40 minutes, often coordinated with a tour of the museum itself, which usually takes about 20 minutes. Afterward, the groups proceed to the planetarium. Upon their arrival, we provide them with instructions and guidelines, including what is prohibited during the session. Once inside, for safety reasons, attendees are advised not to leave their seats as the room will be darkened. The session typically begins with an introductory video, followed by another one detailing the history of telescopes from antiquity to modern times. Finally, there is a video presentation on the International Year of Light, discussing the significance of light in our lives. Additionally, the museum occasionally hosts art exhibitions, as well as physics-related events and lectures."

A third and final question aimed to inquire about the museum's role in the professional development of its employees. One interviewee highlighted that working at the museum led to a significant expansion of their knowledge in the field of astronomy. In their own words:

"We had to prepare ourselves; we had to study a bit about the city's history, the circumstances surrounding the 1919 observation, and delve into astronomy to be able to engage with the students effectively, as they often had many questions at the end of the session. So, we needed to be well-prepared. I believe that what I learned most during my time there was primarily about astronomy. "

When working at the Eclipse Museum, employees are taken to readings, through which they acquire new scientific, historical, and cultural knowledge. For physics students, this experience enables them to connect what they learn during their undergraduate studies with other disciplines, such as astronomy.

4 FINAL CONSIDERATIONS

The results of the field research carried out point to a harmonious partnership between basic education schools in Sobral and the Eclipse Museum of Sobral, with the former being the main link between the local public and the museum. It seems that the general population does not spontaneously visit the Eclipse Museum for entertainment or personal satisfaction. Therefore, governmental initiatives are needed to increase awareness and motivation among the public, encouraging them to visit such a space. This would enable the aggregation of scientific and cultural knowledge while reinforcing the significance of the observation made on May 29, 1919. This event placed Sobral at the forefront of the scientific community by providing data that supported the experimental confirmation of the general theory of relativity.

On the other hand, there are evident shortcomings in local school education and the basic education curriculum when it comes to integrating scientific knowledge with extracurricular cultural understanding. Despite being familiar with the museum institution and having visited it, the interviewees, almost unanimously, struggle to link the observation of the 1919 eclipse with subsequent technological advancements grounded in relativity. Moreover, their limited understanding of the theory of relativity prevents them from providing examples of technological applications which rely on it, such as GPS, despite their routine use of such technologies.

The Eclipse Museum has proven to be a conducive and suitable environment for the dissemination of physical, astronomical and cultural knowledge. However, transmitting the basic knowledge necessary to understand the information acquired during technical visits is a function of formal education institutions, such as schools and universities. A local survey carried out by Oliveira et al. (2017) found that special theory of relativity content is covered in basic education classrooms in Sobral, but the basic principles and foundations of general theory of relativity are not yet present at this level of education.

A review of local physics undergraduate curricula reveals a significant emphasis on teaching the special theory of relativity. However, the general theory of relativity is virtually absent from these curricula, underscoring the urgent need to reconsider the educational frameworks of both schools and universities. Such a revision is essential to ensure that learning outcomes are more coherent and better aligned with the local context.

In general, it is evident that the local population highly values non-formal educational institutions, particularly the Eclipse Museum, which has emerged as a strong partner for municipal and state schools in Sobral. Moreover, the museum has garnered attention from national and international individuals and institutions due to its visibility, stemming from its association with a scientifically significant international event and the groundbreaking nature of the general theory of relativity. However, due to a lack of technical preparedness on a broader scale, the population has yet to fully grasp the importance of general relativity.

The activities conducted by the Eclipse Museum primarily cater to the school and scholarly audience, leaving room for improvement in terms of strategies aimed at popularization and broader public engagement. Developing initiatives to bridge the gap between the museum and the

wider community can foster a sense of ownership of the museum and its collection as a collective asset of local cultural heritage. This, in turn, could lead to increased visitation rates beyond school-related activities and cultivate a culture of leisure centered around visits to the museum, which may have previously been overlooked or unknown.

It is necessary for public authorities to adopt measures that enable training courses capable of preparing teachers, theoretically and methodologically, to teach general theory of relativity topics and, thus, enable their students to better understand the contents that are generally transmitted. during the visit to the Eclipse Museum.

Future avenues for research could include:

a) Investigating the impact of collaborative efforts between the municipal government of Sobral and other educational institutions in commemorating the Centenary of the Eclipse of Sobral. These celebrations, initiated on May 29, 2018, continue to unfold through various initiatives in Sobral, across Brazil, and internationally.

b) Proposing innovative teaching methodologies for introducing topics related to the general theory of relativity within basic education. Drawing inspiration from the work of Medeiros and Medeiros (2005), exploring engaging and cost-effective teaching materials could enhance the learning experience for students.

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