OAE Mini-Review

# International Collaborations with an Educational Component

Publications of the
IAU Office of Astronomy for Education

The following is a collection of summaries originally published in the proceedings of the 3rd Shaw-IAU workshop on Astronomy for Education held 12 – 15 October, 2021 as a virtual event. The workshop was organised by the IAU Office of Astronomy for Education. More details can be found on: https://astro4edu.org/shaw-iau/3rd-shaw-iau-workshop/.

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The IAU Office of Astronomy for Education (OAE) is hosted at Haus der Astronomie (HdA), managed by the Max Planck Institute for Astronomy. The OAE's mission is to support and coordinate astronomy education by astronomy researchers and educators, aimed at primary or secondary schools worldwide. HdA's hosting the OAE was made possible through the support of the German foundations Klaus Tschira Stiftung and Carl-Zeiss-Stiftung. The Shaw-IAU Workshops on Astronomy for Education are funded by the Shaw Prize Foundation.

The OAE is supported by a growing network of OAE Centers and OAE Nodes, collaborating to lead global projects developed within the network. The OAE Centers and Nodes are: the OAE Center China–Nanjing, hosted by the Beijing Planetarium (BJP); the OAE Center Cyprus, hosted by Cyprus Space Exploration Organization (CSEO); the OAE Center Egypt, hosted by the National Research Institute of Astronomy and Geophysics (NRIAG); the OAE Center India, hosted by the Inter-University Centre for Astronomy and Astrophysics (IUCAA); the OAE Center Italy, hosted by the National Institute for Astrophysics (INAF); the OAE Node Republic of Korea, hosted by the Korean Astronomical Society (KAS); OAE Node France at CY Cergy Paris University hosted by CY Cergy Paris University; and the OAE Node Nepal, hosted by the Nepal Astronomical Society (NASO).

# International Collaborations with an Educational Component

Session organiser: Alessandra Zanazzi,
INAF - National Institute for Astrophysics,
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## SESSION OVERVIEW

The session focused mainly on two aspects of international collaborations and networking activities that could be crucial for educators. On one hand, examples of international projects especially intended for education and communication to the public. These normally promote teacher training, networking occasions and activities and resources to share. They could also provide ideas, sometimes funding, always motivation, and inspiration to teachers and kids everywhere.

On the other hand, examples of international scientific big research projects that have a very interesting public part and educational component, which is of course very useful because it provides insights, data, ideas at the forefront of scientific research that are inspirational both for teachers and students.

Huge networks of teachers and activities with different approaches were presented, some of them "really international", others more local; examples of how international projects could be adapted locally; examples of networks for producing and sharing resources and activities on non-traditional innovative science (gravitational waves, cosmic rays), resources, training, and tools to engage the students and the public at best.

# TALK CONTRIBUTIONS

## Astronomy Education in a World Without Frontiers

Speaker: Rosa Doran, NUCLIO, Portugal

Astronomy is a very powerful tool to foster international collaboration. Education beyond borders will be the team of this presentation where the experience of 20 years of collaboration with people worldwide will be shared. The recent pandemic has strengthened and opened an opportunity for global collaboration but has also brought to light the dangers of gender imbalances, stereotypes and the challenges of the digital divide. Strategies to tackle this and other aspects for a truly global collaboration will be presented.

Talk link: https://youtu.be/E3dw1tgiP-w

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The main objective of this talk is to share with the audience our experience in teacher training and its importance not only for the spread of Astronomy per se but also to create awareness of the importance of its understanding for a more human friendly attitude to life on Earth.

One of the missions we have as astronomy educators is to empower educators to promote astronomy learning in a more innovative way and ensure that students and their families understand and recognize the importance of Astronomy in our daily lives. There are many international programs devoted to the professional development of educators in the field of Astronomy. I am presenting the ones that are known to me, probably forgetting many other important ones. Listed below are the links to the ones mentioned in my presentation, in alphabetical order:
CESAR - https://cesar.esa.int/
COSPAR panel of Education - https://cosparhq.cnes.fr/
ESERO - https://www.esa.int/Education/Teachers_Corner/European_Space_Education_Resource_Office
European Association for Astronomy Education - https://eaae-astronomy.org/
European Hands-on Universe - http://www.euhou.net/
European School Innovation Academy - https://esia.ea.gr/
Faulkes Telescope - https://www.faulkes.com/faulkes-telescope-project
Galileo Teacher Training Program - http://galileoteachers.org/
Global Hands-on Universe - http://handsonuniverse.org/
IASC - http://iasc.cosmosearch.org/
International Planetarium Society - https://www.ips-planetarium.org/
IUCAA - https://www.iucaa.in/

Las Cumbres Observatory - https://lco.global/education/
NASA - https://www.nasa.gov/hrp/education
NASE - http://sac.csic.es/astrosecundaria/en/Presentacion.php
OAD - https://www.astro4dev.org/
Office of Astronomy for Education - https://www.haus-der-astronomie.de/OAE
Space Awareness - http://www.space-awareness.org/en/
Universe Awareness - https://www.unawe.org/

Although these are quite a few programs, they are in fact far from enough, led by amazing people willing to make this world a better place through education. I will focus on a couple of them, the ones that I am more involved with. The main driver of our efforts is the Galileo Teacher Training Program (GTTP), inspired by the methodology created by the Global Hands-on Universe team. GTTP is a movement of educators at a global level. It does not produce resources but rather supports and endorses the organization of teacher training events. Each event is organized locally and in order to be officially recognized, the training event has to incorporate the following elements:

- Information Communication Technology (ICT) tools such as planetarium software, image processing software, simulators, etc.
- One or more topics of astronomy following a specific list of suggested topics.
- Inquiry and Project-Based Learning and interdisciplinarity.
- Observations of the Sun and/or night sky (naked-eye or with telescopes).
- Integrating at least one of the UN Sustainable Development Goals.
- The adoption of an inclusive approach (UDL for instance)

The Global Hands-on Universe (GHOU) educational efforts and GTTP managed to reach over 70 000 educators worldwide in various types of activities: teacher-training events, big activities, small activities, participation in projects, etc. Every country highlighted in the map has at least one national representative that has helped organize one or more activities in the region. One example of such activities is the Cosmic Light EDU teacher training, an effort that emerged during the International Year of Light in 2015 and counted on the support of the IAU. Another example is the Open Astronomy Schools initiative that incorporated the activities during the celebration of the IAU100 anniversary. GTTP partners with several organizations and events to enrich the offer to educators and also extend the coverage to regions that can benefit from these events where scientists, trainers and educators are sharing their best practices, exchanging ideas and creating a strong community of astronomy education innovators. Some examples of this collaborations are:
Astronomy Education Adventure in the Canary Islands: http://galileoteachers.org/astronomy-education-adventure-in-the-canary-islands-2021-online-course/
COSPAR K: https://www.cospar2020.org/stem/
Journey to Space Exploration:
https://cesar.esa.int/index.php?Section=Events&Id=198
Global Hands-on Universe: https://handsonuniverse.org/ghou2021/

In the end, the main aim is to ensure educators are equipped with the necessary tools to enthuse students towards a better understanding and appreciation of astronomy and science as an overall. During the training events, high importance is devoted to 21st century skills, to the sustainable development goals, to the use of ICT to enhance learning, to the use of Open Educational Resources and the adoption of inclusive attitudes. But the training is not all that is necessary, the training events are just part of a much broader strategy that uses what we call the 5 Pillars of Community Building". There are 5 phases that need to be in place in order to achieve a proper adoption and implementation of the opportunities presented to educators: Engagement, Training, Support, Recognition and Community. During the training events some elements are very empowering. The integration of real data to enable the feel of an authentic discovery, the work with scientists, the replication of scientific discoveries and the possibility to dive into real research experiences, such as the discovery of supernovas, asteroids, the observation of exoplanets, etc. The importance of careers in space exploration and astronomy research is also highlighted during the events, trying to avoid stereotypes in terms of gender, abilities and competencies.

The major goal in the end is to help educators raise generations of science-literate individuals, capable of making wise decisions, grounded on critical thinking and on the solidity of science.

Finally, in order to help everyone recognize that we live in the same world, that we are all humans under the same sky.

## Benefits Global Science Outreach Programs Bring to Educational Initiatives

Speaker: Jorge Rivero González, Joint Institute for VLBI ERIC (JIVE), The Netherlands

Astronomy is considered a gateway science for education due to its ability to encompass many subjects present in school curricula worldwide, inspire curiosity and foster critical thinking. In this sense, astronomy education initiatives are a keystone for global public engagement programs organised in recent years such as the UN IYA2009, IYL2015 or the IAU100 initiative. Among their benefits, these programs mobilise economic resources, distribute and support localisation of educational resources and foster organisation of initiatives to reach communities that have little or no access to these types of actions, e.g. GalileoMobile project. In this talk, I will present lessons learnt from designing, coordinating and implementing international collaborations with educational components.

Talk link: https://youtu.be/voaeQ6qgtgg

In this summary, lessons learnt from designing, coordinating and implementing international collaborations with educational components are presented.

**Why astronomy for education?**

Astronomy is the perfect tool for development, education, diplomacy and outreach and, indeed, there are a wide variety of examples of projects that help support the UN Sustainable Development Goals (https://sdgs.un.org/es/goals). If we look specifically into education, astronomy is considered a gateway science for education [1] due to its ability to encompass many subjects present in school curricula worldwide, inspire curiosity and foster critical thinking. Astronomy has been indeed identified as the favourite topic for boys and girls in many countries around the world [2].

**International initiatives with educational components**

Astronomy education initiatives are a keystone for global public-engagement programs organised in recent years such as the UN IYA2009 (https://www.astronomy2009.org/resources/documents/IYA2009_Final_Report/index.html), IYL 2015 (https://www.light2015.org/Home/About/IYL-Final-Report.html) or the IAU100 initiative (https://www.iau.org/static/archives/announcements/pdf/iau100-final-report-ann20019.pdf). These initiatives have reached hundreds of millions of people around the world and comprised the key aspect of astronomy/science for education as one of their goals. Other interesting initiatives are the EC-funded Universe Awareness (https://www.unawe.org/), Space Awareness (http://www.space-awareness.org) and spaceEU (https://www.space-eu.org/) projects, which reached 1 million students with their actions. Another example is a project that specifically works with underrepresented communities, such as GalileoMobile (www.galileomobile.org), which since its foundation in 2009 have shared different cosmovisions under the same sky and reached over 17,000 students and 2,000 teachers in 15 countries.

**Benefits of global science outreach programs for educational initiatives**

**Community Engagement:** global astronomy outreach programs mobilise the international communities of amateur astronomers, communicators and educators. Examples of these are the 100 Hours of Astronomy in 2009 and 2019 or the Astronomy Day in Schools in 2019 that included many activities with educational components inside or outside schools. These types of initiatives also provide opportunities for the development of innovative approaches and for people to start their involvement in astronomy education.

**Production, localisation and distribution of resources:** global astronomy outreach programs attract institutional support, bringing funding for the production of educational resources, which are fundamental for communities that could not afford basic materials. Prominent examples of resources produced through international projects are the Galieoscope (Pompea et al., 2011), the Universe in a Box (https://www.unawe.org/resources/universebox/), and the IAU astroEDu platform (https://astroedu.iau.org). However, it is important to notice that the production and distribution of resources are not enough. Localisation is equally important with translations and the adaptation of materials/activities to local reality to make resources relevant to local teachers.

**Understanding National curricula:** international collaboration contributes to learning about different realities of educational systems and international projects bring the expertise and opportunities for it. As an example, the Space Awareness Project made a preliminary study in 2016 about how astronomy was present in school curricula in the 11 countries where its activities were implemented as a basis for the production of their own activities. Another recent example is the review of astronomy on educational systems in 66 done by the IAU OAE National Astronomy Education Coordinator Teams (https://www.haus-der-astronomie.de/oae/worldwide).

**Teacher Training:** international initiatives bring opportunities for funding for the organisation of teacher training, see initiatives from the Galileo Teacher Training (http://galileoteachers.org/) or the NASE (http://sion.frm.utn.edu.ar/nase-prueba/) programs during IYA2009 and IAU100. In recent years, The co-creation of programs and work with pre-service teachers have also been important in order to introduce the benefits of astronomy in workshops that involve teachers at the first stages of their careers.

**Promote inclusive actions:** a key aspect of global outreach initiatives is emphasising the participation of underrepresented groups. Examples such as "A Touch of the Universe" (https://www.uv.es/astrokit/) project or the IAU "Inspiring Stars" (https://sites.google.com/oao.iau.org/inspiringstars) exhibition inspire our community and encourage people to not leave anyone behind as we reach for the stars.

**Sustainability:** It is very important when organising global programs to consider early on the sustainability of your actions. For educational activities, it is very important to train teachers so that they eventually continue using astronomy in their classrooms. As far as sustainability is concerned, especially working with underrepresented communities, lessons learnt from the GalileoMobile project show the importance of continuous contact with communities. For instance, the Amanar project (https://www.galileomobile.org/amanar) that supports the long-standing refugees of Western Sahara, started the e-Amanar project, which used the WhatsApp platform to implement continuous capacity-building support to Sahrawi teachers.

Education is the most important tool that can be used to change the world. It is our job as an international community to learn from each other and work together toward this goal.

**References:**


1. The Gateway Science: a Review of Astronomy in the OECD School Curricula, Including China and South Africa - Salimpour et al. (2020)

2. The ROSE project An overview and key findings - Sjøberg and Schreiner (2010)

# The AWB Nigeria Experience

Speaker: Olayinka Fagbemiro, Astronomers Without Borders (AWB) Nigeria, Nigeria

AWB Nigeria has over the years collaborated with various international organizations in the effort to take Astronomy to every child in the country. Without the support of these partners, it would have been very difficult to reach the thousands of kids reached to date. Supports have been in the form of resources, funding and human resources. Nigeria being a country where Astronomy is not taught in schools at both Elementary and High School levels, the teachers have had to rely on other means of incorporating Astronomy into the curriculum mostly through extracurricular activities. AWB Nigeria has enjoyed the support of partners in carrying out Astronomy outreach, competitions, among others. Also, being part of various workshops, conferences, symposia, etc. has exposed members to international best practices in Astronomy Education.

Talk link: https://youtu.be/k27zAVRT8MY

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The Astronomers Without Borders (AWB) Nigeria, is a non-governmental organization with the aim of spreading Astronomy and its benefits throughout Nigeria. AWB Nigeria organizes astronomy-based events on a regular basis. Astronomical events, which capture the popular imagination, create excitement and generate media attention.

Our organization uses astronomy as a tool to inspire children and as a starting point for continuing STEM education in their schools. Our scope also involves the development of school extracurricular activities that will drive STEM Education in schools, teacher training, setting up of Astronomy clubs in schools and other science-based outreach activities.

The need for collaboration in Astronomy Education in Nigeria arises since Nigeria is a country where Astronomy is not taught in schools either at elementary or high-school levels. Teachers have had to rely on other means of incorporating Astronomy into the curriculum, mostly through extracurricular activities. Nigeria has a really low number of Professional Astronomers. Lastly, without collaborations, the scope of engagement in Astronomy would have been too small and based on the prevailing circumstances. The benefits of collaborations in Astronomy for developing countries are the expansion of Astronomy Education scope, exchange of knowledge about international best practices in the teaching of Astronomy, teacher training, hands-on resources and exchange programs for school kids.

The past and current, local and international collaborations by AWB Nigeria are the Nigerian Space Agency, Defence Space Administration, the National Commission for Refugees, Migrants and Internally Displaced Persons, Office of Astronomy for Development (OAD), Astronomers Without Borders (AWB) International, SSVI, Vixen Company, Japan, ASGARD, Belgium, and

UNAWE. Some of these can be found in the following links:
https://awbnigeria.org/covid-19-support-for-internally-displaced-persons-project/
https://awbnigeria.org/idp-children-astronomy-outreach-project/
https://awbnigeria.org/astroart-competition-organized-by-the-ohio-state-university-department-of-astronomyfirst-place-cornelia-egbodor-from-nigeria-age-13-e-t-extra-terrestrial/
https://awbnigeria.org/asgard-near-space-experiments/

The challenges of international collaboration in Astronomy Education are the differences in time zones, differences in school curricula, heavy custom duty on donations from abroad, and the high cost of shipping materials from abroad.

## A Journey of a Thousand Miles Begins with a Single Step: Education in International Collaboration

Speaker: Beatriz Garcia, ITeDA (CNEA-CONICET-UNSAM) and National Tech. University-Mendoza, Argentina

In the era of multi-wavelength and multi-messenger Astronomy, the cooperation in multidisciplinary collaborations is part of the development of the discipline. This approach is also an opportunity to innovate in education, opening a new door to the knowledge using strategies designed from the beginning of the experiments and which are part of the Project Management. In this contribution we will present the formal framework and challenges that conform the road map for education of non-traditional topics and non-traditional detection, from the moment in which the idea of the contact with the community is born, until the moment in which the collaborations open the original data for public uses, especially in education, is part of the activities inside large collaborations. As an example and evidence of the meaning of education in a big collaboration, we focus on the Pierre Auger Observatory (https://www.auger.org/), located in Malargüe, Argentina, the largest observatory available for measuring ultra-high-energy cosmic rays. Along with important scientific discoveries, education and outreach work has been carried out across the 18 participating countries and online.

Talk link: https://youtu.be/-bvVZSHlSoo

**Management in Education and Outreach:** Beyond Management, the organization of the Collaboration consisted in task groups, led by task and co-task leaders. The activities are planned, discussed inside the Task Force, submitted to the Collaboration Board, and performed or implemented. One of the tasks is Outreach. Big projects bring together expertise from frontier scientific research and educational research in formal and informal science learning, along with user communities, to demonstrate how even Nobel Prize-winning science can be systematically integrated into the school curriculum.

**Design thinking and continuous upgrade as a strategy:** Design thinking is a non-linear, iterative and a User-Centred process that teams employ to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. Involving five phases — **Empathize, Define, Ideate, Prototype, and Test** — it is most useful to tackle problems that are ill-defined or unknown. This is the framework for Education and Outreach design in Pierre Auger and many collaborations.

The Pierre Auger headquarters was designed with a VC, which was inaugurated in 2001 and it is a "living" space, which is upgraded permanently, in the same way, and with the same vision as the detectors. This Center welcomes on average 8000 visitors a year. Permanent and temporary exhibitions have been prepared both in reality and virtually. Most of the activities and resources are available in English and Spanish.

**Successful histories of the PA:** As part of the community of Malargüe, every year the Pierre Auger Observatory takes part in the parade celebrating the anniversary of the town, it has promoted the creation of a devoted Argentinian Stamp, the installation of the James Cronin High School, the development of science fairs for elementary and high-school students from all the country every 2 years. It has given the support for the installation of the first digital Planetarium in Argentina, presented the initiative for the Ordinance 1298/15 on Dark Sky Protection in Malargüe (sanctioned on Abril, 14 2005). It installed one of the first interactive VC of a scientific institution in the country with a virtual visitor tour available in English and Spanish; this can be found in the website of Auger (izi) and has become very important during the lockdown period, when the visits in person have been very limited. Several activities were organized in order to highlight the importance of the work in science developed by women.

**Open Access Data and Masterclasses:** In 2021 the Collaboration decided to release 10% of the data used for the results reported at the International Cosmic Ray Conference 2019. The purpose of the release is to allow a wide community including professional scientists, people interested in education and outreach initiatives, and citizen scientists to re-use the data in their projects. This first sample amounts to over 20000 showers measured with the surface detector array and over 3000 hybrid events obtained from the surface and fluorescence detectors.

The Master Classes have been a very powerful tool to get high school students involved in the work made in the big experiments for years. The Pierre Auger Collaboration has prepared Master Classes to reinforce outreach efforts.

**Virtual Visits (VV):** Between 2020 and 2021 PAO started the Virtual Visits to the Observatory completely synchronous, mainly as a consequence of the pandemic. The idea arose from the contact with Frontiers from H2020 and was extended to more visits not only in English, mainly for European countries, but also in Spanish for Latin America. This activity completely modifies

the way to communicate science to the public, required training for the local guides for the online transmission of the visit, allows the assistants to know all about Pierre Auger, and see normally forbidden areas (like the Assembly Building, where the detectors are prepared or the Central Data Acquisition area).

Synchronous VV permits immediate feedback from the public. After the VV a survey is sent to all the participants to collect opinions, feelings, suggestions and ideas and assure a permanent improvement of the activity. These visits increased the number of visitors by more than 100% and will continue beyond the pandemic restrictions in a hybrid format.

**A new experience: QUBIC Collaboration:** Based on the experience in PAO, QUBIC Collaboration started the Education and Outreach activity in San Antonio de Los Cobres. QUBIC, an acronym that means Q-U Bolometric Interferometer for Cosmology, is a very innovative instrument to study the CBM. It is under assembling at this moment in Salta city and will be installed in Alto Chorrilos, near SAC at 5000 masl in 2022.

**Not a lonely project:** The Research Infrastructures FOR Citizens in Europe project (REINFORCE; https://www.reinforceeu.eu/), developed under the Project REINFORCE (GA 872859) with the support of the EC Research Innovation Action under the H2020 Programme SwafS-2019-1, aims at engaging and supporting citizens to cooperate with researchers and actively contribute to the development of new knowledge for the needs of science and society. Four demonstrators are ready to be launched as Citizen Science projects using the Zooniverse platform, assuring accessibility through the sonification of the data.

Inherent to International Projects, a special mention of cooperation in the development of Citizen Scientist proposal combining the know-how of different groups, institutions and Collaboration, is also deployed. Good communication media must be available using different tools like websites, networks, YouTube channels, access to open data, guided visits (face-to-face and virtual), satisfaction surveys, Citizen Scientist projects, open classes.

The participation in a collaboration means several responsibilities, because the communication of the results with the public must have the agreement of all the members and is an opportunity to learn from other institutions, groups and scientists with a great experience in outreach showing that "**A journey of a thousand miles begins with a single step**", according to the Chinese proverb, and the possibilities along the road are, as the wavelengths and the messengers, multiple, as well as the challenges.

**References:** Caballero Mora, K.S, for the Pierre Auger Collaboration, Outreach activities at the Pierre Auger Observatory, 37th International Cosmic Rays Conf. (ICRC), PoS(ICRC2021)1374 - Proceeding of science, 2021.

# IGrav: Engaging People Throughout the World in Exploring the Exciting Field of Gravitation

Speaker: Magdalena Kersting, University of Oslo, Norway

The mission of IGrav (the International Gravity Outreach Group) is to engage people throughout the world in exploring the exciting field of gravitation, and in particular gravitational-wave and multi-messenger astrophysics. IGrav will accomplish this mission through the creation, sharing, and dissemination of a variety of educational and outreach resources. In this talk, we will discuss how we can create opportunities and promote knowledge transfer across international collaborations, and how we can find the most effective ways of working together within the astronomy & astronomy education community. One particular focus will lie on creating a platform to determine best practices and promote education and evaluation efforts in astronomy education.

Talk link: https://youtu.be/lGBu8z307xM

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We discuss the creation, sharing and dissemination of education resources across international astronomy and astrophysics collaborations.

**Why do we collaborate within IGrav?:** We care about educating future generations and establishing public understanding of the scientific process. We want to find effective ways of working together within the gravity community. Through collaborative efforts in education & outreach, we hope to accomplish more than individual members of our gravity community could accomplish alone. We are pretty global. We have an Indico category hosted at EGO in Italy, mailing-lists hosted at LIGO Livingston, a website hosted in Caltech, and a wiki hosted in Glasgow.

We continue to gather enthusiasts and advocates for gravitational-wave education & outreach. By collaborating across universities, countries, and organisations, we can extend our reach through extended networks and shared resources and methods. Bringing together different perspectives to use complimentary approaches and pool educational efforts and expertise in gravity education & outreach. Pooling efforts provide insights into the efficacy of our approaches, which allows improving their quality and tailoring them to the needs of different groups of audiences.

**What can we do and achieve?** Development of IGrav:
2018: Virgo-LIGO-IPPOG meeting in Pisa
2019: 1st meeting in Valencia (Amaldi 13 & GR 22)
2020: 2nd (virtual) meeting (LISA symposium)
2021: IGrav becomes a subcommittee of GWIC (Gravitational Wave International Committee)

IGrav is organized into six working groups: Formal education & evaluation, Science festivals, Art

and science, Multi-messenger astronomy, Diversity, equity and inclusion, Igrav governance, and Communications & governance. The IGrav Formal Education & Evaluation working group gathers passionate physicists, educators, and teachers with a shared interest in formal education and evaluation of education and outreach efforts in topics of modern gravitation and gravitational waves. The group aims to create a platform to share existing resources, determine best practices, and promote formal education and evaluation efforts.

**How to promote education efforts?:** We do not want to reinvent the wheel. We have started to compile lesson plans and **resources**, including relevant curriculum links. Eventually, we aim to set up a **repository** on the IGrav webpage. How can we incorporate our resources in teacher professional development **workshops** and programs? Our main challenge is to reach **teachers** and instructors.

IGrav (www.igrav.org) will continue to support and sustain our gravitation education & outreach community.

## But Do They Understand Me? How to Make Astronomy Beliefs Visible and What to do When You Find out

Speaker: Linda Shore, Astronomical Society of the Pacific, USA

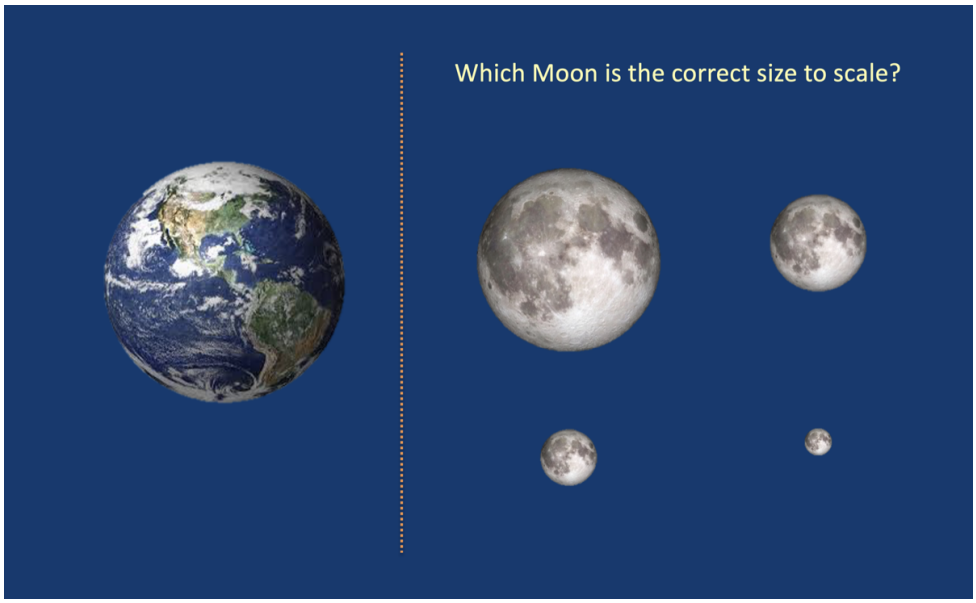
Collaborators[1]: Suzanne Gurton (National Radio Astronomy Observatory), Anna Hurst (Astronomical Society of the Pacific), Kari O'Connell (Oregon State University), Dennis Schatz (Institute for Learning Innovation)

Whether you are an astronomer communicating with the public, a museum educator leading planetarium experiences, or a teacher working with students, knowing what your learners are thinking "in the moment" is key to successful engagement. The Astronomical Society of the Pacific has been developing "feedback tactics" scientists and science educators across the globe can use to spark audience curiosity and make audience thinking visible. The ASP also provides scientists with training and support on how to interpret feedback they get and modify their presentations based on responses. In this session we will introduce you to engaging astronomy feedback tactics you can use in a science classroom, museum, or under the stars.

Talk link: https://youtu.be/cnj9uGFuKtk

How many of us, as educators, have led an astronomy lesson and wondered whether our students are learning? Are our explanations making sense? Are our demonstrations helping make the

[1]Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.




Example of an astronomy poll used in a virtual public engagement event.

concept clear? Are we using too much jargon? Was the hands-on activity effective in addressing preconceptions? Regardless of whether the students are young children in elementary school, families visiting a planetarium, or adults attending an evening lecture, the fundamental question all educators ask themselves is the same: *are they understanding me and if they are not, what can I do right now to change that?* Knowing what learners think, feel, and believe "in the moment" and using that knowledge to make immediate adjustments to a lesson is the key to successful teaching (NAP, 2017). While most educators know this and strive to engage their students in authentic investigations and lively discussions, too many of us still forget to check in with our learners, observe and listen carefully to what they have to say, and respond to their feedback in ways that will spark curiosity, increase interest, and enhance learning.

The Astronomical Society of the Pacific, in partnership with Oregon State University, the Institute for Learning Innovation, and the National Radio Astronomy Observatory are working collaboratively to develop tools and resources for professional astronomers designed to help them use engaging "feedback tactics" to make audience thinking visible. The project also provides scientists with training and support on how to interpret the feedback they get and modify their presentations based on audience responses While the OTSF project focuses attention on helping professional astronomers, the tactics and approaches we are developing can be used by any astronomy educator, in a variety of venues, and with learners of all ages and backgrounds. The project is funded by the National Science Foundation, NSF DRL AISL #18110222, *The On-The-Spot Feedback Project*.

What is a "feedback tactic" and how do you design them? Tactics include polling an audience, having learners use models to show what they think, engaging learners in kinesthetic activities, and interpreting student drawings (see Table 1). There are many ways to get audience feedback and the tactic you choose often depends on the age and background of the audience, as well as the goals for the astronomy lesson. For example, when working with very young children, kinesthetic activities and drawings are often a better way for them to articulate their thinking. What all successful tactics have in common is that they not only make audience knowledge

visible to the educator but can (and should) spark curiosity and interest. The Figure above is an example of an audience/student poll that we recently shared with astronomers leading virtual public engagement events. The COVID-19 pandemic forced almost all education venues to pivot from "face-to-face" to entirely virtual instruction. We found that audience responses could still be collected in engaging ways using the annotation function included in video conferencing platforms, like Zoom.

Using, interpreting, and responding to responses to audience feedback is part of a larger approach to audience engagement our OTSF Project promotes and includes Planning, Implementing, and Reviewing. *Planning* includes knowing the background and expectations of the learners and setting specific goals (Besley and Dudo, 2018); *Implementing* involves gathering audience responses and responding in the moment (NAP, 2017); *Reviewing* is done at the conclusion of the event and requires educators to reflect on what aspects of the lesson worked and what can be improved in the future. Table 2 summarizes the steps that define successful science engagement.

**Resources:**

- The On The Spot Feedback Project Website (under construction): https://astrosociety.org/education-outreach/higher-education-and-early-professionals/on-the-spotfeedback.html

- National Academies of Sciences, Engineering, and Medicine 2017. Communicating Science Effectively: A Research Agenda. Washington, DC: The National Academies Press. https://doi.org/10.17226/23674.

- Besley JC, Dudo A, Yuan S. Scientists' views about communication objectives. Public Understanding of Science. 2018;27(6):708-730. doi:10.1177/0963662517728478

**Table 1: Examples of "Feedback Tactics" in Astronomy**

| | |
|---|---|
| **Polls** | *"Which shape most closely represents the way Mars orbits the Sun."* |
| **Drawings** | *"Draw what you think the Moon will look like in a week from now."* |
| **Building & Using Models** | *"Using two coins to represent the Milky Way Galaxy and the Andromeda Galaxy, show me how far apart you think they are in space, to scale?"* |
| **Kinesthetic activities** | *"With your partner as the Earth, can you be the Moon and show me how you move in space during a month?"* |
| **Open-Ended Questions** | *"Why do you think it's hotter in the summer months compared to the winter months?"* |

**Table 2: Designing Successful Science Engagement Activities and**

| CYCLE | ELEMENTS | DETAILS |
|---|---|---|
| **PLAN** ***Before the Event*** | Learn | • About your audience<br>• About the event and venue<br>• About audience expectations |
| | Decide | • Your main engagement goals<br>• What to assess and monitor |
| | Develop | • Feedback tactics you'll use<br>• Alternative approaches and activities |
| **IMPLEMENT** ***During the Event*** | *Check the Audience* | • Audience reactions and responses to tactics |
| | *Observe the Audience* | • Identify audience preconceptions, beliefs, understanding, etc. |
| | *Respond to the Audience* | • Make needed adjustments<br>• Add, revise, or skip activities, if needed |
| **REVIEW** ***After the Event*** | Reflect | • What worked?<br>• What can be improved? |
| | Revise | • Make changes to how you facilitate the event<br>• Make changes to the activities<br>• Make changes to the tactics used |
| | Repeat | • Design a revised event<br>• Lead new event and follow the same steps |

# Discussion summary

The discussions at the end of the sessions focused on different aspects: first of all the language and adaptation issues emerged strongly. The speakers and the participants stressed the need for translating but also of adapting, contextualising and "decolonising" the activities proposed in the framework of international projects. This need for inclusion is, of course, particularly acute in the case of collaborations, which by their nature involve several countries, languages and cultures. One way could be thinking – or re-thinking – the activities so that, for example, there is less need for written content, they use more visual materials.

Another issue is the sustainability of the projects - not all local communities can think of financially supporting international education and training efforts on their own. It is the responsibility of the projects to help, for example, by empowering the local teachers that will provide a multiplier effect. This model of empowering others to do things is very frightening but enables us to reach out to more and more people. Also, whatever the project, it has to be flexible enough so that the local community can use local materials and resources and it can be empowered to adapt according to what they have. The actions of projects should help the local communities to sustain their own programs and should take an open, bottom-up approach so that they can be engaged in the implementation from the very beginning.

We also discussed the lesson learnt from the pandemic: the need to organise online low-cost events has allowed us to see ‘new faces’ of people that would not have been able to travel long distances and participate in person (for example, in teacher training activities, or at conferences). This has allowed the involvement of people from disadvantaged and remote areas and indeed from all over the world. This, while not replacing face-to-face interaction, offers huge advantages that must be taken into account.

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