Chapter #6

COASTRO: @N ASTRONOMY CONDO – TEACHERS' ATTITUDES AND EPISTEMOLOGICAL BELIEFS TOWARDS SCIENCE IN A CITIZEN SCIENCE PROJECT

Ilídio André Costa[1], Carla Morais[2], & Mário João P. F. G. Monteiro[3]
[1]Agrupamento de Escolas de Santa Bárbara, Planetário do Porto – Centro Ciência Viva, Faculdade de Ciências da Universidade do Porto, Instituto de Astrofísica e Ciência do Espaço da Universidade do Porto, Portugal
[2]Centro de Investigação em Química da Universidade do Porto, Unidade de Ensino das Ciências, Departamento de Química e Bioquímica, Faculdade de Ciências da Universidade do Porto, Portugal
[3]Departamento de Física e Astronomia da Faculdade de Ciências da Universidade do Porto, e Instituto de Astrofísica e Ciência do Espaço da Universidade do Porto, Portugal

ABSTRACT
An attitude is seen as a hypothetical construct related to a tendency expressed by evaluating a particular entity with some degree of favour or disfavour. In the case of attitudes toward science, these cannot be isolated from understanding science's processes: the path to produce, refute, and change knowledge. Thus, it is critical to promote public engagement with science-astronomy and technology with the goal of understanding content, but also of understanding what science is and how it is built. In this context, CoAstro: @n Astronomy Condo emerged – a citizen science project starts with the engagement of primary school teachers with the Research Group on the "Origin and Evolution of Stars and Planets" at the Instituto de Astrofísica e Ciências do Espaço (IA). A semi-structured interview was conducted to study teachers' attitudes and epistemological beliefs towards science and the changes promoted by CoAstro. The interview was performed before and after the development of the CoAstro. It involved nine primary school teachers with no degree in science and who volunteered to participate in CoAstro. The results show that there has been an increase of interest in astronomy and the reinforcement of epistemological beliefs.

Keywords: citizen science, science communication, epistemological belief, attitudes towards science.

1. INTRODUCTION

Although not all research has as its primary intention science communication to lay public (Burns, O'Connor, & Stocklmayer, 2003), its social relevance should be one of the starting points to decide the pertinence of its dissemination to this type of audience. For them, neither understanding the results nor understanding the processes that led to these constitute trivial tasks.

Therefore, it is urgent to associate the increase of scientific production (Bretones, 2018; Bretones, Jafelice, & Horvath, 2016; GGS, 2021; Lelliott & Rollnick, 2010; Pordata, 2021) with the strategies that enable the dissemination of scientific methods. The process will be relevant to promote attitudes and beliefs towards science because they enhance understanding and engagement with science.

In this context emerged the idea of the citizen science project "CoAstro: @n Astronomy Condo". It brought together astronomers, science communicators, and primary school teachers. This project had three main goals: i) to structure, implement and evaluate a citizen science project; ii) perceive the importance of the project for the participants; iii) evaluate scientific knowledge, attitudes, and beliefs. It is precisely from this last goal that emanates the present work.

2. BACKGROUND

Science communication can be understood as any act that aims to promote one or more of the following paradigms (Burns et al., 2003; Oliveira & Carvalho, 2015): i) public awareness of science (PAS) - predominantly about attitudes toward science; ii) public understanding of science (PUS) - understanding of science content, methods of inquiry and science as a social enterprise; iii) public engagement with science and technology (PEST) - the engagement will correspond to the involvement of non-specialists in scientific-technological subjects, under a philosophy of reciprocal learning. Such desiderate to be most easily attainable if citizens can be directly involved in scientific production – citizen science – to understand contents and what science is and how it is built. That was done in "CoAstro: @n Astronomy Condo".

2.1. CoAstro – A citizen science project

The term citizen science refers to public engagement in different stages of scientific processes (Bultitude, 2011; Marshall, Lintott, & Fletcher, 2015; Roy et al., 2012). This collaborative concept, between astronomers and volunteers, is becoming increasingly popular in non-formal science education (Price & Lee, 2013). Indeed, citizen science can easily create a win-win context: it attracts more researchers to science communication and, on the other hand, allows the public to participate directly in scientific processes (Riesch & Potter, 2014).

Thus, CoAstro defines itself as a citizen science project which, during one school year (2018/2019), had the participation of: four astronomers from the Instituto de Astrofísica e Ciências do Espaço (IA) in Portugal, nine primary school teachers, four science communicators, and one mediator (these belonging to the Porto Planetarium – Ciência Viva Center – PP-CCV). Under this project, the public engagement with science-astronomy and technology (PESaT) was made with the goal of understanding contents, but also to promote "positive" attitudes and epistemological beliefs towards science.

CoAstro was organized into eight main work packages. One took a central role in the process: the involvement of primary school teachers and the Research Group on the "Origin and Evolution of Stars and Planets" at IA. That followed a collaborative model of citizen science (Bonney et al., 2009): their analysis accompanied data collection. This feature allowed the project to be extended to the school community by engaging approximately one thousand persons.

To engage teachers in astronomy research, two subprojects were developed in CoAstro: "Stars" (aiming the analysis of standard stellar spectra to allow the determination of the composition of 57000 stars and the characterization of their brightness, using *Data Release 2* from the European Space Agency – ESA – *GAIA Mission*) and "Planets" (aiming the production of a planetary transit video, using *Python* program and the analysis of light curves to signal the presence of potential exoplanets).

CoAstro assumed, from its conception, that one of its objectives would be to work attitudes and epistemological beliefs towards science. Thus, it would be necessary to analyse the teachers' attitudes at the beginning and end of the project to understand CoAstro's contributions to this process. It is in this context that we will now present the process that led to that assessment.

2.2. Attitudes and epistemological beliefs towards science

The individual science conceptions may be one of the primary conditioning sources of attitudes towards science and visions about building it (Tytler, 2014). The interest for this attitudinal domain starts within reach of education in science when this is assumed as a means to reach two goals: the promotion of scientific literacy and the preparation of new generations of scientists (Millar & Osborne, 1998; Tytler, 2014).

Attitudes towards science are defined by Osborne, Simon, & Collins (2003, p. 1053) as "the feelings, beliefs, and values held about an object that may be the enterprise of science, school science, the impact of science on society or scientists themselves". These authors assume that the concept established is no more than the synthesis of the set of affective behaviours previously listed by Klopfer (1971): the presence of favourable attitudes towards science and scientists; the acceptance of scientific methods as a way of thinking; the adoption of scientific attitudes; the pleasure associated with scientific learning opportunities; interest in science and related activities; and the interest in pursuing scientific careers. However, these days, as noted by Rutjens, Heine, Sutton, & van Harreveld (2018, p. 125), "as science continues to progress, attitudes towards science seem to become ever more polarized. Whereas some put their faith in science, others routinely reject and dismiss scientific evidence".

Miller (1983) considers attitudes towards science as an element of scientific literacy: attitudes towards science and knowledge (towards science) – the social impact of science on the individual and society itself. However, Miller does not isolate this domain from the understanding of scientific processes: the nature of science (Osborne, Simon & Tytler , 2009). For Ozgelen (2012, p. 104), this refers to "epistemology and values and beliefs for scientific knowledge and how that knowledge is developed, refuted, and changed". Thus, Price and Lee (2013, pp. 780-781) prefer to designate this domain as epistemological beliefs about science:

> We feel it is flexible enough to reflect that attitudes, feelings, and understanding change and is somewhat subjective. Other words such as "knowledge" or "awareness" imply a hard reality the participant is being judged against and oversimplifies what constitutes the "nature of science", a term that stirs strong emotions in many academics.

That seemed to us to be the understanding that best represents what we are trying to measure in the present work. Thus, we will designate the two attitudinal components analysed using the following terminology: i) attitudes towards science; ii) epistemological beliefs.

Brossard, Lewenstein, & Bonney (2005) analyzed the impact of a citizen science project on knowledge and changing participants' attitudes. Their conclusions reveal that:

> The project had an impact on participants' knowledge of bird biology. No statistically significant change in participants' attitudes toward science or the environment or participants' understanding of the scientific process could be detected. The results suggest that projects must make explicit to participants the issues that they are experiencing (Brossard et al., 2005, p. 1099).

These authors even compared a group of participants, in a citizen science project, with a control group: they found no differences between them in understanding scientific processes. That also occurs in previous work (Trumbull, Bonney, Bascom, & Cabral, 2000) that verified the existence of strong epistemological beliefs in the participants, but could not attribute them to the participation in the project: "we cannot state that participation in a citizen-science project caused this thinking" (Trumbull et al., 2000, p. 265). Years later, Jordan, Gray, Howe, Brooks, & Ehrenfeld (2011) demonstrated that citizen science projects seem to affect increasing participants' knowledge, but not in terms of their scientific attitudes:

> Knowledge of invasive plants increased, on average, 24%, but participation was insufficient to increase understanding of how scientific research is conducted. Participants reported increased ability to recognize invasive plants and increased awareness of invasive plants' effects on the environment, but this translated into little change in behaviour (Jordan et al., 2011, p. 1148).

Price and Lee (2013) looked at scientific attitudes and epistemological beliefs changes in the participants of an astronomy citizen science project. This study led to our interview script, and it is presented in the next section of the present work.

3. METHODOLOGY

This section will present the attitudes instruments and the process that led to the interviews' script.

3.1. Attitudes instruments for CoAstro

To study teachers´ attitudes and epistemological beliefs towards science, as well as to analyse any changes promoted by CoAstro, a semi-structured interview (with the Portuguese acronym EAC), based on the Scientific Attitude Instrument (SAI) and the Shortened Nature of Scientific Knowledge Scale (SNSKS) was prepared.

The Scientific Attitude Instrument (SAI) is an instrument presented by Price and Lee (2013), built due to the lack of attitude instruments properly developed outside the educational context. That was our motivation to build EAC based in SAI: SAI is an attitude instrument assembled to match an older citizen science audience's characteristics. It is "constrained in length, focus on the use of science in everyday life, and include questions that would measure behaviour unique to a citizen science audience" (Price & Lee, 2013, p. 780).

SNSKS was based on the Nature of Scientific Knowledge Scale (NSKS) established by Rubba and Andersen (1978). The items in the original NSKS included 48 items grouped into six categories of the nature of science (amoral, creative, developmental, parsimonious, testable, and unified). Each category included four positively stated items and four negatively stated items. The SNSKS kept the number of categories but reduced to four the number of items per category. That was made in response to the pilot study: the authors omitted all negative items. This shortening was necessary due to Price & Lee's citizen science participants' resistance: they rebelled on the project's public discussion forums. That is a common problem in citizen science (Price & Lee, 2013). SNSKS was chosen over other attitudes instruments because: i) it is based on a survey instrument with extensive pedigree (NSKS); ii) it was experimented in citizens science projects; iii) its application, simultaneously with SAI, was already tested (Price & Lee, 2013).

SAI has nine items, and SNSKS twenty-four items answered with a 5-point Likert scale consisting of Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree categories. SAI´s reliability ($\alpha = 0.95$) and SNSKS´ reliability ($\alpha = 0.94$) were high.

SNSKS agreed, in general, with previous validation work on the original NSKS instrument, despite its shortened length.

A total of 3180 participants completed the pre-test (with SAI and SNSKS simultaneously) made by Price & Lee (2013). They were invited to take the post-test after six months: 365 participants complete that task.

The above description justifies the choice of the SAI and SNSKS as the basis for our interview about attitudes and epistemological beliefs (EAC) done to teachers involved in CoAstro. Therefore, in this section, we will characterize the EAC respondents and the whole process that, starting from SAI and SNSKS, led to the EAC's adaptation and application in the CoAstro project.

The option for a semi-structured interview was made due to the number of CoAstro teachers: nine. Therefore, we decided to adapt SAI and SNSKS and built an interview script based on them.

To produce the EAC´s interview script, we started by translating SAI and SNSKS from English into Portuguese. This first translation was the subject of scientific analysis by a Science Education and Communication expert. In this analysis, the expert verified the need to make some adjustments to avoid changing the meaning of the SAI/SNSKS.

Subsequently, a graduate person, working in the United Kingdom for seven years, made the retroversion of that translation. This process did not reveal any important difference between the translation and the original SAI/SNSKS.

This whole process of translation, analysis, and retroversion led to a first stabilized version of the EAC that allowed us to proceed to the next phase: the interview script. The same Science Teaching and Dissemination expert also analysed it. With minor changes needed, we had the final version of the EAC script. This script has the same number of questions as to its predecessors (SAI/SNSKS): we only translated them and validated that translation.

3.2. EAC’s participants

EAC´s and EDD´s participants were 45 years old, on average. Eight respondents were female, and one male. Four teachers completed high school in urban areas, two in suburban areas, and three in rural areas. However, at the time of the first interview, five worked in suburban schools, three in urban schools, and only one in a rural school. All teachers stated that they had never taken any specific astronomy course or participated in any astronomy initiative. For three of these teachers, CoAstro provided the first contact with the Porto Planetarium – Ciência Viva Center (PP-CCV).

3.3. EAC’s application

The first moment of the interview (EI) ran between the 23rd of January and the 18th of February. They took place in a “familiar” context for the teachers (school, coffee shop, home…). At that point, teachers were aware solely of CoAstro objectives. The interview was recorded with the interviewee's authorization. All nine interviews followed a familiar dynamic: the interviewer read each statement of the interview script; the interviewee positioned himself according to a level on the Likert scale and justified when he deemed it was necessary for his answer. The interviewer, also when necessary, asked for clarification of any idea presented by the interviewee. Thus, nine interviews were completed.

With the same procedure and in the same application context, the second moment of the interview (EII) ran between the 20th of September and the 8th of October. All the nine teachers completed EII by two months after the end of the project.

4. RESULTS

We start by recalling that the data collected through the EAC had as objectives: i) to know what are the attitudes towards science and the epistemological beliefs of the primary school teachers involved in CoAstro; ii) verify if their participation in CoAstro has modified those same attitudes and beliefs.

Based on the interview script and its objectives, an analysis framework was produced with categories (A and B) and subcategories (A1 and A2; B1 to B6), from which the content analysis of the interviews was made: A. Attitudes towards science (A1. Interest and proactivity; A2. Understanding and use of scientific knowledge); B. Epistemological beliefs (B1. The amorality of scientific knowledge and its application; B2. Creativity in science; B3. Knowledge construction process; B4. Parsimony in science; B5. Validation of knowledge; B6. The interdisciplinarity of science). The following summarizes some of the main results, supported by excerpts from the interviews, which we translated from Portuguese to English.

Regarding category A, the results showed that from EI to EII, there was an increase in science interest, in citizen science projects, more specifically in those astronomy based; "I occasionally find myself going to TESS [Transiting Exoplanet Survey Satellite], something I never did before, (Teacher 3)". However, that was made without high levels of proactivity when looking for news: "I don't make it my banner to go to the newspaper…, but if it has [some about astronomy], I see, I read, and I'm interested, something that didn't happen before" (Teacher 6). Teachers said that they were more knowledgeable about science (although little familiar), which allows them to make greater use of that knowledge to evaluate claims made about science and to place it in their daily lives (mainly in terms of their teaching practice): "In terms of astronomy yes [changed], ... because it was very little what I knew [to be able to assess scientific knowledge] ..., but today I already operate in another way" (Teacher 8).

The elapsed period between EI and EII helped reinforce the conviction that it is possible to judge scientific knowledge applications, but not knowledge itself (B1 category). The reinforcement of the pre-existing belief regarding creativity in science (B2 category) was also found from EI to EII. However, for most of the interviewers, creativity in science exists only at the beginning of the scientific process: "In scientific theory, we can perceive the creative way in which the scientist got there, but the concept itself, the law and theory, for me, does not have creativity" (Teacher 2). There was no change in most participants regarding the understanding of how scientific knowledge is constructed (B3 category). The interviewers already considered at EI that scientific knowledge results from past knowledge, valid in the historical context in which was produced; it is provisional because even at the time of its acceptance, it can include errors. The concept of parsimony (B4 category) was unknown to teachers. At EII, the concept was already evident for teachers, but the tendency to associate it with scientific knowledge is not univocal. Even so, in the period between EI and EII, this issue was pondered by teachers.

It is possible to establish a direct relationship between participation in CoAstro and the reinforcing of the belief that repeatability and consistency of results are conditions for the validation of scientific knowledge (B5 category): "In different parts of the world… [the] scientists will have to reach equivalent results again" (Teacher 8). In the EII, there is an almost generalized idea that observations allow the laws, theories, and scientific concepts to be tested.

Most teachers, already in EI, had an interdisciplinary view of science (B6 category), although only between some specific sciences (such as Physics and Chemistry). That interdisciplinary understanding of science was unanimous, reinforced, and universalized at the time of the EIIs and already among all sciences (biology, chemistry, and physics): “Biology also has chemistry, and it also has physics… I think they are interconnected with each other” (Teacher 7).

5. FUTURE RESEARCH DIRECTIONS

Based on the work carried out, we aim, in the future, to learn about the attitudes and epistemological beliefs of the other participants in CoAstro: astronomers and science communicators. It would also be our intention to obtain data from students, their families, and other members of the school communities involved in CoAstro’s astronomy outreach activities.

It would also be relevant: i) set variables to establish control groups that would allow us to understand the effective gains of CoAstro´s work model; ii) to compare the effects of CoAstro in different groups of teachers (primary, middle, and high school teachers) and between children of different grades; iii) migrate to a model of combining data collection and data analysis methods that allow a more holistic view of the object of study.

6. CONCLUSION/DISCUSSION

For the defined content analysis categories, the influence of CoAstro in B3 was not seen only in B3 (knowledge building process) and in B5 (parsimony in science). Although this last concept became known to teachers (after CoAstro), it was not uniquely associated with scientific processes. There is a reinforcement of beliefs in all other categories, an increase in science interest, and the understanding and use of scientific knowledge. The rise in proactivity was not significant, perhaps due to the subscription of new resources (such as newsletters) between EI and EII, or because teachers started to resort to means (such as content suggestions from online services and software companies) in which the news is presented, according to their research interests.

A comparison with Price and Lee’s results (2013), although it may be done, requires some caution, because: i) the data were treated in a quantitative way; ii) SAI/SNSKS were provided when participants first registered via the web site of the project – interest in astronomy and science was, already, very high; iii) the nature of the Citizen Sky Project – a web-based project aiming the report, by volunteers, of visual brightness estimates for a multiple star system (ε Aurigae) – is very different from CoAstro´s nature.

Thus, as Price and Lee’s results, we detected a significant change in the scientific attitude. Other citizen science projects have not reported any change in scientific attitude (Brossard et al., 2005; Jordan et al., 2011; Trumbull et al., 2000). Also, as Price and Lee, our results suggest that epistemological beliefs were reinforced, rather than restructured. This alignment with Price and Lee’s results is essential because they were the firsts in the literature to show a change in epistemological beliefs through a citizen science project.

Therefore, our results reveal that a citizen science project, built on a model such as CoAstro’s, supported by a collaborative view of citizen science and aligned with a PEST paradigm, can effectively contribute to the increase of interest, understanding, and use of scientific knowledge and the reinforcement of correct epistemological beliefs. For this purpose, the key elements appear to be teachers’ involvement in astronomy research.

REFERENCES

Bonney, R., Ballard, H., Jordan, R., McCallie, E., Phillips, T., Shirk, J., & Wilderman, C. C. (2009). *Public Participation in Scientific Research: Defining the Field and Assessing Its Potential for Informal Science Education*. Washington, DC: Center for the Advancement of Informal Science Education's Public Participation in Scientific Research. Retrieved from https://www.informalscience.org/sites/default/files/PublicParticipationinScientificResearch.pdf

Bretones, P. S. (2018). Overview of the Astronomy Education Research landscape. *Proceedings of the International Astronomical Union*, *14*(A30), 570-571. doi:10.1017/S1743921319005441.

Bretones, P. S., Jafelice, L. C., & Horvath, J. E. (2016). Ten years of Latin-American journal of astronomy education RELEA: achievements and challenges for international astronomy education development. *Journal of Astronomy & Earth Sciences Education (JAESE), 3*(2), 110-124.

Brossard, D., Lewenstein, B., & Bonney, R. (2005). Scientific knowledge and attitude change: The impact of a citizen science project. *International Journal of Science Education, 27*(9), 1099-1121.

Bultitude, K. (2011). The why and how of science communication. In P. Rosulek (Ed.), *Science Communication*. European Commission.

Burns, T. W., O'Connor, D. J., & Stocklmayer, S. M. (2003). Science communication: A contemporary definition. *Public Understanding of Science, 12*(2), 183-202.

GGS. (2018). *Mining 50 years of astronomy and astrophysics publications data*. Retrieved from https://gender-gap-in-science.org/2018/03/17/mining-50-years-of-astronomy-and-astrophysics-publications-data/

Jordan, R. C., Gray, S. A., Howe, D. V., Brooks, W. R., & Ehrenfeld, J. G. (2011). Knowledge gain and behavioral change in citizen-science programs. *Conservation Biology, 25*(6), 1148-1154.

Klopfer, L. E. (1971). Evaluation of learning in science. In J. T. H. B. S. Bloom, G. F. Madaus (Ed.), *Handbook of formative and summative evaluation of student learning* (pp.559-641). New York: McGraw-Hill.

Lelliott, A., & Rollnick, M. (2010). Big ideas: A review of astronomy education research 1974-2008. *International Journal of Science Education, 32*(13), 1771-1799.

Marshall, P. J., Lintott, C. J., & Fletcher, L. N. (2015). Ideas for Citizen Science in Astronomy. *Annual Review of Astronomy and Astrophysics, 53*(1), 247-278.

Millar, R., & Osborne, J. (1998). *Beyond 2000: Science education for the future: A report with ten recommendations*. King's College London, School of Education.

Miller, J. D. (1983). Scientific literacy: A conceptual and empirical review. *Daedalus, 112*(2), 29-48.

Oliveira, L. T. d., & Carvalho, A. (2015). Public Engagement with Science and Technology: contributos para a definição do conceito e a análise da sua aplicação no contexto português [Public Engagement with Science and Technology: contributions to the definition of the concept and the analysis of its application in the Portuguese context]. *Observatorio (OBS*), 9*(3), 155-178.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*, *25*(9), 1049-1079.

Osborne, J., Simon, S., & Tytler, R. (2009, April). *Attitudes towards science: An update*. Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, CL.

Ozgelen, S. (2012). Exploring the Relationships among Epistemological Beliefs, Metacognitive Awareness and Nature of Science. *International Journal of Environmental and Science Education, 7*(3), 409-431.

Pordata. (2020). *Publicações científicas: número, publicações citadas e citações* [Scientific publications: number, cited publications and citations]. Retrieved from https://www.pordata.pt/Portugal/Publica%C3%A7%C3%B5es+cient%C3%ADficas+n%C3%BAmero++publica%C3%A7%C3%B5es+citadas+e+cita%C3%A7%C3%B5es-1996

Price, C. A., & Lee, H. S. (2013). Changes in participants' scientific attitudes and epistemological beliefs during an astronomical citizen science project. *Journal of Research in Science Teaching, 50*(7), 773-801.

Riesch, H., & Potter, C. (2014). Citizen science as seen by scientists: Methodological, epistemological and ethical dimensions. *Public Understanding of Science*, *23*(1), 107-120.

Roy, H. E., Pocock, M. J., Preston, C. D., Roy, D. B., Savage, J., Tweddle, J., & Robinson, L. (2012). *Understanding citizen science and environmental monitoring: final report on behalf of UK Environmental Observation Framework*. Retrieved from http://nora.nerc.ac.uk/id/eprint/20679/1/N020679CR.pdf

Rubba, P. A., & Andersen, H. O. (1978). Development of an instrument to assess secondary school students understanding of the nature of scientific knowledge. *Science Education*, *62*(4), 449-458.

Rutjens, B. T., Heine, S. J., Sutton, R. M., & van Harreveld, F. (2018). Attitudes towards science. In J. M. Olson (Ed.), *Advances in experimental social psychology: Vol. 57.* Advances in experimental social psychology (pp. 125–165). Elsevier Academic Press..

Trumbull, D. J., Bonney, R., Bascom, D., & Cabral, A. (2000). Thinking scientifically during participation in a citizen-science project. *Science Education*, *84*(2), 265-275.

Tytler, R. (2014). Attitudes, identity, and aspirations toward science. In N. G. L. Sandra K. Abell (Ed.), *Handbook of Research on Science Education, Volume II* (pp. 96-117). Routledge.

ACKNOWLEDGEMENTS

This work was partially supported by FCT - Fundação para a Ciência e a Tecnologia through national funds and by FEDER - Fundo Europeu de Desenvolvimento Regional through COMPETE2020 - Programa Operacional Competitividade e Internacionalização by these grants: UID/FIS/04434/2019; UIDB/04434/2020 & UIDP/04434/2020.

AUTHORS' INFORMATION

Full name: Ilídio André Pinto Monteiro da Costa
Institutional affiliation: Agrupamento de Escolas de Santa Bárbara / Planetário do Porto – Centro Ciência Viva / Instituto de Astrofísica e Ciências do Espaço – Centro de Astrofísica da Universidade do Porto / Faculdade de Ciências da Universidade do Porto
Institutional address: Rua das Estrelas, PT-4150-762 Porto, Portugal
Email address: ilidioandrecosta@astro.up.pt
Short biographical sketch: He has a degree in Biology-Geology (teaching), a Master in Astronomy Teaching and a Ph.D. in Teaching and Dissemination of Sciences, all from the Faculty of Science of the University of Porto. He is an middle and high school teacher but in recent years was deployed to Centro de Astrofísica da Universidade do Porto: Porto Planetarium – Ciência Viva Center. Furthermore, he is an author of textbooks on Natural Sciences and teacher trainer (in-service and pre service teacher training). More recently, a researcher at the Instituto de Astrofísica e Ciências do Espaço. His research areas of interest are citizen science, science education and communication, professional development, and pedagogic practice for primary, middle, and high school grades.

Full name: Carla Susana Lopes Morais
Institutional affiliation: CIQUP, Unidade de Ensino das Ciências, Departamento de Química e Bioquímica, Faculdade de Ciências, Universidade do Porto
Institutional address: Rua do Campo Alegre s/n, 4169– 007 Porto, Portugal
Email address: cmorais@fc.up.pt

Short biographical sketch: She has a degree in Chemistry, a Master in Multimedia Education, and a Ph. D. in Teaching and Dissemination of Sciences from the Faculty of Science of the University of Porto. She is an Assistant Professor and member of the Science Education Unit at the same Faculty. She is a member of the Centre for Research in Chemistry at the University of Porto (RG5: Education, Science Communication, and Society). She is the director of the Master in Science Education and Communication, the coordinator of the specialization in Education of the Master in Multimedia, and the tutor of the Education area of the Ph.D. Program in Digital Media of the University of Porto. Her areas of interest include professional development and pedagogic practices for Physics and Chemistry teachers; dissemination models and processes for scientific knowledge and the involvement and participation of citizens in Science; technological and digital ecologies in Science Education and Communication.

Full name: Mário João Pires Fernandes Garcia Monteiro
Institutional affiliation: Departamento de Física e Astronomia – Faculdade de Ciências da Universidade do Porto and Instituto de Astrofísica e Ciências do Espaço – Centro de Astrofísica da Universidade do Porto
Institutional address: Rua das Estrelas, PT-4150-762 Porto, Portugal
Email address: mario.monteiro@astro.up.pt
Short biographical sketch: He is an Associate Professor at and the Director of the Physics and Astronomy Department of the University of Porto. After an undergraduate degree in astronomy in Porto, he did a Masters and a Ph.D. (1996 - on the physics on the Sun) at Queen Mary University of London. He was (2010-2019) the Course Director for the Doctoral Program in Astronomy at the University of Porto, and coordinated the Doctoral Network for Space Sciences (Ph.D.: SPACE) in Portugal. The research areas of interest are centered in Stellar Physics, namely on the physics of stars and how it impacts the structure and evolution of stars of different mass and age, including our own Sun. The research activity is developed at the Instituto de Astrofísica e Ciências do Espaço, where he is the group leader for the "Origin and Evolution of Stars and Planets".