

# Educational Project with Robotic Telescopes (PETeR): robots looking to the future.

Rodríguez Eugenio, N.<sup>1,2</sup>

<sup>1</sup> Instituto de Astrofísica de Canarias (IAC), E-38205 La Laguna, Tenerife, Spain

<sup>2</sup> Universidad de La Laguna (ULL), Departamento de Astrofísica, E-38206 La Laguna, Tenerife, Spain

## Abstract

The “Proyecto Educativo con Telescopios Robóticos” (PETeR) of the Instituto de Astrofísica de Canarias is an online inquiry-based laboratory that allows school students to carry out their own observations and research projects in astronomy using professional robotic telescopes. The availability of observing time on several telescopes, which also offer different types of observations through user-friendly portals, has allowed us to open the project to the entire Spanish educational community, from primary to secondary school and vocational training. This paper outlines the project’s goals, materials and educational approaches used, as well as the teacher training programmes we provide in the framework of PETeR.

## 1 Introduction

Student lack of interest in STEM (Science, Technology, Engineering and Mathematics) studies and careers is a growing concern in many European countries [2]. In Spain, the demand for enrolment in these university studies is five percentage points below the European average [1]. Factors influencing students’ disenchantment with STEM include: the way these subjects are taught in schools, the perception that they are difficult studies, and the apparent lack of sufficiently attractive career opportunities [5].

Therefore, in order to engage students in these areas, it is necessary to focus on three aspects: 1) promoting hands-on science education; 2) providing teachers with the necessary resources, training and support to enable them to develop a more attractive and stimulating STEM education for their students; and 3) contributing to improving the social perception of science and technology professions.

Astronomy is the perfect engine to arouse interest in STEM subjects [6]. In addition to its aesthetic and general appeal, the development of robotic telescopes in recent decades, together with tools that allow their use by non-professional observers, has opened up this science to the participation of the educational community [4]. Robotic telescopes also allow developing an inquiry-based approach to teaching-learning STEM, which translates into a better understanding and assimilation of concepts [3].

The Instituto de Astrofísica de Canarias (IAC) has made a firm commitment to STEM education deciding to allocate part of its guaranteed time on some robotic telescopes to the Spanish educational community. To this end, it launched the Educational Project with Robotic Telescopes (known by its Spanish acronym PETeR), linked to its Outreach and Communication Unit.

PETeR seeks to foster the interest of pre-university students in science and the development of their STEM skills through their participation in real research experiences using professional robotic telescopes. Our objectives also include training teachers in astronomy and inquiry-based learning methods, as well as contributing to the dissemination of astronomy and astrophysics.

## 2 PETeR robots

PETeR was launched in 2006, following the installation of the Liverpool Telescope (LT) at the Roque de los Muchachos Observatory (Canary Islands). The LT was the first of the fully autonomous 2-metre robotic telescopes and it is one of the largest and most advanced even today. The IAC decided to allocate 25% of its observing time with the LT to PETeR, which is 5% of the total observing time on this telescope.



Figure 1: Some of the robotic telescopes available through PETeR. Left: the Liverpool Telescope, credit: Daniel López / IAC. Middle: worldwide distribution of the LCO 0.4 m telescopes (bottom) and image of those at the Teide Observatory (top, credit: Daniel López / IAC). Top right: PIRATE and COAST telescopes, credit: IAC. Bottom right: SARA telescope at the Roque de los Muchachos Observatory, credit: ING / IAC.

In addition to the LT, other “robots” have been added to the project in recent years. In 2018, PETeR joined as educational partner of Las Cumbres Observatory (LCO) through the [Global Sky Partners](#) programme, which gives access to its network of 40 cm telescopes located in six observatories around the world, in both the Northern and Southern Hemispheres

(see Fig. 1). Since 2019, PETeR users can also observe with the 0.5-metre-class PIRATE and COAST telescopes of the Open University, installed at the Teide Observatory (Canary Islands). The latest telescopes that we have incorporated into the project are those of the [Southeastern Association for Research in Astronomy](#) (SARA) network, of 1-metre class, located in the Canary Islands, Chile and the USA.

All the telescopes available at PETeR are fully autonomous, except for the SARA telescopes, which are controlled remotely. In the first case, users can access the portals of the different telescopes through the PETeR website to request their queued observations and download the images once they have been obtained. At the SARA network telescopes, we request half nights at the Kitt Peak (USA) and Cerro Tololo (Chile) observatories to coincide with school hours in Spain, allowing schools to connect live to the remote observations.

### 3 Target audience

The availability of observing time on several telescopes, which also offer different types of observations through user-friendly portals, has allowed us to open the project to all levels of pre-university education, from primary to high school and vocational training. The observation time is offered to schools completely free of charge and, for the time being, with no limitation other than the division of the available time among the registered schools.

At present, PETeR's users include more than 300 schools throughout Spain, some 25 secondary schools in other countries that collaborate in specific projects with Spanish schools, as well as some 40 non-formal schools and associations of amateur astronomers that participate in the project by carrying out educational and outreach activities with children and young people. The scope of the project is currently around 10,000 students per year.

### 4 PETeR approaches

PETeR works as an online inquiry-based laboratory ([www.iac.es/peter](http://www.iac.es/peter)) that allows students to discover the Universe by carrying out their own astronomical observations and research. To do this, we offer different tools, resources and formats.

In 2012, we launched a survey among Spanish teachers, active and potential users of PETeR, to find out their needs and the project models they found most interesting and appropriate. Based on the results of that study [7], we proposed three active learning approaches, complementary to each other, which try to cover most of the demands of the educational community. Below we present the different models that we offer in the project.

#### 4.1 Pre-defined observations

This model consists of obtaining and analyzing one- or three-color images of different types of objects that can be selected from a list. The observing interface sets, for each object, the appropriate instrument, filter(s), and exposure time. Therefore, this is the easiest option to integrate into teaching practice, as it requires less prior knowledge and is less time-consuming.

For this approach, we use the LT and the observing portal of the [National Schools' Observatory](#) (NSO), which allows observations of regions of the Moon, planets, nebulae, stellar clusters and galaxies. On the PETeR website, we also offer a programme for visualising and analysing astronomical images, [PeterSoft](#), which is specially designed for education.

## 4.2 Didactic Units

Each Unit introduces several astronomy concepts related to primary and secondary school curricula, and provides one or more activities, which make use of pre-observed data and serve as a practical introduction to the different tools of the image processing software. Some of the topics proposed are the structure of the Solar System, the movements of planets and satellites or the determination of distances in the Universe. The aim of this approach is for students to develop their STEM skills while assimilating knowledge about the topic presented.

## 4.3 Research Projects

This format corresponds to real scientific processes, either guided or open enquiry. In the first case, we propose to teachers the type of objects to be studied and the possible methodology to select the objects, programme the observations and analyse the data obtained, providing them with the teaching resources and software necessary to carry out the research. Some examples of guided research projects we offer are the search for supernovae and for variable stars, the characterisation of exoplanets with transits or the confirmation of asteroid orbits.



Figure 2: Sixth grade primary school students (left) and 12-year-old secondary school students (right) developing different research projects with PETeR. Image credits: Aleix Roig, Escola GEM (left), IES El Calero (right).

In open research projects, it is the groups of students plus their teacher who decide what they want to investigate and how. In all cases, we provide scientific and technical advice to the users for the development of the project.

The observations required for these types of projects can be performed directly by our users through the [LCO observation portal](#), the [Open University's public portal](#), and the advanced

interface of the NSO portal. By requesting their observations autonomously, PETeR users have a real experience of obtaining data in astronomy. The strength of this approach is that students experience the scientific process in all its phases. Collaborative work is also encouraged, both within the classroom and with other schools in Spain and other countries.

## 5 Teachers: a key factor

During the first years of the project, few observations were made. One of the reasons given by teachers was their lack of knowledge in astronomy to guide their students in the research projects. Thus, in 2015 we started to run teacher trainings that introduce astronomy and astrophysics concepts but are eminently practical. Our courses focus on the use of robotic telescopes, software and web resources to visualize and analyse astronomical images, inquiry-based learning methods, and examples of research projects that can be develop with PETeR.

One of our main target groups is teachers in the Canary Islands, as we aim for the local educational community to identify the scientific culture and sky of the Archipelago as part of their own heritage. We offer them extensive training along the school year, both in person and online, in collaboration with the Department of Education of the Canarian Government. During the school year, we also run online training sessions for teachers from all over Spain.

In summer we run the international school “[Astronomy Education Adventure in the Canary Islands](#)” (AEACI), which celebrated its eighth consecutive edition in 2022. This teacher training is organized with the collaboration of [NUCLIO](#), the [NSO](#), the [Faulkes Telescope Project](#) and, in the last four editions, the [CESAR](#) project. It consists of a week of intensive training that includes lectures, workshops, visits to the IAC facilities and activities that allow participants to establish links with teachers from other schools in Spain and other countries, fostering cooperation between schools around the world.

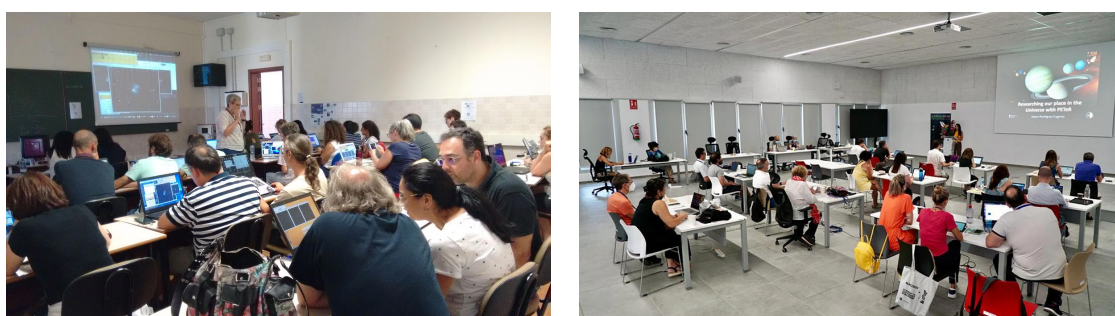


Figure 3: Pictures taken during the AEACI 2019 and AEACI 2022 international schools. Credit: IAC.

We have trained more than 1,200 teachers and educators from over 60 countries of the five continents (more than 800 of them from Spain) through the different courses that we organize or in which we participate.

## 6 Conclusions

Educational projects with robotic telescopes require a significant investment of technological resources (telescope time, observation portals, educational software, etc.) and human resources (staff dedicated to developing teaching materials and research projects, advising and training teachers, etc.), but the benefits are considerable. PETeR and other similar projects democratise access to the sky and to astronomy, allowing hundreds of schools to observe with telescopes located in some of the best observatories on the planet, regardless of their economic level and without the light pollution of the region where they are located being an impediment. In addition, queued observations as well as remote observations during school hours greatly facilitate the participation of schoolchildren aged 6 to 12, for whom night-time observing activities are not usually organised.

In the field of STEM education, the results show that the educational use of robotic telescopes can effectively develop inquiry-based teaching-learning processes, foster students' interest in these areas and stimulate scientific thinking. In Astronomy, we often say that our tools, the telescopes, allow us to look into the past. At PETeR, we use them to encourage the scientific minds of the future.

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