Proceedings for the
3rd Shaw-IAU Workshop
on Astronomy for Education

What Everybody Should Know about Astronomy Education

12 – 15 October, 2021

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The following is a summary 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/.

The Office of Astronomy for Education (OAE) is hosted by the Haus der Astronomie on the campus of the Max Planck Institute for Astronomy in Heidelberg. The OAE's mission is to support and coordinate astronomy education by astronomy researchers and educators, aimed at primary or secondary schools worldwide. The OAE is an office of the International Astronomical Union, with substantial funding from the Klaus Tschira Foundation and the Carl Zeiss Foundation. The Shaw-IAU Workshops on Astronomy for Education are funded by the Shaw Prize Foundation.

Foreword

3rd Shaw-IAU Workshop on Astronomy for Education

Teaching astronomy takes both solid knowledge of the subject itself as well as educational skills, such as knowing appropriate methods and techniques for teaching. To this, specific sub-fields of astronomy education add their own specialized skill sets: knowing how to operate remote telescopes, for instance, or the ins and outs of daytime observations. Last but not least, there are the skills needed in order to make our teaching fair, equitable, and inclusive.

In practice, most of us who are active in astronomy education have only been taught a subset of those skills in our academic training. Those who come from professional astronomy and have branched out into education and outreach typically have advanced training in astronomy, but not in the relevant areas of pedagogy. Most teachers, on the other hand, have pedagogical training as well as training in the subjects their teach, but often that does not include formal training in astronomy and astronomy education.

If this description includes you, and if in consequence you have ever felt motivated to expand your astronomy education skill set, then this workshop was, and is, meant for you. It is the third in a series organised as a collaborative venture between the Shaw Prize Foundation and the International Astronomical Union, and with 89 talks and 50 posters in a total of 18 sessions, it provides a fairly comprehensive "Astronomy Education 101".

For those who were unable to attend, or did not manage to attend all of the sessions they were interested in, we present these proceedings, and the associated talk videos from the workshop. While they lack the interactivity that the 580 workshop participants enjoyed as they posed their questions to the speakers, or interacted in the chat, we do believe that they are valuable in their own right — and we asked speakers to include in their write-ups helpful pointers to additional resources, so you have the opportunity to delve deeper. If you find these resources useful, and I hope they will be useful to many, please share them widely.

The workshop was made possible by funding from the Shaw Prize Foundation, for which we are very grateful. You can find the names of the individuals and institutions who organised the workshop on p. 6 — a big "Thank you!" to all of you!

For us at the International Astronomical Union's Office of Astronomy for Education (IAU OAE), this is just the start. Helping those who are active in astronomy education to grow their skills, and to become more professional in their activities, is one of our main objectives. Stay in touch if you want to make sure not to miss what is next — from additional events to more resources. On the web, you can find us at http://astro4edu.org, and on that page, you can also find your country's National Astronomy Education Coordinator Team. We are also on Twitter and on Facebook as @astro4edu.

Markus Pössel
Director, IAU Office of Astronomy for Education
Heidelberg, November 16, 2021

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In addition to the efforts from the OAE office in Heidelberg, Germany, the following OAE Centers and Node made key contributions to organizing this event:

OAE Center Italy

OAE Center Cyprus

OAE Node Nepal

The OAE Center India was not formally established at the time of this workshop but also made significant contributions.

Equity, Diversity and Inclusion in Education

Session organiser: Stefania Varano,
INAF - National Institute for Astrophysics, OAE Center Italy, Italy

Session overview

Astronomy is always pinpointed as the "most fascinating of all sciences", the one with the greatest potential of interesting and involving enormous amounts of people, regardless of their age, culture, personal history, tastes, learning styles. Great power and opportunities, but also deep duties. Particularly the one of being aware of the huge diversity our world hosts, where no one is equal to another and where everybody should be given the free choice and opportunity to approach science and astronomy.

In this session, we tried to give specific suggestions and insights on how to deal with such diverse individuals and how to devote the power and charm of astronomy to enhance equity in access to scientific culture, and to foster diversity awareness.

During the session, Amelia Ortiz Gil presented Universal Design for Learning, Angela Perez offered a series of inspirational ideas for inclusive education in planetariums, Alan Alvez Brito suggested how astronomy can also foster interculturality, by enhancing self-awareness of cultural and social complexities, Keivan Stassun talked about neurodiversity in scientific learning contexts, and Angelica Minodora Nechifor presented effective student-centred approaches, such as project-based learning.

TALK CONTRIBUTIONS

Universal Design for Learning in Astronomy Education

Speaker: Amelia Ortiz-Gil, University of Valencia Astronomical Observatory, Spain

The Universal Design for Learning (UDL) is an educational framework that relies on the individual abilities of each student to conduct a successful learning process. UDL is about breaking the barriers (physical, emotional, cognitive) that many students face, in particular those with a disability. In this talk, we will outline some general strategies to develop education resources in Astronomy following the UDL principles along with some examples.

Talk link: https://youtu.be/sWja71f04ec

Every day we have to deal with a lot of diversity in our classrooms. Each student is unique and has a unique learning style. Some can even be differently abled. But all of them also have unique learning strengths which are closely related to their unique learning styles. Therefore, to get the most out of them as students we need to take into account everyones' uniqueness. So the question is: how can we teach all this diversity together?

Universal Design for Learning (UDL)

The Universal Design for Learning is a framework that focuses on removing all kinds of barriers (which could be physical, sensorial, affective or cognitive) to gain access, learning and participation for students. This is even more clear in the case of students with special needs. The key is not to focus on the "disabled person" trying to change them, but rather on the "disabling environment".

UDL principles: The key to address diversity is multiplicity:

- Provide **multiple means of representation**: as different people perceive and understand the information in a different way, we must provide the contents through different perception channels. An example of an activity that follows this approach is the planetarium show "The Sky in your Hands", which combines visual, tactile and sound elements.

- Provide **multiple means for taking action and expression**: students differ in the ways in which they «navigate» through the learning environment and communicate their thoughts.

Give opportunities for taking action (through materials everyone can interact with) and opportunities for communication (through software and other means). Without these alternative means for communication and interaction, Prof. Stephen Hawking would have never made his extraordinary discoveries about the Universe.

- Provide **multiple means for engagement**: students differ in the ways in which they can feel engaged and motivated to learn. We can make use of broad choices that reflect the student's interests and provide them with strategies to deal with new contents/activities so they feel more confident. A good way to engage your students is by taking advantage of virtual reality technology, as is done in Chandra's project "Walking among the stars".

A UDL general protocol: A general protocol to follow when designing learning activities in UDL could be summarised by the following:

1. **Teach to all the senses**: There are as many different learning styles as learners. Everyone has his or her own way to learn. This is often usually linked to a particular sense: some students remember better what they see, others remember better what they hear, or some others what they touch, for example. Moreover, several research works have shown that we learn and remember better the information that we have acquired through more than one physical sense.

2. **Teach to strengths**: Use the natural abilities and talents as a foundation for learning or, in order words, focus on the abilities and not on the disabilities, if there are any.

3. **Provide multiple forms of feedback**: To find about your students' strengths, you need also to provide multiple forms of feedback to gather a complete picture of the students' abilities and to check whether the contents are being acquired correctly.

Specific actions

- Check with the students about their special learning needs. Take into account that if you help those who are in the extremes of the learning spectrum, you are also helping those in the middle.

- Make sure that the activities, resources and equipment are physically accessible to and usable by everybody. For example, reading aloud some written information while the students read it will help everybody to understand and remember it better, in particular those with reading problems, or the visually impaired.

- Provide a variety of means to deliver content, motivate and engage the students. This can be done through hands-on activities, collaborative learning, inquiry-based learning, educational software, internet-based communications.

- Make sure that the communication methods are accessible to all.

- Perform group activities in which students have to support one another by placing a high value on their different skills and capacities. This helps them a lot to build up their self-esteem.

- Ask for feedback from the students regularly and then adjust the activity accordingly, if needed.

- Plan for alternative accommodations for students whose learning needs are not met by the activity, for example, by providing materials under other formats.

Resources:

- US National Center in Universal Design for Learning (https://www.washington.edu/doit/national-center-universal-design-learning)

- Space Learning is for Everyone (https://www.nasa.gov/stem-ed-resources/Space_Science_Is_for_Everyone.html)

- The Sky in your Hands / A Touch of the Universe (https://astrokit.uv.es)

This work has been funded by the project PID2019-109592GB-100/AEI/10.13039/501100011033 from the Spanish Ministerio de Ciencia e Innovación - Agencia Estatal de Investigación.

Astronomy and Education, with Planetarium Eyes

Speaker: Angela Patricia Pérez Henao, NAEC Colombia, Planetarium of Medellín, Colombia

To understand how to contribute with strategies and activities for students and the general public in astronomical observatories and planetariums that constantly receive diverse audiences, from the IAU's motor disability group we conducted a survey that would allow us to understand this situation. We will present the results that we have so far and the conclusions and contributions that we have.

Talk link: https://youtu.be/_STlVWqRt7A

For several years the need for city spaces or places that welcome all types of audiences without distinction has been on the rise. In order to strengthen the processes and experiences of inclusion and equity in the institutions with which I have the opportunity to interact, schools and planetariums, and to contribute to a more inclusive society, I have been involved in the

development of accessible itinerant educational material. I am part of a working group of the IAU that seeks to understand the real situation of the Planetariums to receive visitors, among these students, with special mobility capacities.

From the previous perspective, it is irrefutable that the protection and enjoyment of the rights of people with disabilities can be given from the presence and interaction in different spaces, in this case cultural, that enable comprehensive training through the elimination or reduction of physical and social barriers. In this sense, spaces such as the museum have been thinking about their accessibility for people with disabilities, trying to eliminate architectural barriers, favoring access to information, adapting galleries and/or museum collections, among others.

First approach: We focus our efforts on raising awareness in the population about the cultural needs of people with disabilities. Hence, we developed the Astronomy suitcase with all the senses, a proposal that was born from the interest of two teachers and myself, to awaken the interest in astronomy topics, to blind students from some educational institutions in the city of Bogotá. This project in the first place with volunteering and the firm purpose of expanding the opportunities of blind children as well as providing new teaching tools to their teachers.

The strategy was well received by the target audience and it surprised us, as it also became a training tool for teachers on accessibility issues, a tool that raises awareness in students, teachers and the general public to understand that we all have the same right of access to the information. Thanks to the support of the OAD, this material exists in Colombia and Chile, with the possibility of free replication to those who wish to copy it.

With this material we understood that access to information on astronomy issues should also be extended, with this methodology, to neurotypical people, and even cognitive disabilities and reduced mobility. The use of 3D models, which can be easily manipulated, allows the experience of knowledge to pass through the body. This becomes beneficial for all types of people.

Second approach: With the working group on physical disability of the International Astronomical Union, three people in different contexts (UK, USA, and COL), we want to better understand how the accessibility situation is in Planetariums. We want to analyze, gather references and produce written, audiovisual, sound material that facilitates the approach or learning of astronomy to people with physical disabilities.

The strategy was well received by the target audience and it surprised us, as it also became a training tool for teachers on accessibility issues, a tool that sensitizes students, teachers, and the general public to understand that we all have the same right of access to the information. Thanks to the support of the OAD, this material exists in Colombia and Chile, with the possibility of free replication to those who wish to copy it.

On the other hand, the deepening of the universal design created mainly to generate spaces for everyone can be extrapolated for use in the development of strategies beyond the infrastructure, as it can inspire in the processes of content design, teaching material, activities, and strategies for teaching and disseminating science.

Contribution in education: From my perspective as a disseminator and teacher trainer in didactics of astronomy, I have found that the generation of the material in the Astronomy

Evaluation of prototypes with blind students.

suitcase with all the Senses and the incipient findings of the survey on disability in planetariums, with the view of the use of spaces. It makes me think that the Planetarium and the School have a lot to share as educational and/or outreach spaces.

In this sense, the teaching and learning strategies of both spaces complement each other, especially from the Planetarium to the School.

Resources:

- http://astrokit.uv.es/
- http://materialdidacticoparaciegos.blogspot.com/2013/10/el-sol-tactil.html
- http://science.nasa.gov/science-news/science-at-nasa/2008/15jan_touch/
- Photographic record 2006 – 2014 Angela Pérez
- Photographic record Nayive Rodríguez
- Inclusión working group: https://iau-oao.nao.ac.jp/iau-inclusion/motor-impairments-2/
- Questionnaire for planetariums: https://docs.google.com/forms/d/e/1FAIpQLSdw7x9Z1QiInyELCoZ5u67g269vh8NQhg3ArmMvWOTasdM8TQ/viewform

Interculturality and Ethnic-racial Relations in Astronomy Education and Communication

Speaker: Alan Alves-Brito, Institute of Physics - Federal University of Rio Grande do Sul, Brazil

Focusing on Astronomy, I will address some key aspects related to the main challenges and potentials of the science education and communication platforms for the promotion of social justice, equity, diversity and inclusion in Brazil, disentangling not only ethnic-racial and gender issues, but also historical and philosophical elements of science. I will show some ongoing projects, discussing their methodologies and main outcomes.

Talk link: https://youtu.be/IRdunCbN7pI

First, I present the situation in Brazil from the ethical-racial perspective, showing some numbers that reveal Brazil's daily structural, epistemic and symbolic racism toward black and indigenous people. The remarkable reality is that even though 56% of the Brazilian population is self-declared black, the great majority have no access to (quality) education and scientific culture. At the University system, black/indigenous people are underrepresented, with only 10% of the professors/scientists accounting for black people. In this context, Intercultural Astronomy is considered as a strong tool in Brazil to benefit society and trigger development, as since 1988 different education laws/documents have been approved, which acknowledge that black and indigenous people are citizens, requiring the mandatory treatment of the history, culture and contribution of African, Afro-Brazilian and Indigenous people to science and Brazilian life at all levels of the education system.

Second, I present three main educational/communication projects focused on Intercultural Astronomy that we have been developing since 2017: (i) Akotirene Kilombo Ciência that is focused on the empowerment of black girls/boys specifically from Maroon (quilombola) origin; (ii) OruMbya (Orum, sky in Yorubá, and Mbya, a Brazilian Guarani ethnicity) is a pilot project to celebrate Astronomy as the fuel of life, in which the stories of the stars are preserved in the resilience of people from four different continents and shared over months, through scientific-cultural activities focused on the dissemination of knowledge, promotion of social inclusion and sustainable development in the context of PLOAD (Portuguese Language Office of Astronomy for Development); and (iii) Zumbi-Dandara dos Palmares Project, which is an action-research project focused upon developing a complete diagnostic of the quilombola's education in Brazil and, at the same time, offering workshops on artificial intelligence, digital skills and the development of computational thinking for black girls/boys, everything mediated by Astronomy tools as well.

Third, I will mention the main theoretical and methodological references we have been using to date. We have used a decolonization approach, as well as the participant-ethnographic perspective, being together with black and indigenous communities all the time, listening to them and helping them in their political movements for a better life, that is, education combined with other aspects of their lives. We have been taking the black and indigenous people's thoughts and insights into account on different aspects of their alterities. As a rule, being together with people, listening to them and exchanging ideas and cosmic perceptions, has been crucial to the success of our projects. In order to do this, Inter-Cultural Astronomy has been our main theoretical and methodological umbrella, as different narratives on phenomena that happen or are present in the sky have driven us away from the colonial way of thinking and interpreting reality.

Fourth, I mention some of our main results, which are, from the University's point of view, related to a better training of our undergraduate students, as well as building new ways of thinking about history and philosophy of science, epistemology, psychology, language, politics and culture. I discuss how the historical construction of the contemporary concept of science, technology, development, innovation and meritocracy needs to be changed, to help us answer fundamental questions: why are there so few black people in Physics and Astronomy in a mostly black country? Are these areas of knowledge "affirmative actions" for whites? Why does scientific racism, a pseudoscience, not have the same status (concern) in science education and dissemination programs in Physics and Astronomy? I conclude by pointing out that science and its methodologies are human constructions indissociable in its historical, social and political dimension and, thus, the social markers of difference (subject versus object) in science and science education and communication need to be considered in the whole process of face-to-face contact with people. This attitude is crucial in order to allow us to rethink our power relations in science at school, university and society, decolonizing our thoughts and building positive models based on the black and indigenous identities, promoting the urgent racial equity in Brazil.

Supporting Neurodiverse Learners for Research Experiences in Astronomy

Speaker: Keivan G. Stassun, Vanderbilt University Frist Center for Autism & Innovation, USA

We describe the activities and lessons learned from a physics and astronomy research internship program operated by the Frist Center for Autism and Innovation at Vanderbilt University. The program is intended to engage and support neurodiverse learners in research experiences that prepare them for success in university, graduate school, and future research careers. We describe the program goals, outcomes, and tools that have been developed for use by others seeking to increase the participation and success of neurodiverse individuals in astronomy careers.

Talk link: https://youtu.be/h9ySVyu5-kg

As a way of introducing neurodiversity in the context of astronomy research and discovery, we present the example of the discovery of stellar granulation "flicker", originally published in Nature by Bastien et al. (2013). That discovery—which has advanced the ability to accurately characterize the sizes and ages of stars, and therefore of exoplanets orbiting those stars—was made by a team of faculty and students at Vanderbilt using a novel data visualization tool called Filtergraph, which was invented by an autistic researcher on the team (see Burger et al. 2013). The complete story of the invention of this tool and of the astronomical discoveries that resulted was recently highlighted in the television news show 60 Minutes with the American journalist Anderson Cooper (see https://www.youtube.com/watch?v=YnAUy4BM0w8).

Supporting Neurodiverse Students: COVID and Beyond

It is important that as a community we learn how to best mentor and support our students. The past year of COVID has forced us to learn to support all of our students in new ways. During normal times, at the Frist Center we run a research internship program in person, with on-site coaches for social skills (Figure 1). We also have launched an interdisciplinary PhD program that we call Neurodiversity Inspired Science and Engineering, through which graduate students – both neurodiverse and neurotypical – pursue research projects that lead to innovations to support and/or are inspired by neurodiversity. In addition, we have partnered with major international companies, such as Ernst & Young to place our interns into great jobs after graduation, for those who wish to take their astronomy training into the private or corporate sector.

During Covid, we had to implement some new types of supports as everyone worked in remote or hybrid environments. These include regular check-ins on zoom with a coach to discuss progress, get advice on managing time and workloads, and mental health. A social worker

Figure 1: Neurodiverse research interns at Vanderbilt's Frist Center for Autism & Innovation, shown with on-site coach at far right. Credit: Vanderbilt University.

Figure 2: Screenshot of the free online resource developed by the Frist Center for Autism & Innovation to assist autistic and other neurodiverse teens and adults set and pursue self-determined goals. Available at `triad.vkclearning.org`.

has been available as needed for emotional and psychological support. We also have used the challenges of the Covid experience to elevate autistic voices and to develop new tools.

For example, we started a monthly webinar series featuring our autistic staff and interns, discussing the challenges of Covid and of neurodiversity from a global perspective including autistic researchers from around the world. These discussions proved so valuable for building a global community, that we are continuing them even after Covid.

Finally, we have used our experience to create an online self-guided tool for learning how to set and pursue goals that autistic and other neurodiverse people can use for their own professional development (Figure 2). It is available at the web address: `triad.vkclearning.org`.

References:

- Bastien, F. A., Stassun, K. G., Basri, G., Pepper, J., 2013, Nature, 500, 427, "An observational correlation between stellar brightness variations and surface gravity"

- Burger, D., Stassun, K. G., Pepper, J., Siverd, R. J., Paegert, M., De Lee, N. M., Robinson, W. H., 2013, Astronomy and Computing, 2, 40, "Filtergraph: An interactive web application for visualization of astronomy datasets"

Astronomy and Inclusive Education through Project Based Learning

Speaker: Angelica Minodora Nechifor, CYGNUS Scientific Society, Romania

Project based learning and inclusive education is a way to promote Astronomy Education, STEAM subjects, to develop skills: critical thinking, problem solving or inter and transdisciplinary approach communication. Teachers and students from all over the country, or world, can work together, supervised by teachers for Sciences, Astronomy, and astronomers by Science, Technology, Arts and Mathematics activities. We would like to present you the way we can teach astronomy using practical and attractive, non-formal methods, linked to outdoor education and CLIL. It is innovative and creative. Children from primary schools can work with secondary and high school students to ensure peer and collaboration learning. In August, we will organise a conference and we wish to present also its results.

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

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I am a teacher in a mainstream school, but at the same time an inclusive one, situated in a beautiful mountain area, but, unfortunately, in a former mono-industrial town.

Since 2006, when the copper mine closed, there are no jobs for people living here; therefore, many of our students' parents left to find jobs in other countries. Our students come from different environments, with very diverse backgrounds. Most of our students are Romanian, but some are Hungarian, or from mixed families, some are Romas. Their parents and grandparents came years ago from different parts of the country to work in the copper mine, so they are very diverse in culture too. Being a multi-ethnic, cultural and religious community made us appreciate diversity; it is useful for each community member's tolerance, empathy and assertiveness.

However, there are many problems due to the poor family background of some of our students or to their psychological and emotional state. We have at least one special education needs child in each class, meaning students with autism, ADHD, Down syndrome, dyslexia and dyscalculia, intellectual disability. We even have students with visual and hearing impairments, to different degrees. What most concerns us is that many of them are not diagnosed and this challenges us to use integrated and inclusive teaching methods to make sure that each child in our school is

valued and motivated to learn. With these children, we work with an adapted curriculum for their needs. We do encounter problems, but we try to cope and show them attention. In terms of Astronomy, we can only teach easy things and this is why we want to implement the "RO300 Stars" project, or "Wandering through the Universe, We Aim to the Stars"

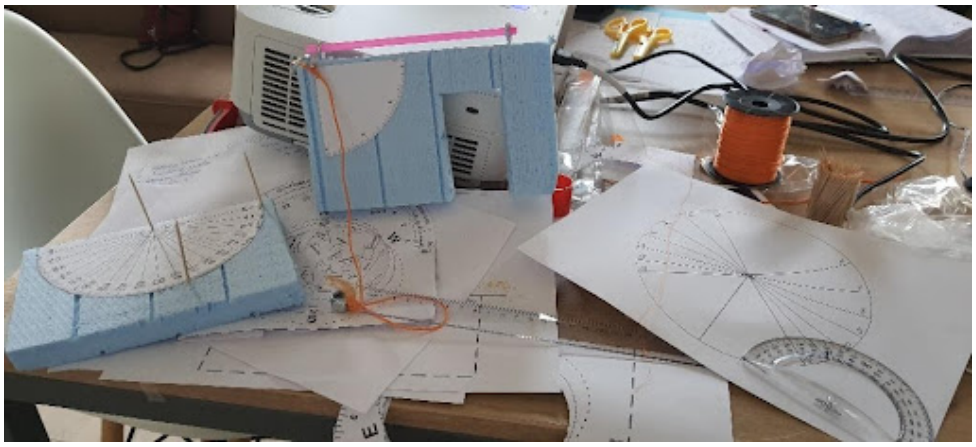
This project is about promoting educational activities related to the field of Astronomy and Space Sciences with a view to a future STEAM professional career, as well as to sharing and using examples of good practice for sustainable development (clean energy, solutions for the climate change etc.) at local/ national/ global level.

It involves students aged between 6 and 11 years old (divided into two categories: aged 6-8 and 9-11), with different backgrounds: students from mass schools, including those being in risk situations, such as learning difficulties or even Special Educational Needs, severe disabilities, like blindness, under-privileged group belonging, minorities, difficult family situations.

An example of PBL is one of the activities in the We aim to the Stars Workshops (WSW) **"Guides for teaching Astronomy to primary classes"**, namely **"How to land on the Moon or Mars?"**.

Children work in teams, with specific roles, with names. They have to build a spaceship that will take the astronaut – an egg – safely to the moon. They have to "go" to a shop and buy things they need to build their ship. They have to undergo a fixed budget, so entrepreneurial skills are developed. When they have everything they need, they start to design their ship, drawing it on a scale, and so these little engineers can exercise their planning, counting and technical drawing skills. Then they move to the practical part of this activity and build their ship in which "the astronaut" will be set for its mission to the Moon. Finally, all the spaceships are launched and if the astronaut lands safely, meaning the egg is safe and entire, they are declared space engineers. As children are attracted to rewards, we can even design some ID cards or badges using different apps such as Canva. I think it is obvious how many skills we can develop with an activity like this: entrepreneurial, mathematical, design, communication, collaboration and so on. If we ask them to send a message into space in a foreign language, we can even develop linguistic skills. Each child, even the special needs ones, can find something interesting in working in this kind of activity.

In order to cope with the needs of this pandemic situation, we can use many applications to help students work together, even if they will not be able to meet. One I have already worked with is Action bound, an application for smartphones and tablets that helps the participants to accomplish a mission. Teachers need to create an account in order to create the challenges for the bound and we can use it for different treasure hunts, missions or games. Participants can participate on their own or, more important for us, in groups. Challenges can be played outdoors or online, depending on what we want to achieve, on our imagination and on the proposed challenges. We used it for a local treasure hunt this August 2021, but we should let our imagination fly and create bounds connected to what we like or to our students' interests. It is more than important to understand that nowadays students are different from former generations, that we need to be creative to catch their interest. Information is now at one-click distance, they do not need teachers anymore to "inform" them, but to guide them. The future successful teachers will be those who will be able to find each individual's needs and to guide them until they find their way, whichever that is.



Instruments built by children

Working together on the spaceship in the activity "How to Land on the Moon or Mars?"

Final product and launching the spaceship

The Past, Present and Future of Earth and Space Education, and Implication for Equity

Presenter: Christine Hirst Bernhardt, University of California, Santa Barbara, Endeavor STEM Teaching Project, USA

Astronomy education, particularly in Western Nations, has the potential to disrupt colonial narratives while providing greater access to 21st century skills. Participants will be provided a space to explore the integrations of astronomy to foster and facilitate equity and justice, while connecting to the natural world. Some issues may be personally challenging to address, such as environmental racism and bias. This session will be highly interactive and allow participants to explore the use of satellite imagery to address social justice issues in their region and abroad. Participants will develop their own activities connected to their individual spaces which they can immediately use in formal K-12 education settings.

Poster link: https://youtu.be/5zYEirg9Z0w

This session will explore astronomy education as a tool of equity while equipping educators with the tools to build bridges between student experience and the natural world through a social justice lens.

Earth and Space sciences encompass the most neglected realm of science education in the United States, as well as the lowest representation of Women and People of Color. For over a century, high school science coursework has minimally included biology, chemistry and physics, integrating Earth sciences in middle grades and eliminating astronomy. There has been no national test, curricula or standardization for astronomy coursework. The scarcity of course offerings and absence of Advanced Placement or IB courses have relegated coursework to university settings, by which time the moment to select a STEM field has likely passed. Secondary and primary environments are critical for the formation of a STEM identity, particularly amongst girls and students of non-dominant groups. This session will explore the integration of space sciences in formal education settings to foster STEM identities and build bridges between science, community, and the classroom. Utilization of the space environment can unify learning from other contents, while providing opportunities to explore the evidential sources of knowledge of our world. The United States is currently at a pivotal crossroads in science education; the recent inclusion of Earth and Space content into newly adopted national standards, particularly in earlier grades, provides a unique opportunity to contextualize science learning. This is especially important following a year of remote learning, and more so for students in urban environments. In 2013, the National Research Council adopted the Next Generation Science Standards (NGSS),

which identified and assigned equal weight to the content areas of life (biology), physical (chemistry and physics) and Earth and Space. This is a stark difference from the previous 100 years of education, and allows for a drastic restructuring of science course sequencing. There is now a far greater emphasis on Earth-Space systems across all grade levels, reflecting the interdisciplinary nature of the field. The exposure to meaningful and relevant science activities can provide an inclusive environment to traditionally marginalized students who do not see the real world applicability of science in their lives.

This session will explore astronomy education as a tool of equity. Students in urbanized settings may have even less academic exposure to astronomy and space sciences through a vicious cycle of deficit thinking and systematic oppression. A pedagogy of poverty has been the dominant narrative in which high teacher turnover in urban schools fosters a reliance on curricularizing [science] coursework to a minimum set of knowledge requirements, which remove connection and application to local context and settings. In urban schools, this curicularization may look like non-local examples, unrelatable representation, and a failure to incorporate areas of relevancy and urgency from daily life into the classroom. This can further complicate the incorporation of space sciences, which may seem abstract, complicated, and unnecessary. One can only imagine the magnification of this separation following a year of remote, removed learning mediated by a screen. By providing mechanisms of access to space sciences connected to local environments, educators can facilitate authentic learning experiences to previously excluded students in these fields.

Astronomy education, particularly in Western Nations, has the potential to disrupt colonial narratives while providing greater access to 21st century skills. Participants will be provided a space to explore the integrations of astronomy to foster and facilitate equity and justice, while connecting to the natural world. Some issues may be personally challenging to address, such as environmental racism and bias. This session will be highly interactive and allow participants to explore the use of satellite imagery to address social justice issues in their region and abroad. Participants will develop their own activities connected to their individual spaces which they can immediately use in formal K-12 education settings.

The Urgency and Contribution of the Planetarium in the Development of Astronomy in Rural Areas

Presenter: Muchammad Toyib, Surabaya Astronomy Club, East Java Amateur Astronomer Communication Forum (FOKALIS JATIM), Indonesia

A planetarium is a theatre built primarily for presenting educational and entertaining shows about astronomy and the night sky, or for training in celestial navigation. The position of the planetarium in an archipelagic country like Indonesia is very important, especially for people in rural areas to get equal rights in obtaining education and access to technology. With a planetarium that is easily accessible, it certainly allows the public to observe celestial objects together and gradually get scientific information to bring them closer to science, especially astronomy, using fun, interesting, and engaging activities. Through this process, the existence of a planetarium has become a potential tool for community building in various regions and even rural areas in Indonesia.

Poster link: https://astro4edu.org/siw/p47

Over time, human civilization has been progressing. We have successfully launched artificial satellites for decades, humans have even been able to walk on the surface of the moon, set up the International Space Station, send probes to other planets, and most recently, we are still trying to uncover the possibility of other habitations beyond there. On the other hand, although we often hear about some of these achievements through the media, few of us have in-depth knowledge of celestial objects, or simply about the Earth we live on. In fact, we hardly care about any of these things.

The planetarium is not only a means to acquire astronomical knowledge but is also a valuable medium to increase people's awareness and love for this one and only habitable planet. Planetariums can give the impression of the infinity, dignity, regularity, and wonder of the cosmos and inspire our minds to explore so many other fields of science. Planetariums can also provide an escape from the stress of everyday life. Relaxing under the serene starry sky brings peace and creativity back to the overworked mind. Lastly, the planetarium functions as a science center, where the public has access to the latest news about the current scientific happenings, as well as a place for a scientific discussion about the universe.

Above all, planetariums benefit our minds and souls as social beings. They can give great power to imagination and stimulate creativity in future generations, which will shape the future of our civilization. In this way, building a planetarium brings countless rewards. The development of planetariums in various regions can be a positive paradigm, which will cancel the dichotomy of access to education that often occurs between those who live in urban areas and those who live in villages or even rural areas.

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Teaching Astronomy with Culturally Responsive Citizen Science Curricula

Presenter: Christine O'Donnell, Arizona State University, USA

Collaborators: Molly Simon and Peter Smith (Arizona State University)

We are developing culturally responsive curricular materials based on Zooniverse projects for general-education college courses. The Zooniverse is the largest online citizen science platform; since launching in 2007, it has supported over 200 projects and connected researchers with over 2 million volunteers worldwide. Our curricular materials improve the teaching and learning of astronomy by guiding students to contribute to ongoing research projects and by empowering students to connect content with their own lived experiences. Students will also practice critical reflection skills and engage in scaffolded dialog about equity and inclusion in astronomy and space exploration. These materials will undergo extensive pilot testing beginning in Fall 2021 before being made publicly available.

Poster link: https://youtu.be/ouRZg0CalCE

In the US, hundreds of thousands of college students take general education science courses each year. These courses are designed for non-science majors to contribute to their broad set of skills and knowledge for their future lives and careers as policymakers, business leaders, voters, teachers, parents, etc., but these courses also often represent the last formal exposure to science that these individuals will have.

From previous education research [1-2], we know that general education science courses struggle to foster both a sense of self-efficacy (i.e., the feeling that one is capable of engaging in science) and a sense of belonging. However, research also illustrates strategies that can be used to address each of these challenges. For example, curricular materials that have students participate in citizen science efforts, which are projects designed to engage the public in the process of scientific discovery by making real and valuable contributions, can increase students' self-efficacy [3]. Additionally, culturally responsive approaches that connect students' own knowledge and beliefs with content, promote reflection, and foster peer connections and community can encourage students to feel a sense of belonging [4].

In this work, we aim to create a new framework for curricular activities (intended for two 50-75 minute class sessions with homework in between) that are built on a culturally responsive foundation and engage students in ongoing citizen science research projects to improve the teaching and learning of astronomy. Our materials feature projects from the Zooniverse, the largest online citizen science platform; since its launch in 2007, it has supported over 200 projects and connected researchers with over 2 million volunteers worldwide. Specifically, we have students who take part in the Planet Four project [5], which has volunteers identify and classify features on the Martian surface to learn about the weather and climate of Mars. Throughout the activities, students will learn about why researchers study Mars and how their work might benefit people on Earth. Before engaging with Planet Four, students are asked about their current notions of what it means to "do science," and after contributing to the Planet Four research project, we ask students to reflect on their experiences and to compare with their prior beliefs about "doing science". Next, students will have options for completing a deeper investigation into the study and exploration of Mars that aligns with their own personal interests. They will have opportunities to share their findings with their peers to foster peer connections and community. Finally, students will work in small groups to engage in a discussion on current topics and policy debates, such as planetary protection. These materials are currently undergoing an extensive pilot-testing at a range of different institutions (including R1 universities, liberal arts colleges, and community colleges) before being made publicly available.

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Cazadoras de Estrellas: Reduce the Gender Gap in STEM

Presenter: Victoria Paz Perez Gonzalez, Universidad de Chile, Chile

Cazadoras de Estrellas is an astronomy course for Chilean high school girls, founded in 2018 by female astronomy grad student at the U.Chile. In this course, the girls learn about the astronomy career, programming in Python, and most importantly, the role of women in Astronomy. We include specific moments to talk with them about women in science. We want them to know about our own journeys as astronomy students, and question their own interests and experiences. In this presentation we want to share the importance of an explicit approach to gender problems in Astronomy Education, giving young women space to reflect about this and meet with young female scientists, helping them identify the main problems that women still face when deciding to be scientists.

Poster link: https://astro4edu.org/siw/p50

Historically women were not included in academic institutions, resulting nowadays in a lack of feminine role models and STEM fields being considered as "masculine". In Chile, overall women's university enrollment is around 54%, but for STEM careers it goes down to 22,6% (CONICYT, 2018). Additionally, female participation decreases to 10% at an academic level. As a group of female astronomy grad students at the University of Chile, this problem worries us and makes us want to propose a solution for it.

Cazadoras de Estrellas project founded in 2018 that consists of a series of courses that teach Astronomy to Chilean high-school girls, with more than 850 applicants and 450 participants to date. We offer a course in Astronomy, in which the girls learn about Variable Stars as a central topic. Through that, they learn about the history of Women in Astronomy, the Astronomy career in Chile, programming in Python, and most importantly, the contemporary role of women in Science. *Cazadoras de Estrellas* has visited 6 regions in Chile during 2018 and 8 more during 2020-2021. For the second round of courses we have been able to take this experience to interested girls, and also develop a research on women in science based on our participants, where we are interested in knowing more about gender stereotypes that our female students deal with in different territories inside our country.

Our courses include specific moments of open discussion about gender issues in science. We want them to know about our own journeys as astronomy students, and question their own

experiences. Originally, the course was designed as a 2-day classroom course, but due to the COVID19 pandemic, we had to adapt our plan and transform it into a complete online experience that would last two weeks, just for the pandemic epoch.

In this poster presentation, we share our experience teaching these courses and also communicate the importance of treating gender issues with girls. A key part of our course consists in giving young women the space to talk and think about this, through open discussions with us, young female scientists. We share our academic and personal paths as women to newer generations, and through this experience, we identify the main problems that women still face when deciding to continue scientific careers nowadays, female students still have to deal with a lot of barriers in comparison with men. Gender bias still is an obstacle for young women to enter STEM fields.

Our experience with *Cazadoras de Estrellas* has shown us that it is important to highlight female role models to young women. Role models and safe spaces can help bridge the gender gap in science. After the workshop, girls feel more empowered and self-confident as they wrote in the closing questionnaires.

Discussion summary

The main aim of the session was to encourage diversity awareness and to support designing processes that aspire at granting everyone the opportunity and free choice to access scientific culture. Not only, we tried to figure out to what extent astronomy, also thanks to its universality, charm and fascinating power, can be a means to add something to this framework, and how we can use it to foster everybody's self-esteem and self-confidence with regards to science, but also life in general and not to self-exclude by activities they feel are not "for them".

One of the main issues we discussed at the end of the session was if and why Astronomy can be a privileged way of access and pursue equity goals. Some of the issues with regards to that were: how Astronomy has a special appeal that helps the teachers, astronomers to translate it in something understandable for everyone, also addressing other disciplines; how Astronomy is made by very diverse groups within large international collaborations, helping fostering equity between the different countries and different cultures; how Astronomy is a human science in the first place, making it effective for reminding everybody that they have the right to be part of the game, bringing their own cultural, social and historical narratives on the table. Finally, Astronomy allows us to think about the past, present, future, who we are, why we are here, so philosophical questions are also playing a big part in the self- and diversity awareness process.

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