

Highlights in the Implementation of the AstroBVI Project to Increase Quality Education and Reduce Inequality in Latin America

Maria Argudo-Fernández

Instituto de Física, Pontificia Universidad Católica de Valparaíso (PUCV)
maria.argudo@pucv.cl

Nicolas Bonne

Institute of Cosmology and Gravitation (ICG), University of Portsmouth (UP)
nicolas.bonne@port.ac.uk

Coleman Krawczyk

Institute of Cosmology and Gravitation (ICG), University of Portsmouth (UP)
coleman.krawczyk@port.ac.uk

Jen Gupta

Institute of Cosmology and Gravitation (ICG), University of Portsmouth (UP)
jennifer.gupta@port.ac.uk

Alexis Rodríguez Quiroz

AstroBVI project Peru
alexiserquiroz@gmail.com

Penélope Longa-Peña

Centro de Astronomía (CITEVA), Universidad de Antofagasta
penelope.longa@uantof.cl

Juan Pablo Colque-Saavedra

Centro de Astronomía (CITEVA), Universidad de Antofagasta
juanpablo.colque@uantof.cl

Médéric Boquien

Centro de Astronomía (CITEVA), Universidad de Antofagasta
mederic.boquien@uantof.cl

Eduardo Unda-Sanzana

Centro de Astronomía (CITEVA), Universidad de Antofagasta
eduardo.unda@uantof.cl

Amelia Ortiz-Gil

Astronomical Observatory, University of Valencia
amelia.ortiz@uv.es

Ángela Pérez-Henao

Parque Explora, Planetario de Medellín
angela.perez@parqueexplora.org

Guilherme Couto

Centro de Astronomía (CITEVA), Universidad de Antofagasta
guilherme.couto@uantof.cl

Alessandro Martins

Federal University of Jataí/Universidade Federal de Goiás
alexm@ufg.br

Keywords

Astronomy, Education, Inclusion, Galaxies

AstroBVI is an inclusive astronomy project funded by the International Astronomical Union Office of Astronomy for Development (IAU OAD). AstroBVI has been designed for the blind and visually impaired (BVI) community, who are often excluded from outreach and educational activities concerning visually-intensive areas of knowledge such as astronomy. In this project we aim to break down the barriers between science and ability, and to bring astronomy's beauty to a visually-impaired public, independently of gender, wealth and social status. We have created and distributed educational kits composed of 3D tactile maps of galaxies accompanied by a manual and multimedia material in Spanish and Portuguese. Our kit has been mainly distributed to Latin American countries, where we have created a community of AstroBVI teachers. We present the project and highlight some of the activities carried out by this community.

The AstroBVI Project

AstroBVI¹ originated from a one-minute lightning talk presentation by Dr Nicolas Bonne from the University of Portsmouth during the annual meeting of the MaNGA² collaboration at the University of Wisconsin–Madison in 2015. During his talk, he presented the pilot version of the Tactile Universe project³, showing a prototype of a 3D-printed tactile galaxy image and explaining how they were working with their local BVI community. Dr Maria Argudo-Fernández, from the University of

Antofagasta at that time, returned to Chile with the aim of implementing the project in the Spanish-speaking community and reaching as many school children as possible. She gathered a team composed of collaborators around the world, including professional astronomers and specialists in education and inclusion as well as partner projects such as A Touch of the Universe⁴ and Astronomy with all Senses⁵ to produce materials with 3D printers in the astro-engineering lab of the university. The path to achieve our goal was ambitious: to create and distribute as many educa-

tional kits as possible to teachers and science communicators in different countries in Latin America. We started the project thanks to funding in 2018 from the IAU OAD⁶.

The AstroBVI Kit

The AstroBVI educational kit is composed of 3D printed tactile images of different galaxies in different light wavelengths (colours), created using 3D model files provided by the Tactile Universe team,

a collaboration that was central to the AstroBVI project.

The Tactile Universe 3D galaxy images were developed in consultation with a local BVI support group in Portsmouth, England and were created by converting a single-band (i.e. single colour) image of a galaxy into a height map: the brighter an image pixel was, the taller its representation was on the tactile image. A full description of the initial development and pilot phase of the Tactile Universe project can be found in Bonne et. al. (2018). Tactile Universe provided these files to AstroBVI in advance of their public release³, and therefore AstroBVI drew closely upon the Tactile Universe team's experience and resources, including adapting and translating written material into Spanish and Portuguese.

The sample of galaxies composing the AstroBVI kit was selected according to their morphology to have one type of each galaxy in the Hubble fork morphological diagram, as shown in Figure 1. The AstroBVI kit is therefore composed of tactile images of the following galaxies:

- M100: a face-on spiral galaxy with no bar observed in the photo-metric B-band;
- M109: an inclined barred spiral galaxy observed in the B-band;
- M51: a face-on galaxy merger of a spiral and an elliptical galaxy, observed in the R-band and B-band;
- M105: an elliptical galaxy observed in the R-band;
- NGC5866: a lenticular galaxy observed in the R-band.

The kit includes the corresponding Digital Sky Survey (DSS) images of the galaxies used to create the 3D tactile images, coloured images of the galaxies, a guide to help with touching each galaxy (text and audio formats), two guided activities for teachers and a video-manual. All multimedia material is hosted on the website of the project⁷ in Spanish and Portuguese. The 3D galaxy models for printing are also freely available under a Creative Commons (CC BY-NC-ND 4.0) license⁸.

With the available funding, we created and distributed 100 kits to what we named the AstroBVI Teachers Community.



Figure 1. Elements composing the AstroBVI kit (tactile images, galaxy pictures, galaxy guide, and bag). Image Credits: AstroBVI project

The AstroBVI Teachers Community

The kits were distributed to a selection of teachers and science communicators based on motivation, impact and representation in as many countries as possible. Teachers submitted applications online, which were then reviewed by members of the AstroBVI team, who gave a score of 1 to 5 aforementioned criteria.

Latin American countries are in general developing countries with high economic inequalities and many socio-economic challenges, where the resources are very centralised in the capitals and larger cities. Fortunately the AstroBVI teachers are not concentrated in these areas. They are running many different activities (e.g. stands, workshops, school lessons) at many different levels (children, general public, pro-

fessional, and scientific community) using the AstroBVI kit. The selection process aimed to evenly distribute kits across gender, wealth and social status. In fact, 50% of the AstroBVI teachers are women.

The selection was also done independently of an applicant's level of knowledge of astronomical concepts (Argudo-Fernández et al., 2019). We therefore held two virtual workshops to train AstroBVI teachers, one on astronomy and one on inclusion. These workshops included how to effectively work with the kit in the classroom, starting with easy concepts (e.g. planets and distances) then gradually moving onto more complex ones (e.g. galaxy formation). The workshops were delivered in collaboration with the Galileo Teacher Training Program⁹, and the lessons are publicly available¹⁰.

The selected teachers composed the AstroBVI Teachers Community. They are mainly distributed in Latin American countries (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Honduras, México, Paraguay, Peru and Venezuela), but also in Spain and Nepal.

Astronomy for Development

Among all the countries where we distributed our kit, we would like to highlight the experiences from Chile and Peru. Chile submitted the largest number of applications in our global call (Argudo-Fernández, 2019), especially for the primary and secondary school level. Peru submitted only two applications, but this resulted in the presence of inclusive astronomy activities in Peru for the first time, generating a high impact.

AstroBVI in Chile

Chile is a Latin American country with a large and growing astronomical community (Chilean Astronomical Society, 2019). It is also a country with a growing community in astronomy and inclusion (Núcleo de Astronomía UDP, 2019). Thanks to the AstroBVI teachers, different types of activities (e.g. exhibitions, stands, workshops) are being held throughout the country.

Through the actions of seven core members of the AstroBVI team, all of whom are located in Chile, the project has pushed high-level activities for inclusive astronomy in the country. During the first stages of the project AstroBVI in Chile joined the Astronomy for All group, which shows different initiatives of inclusive astronomy in Chile. With them the team participated in an IAU Inspiring Stars exhibition¹¹. This collaboration has since grown into an interdisciplinary working group on astronomy and inclusion composed of more than 50 participants in the last year (Núcleo de Astronomía UDP). The membership¹² have identified some problems and challenges with respect to the public education system¹³, and we are working together on building a culture of inclusion through dissemination and education in astronomy to expand inclusion into other scientific disciplines.

Among the activities the working group are carrying out, we are collaborating with the Giant Magellan Telescope¹⁴ and Ecoscience Foundation¹⁵ in the creation of a manual for educators in Chile on inclusive astronomy, which we plan to give to vulnerable schools, mainly located in rural areas. We are collecting the successful experiences from our inclusive astronomy activities to create this manual, which will be written for teachers of public schools

who teach students with different abilities¹⁶.

AstroBVI in Peru

AstroBVI in Peru demonstrated to the public and politicians the incredible potential for people, regardless of their condition, status or age, to learn about the universe, making a remarkable leap for astronomy education in Peru. The tactile materials gave BVI participants the opportunity to become interested in science and especially astronomy. In 2019, seven AstroBVI workshops were held in Lima, one every month between April and November (Figure 2), with 165 BVI participants from 6 to 75 years old, 21% of whom were women and girls. The workshops were held in public libraries and schools. In each session, attendees met for two hours to learn about the wonders of space.

It is worth noting that basic science education for students with visual impairments in Peru is minimal due to the lack of teaching material and limited academic curriculum available in schools. Therefore, the AstroBVI workshops have enormously helped students understand the place of our planet in the universe. Through qualitative evaluation, many participants said that it was the first time they understood what a galaxy is and how they look or learnt about the size of the planets, the solar system and other astronomical objects.

The AstroBVI teachers said that the project has also had an impact on them, showing them that astronomy can be inclusive—that no disability matters if someone wants to learn. With the right tools, patience and willpower, the knowledge of the universe can be held in anyone's hands.



Figure 2. Image from one of the activities carried out by AstroBVI teachers in Peru in 2019. Credit: Alexis Rodríguez Quiroz/AstroBVI project

References

- Argudo-Fernández et al., "AstroBVI: An Astronomical educational kit for the Blind and Vision Impaired community in Latin America", *Boletín de la Asociación Argentina de Astronomía*, vol. 61a, 2019, p.268-270
- Bonne, N.J. et al., "Tactile Universe makes outreach feel good", *Astronomy & Geophysics*, vol. 59, 2018, p. 1.30

'Censos de Astronomos', Chilean Astronomical Society (SOCHIAS) [website], 2019, <https://sochias.cl/censos-de-astronomos/>

'Primera reunión del Grupo de Astronomía Inclusiva se realizó en la UDP', Núcleo de Astronomía Universidad Diego Portales (UDP) [online], 20 December 2019, <https://astronomia.udp.cl/es/espanol-primera-reunion-del-grupo-de-astronomia-inclusiva-se-realizo-en-la-udp/>

Notes

- 1 AstroBVI website: www.astroBVI.org
- 2 Mapping Nearby Galaxies at Apache Point Observatory (MaNGA) website: <https://www.sdss.org/surveys/manga/>
- 3 All the 3D printing files and associated lesson plans and materials are available to download for free from the Tactile Universe website: www.TactileUniverse.org
- 4 A Touch of the Universe website: <https://astrokit.uv.es>
- 5 Astronomy with all Sense reports and material on the IAU OAD website: <http://www.astro4dev.org/blog/category/tf3/astronomy-with-all-senses/>
- 6 Project reports and materials are available on the IAU OAD website: <http://www.astro4dev.org/blog/category/tf2/astrobi-an-astronomical-educational-kit-for-the-blind-and-vision-impaired-bvi-community-in-south-america/>
- 7 Multimedia material hosted on the AstroBVI website: <https://www.astroBVI.org/profes>
- 8 Attribution-NonCommercial-NoDerivatives 4.0 International license information: www.creativecommons.org/licenses/by-nc-nd/4.0/
- 9 Galileo Teacher Training Program: www.galileoteachers.org
- 10 Galileo Teacher Training Program lessons: www.youtube.com/channel/UC4Ad_VHSsqJfYat7sqcePOg
- 11 Inspiring Stars website: sites.google.com/oao.iau.org/inspiringstars
- 12 Members include astronomers, science journalists, anthropologists, public administrators, as well as people of various other disciplines.
- 13 Some of these problems include a lack of training and resources for supporting teachers of students with different disabilities or special needs, and a lack of even distribution of the resources available. We received a number of requests for an AstroBVI kit from Chilean PIE teachers, where their motivation was a need for materials and training in case they received a student with blindness in their class. More information regarding the state of special education in Chile can be found in Spanish here: <https://repositorio.uc.cl/handle/11534/15764>

¹⁴ The Giant Magellan Telescope: www.gmto.org

¹⁵ Ecoscience Foundation: <http://www.ecoscience.org/>

¹⁶ These teachers are known as PIE teachers, by the acronym in Spanish of School Integration Program.

Acknowledgements

We acknowledge invaluable help and support of our partner projects: Tactile Universe, A Touch of the Universe, Astronomy with All Senses, Dedoscopio, Breaking the Silence, and Breaking the Barriers. Special thanks to all the AstroBVI teachers for bringing astronomy where we can't in an inclusive way. We would also like to thank the Chilean Astronomical Society (SOCHIAS), REUNA, Star Tres, and Astrofísicos en Acción for their support. We acknowledge the IAU Office of Astronomy for Development, which funded the AstroBVI project during 2018 and part of 2019. We would also like to acknowledge funding from the FONDECYT regular project 1170618.

Biography

María Argudo Fernández is an astrophysicist at the Institute of Physics of the PUCV, in Chile. Her research aims to understand the effects on the environment on galaxy formation and evolution. She is involved in astronomy outreach activities and leads the AstroBVI project.

Nicolas Bonne is an astrophysicist and science communicator at the ICG of the UP. His main research interest is on Galaxy Evolution. He leads the Tactile Universe, developing materials to engage vision impaired and blind people with current astronomy research.

Coleman Krawczyk is an astrophysicist at the ICG of the UP. He is involved in The Tactile Universe as Technical Lead.

Jen Gupta is the Public Engagement and Outreach Manager for the ICG at the UP. She oversees the ICG's strategic outreach and public engagement programme, including running the school visits, supporting ICG members to do public engagement activities, and evaluating the impact of this work. She is the public engagement advisor for the Tactile Universe.

Alexis Rodríguez Quiroz, physicist at the Universidad Nacional Mayor de San Marcos, worked in the Direction of Hydrography and Navigation of Peru and in the Space Agency of Peru. Participated in the 2016 Latin American School of Observational Astronomy (ESAOBELA) and The 2018 International School for Young Astronomers (ISYA).

Penélope Longa-Peña is an astrophysicist at Universidad de Antofagasta (Chile). She is currently studying orbital parameters of Compact Binary Stars.

Juan Pablo Colque-Saavedra is the coordinator of the astro-engineering laboratory of the University of Antofagasta. He is involved in the AstroBVI project as a Technical Lead.

Médéric Boquien is currently an Associate Professor at Universidad de Antofagasta (Chile). He obtained his doctorate from Université Paris VII (France) and subsequently had postdoctoral stays in the USA, France, and the UK. He studies the formation and evolution of galaxies using both multi-wavelengths observations and models.

Eduardo Unda-Sanzana is an Associate Professor and current director of the Center of Astronomy (CITEVA) at Universidad de Antofagasta. Since completing a PhD in Astronomy at University of Southampton (2005) he has managed several high-level projects including the development of the Kcoirama Observatory and region-wide outreach efforts.

Amelia Ortiz-Gil is an astronomer working in outreach and education at the University of Valencia in Spain. She is an award-winning astronomy communicator, creating the groundbreaking BVI kit "A Touch of the Universe". She is the chair of the International Astronomical Union (IAU) Working Group of Astronomy for Equity and Inclusion and is the IAU National Outreach Coordinator for Spain.

Ángela Patricia Pérez Henao is an astronomer and educator at the Medellín Planetarium in Colombia. She coordinates the astronomy and education working group (TF2) of the Andean OAD region, developed the Astronomy with all the Senses suitcase, and supports teacher training programmes for astronomy.

Guilherme Couto is a postdoc at Universidad de Antofagasta. He got his PhD at UFRGS in Porto Alegre, Brazil in 2016. His main research interests are galaxy evolution and active nuclei, and he is also interested in any outreach program he feels can contribute to, such as AstroBVI.

Alessandro Martins is a physicist, research at the Federal University of Jataí in Brazil. He does outreach activities as a science and astronomy communicator. He created the Rediscovering Astronomy project with activities in midwest Brazil.