Proceedings for the
4th Shaw-IAU Workshop
on Astronomy for Education

Leveraging the potential of astronomy in formal education

15 – 17 November, 2022

Editors: Asmita Bhandare, Eduardo Penteado, Rebecca Sanderson, Tshiamiso Makwela, Niall Deacon, Moupiya Maji, Emmanuel Rollinde, Francesca Cresta, and Aniket Sule

Publications of the
IAU Office of Astronomy for Education

Compiled & Edited by:
Asmita Bhandare, Eduardo Penteado, Rebecca Sanderson, Tshiamiso Makwela, Niall Deacon, Moupiya Maji, Emmanuel Rollinde, Francesca Cresta, and Aniket Sule.

The following is a collection of summaries from the 4th Shaw-IAU workshop on Astronomy for Education held 15 – 17 November, 2022 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/4th-shaw-iau-workshop/.

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).

IAU

IAU OFFICE OF ASTRONOMY FOR EDUCATION
OAE

THE SHAW PRIZE
邵逸夫獎

Foreword

4th Shaw-IAU Workshop on Astronomy for Education

What would you need to know to be able to strengthen the role of astronomy in schools? You might want to look at how curricula are created in the first place, and you will want to profit from the experiences of those who have already been successful in including astronomy in their countries' curricula. You would likely be interested in the various roles that astronomy can play in practice, in both primary and secondary schools. You might turn to astronomy education research for answers to questions about what fosters student interest in the STEM subjects science, technology, engineering and mathematics — and since at least part of the answer appears to be that cutting-edge results, such as those involving black hole shadows or exoplanets, are of particular interest to numerous students, you might want to look into including those topics in school teaching. Last but not least, you might look for synergies between astronomy and raising awareness for one of the most pressing challenges of our time: climate change.

That, at least, were our assumptions when we considered which sessions to include in this year's Shaw-IAU Workshop, and from the feedback received so far, we seem to have hit the mark. The workshop itself was truly global, with 600 participants from more than 90 countries. We particularly salute those participants who had to make special efforts to attend, circumventing state-imposed restrictions on international communication. With these proceedings, as well as the videos and posters from the workshop that are available online, we make the various contributions available beyond the confines of the workshop itself.

Although the total count is only up to four, the Shaw-IAU Workshops have already become something of an institution. Their genesis, of course, is directly linked to the International Astronomical Union's establishment of its Office of Astronomy for Education in late 2019, hosted at Haus der Astronomie and the Max Planck Institute for Astronomy in Heidelberg, Germany, and the evolution of the Shaw-IAU Workshops has paralleled the building of the OAE as a whole. The online format started out in 2020 as a pandemic necessity. But we soon realised that the kind of online meeting the Workshops provided was a highly accessible format that would allow us to make these workshops truly global, and to set the threshold for participation as low as possible. We acknowledge that there still *is* a threshold – since internet access with sufficient bandwidth is required – and we will continue to look for ways of increasing accessibility even further. Perhaps the hybrid format pioneered by the OAE Center China-Nanjing this year, which combined the virtual and international Shaw-IAU Workshop with an in-person teacher workshop (as well as a nation-wide online workshop) is a model for the future?

On the part of the Office of Astronomy for Education, we hope that these proceedings will help you to make better and more effective use of astronomy in support of primary and secondary school education. It's a big universe out there — let's encourage students to explore it!

Markus Pössel
Director, IAU Office of Astronomy for Education
Heidelberg, December 2022

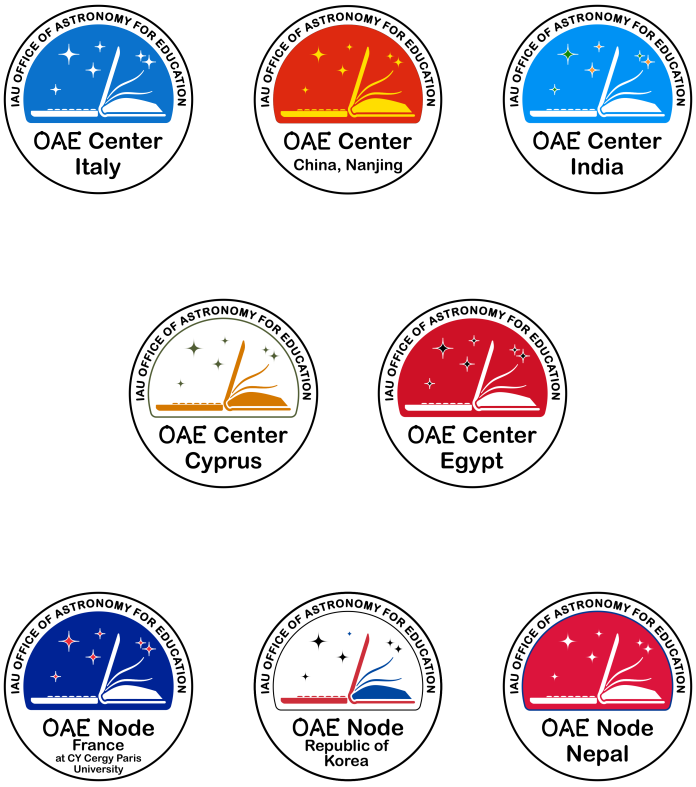
Contents

Organising Committees

Local Organising Committee:
Asmita Bhandare, Ankit Bhandari, Sigrid Brummer, Niall Deacon, Natalie Fischer, Esther Kolar, Anna Ladu, Tshiamiso Makwela, Carmen Müllerthann, Eduardo Penteado, Markus Pössel, Bhavesh Rajpoot, Saeed Salimpour, Gwen Sanderson, Rebecca Sanderson, Anna Sippel, Tilen Zupan.

Scientific Advisory Committee:
Mohamad Alassiry, Ali Al-Edhari, Mashhoor Al-Wardat, Asmita Bhandare, Suresh Bhattarai, Estelle Blanquet, Silvia Casu, Ahmed Chaalan, Merryn Cole, Hassane Darhmaoui, Niall Deacon, Rosan Doran, Federica Duras, Livia Giacomini, Edward Gomez, Violette Impellizzeri, Jacob Tolno Israel, Li Jian, Cui Jie, Awni M. Khasawneh, Colm Larkin, Hamid El Naimiy, Tshiamiso Makwela, Giulio Mazzolo, Farseem Mohammedy, Magda Moheb, El-Fady Morcos, Surhud More, Thomson Mucavela, Assia Nechache, Li Peng, Eduardo Penteado, Frederic Pitout, Markus Pössel, Gilles Remy, Sara Ricciardi, Emmanuel Rollinde, Somaya Saad, Gwen Sanderson, Stefano Sandrelli, Hyunjin Shim, Anna Sippel, Jungjoo Sohn, Abdelhafidh Teyehi, Alessandra Zanazzi, Jin Zhu.

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



Students in a Changing Climate: How Can Astronomy Help?

Session organisers: Eduardo Penteado (OAE Heidelberg), Asmita Bhandare (OAE Heidelberg), Anna Sippel (OAE Heidelberg), Violette Impellizzeri (Allegro Leiden, founding member of Astronomers for Planet Earth), and Colm Larkin (OAE Center Cyprus)

Session overview

Scientists and researchers from around the world share their experiences about discovering how astronomy helps us understand the changes occurring in Earth's many climates. This session also explores how astronomical activities can help predict the challenges and impacts those changes will have on indigenous populations around the world.

Cecilia Scorza shares the ideas behind the project "Pale Blue dot: Looking back at home". Kathryn Williamson presents methods developed for generating conversations on the issue of Climate Change for a range of demographics from students in universities to policy makers in West Virginia state's capitol, with a focus on breaking down cultural stigmas and discovering common ground. Anniek Gloudemans discusses the project "Life in the Universe" aimed at inspiring and informing the public about our Earth and our special place in the universe. Participants of this activity learn and relate to their own experiences and choices helping them appreciate the conditions and factors necessary for life and our life to exist.

Addressing issues such as gender, ethnicity and location, Christine Hirst Bernhardt presents her methodologies on guiding students to address the inequalities in Astronomy and the sciences in general. Exodus Chun-Long Sit describes an interdisciplinary project, ASTROx, which aims to go beyond the classroom connecting astronomy with other possible academic disciplines or subjects, based on Sustainable Development Goals. Mila Mitra illustrates how climate change and astronomy are connected and the impacts each has on the others and shows how climate change can have drastic impacts on ground-based observations and facilities. She presents some examples of activities to help younger students learn about climate conditions for planetary settlements and rising sea levels.

A message from Astronomers for Planet Earth (https://astronomersforplanet.earth/): https://youtu.be/lewxHQvbrFs (Talk by Violette Impellizzeri).

TALK CONTRIBUTIONS

Pale Blue Dot: Looking Back at Home

Speaker: Cecilia Scorza, LMU Faculty of Science, Germany

Climate change is the greatest global challenge of the 21st century. The high speed at which climate change is progressing poses an enormous problem. Neither flora and fauna nor humans can adapt that quickly to the change of environmental conditions. What can we astronomers contribute to raise the attention of students and their teachers to global warming? How can we link the fascinating astronomical objects with such a terrestrial issue? These questions are addressed in this contribution.

Talk link: https://youtu.be/zDJDtAK-02o

There is No Planet B: Engaging Students and Teachers in Climate Learning and Action

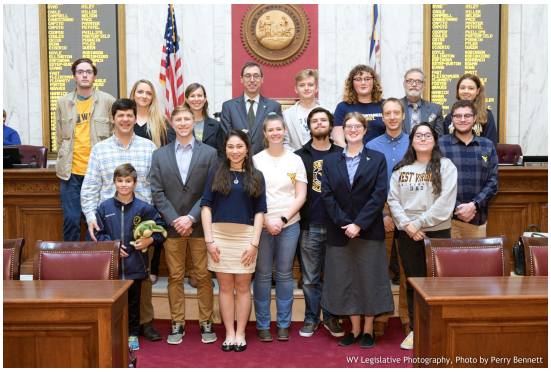
Speaker: Kathryn Williamson, West Virginia University, USA

Astronomy helps us understand planetary systems and it provides a big-picture perspective of ourselves as Earthlings. We can teach climate change through topics such as the greenhouse effect; however, understanding the science alone is not enough. We must empower students with solutions and help them use their voices and take action. I provide concrete examples of how we have done this in West Virginia, a coal state in the USA, through efforts such as a book club, podcast, field trip, and ongoing teacher training. I also invite participants to join "Astronomers for Planet Earth", a grassroots international effort by astronomers across the world to unite and speak up about climate change with the message that, "There is no Planet B".

Talk link: https://youtu.be/LxYliZnk-g8

Astronomy helps us understand planetary systems and it provides a big-picture perspective of ourselves as Earthlings. For example, we can teach climate change through topics such as the greenhouse effect. While early astronomers thought Venus would be a lush tropical paradise, we now know that Venus is a dire warning of a "runaway" greenhouse effect. We see that despite how much we may dream about exploring and habitating other worlds, creating a planet that can truly support us is only a distant dream. Even as we discover Earth-like planets orbiting other stars, the Cosmos is too vast; we cannot relocate anytime soon. Therefore, there truly is no "Planet B" that we could move to, if through some catastrophic event or our own actions, Earth were to become uninhabitable. It is imperative that, as educators, we help our students understand the degree to which we must care for our home planet. The topic of climate change has become fraught in the public dialogue, so teaching about it must go beyond science alone. Even if our students can describe the greenhouse effect in detail, they may not understand how to move towards the actions needed to change the way we live as Earthlings and care for the planet. We must empower students to see solutions, to use their voices and their skills, across all areas, and to move toward action and quickly.

For the past few years during my time as a college professor, I experimented with various ways of doing this in the state of West Virginia in the USA. West Virginia has a reputation for its once-thriving coal industry and extractive practices, which provided well-paying jobs for communities. Therefore, talking about climate change, and the importance of reducing our dependence on fossil fuels, can generate fear of job loss and economic security. In engaging in climate change discussions, my aim was to be sensitive to this history, and find and amplify the ways that West Virginia has the potential to move toward a "just transition", where coal communities are not left behind, but empowered to grow and thrive while solving climate change. Inspired by Katharine Hayhoe's TED Talk, "The Most Important Thing You Can Do To Fight Climate Change Is To Talk About It", my primary effort has been to generate conversations, and empower students and



Students and faculty at the WV State Capitol for a “Climate Education Day”

teachers to generate their own conversations, so we can break down these cultural stigmas and find common ground. The methods for generating these conversations were primarily through: a campus book club, a podcast, a field trip, and ongoing teacher training, as described below.

In Fall 2019, I taught a climate change book club at West Virginia University, in which students read 3 books related to climate change, “The Two-Mile Time Machine: Ice cores, abrupt climate change, and our future” by Richard B. Alley, “Earth in Human Hands” by David Grinspoon, and “Renewable: One Woman’s Search for Simplicity, Faithfulness, and Hope” by Eileen Flanagan. These books generated many discussions and reflections, and students were inspired to do a final project to go beyond the course. We collectively decided to create an accompanying podcast, called “WVU Climate Conversations”. Each of the 7 students in the class hosted an episode in which they interviewed a climate expert from our campus or state. Episode topics included how to live sustainably in the dorms, how to navigate political conversations that involve climate change, how to think globally and locally, and how to learn from historic droughts and famines. The podcast is available on all major platforms. Later, in February 2020, I organised a field trip for students and faculty to visit the state capitol for a “Climate Education Day”. Rather than lobbying for a specific bill or policy, the aim was to showcase the climate change research and educational efforts that are happening in our state. Students and faculty hosted stations, such as an ocean acidification demonstration with purple cabbage juice as a pH indicator, a greenhouse effect demonstration with an infrared camera, an interactive carbon footprint calculator, a scientific research poster about tree ring data as a proxy for climate change, and others. Lawmakers cycled through the stations and talked with students and faculty to learn more about climate change. Overall, the conversations were productive, and students reported feeling excited and empowered to continue such efforts in the future.

A more sustained effort over the last 4 years has been engaging teachers in climate change learning and action. In 2019, a team of astronomy educators started the “West Virginia Climate Change Professional Development” (WVCCPD) project, which has so far engaged over 100 teachers in at least 1 climate change activity, learning event, or course. Teachers who take the WVCCPD course earn continuing education credits. The course is divided into 3 parts: 1 for climate change physical science and social science, 1 for climate change communication and youth empowerment, and 1 for action, in which teachers engage their students in a full lesson plan with an action component. Additionally, for the last 2 years, we have hosted a “Public Service Announcement” (PSA) contest, in which students submit video and audio clips, our grants then pay to broadcast on local television, radio, and news channels. We estimate that these PSAs have reached tens of thousands of local residents. The winning students have also

been invited for interviews on local news channels, and they have received much praise and accolades from their schools and communities.

I hope these activities inspire other astronomy educators to try to engage their students, peers, and community members in climate change learning, dialogue, and action. We can all work to develop our identities as Earthlings who are empowered with the knowledge that there is no "Planet B". This is the message of a new grassroots group of hundreds of astronomers around the world who join together as "Astronomers for Planet Earth" and are speaking out about climate change. Please join us!

Life in the Universe: Using Astronomy to Teach Primary School Children About Climate Change

Speaker: Anniek Gloudemans, Leiden Observatory, The Netherlands

Astronomy is a powerful tool to fascinate children about our Universe and offers a new perspective on the climate discussion by making them realise how unique our Earth is compared to other uninhabitable planets and why we have to protect it. Therefore, as a part of the sustainability committee at the Leiden Observatory in The Netherlands, we have developed a 5-day lesson program designed for primary school students (9-12 years old) to discover the principles of astronomy, conditions for life in the Universe and on planet Earth, and sustainability. In this contribution, I discuss the goals of the project, the challenges that we faced, and our outlook on the future.

As a part of the sustainability committee at the Leiden Observatory in The Netherlands, we have developed a 5-day lesson program designed for primary school students (9-12 years old). The main aim of this project is to fascinate children about the Universe and make them realise how unique our Earth and climate are from a cosmic perspective. Education on the climate change crisis is an urgent topic on the Sustainable Development Goals agenda and highly relevant for schools in the Netherlands. Astronomy is a powerful tool to fascinate children about our Universe and offers a new perspective on the climate discussion by making them realise how unique our Earth is compared to other uninhabitable planets and why we have to protect it.

The idea is that we achieve our goals through play. The children work in groups, over the course of 5 lessons/days. Each group is assigned to a planet or moon in the Solar System and is asked to design and build an alien that can live on it (based on a workshop from astroEDU). For the first part of the activity they will be actively gathering information about the planet/moon assigned to them. Once they know enough, they will start the design and construction of the aliens.

Our alien mascot is called Dumpy!

For the second part of the activity, once the aliens are finished, they will then have to test the survivability of their alien using testing stations to mimic for example cold, wind, or high gravity.

All group activities will be guided by the school teachers and astronomy educators who will help introduce concepts like habitability and adaptation. Once the children have finished their design of the alien and passed the testing phase, they will present it to the other groups on the last day. The teachers/educators will conclude the activity with a discussion on why the Earth is so special for us, about habitability and the interconnectedness of life in the Universe; we depend on our planet's health, which is part of a larger ecosystem.

Our pilot project has been very successful and with the support from the ET Outreach award we have been able to further develop the lesson material, which will be made available online for everyone to use in the near future (see https://www.universiteitleiden.nl/leven-in-het-heelal/over-leven) .

Astronomy as a Bridge to Equity

Speaker: Christine Hirst Bernhardt, University of Maryland, USA

This contribution explores the integration of space science technologies to demonstrate global change in a tangible way, emphasising modelling, data analysis and problem solving. Astronomy is presented as a moderator between all systems of the terrestrial sphere, and a means by which to make local and global decisions. Participants are provided with tools and lessons to foster STEM identities and build bridges between science, community, and the classroom. Utilisation of astronomy with a climate lens can unify learning from other contents, while providing opportunities to explore the evidential sources of knowledge of our world.

Talk link: https://youtu.be/S8e5ekNFD2o

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 Colour. 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 standardisation for astronomy coursework. The scarcity of course offerings and absence of Advanced Placement or IB courses have relegated coursework to university settings, by that 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 contribution explores the integration of space sciences in formal education settings to foster STEM identities and build bridges between science, community, and the classroom. Utilisation 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 contextualise 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 the 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 marginalised 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 urbanised 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 curricularising [science] coursework to a minimum set of knowledge requirements, which remove connection and application to local context and settings. In urban schools, this curicularisation 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.

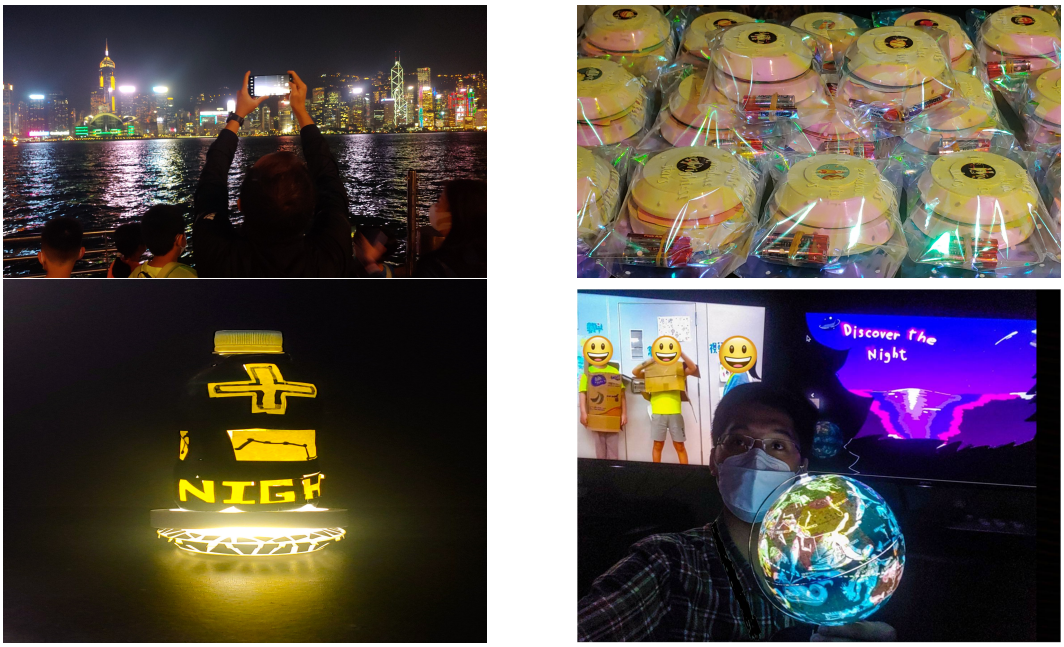
ASTROx Sustainability: Student-Led Social Innovation Project Achieves Sustainable Development Goals

Speaker: Exodus Chun-Long Sit, Starrix, Hong Kong

Sustainability is an urgent problem that students will always be aware of the climate change from the textbooks. Beside traditional lessons in the classroom or group project presentation, how can we imply sustainable actions with astronomy education? ASTROx is an interdisciplinary project that aims to connect astronomy with other possible academic disciplines or subjects, based on Sustainable Development Goals. The contribution will showcase a student-led social innovation project about dark-sky advocacy and science communication, solving real-life issues in the community. Students had explored different ways to raise the awareness of urban light pollution by outdoor classrooms, design thinking lessons and hands-on experience.

Talk link: https://youtu.be/FQiN17HqD40

It is so grateful to start a new student-led social innovation project called “Hong Kong Light Pollution Rescue Team” about dark-sky advocacy, and solving real-life issues in the community.



This is star walking activity in Wong Tai Shi, Kowloon District (Central City Regions) organised by Starrix Hong Kong. Besides traditional stargazing tours or sidewalk astronomy, light pollution field trips are highly recommended for astronomy educators and science communicators to organise. It would be a great opportunity to make the participants aware of the issues of urban light pollution and stargazing etiquette.

Regarding the research conducted by the Physics Department at the University of Hong Kong, as a part of the Hong Kong Night Sky Brightness Monitoring Network (https://nightsky.physics.hku.hk/en-hk), the measurements of average night sky brightness in the evening near the Tsim Sha Tsui Area (the central city region of Victoria Habour, Hong Kong) is 1200 times brighter than the darkest sky, comparing to the international standard of the International Dark-Sky Places. Even though the area of Hong Kong is really small, due to its light pollution issue, it could still be able to be seen on the global night sky map and the observation from the International Space Station. Therefore, Hong Kong's Light Pollution Rescue Team organised a light pollution field trip in Tsim Sha Tsui, which is an urban area with lots of skyscrapers near the Victoria Habour (Fig. 1a). It aimed to allow the team members to have a social observation of

outdoor lighting designs and be aware of the seriousness of artificial light at night in different disciplines in our daily life.

Inspired by the issues defined by the United Nations' 17 sustainability development goals, design thinking experiential workshops were also organised to transform social observation into practical projects and learning outcomes with teachers' guidance and scaffolding of lesson designs. To have a better understanding of the relationship between outdoor lighting designs and urban light pollution, the "Light Pollution Kit Set" for dark sky advocacy and science communication was designed by Exodus Chun-Long Sit as a supporting educational tool (Fig. 1b). It aimed to allow participants to make prototypes of dark sky friendly outdoor lighting shields by using recycled plastic bottles (Fig. 1c), enhancing experiential learning activities and peer interactions at the Light Pollution Rescue Team. There is no right or wrong in the brainstorming stage of the design thinking process, and accepting open-minded discussions. It was great to have motivated the next generation to share their unique ideas and insights from the field trip and learned from other people's successful cases for making adjustments to their original designs.

The Light Pollution Rescue Team had also contributed to several international festivals, such as International Dark Sky Week by the International Dark-Sky Association, Earth Hour by the World Wildlife Fund, UNESCO's International Day of Night, and Dark Sky Awareness Month by the IAU Office for Astronomy Outreach (OAO). And we had also taken part in a student showcase of learning outcomes during the DreamStarter Fair 2022 (Fig. 1d). Night sky advocacy and science communication is a long-term goal to create a better world, raising more public awareness of sustainability developments and climate change issues.

Including Climate in Astronomy Education

Speaker: Mila Mitra, Co-Founder, STEM and Space, India

Collaborator: Aditi Tomar, Senior Educator, STEM and Space, India

Is our planet in danger from changing temperatures and rising sea levels? In this contribution, we discuss educational activities to enhance student's awareness on climate change, specifically the rise in sea-level and how it has started impacting life on Earth. Sea level is rising, in part, because increase in greenhouse gases contribute to melting glaciers on land which are adding to Earth's oceans. Sea ice is not a significant contributor to sea level rise. Thermal expansion of water is also a major contributor. Understand these points through two investigative activities. We discuss how such images of sea levels are taken through satellites and do a trending activity

Talk link: https://youtu.be/GrOu5s-Q8R0

Figure 1: A model of a settlement on Mars

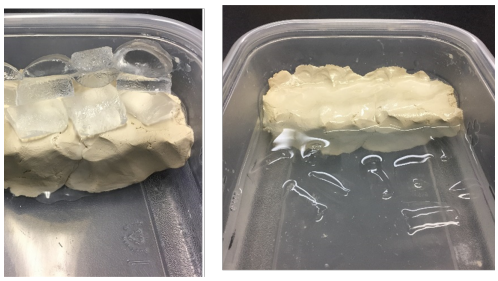


Figure 2: Experiment to study contribution of land ice vs water ice melting to sea level rise

Figure 3: A model of the layers of the atmosphere

Climate change is one of the biggest issues in today's society. Children and youth have a lot of concerns about their future related to the effects of climate change. Should astronomers include climate as a topic along with Astronomy and space education? There are several reasons why they should do so. Climate is a natural extension to what astronomers teach. Earth sciences and atmosphere are already an extension that astronomers include. Learning about space translates to knowledge about our Earth.

Astronomy already assumes some knowledge of atmospheric conditions, in situating their observatories. Telescopes are located in places which are dry and at higher locations, to avoid water vapour that can trap heat and to improve the seeing conditions. Astronomers also try to avoid light pollution. So, we are already conveying points about understanding our atmosphere.

Studying about terrestrial planets, their atmosphere and their terrain help students understand the atmosphere and changes on our planet. For example, students learn about Venus and why it is the hottest planet due to an atmosphere that has greenhouse gases and traps heat. Through planet history of terrestrial planets - planets like Mars that may have evolved from liveable to unlivable climates and may have had water earlier, they may also understand that such an evolution is possible on our planet. This can be extended to an understanding that not only planetary changes but human actions can cause climate changes.

Astronomy also studies why our Earth is the only known habitable planet in the Solar System. Due to its optimal location, Earth has temperature, has water and an atmosphere. As astronomers study other potential locations and their conditions, students can understand the parameters of life and how major changes factors can affect life. They may also realise that it will be hard to find a planet B.

We already teach about satellites which gather astronomy data. So, students are versed in astronomy data and analysis. We can easily extend this to studies of the Earth and atmosphere and show climate related data to students and help them study trends.

Astronomers are popular and are trusted as they are less controversial and not political. Astronomers reach a lot of people, there are many astronomy clubs and amateur astronomers and astronomy education is popular. Hence, astronomers already have eager communities they can spread the word to.

STEM and Space is an educational institute in India that has been active in fostering interest in STEM (Science Technology Engineering and Maths) education through the domains of space and astronomy. Seeing the interest of today's youth in climate, we have started extending our educational sessions to include atmosphere and climate.

In this contribution, we also present a few such activities. These include studying the atmosphere and other conditions on Mars towards building a settlement there. Another activity involves doing simple experiments to understand climate change problems such as sea level rise. For younger students, activities introduce them to our atmosphere and how it protects us and greenhouse gases.

Discussion summary

The quote "*Many little people, in little places, doing little things, can change the world*" by Eduardo Galeano perfectly sums up the efforts highlighted in this session. All the projects discussed were born locally, independently of each other but despite the different approaches there was a synergy of everyone finding ways to address the global issue of climate change.

The panellists shared that it is easy to capture the attention of students already interested in astronomy and use that as a starting point to also educate them about the effects of climate change, importance of sustainability and individual actions. Introducing various activities at school in astronomy, geography, chemistry, biology, environmental science or even art courses can be extremely powerful and have ripple effects in engaging a wider community. One can use local and visible events such as light pollution in cities, flooding, extreme temperatures etc. to point out the impact of climate change. Students can bring home what they learn from these activities and share it with their families. This also empowers students, builds their self-esteem and their resilience for any challenges that may come up and helps them understand that their voice matters in making a significant impact.

Students will eventually be the future decision-makers and voters and it is important that they understand what climate science is, how it impacts them and what they can do about it. It is also crucial to equip teachers with more resources and allow them to make flexible and informed decisions. This would then enable them to help students find the right tools to take action because many of them are unaware of ways to utilise the knowledge that they have. Creating platforms for amplifying student voices is necessary. Moreover, the use of social media to address climate change can be beneficial, especially for boosting efforts by the younger generation.

The main take-away point from the contributions and lively panel discussion was that open conversations about climate change with a more positive and hopeful outlook and developing different creative forms of outreach to spread awareness can prove to be a very useful tool. Furthermore, it is also important to find ways to reach people from different backgrounds and older generations, so that we can translate ideas to actions more efficiently.

The audience echoed the message that all the activities discussed seemed like they are too small to make a difference, but change happens in small steps and bringing up children who know climate change to be an indisputable fact is immensely powerful.

Resources shared during the discussion:

- Collection of resources for "Carbon Footprint of the Astronomy Profession", which includes concrete examples of observatories changing their carbon footprints: https://astronomersforplanet.earth/public-resources/, https://klimawandel-schule.de/en
- Design your Alien: https://astroedu.iau.org/en/activities/1303/design-your-alien/, https://www.universiteitleiden.nl/leven-in-het-heelal/over-leven

- West Virginia Climate Change Professional Development project: https://sites.google.com/view/wvclimatechangepd
- Globe Observer: https://observer.globe.gov/do-globe-observer
- All We Can Save - Truth, courage, and solutions for the climate crisis: https://www.allwecansave.earth/anthology

http://astro4edu.org

@astro4edu

IAU OFFICE OF ASTRONOMY FOR EDUCATION

OAE

THE SHAW PRIZE 邵逸夫獎

IAU