Evaluating the Impact of the International Year of Astronomy 2009 in Portugal

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Introduction

The celebration of International Year of Astronomy 2009 (IYA2009) in Portugal offered many people their first opportunity to learn about astronomy in a relaxed and informal environment. Measuring the impact of informal learning is a difficult but worthwhile endeavour, so that the organising committees of science communication projects can learn from past successes and failures.

To assess the impact that IYA2009 activities have had on the public's knowledge of astronomy in Portugal, the country's IYA2009 executive secretariat designed and implemented the methodology that is presented in this article.

Designing the evaluation method

Operationalisation[1]

From the goals outlined by the International Secretariat of IYA2009, the following were selected as being the most relevant for Portugal:

- to promote a scientific culture;
- to promote access to knowledge;
- to support and develop both formal and informal science education;
- to transmit a modern image of science;
- to support and develop collaborative projects.

Each of these goals constitutes a latent variable that cannot be observed or measured directly. However, they can be defined from a range of other measurable variables (Hill & Hill, 2009). Thus it was necessary to operationalise each of the variables corresponding to each goal. In other words, it was necessary to formulate a set of items (factors) that could be measured and make them an integral part of the concept of each goal — our latent variable (Majchrzak, 1984).

Based on the experience of the executive secretaries of IYA2009 and directives sent by the IYA2009 International Secretariat, scales to measure each latent variable were defined. These were measured on a five-point Likert scale (Likert, Roslow & Murphy, 1993) — a type of questionnaire where the respondents specify their level of agreement to supplied statements. For example, the variable corresponding to the first goal of promoting scientific culture was measured by grading the four points listed in Table 1 between 1 and 5, where 1 is "strongly disagree" and 5 is "strongly agree". Four items, each of which is a measurable variable, were used to measure the success of the goal to promote a scientific culture.

Data and sources

The Portuguese laypeople involved in this study (all of whom had participated in IYA2009 events) were selected at random in order to obtain a cross-sectional analysis[2]. With the available resources, the sample size was as large as possible.

Data was collected using an online questionnaire. The format of an online questionnaire was chosen because it enables data to be collected from various geographical areas with ease, and it can also be completed at the respondent's convenience (Saunders, Thornhill & Lewis, 2009).

Methodology

Statistical techniques were selected to fit the aim of this study and the nature of the data. Factor analysis was used to reduce the data and to increase the consistency of the measures. This technique makes it possible to identify the sets of variables that are not directly observable, reducing and combining a wide range of variables in some components (called factors), and identifying possible associations between variables. It is possible, for example, that variations in three or four observed variables mainly reflect the variations in a single

unobserved variable, or in a reduced number of unobserved variables. In this manner, factor analysis initially enables the separate dimensions of the underlying data structure to be identified and then determines the degree to which each variable is explained by each dimension (Hair et al., 2005).

The factor analysis method can only be used when there is a correlation between the variables, so the statistical tool Kaiser-Meyer-Olkin (KMO) was used to establish that such a correlation existed before proceeding with the factor analysis. To justify continuing with factor analysis with principal components, the KMO value should be greater than 0.5 (Hair et al., 2005).

After the factor analysis, and the reduction of the number of variables through the factors, new indexes were created based on the arithmetic averages of the original items.

But first, we needed to estimate how well the new indexes reflected the original items, so we needed to evaluate the internal consistency of the factor analysis using the parameter Cronbach's alpha (α) — a statistic calculated from the pair-wise correlation between items and usually used to measure the internal consistency. If this evaluation gave a satisfactory result, the created indexes could be treated as quantitative variables and used to provide information about the initial items. The Statistical Package for Social Sciences (SPSS) version 17.0 software was used for the statistical treatment. For a detailed description of this methodology, please refer to Pestana & Gageiro (2008).

Data handling and debugging

In this section, in Table 2 we present the results of the factor analysis and the assessment of the internal consistency of the variables. These results were obtained by the method described in the previous section.

The variable Promotion of Scientific Culture was measured by a set of opinion questions using a Likert scale of five points. The principal components factor analysis revealed a correlation between the variables, with a satisfactory KMO value (0.769), so the factor analysis was continued. The four original items (see Table 1) constitute

ITEM	Promotion of Scientific Culture
PSC_a	The event(s) that I performed/participated in during the IYA2009 was (were) an inspiration for other scientific activities.
PSC_b	The event(s) that I performed/participated in during the IYA2009 motivated me to discuss other scientific themes.
PSC_c	The event(s) that I performed/participated in during the IYA2009 led me to want to learn more about astronomy.
PSC_d	The event(s) that I performed/participated in during the IYA2009 enhanced my ability to understand astronomy.

Table 1. Operationalisation of the variable "Promotion of Scientific Culture".

Variables	Dimension	Items	KMO	% Explained Variance	α
Promotion of Scientific Culture	1	4	0.769	63.544	0.808
Promotion of Access to New Knowledge	1	3	0.447	—	0.586
Support and Development of Formal and Non-formal Science Education	1	2	0.500	—	0.503
Transmission of a Modern Image of Science	1	4	0.753	60.197	0.764
Support and Develop Collaborative Projects	1	3	0.656	66.552	0.748

Table 2. Factor analysis and internal consistency of the variables.

Variables	N	Mean	Standard Deviation	Median	Mode
Promotion of Scientific Culture	453	4.299	0.571	4.250	4.000
Transmission of a Modern Image of Science	507	3.678	0.634	3.750	4.000
Support and Develop Collaborative Projects	400	3.839	0.724	4.000	4.000

Table 3. Mean and standard deviation of the variables.

Goals	Results
Promotion of Scientific Culture	Achieved with success
Promotion of Access to New Knowledge	Not possible to assess
Support and Development of Formal and Non-Formal Education of Science	Not possible to assess
Transmission of a Modern Image of Science	Achieved
Support and Develop Collaborative Projects	Achieved

Table 4. Results of the goal analysis.

a single construct explaining 63.544% of the variance for the variable Promotion of Scientific Culture. The Cronbach's alpha of 0.808 indicated that the internal consistency of the variables was good.

The analysis of the variables Promotion of Access to New Knowledge and Support and Development of Formal and Non-formal Science Education showed unacceptable KMO levels and the factor analysis was not carried out. The same was true for the values of the internal consistency, so it was not possible to draw conclusions based on this scale.

For the remaining variables, Transmission of a Modern Image of Science and Support and Develop Collaborative Projects, reasonable values of KMO were obtained (0.753 and 0.656), enabling further factor analysis. The Cronbach's alpha values of 0.764 and 0.748 indicated that the internal consistency of the variables is reasonable.

Analysis of results

The values of the latent variable for each case were obtained by applying factor analysis, and creating indexes, as previously described.

Conclusions about the achievements of IYA2009 in Portugal can be drawn from the analysis of the descriptive statistics of the obtained indexes, which are presented in Table 3.

The results of the study show that, within the observed sample, the objectives of IYA2009 were achieved. Furthermore, the objective Promotion of Scientific Culture was achieved with great success. Table 4 summarises the results.

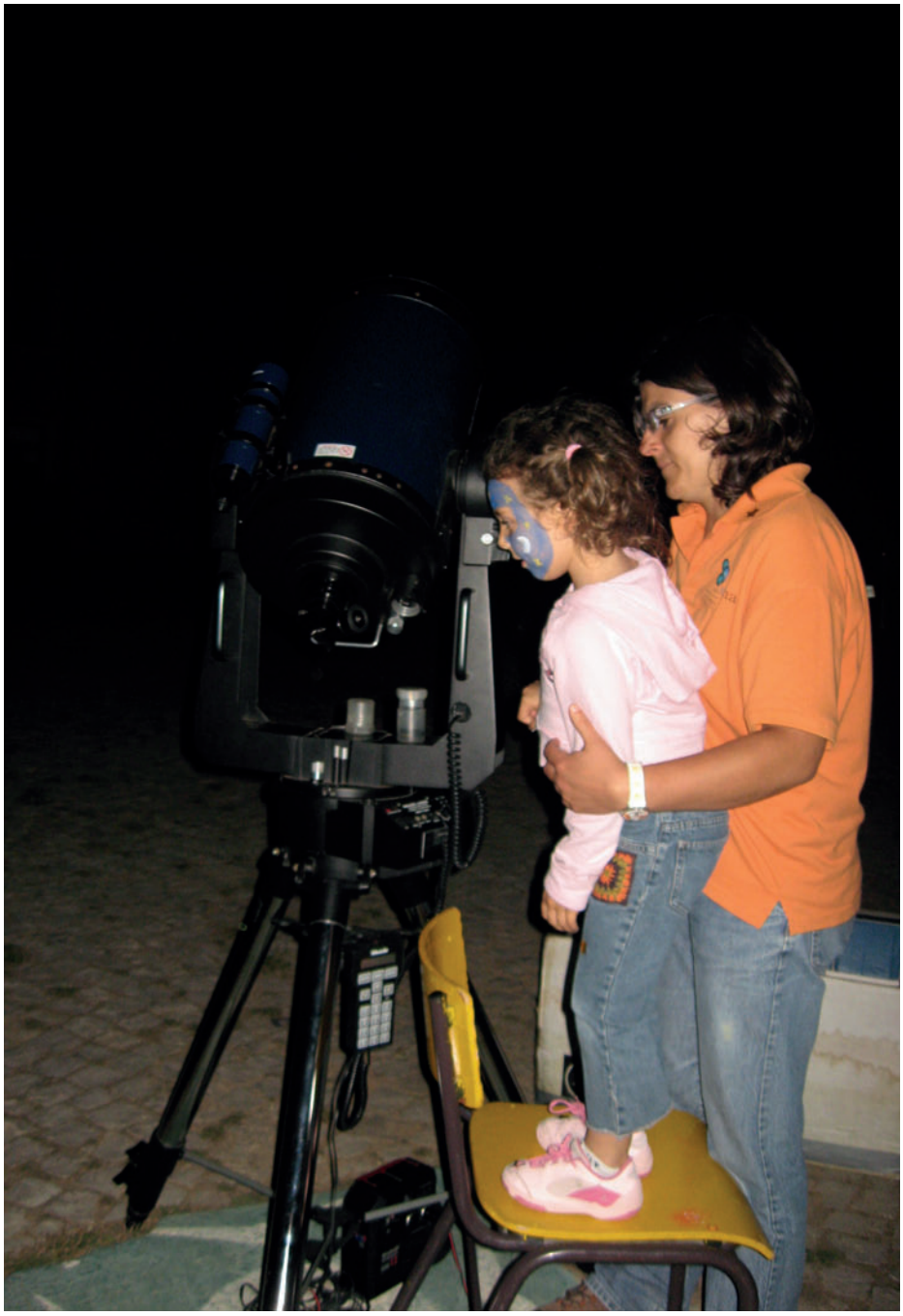

Figure 1. Observing night in Portugal during the International Year of Astronomy 2009. Credit: IYA2009/Portugal.

Conclusions

This study aimed to analyse the impact of IYA2009 based on the set goals of IYA2009. In order to assess this, scales to measure each goal were created. Data were then collected through an online questionnaire and analysed using statistical techniques, principally factor analysis. Given the difficulty in finding scales that have already been constructed and tested in this area, it was not possible to measure all of the goals. There is a clear lack of studies in this area and it was difficult to create and define a set of items to measure the variable Promotion of Scientific Culture (see Table 1).

This study concludes that the goals that could be studied were met, namely the Promotion of Scientific Culture, Transmission of a Modern Image of Science and Support and Develop Collaborative Projects. These results have implications for the strategies that are adopted by the organising committees of other international science communication projects.

For this study, three scales were created to evaluate science communication activities. Those scales could be applied to evaluate other science communication activities in the future.

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Annex A – Operationalisation of the Variables

ITEM	Promotion of Access to New Knowledge
PANK_a	The event(s) that I performed / participated in the IYA2009 helped me to gain knowledge about recent developments in astronomy and space sciences.
PANK_b	How do I evaluate my knowledge of astronomy before the event(s).
PANK_c	How do I evaluate my knowledge of astronomy after the event(s).

Table 5. *Operationalisation of the variable Promotion of Access to New Knowledge.*

ITEM	Support and Development of Formal and Non-Formal Science Education
SDFNSE_a	I want to participate in more astronomy events.
SDFNSE_b	How would you rate the activities carried out throughout 2009 in relation to your expectations?

Table 6. *Operationalisation of the variable Support and Development of Formal and Non-formal Science Education.*

ITEM	Transmission of a Modern Image of Science
TMIS_a	My view of astronomy has changed.
TMIS _b	I learnt about new technologies and scientific advances that were developed through astronomy.
TMIS _c	I found practical applications for the development of astronomy and space sciences that have been introduced into my day-to-day life.
TMIS _d	I learned more about the astronomy that is done in Portugal and/or by Portuguese researchers.

Table 7. *Operationalisation of the variable Transmission of a Modern Image of Science.*

ITEM	Support and Development of Collaborative Projects
ADPC_a	The event(s) I performed / participated in collaborated with other entities.
ADPC_b	The event(s) I performed / participated in eased access to knowledge networks (for example: science centres, research centres, universities, etc.).
ADPC_c	I gained experience in organising and facilitating events.

Table 8. *Operationalisation of the variable Support and Development of Collaborative Projects.*

Notes

[1] Operationalisation is the process of defining a fuzzy concept so as to make the concept clearly distinguishable (in the humanities) or measurable (in the physical sciences) and to understand it in terms of empirical observations. (after Wikipedia, http://en.wikipedia.org/wiki/Operationalization)

[2] Cross-sectional analysis is a type of observational study that involves the observation of an entire population, or a representative subset, at a defined time, and is often used to describe some feature of the population (after Wikipedia, http://en.wikipedia.org/wiki/Cross-sectional_analysis)