FROM SCIENCE COMMUNICATION TO SCIENCE EDUCATION: THE EDUCATIONAL ASSESSMENT OF AN OUTREACH ORIENTED SCIENCE CENTER

I.A. Costa[1,2,3], R. Cardoso Reis[2,3], F. Bessa Almeida[4], I. Monteiro[5]

[1]Santa Bárbara School Cluster (PORTUGAL)
[2]Porto Planetarium – Ciência Viva Center (PORTUGAL)
[3]Instituto de Astrofísica e Ciências do Espaço – Universidade do Porto (PORTUGAL)
[4]Universidade da Beira Interior (PORTUGAL)
[5]Universidade de Lisboa (PORTUGAL)

Abstract

Nowadays we see an increase in science communication activities, but not the same trend on the assessment of those activities. Since its inception, the Porto Planetarium - Ciência Viva Center (PP-CCV) aims at interconnecting science communication activities with science education, for kindergarten, primary and secondary schools. However, a 2016 analysis revealed that, even though the science communication component was well developed, the educational one was lacking. Therefore, the PP-CCV conceived, developed, and implemented a new educational strategy. In this work we present one component of the assessment of that strategy. For that purpose, we used a questionnaire, participant observations and interviews. The focus of this work is the questionnaire, which was based on one from Ciência Viva (the Portuguese Agency for Scientific and Technological Culture), to which we added items strongly related to PP-CCV specific activity. A first version of the questionnaire was analysed by an expert and then used to conduct a pilot study, for instrument validation. The questionnaire was hosted on an online platform and sent, after each school visit, to all the teachers that accompanied their students. We obtained 270 answers to the questionnaire. An analysis framework with categories was produced for the open-ended questions, from which the content analysis was made. A statistical analysis was made for the close-ended questions. The results show that 80,7% of the teachers were happy about the way they were welcomed and 85,2% were happy about the way they were accompanied throughout the activities. The most appreciated were the planetarium shows, but the hands-on laboratories, which complement these shows, were also highlighted. Both activities were considered assets for teachers' classes, with the hands-on laboratories graded with an average of 4,4 and the immersive show with 4,7 (in a 1 to 5 scale). Both activities were also considered well framed in the syllabus, rating the exact same 4,2 on average; 97,4% teachers state that they would return to PP-CCV with their students, and 72,2% with their families. The most positive aspects of the planetarium shows were the visual component, its framework in the syllabus, the interactivity with the students and the performance of the science communicators. Most visitors (71,4%) thought there were no negative aspects in the shows: the only thing pointed out was that PP-CCV should consider a longer duration for it (8,9%). Teachers more frequently (42,9%) mentioned, as the most positive aspect of the hands-on laboratories, the possibility for students to carry out experiments by themselves. The performance of the science communicators was also praised (22,9%). More frequently (48,4%) visitors stated that the laboratory activity had no negative aspects. The most frequent negative aspect mentioned was the high number of students per group (12,9%). These results revealed how we can, effectively, connect science education and science communication, using outreach structures already established in research units. For that, it is necessary for those institutions to understand the school curricula in depth, to design their activities with it in mind. That will be the foundation for us to build upon: i) what students should know, to what is scientifically relevant for them to know; ii) from science education to science communication - from the curricula to the most up-to-date scientific knowledge and processes.

Keywords: Science education, Science communication, Planetarium, Hands-on activities, Astronomy.

1 INTRODUCTION

Nowadays we see an increase in science popularization and public outreach activities in Europe [1]. Nevertheless, this trend does not reflect an increase in the assessment of those activities.

Since its inception, the Porto Planetarium - Ciência Viva Center (PP-CCV) aimed to interconnect science popularization, public outreach activities and science education (for kindergarten, primary and

secondary schools). However, a 2016 analysis revealed that, even though the science communication component was well developed, the educational one was lacking. Therefore, the PP-CCV conceived, developed, and implemented a new educational strategy [2]. After gathering data for three years, we present the main goal of the present work – a full assessment of that educational strategy.

In the literature, we found several studies which evaluate science centers in general [3] and even planetariums, in particular [4]. Most of those studies focus on the effectiveness of informal learning or visitors' attitudes towards science, either of the shows themselves (in the specific case of planetariums) or of the exhibits on display in these spaces [5, 6]. Although fewer in number, there are also some studies of visitor satisfaction [7], and even studies about events which are either sporadic [8] or even unique, such as Science Festivals [9, 10].

Most of the cited studies used a questionnaire to find out the participant's satisfaction. Indeed, even Ciência Viva, the Portuguese Agency for Scientific and Technological Culture, uses questionnaires to assess their science popularization and public outreach activities. With this in mind, we built a new questionnaire and made participant observations and interviews. In this paper, we will only present data from the questionnaire.

2 METHODOLOGY

We based our questionnaire on the one from Ciência Viva [11], adding items strongly related to the specific activity developed in the Porto Planetarium - Ciência Viva Center. A first version of the questionnaire was analyzed by a Science Education and Communication expert, which led to the production of the first stable version, used for instrument validation (in the pilot study). Our questionnaire had eight open-ended and eleven close-ended questions. It was hosted on an online platform and sent, after each school visit, to all the teachers that accompanied their students.

The analyzed data was collected for three years. We obtained 270 answers to the questionnaire. An analysis framework, with categories, was produced for the open-ended questions, from which the content analysis was made. A statistical analysis was made from the close-ended questions.

3 RESULTS

In this section we will present our results, dividing them into two headings: open-ended and closed-ended questions.

3.1 Open-ended questions

An analysis framework with categories was produced for the eight open-ended questions, from which the content analysis was made.

The full didactic sequence, made by the visitor's, potentially includes two major activities: the full dome shows and the hands-on laboratories. The first has two distinct moments: a short and a feature film combo (the recorded component), and a trip in the universe (live interaction between the science communicator and the public).

3.1.1 Recorded component

What was your favourite aspect of the recorded component? To this question we got 63 responses: 23,8% of the visitors mentioned the contents of the show; 15,8% highlighted the visual impact; 15,8% its framework in the syllabus; 9,5% the age suitability; 7,9% the quality of the science communicators' performance; 6,3% thought the activity was a positive stimulus of the students' curiosity; 6,3% highlighted the interactivity of the activities; 3,1% referred the interdisciplinarity of the contents; 3,1% highlighted the good facilities; 3,1% enjoyed everything; 3,1% did not specify anything in particular and 1,5% mentioned the hearing experience.

Which aspect did you like least in the recorded component? To this question we got 44 responses: 69,8% thought that there were no negative aspects in the recorded presentation. The other responses are distributed as seen in table 1.

Table 1. Negative aspect of the recorded component.

	Number of responses
Not age-appropriate	4
Unappealing/lacking animations	2
Inability to stop de the show	2
Venue	2
High rate of the displayed images/ videos	2
The graphical design	1

3.1.2 Live component

What was your favorite aspect of the live component? This question had 67 responses: 22,4% of the visitors mentioned the interactivity of the session; 14,9% the performance of the science communicators; 13,4% the content; 11,9% valued the possibility of students to ask questions; 9% enjoyed that there was both theory and practice in the activity; 7,5% did not specify; 6% enjoyed everything in this activity; 4,5% were satisfied to observe pupils' motivation during this activity; 3% especially appreciated the venue; 3% appreciated its framework in the syllabus; 3% felt that this activity was well organized and 1,5% highlighted the visual impact.

Which aspect did you like least in the live component? This question had 63 answers: 71,4% thought nothing was unfavorable about the activity. However, there were some aspects pointed out, as showed in table 2.

Table 2. Negative aspect of the live component.

	Number of responses
Too short duration	4
Not age-appropriate	4
Lack of dynamism	2
Technical problems	1
High number of students	1
Unclear answer	2

3.1.3 Hands-on laboratories

What was your favourite aspect of the laboratory activity? This question had 35 responses: 42,9% mentioned the possibility for students to carry out experiments, 22,9% praised the performance of the science communicators; 8,6% appreciated the framework with syllabus; 8,6% considered that the activity promoted the development of students interpersonal relationships; 5,7% were pleased to observe that the students had a positive performance; 2,9% enjoyed everything in the activity; 2,9% appreciated the possibility of discussion; 2,9% found that this activity fulfilled the proposed objectives and 2,9% liked that the students could practice making an experimental report.

Which aspect did you like least in the laboratory activity? To this question we got 31 responses: 48,4% wrote that there were no negative remarks. The responses of those who mentioned some negative aspect can be seen in table 3

Table 3. Negative aspect of the hands-on laboratories.

	Number of responses
High number of students	4
Not age-appropriate	2
Too short duration	2
Performance of the science communicator	2
Inability to seat	2
Lack of framework in the syllabus	2
Too theoretical	1
Student's' lack of skills to use laboratory instruments	1

3.1.4 Other comments

On the seventh question, visitors were allowed to leave comments or suggestions. We received 20 answers. Most visitors who have answered (20%) wrote that there were no comments to add. However, there were some aspects pointed out, as showed in table 4.

Table 4. Comments left by teachers.

	Number of responses
Praise to services rendered	7
Lack of content for preschools and primary schools	3
Suggestions to interconnect the activities and the syllabus	1
Suggestions to add questions in the survey	1
Lack of security in the venue	1
Absence of a participation certificate	1
Noise near the dome	1
Lack of subject diversity	1

In the eighth and last question, visitors were asked to indicate what resources, provided by the planetarium, could be helpful in their classrooms. Twenty visitors replied to this question (as seen in table 5).

Table 5. Comments regarding PP-CCV's educational resources.

	Number of responses
Multimedia resources	8
None	4
Laboratory printed resources (laboratory guides)	3
Teacher support (by the PP-CCV)	2
Periodic table of atomic spectra	1
Optical kits	1
Unclear answer	1

3.2 Open-ended questions

The first two questions were aimed at characterizing the teachers. The data shows that most visitors aren't limited to the city of Porto, coming from the North (79.1%) and Center (20.2%) of Portugal. We also see that Porto Planetarium is attracting teachers from different school subjects (figure 1).

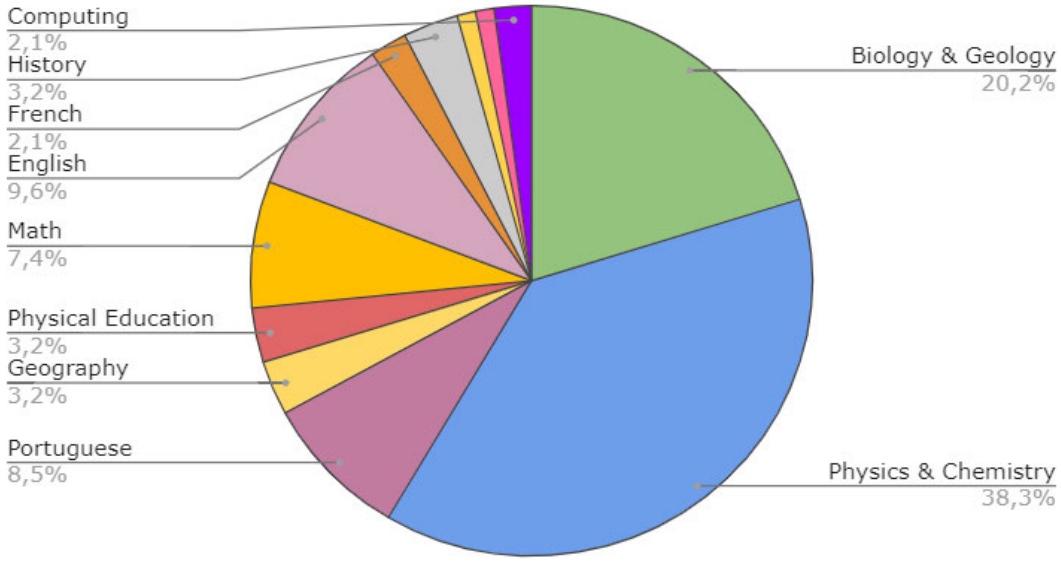

Figure 1. Teachers by school subject field.

To rate PP-CCV's full dome shows and hands-on laboratory we stacked the answers into four categories: i) was it an asset to the students (did they learn with it?); ii) relationship with the school syllabus; iii) interest (did they enjoy the activity?); iv) relevance (of the full dome show) / organization (of the hands-on laboratory).

As we can see (figures 2 and 3), both activities were considered assets, with the hands-on laboratories graded with an average of 4,4 and full dome shows with 4,7 (in a scale from 1 to 5). Both activities were also seen as well framed in syllabus, rating the same exact 4.2 on average.

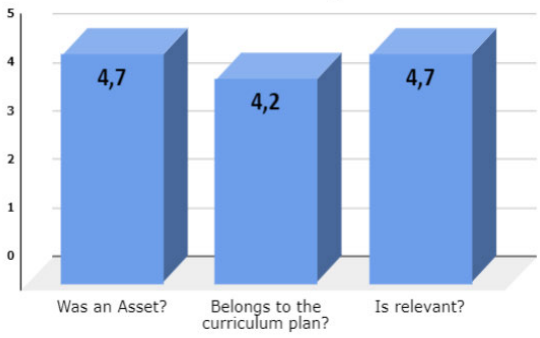

Figure 2. Results from the full dome shows.

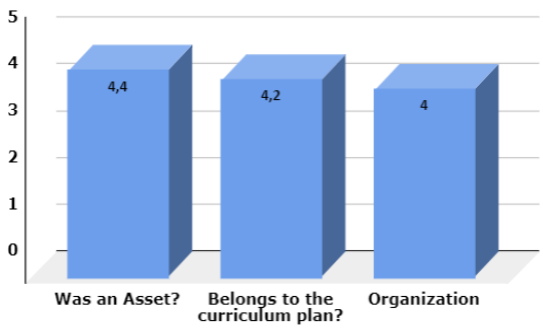

Figure 3. Results from the hands-on laboratory.

We also assessed customer service and the quality of the venue. To do that we used a scale from "Insufficient" to "Very Good" (with the option of not answering – "N/A"). Data reveals that 80,7% of the teachers were happy about the way they were welcomed at PP-CCV (figure 4) and 85.2% were happy about the way they were accompanied throughout the activities (figure 5).

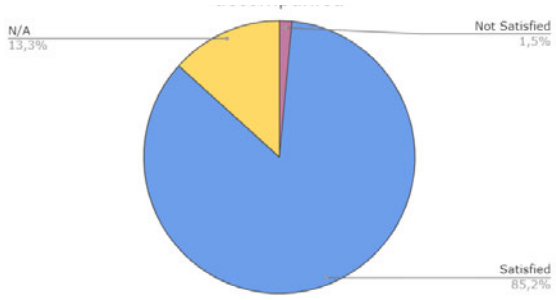

Figure 4. Accompaniment by PP-CCV.

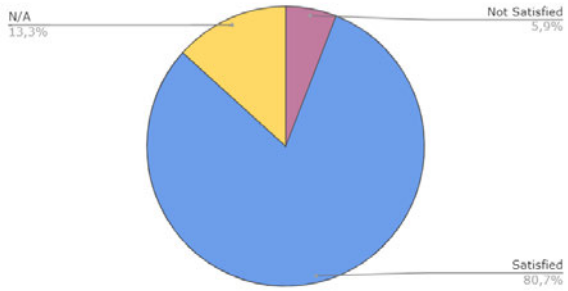

Figure 5. Accompaniment throughout the activities by the PP-CCV.

97,4% of teachers stated that they would return to PP-CCV with their students, and 72.2% would return with their families.

4 CONCLUSIONS

Our results reveal that the activities organized by the Porto Planetarium were valued by the vast majority of visitors. They also show that the activities had a positive impact on the students. On the other hand, the few negative aspects pointed out, already allow us to improve the science communication / education activities of the PP-CCV. Thus, the comments left by our visitors lead us to create new activities for preschool and primary school students and new laboratory printed guides. It also led us to think about the duration of the activities and to implement a digital system to certificate the teachers' participation in our activities. From the opinion of our visitors, we also implemented a different way of organising the visits to include fewer students per group.

Therefore, these results revealed how we can effectively connect science education and science communication using outreach structures already established in research units. To achieve this goal, these institutions must have an in depth understanding of the syllabus, so they can take it into account when designing their activities. That will be the foundation for us to build upon: i) what students should know, to what is scientifically relevant to them to know; ii) from science education to science communication - from the curricula to the most up-to-date scientific knowledge and processes.

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