IAU

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

# Leveraging the potential of astronomy in formal education

15 – 17 November, 2022

IAU OFFICE OF ASTRONOMY FOR EDUCATION

OAE

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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).

# 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<br>
Director, IAU Office of Astronomy for Education<br>
Heidelberg, December 2022

# Contents

# Organising Committees

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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:

# Astronomy Education in Practice

# Teaching Astronomy in Primary Schools: How, Why, and in What Context

Session organisers: Sara Ricciardi (OAE Center Italy), Silvia Casu (OAE Center Italy), Alessandra Zanazzi (OAE Center Italy)

## Session overview

In this session we will pose some questions relevant to Astronomy and Astrophysics in the primary school, considering pupils from 6 to 12 years old, and hopefully we will also try to answer some of those questions together.

How should learning be? How should scientific learning be? What are the best practices to open up to children a scientific point of view about the natural world? What could be the role of the sky and the night sky in developing scientific citizenship? And then how can we encourage those practices in schools worldwide?

In this session, we will listen to different voices of teachers, practitioners, educators, and National Astronomy Education Coordinators (NAECs) from many countries; we will discuss how, through different points of view and perspectives, we can contribute to forming a new generation of young adults able to fully understand our world, so entangled with science and technology development.

Astronomy and Astrophysics in schools could be powerful instruments to build not only scientific literacy but scientific citizenship; it could help us understand the uniqueness of our planet and to understand that our community, the earthlings need peace and kindness to prosper.

# Three Little Steps in the Sky: From Conventional Teaching to Cooperative and Meaningful Experiences

Speaker: Franco Lorenzoni, Movimento di Cooperazione Educativa, casa laboratorio di Cenci, Italy

This contribution describes three experiences that refer to activities developed as part of the research / action project “Between sky and Earth”, experimented together with girls and boys both during extra-curricular workshops and in the school context. Each “step” opens a reflection about the learning that builds knowledge from experience, its possibilities and its meanings.

Talk link: https://youtu.be/VovoA5DNpjA

In this contribution, we describe three experiences developed in the research-action project “Between sky and Earth”[1] and tested with boys and girls in extracurricular workshops and the school context. Every experience brings a new reflection on how deeper and more meaningful learning occurs when knowledge comes from direct and meaningful experiences.

The first step is a story of activity aimed at reestablishing a relationship with the sky and is about daylight observation. Looking at the Sun from a fixed position, using a simple eyelet on top of a long stick, we start recording the Sun’s position at regular intervals (e.g., every hour). To make the observation visible, we use coloured threads and rods. After a few hours of observation and recording, we discuss what the sun-catcher is showing us: the Earth’s rotation on its axis, the partition of this round angle into wedges, and finally, a sense of wonder when the kids discover from this observation a geometric world. An experience like this will not only deepen disciplinary knowledge but also take the kids to the re-appropriation of this knowledge and contribute to understanding the original idea beyond geometry: a measuring instrument of the world.

The second step is about the Earth and the fundamental question – that we have from childhood – about our planet’s shape. Even the most passionate lecture sometimes is not so meaningful

[1] Some of those ideas are illustrated in the book “With the sky in the eyes” by Franco Lorenzoni, La Meridiana editions (in Italian). Nicoletta Lanciano has collected a large number of instruments for astronomical observation, partly historical, and partly reinvented during the research she animates, in the volume “Instruments for the gardens of the sky” (in Italian)

for some boys or girls. In such cases, we then try again to start from a practical experience, hand-building possible models of the Earth starting from the only observation that man had before the space age: the observation of a moon eclipse. From observing this phenomenon or a picture of it, we notice that whichever shape the Earth has, it projects a round shadow on the moon. We then start revising all the models proposed, and we see what kind of shape they cast. We realise that the spherical shape is the only one that really works. Once again, first-hand experience guides to deeper and more meaningful knowledge in a learning community that learns to build knowledge.

The third step comes from a re-appropriation of the classical globe. It shows and makes tangible a pretty complex idea: on the planet Earth, there are at the same time different times of the day - the time zones. This activity is called Globolocal (Localglobe) because the globe is fixed at the local position of us observing. We take it off its support and put it like this: the top of the globe is the place from where we observe, and the north pole is oriented north. In this way, the globe in my hand and the Earth under my feet are oriented in the same way in respect to the Sun; kids can visualise in real-time the shadow and light zones of the globe that correspond to the light and shadow zones on the planet Earth. We can then work on the globe, marking dawns and sunsets to the passing of time and once again measure the movement of the Earth on itself. In conclusion, building, manipulating, and using objects to build a relation to the real world can produce huge discoveries in the classroom; we can rebuild together a piece of knowledge but also learn to develop good thinking together.

## STEM+A@Astronomy:<br>How to Motivate Students to Learn Astronomy

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

Developing future skills are crucial for students to integrate knowledge with an innovative thinking mindset. However, subjects taught are generally separated in mainstream schools. Some students may lack the experience to overcome cross-disciplinary problems when they are facing their future society. Astronomy, as an interdisciplinary science, can be a link between different disciplines, building science literacy. The talk will introduce an interdisciplinary project called STEM+A@Astronomy. It aims to cultivate students' learning incentives and curiosity about the night sky through experiential learning. It could apply to modular lessons in formal education and interactive activities in public education to provide an intensive learning experience for students in their daily life.

Talk link: https://youtu.be/NRBlOoxm7hY

Traditionally building a customised telescope with a unique design usually requires some engineering techniques, such as a DIY maker or computational background for designing and making a prototype through digital 3D printing. For science popularisation, these would be a barrier for astronomy enthusiasts who may not have a related scientific background or 3D modelling experience. However, some entertainment toys could be helpful as educational tools for making telescope prototypes with creativity and low-tech requirement. Building blocks, such as Lego bricks and Nanoblock, could be used to build a telescope in a more accessible way. It will be more user-friendly if you can customise your telescope design with lenses installed in different shapes and colour combinations.

Teaching astronomy by building blocks can help educators and science communicators to visualise complicated structures of space suits, allowing participants to engage with hands-on experience and multi-sensory interaction (Fig. 1). There are existing block sets in the marketplace for science communication demonstration and educational purposes, such as Apollo Saturn V Rocket, Lunar Lander, and International Space Station. But this astronaut's space suit model is unique, in the style of Jason Freeny's anatomical sculpture (`https://jasonfreeny.com`), and allows the participants to understand the complicated structures of space suits. Rarely can students see the actual space suits used for space missions, not to mention how hard it is for them to understand how a space suit works, and its internal mechanism.

Building blocks can allow educators and science communicators to build a 3D model feasibly and freely without the requirement of scientific background or technique-operational experience. Targeted learners will also be able to contribute to the learning experience of building blocks (3D prototypes) based on their imaginations and creativity, allowing them to modify their designs and motivating interactive learning progress through peer evaluation and inspiration from design

Figure 1: Teaching astronomy by using building blocks is helpful to visualise complicated structures of space suits, allowing participants to engage with hands-on experience and multi-sensory interaction.

Figure 2: This reflecting telescope model is built using blocks and based on the actual scales of the telescope with different telescope equipment. It is generally used to demonstrate the procedures and important reminders of setting up a telescope.

Figure 3: Using blocks to build a telescope allows flexibility and creativity in structural design. This refracting telescope Mark I was built in a square tube shape as a prototype of the experiment of using Lego blocks to build a telescope.

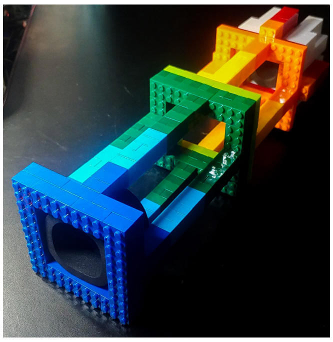

Figure 4: This refracting telescope Mark II is a modified version of a telescope built with a Truss Tube. It is encouraging to try different shapes and diameters during the construction of Lego blocks. It allows you to evaluate the quality of observation and make the adjustment easily just to remove the unnecessary part of blocks to make them lighter and better designed, during the design thinking process.

thinking engagement. There are more hands-on examples, demonstrated in the figures above.

## Observing the Sky in Astronomy Education: Building Benchmarks

Speaker: Gleice Kelen Dornelles Costa, Inter-Unit Post-Graduation in Science Teaching, University of São Paulo, Brazil

Collaborators: Antônio Carlos da Silva, Raquel Gomes dos Santos and Cristina Leite (Inter-Unit Post-Graduation in Science Teaching, University of São Paulo)

The practice of sky observing in basic education can produce good results, but may be hindered by some factors. To understand which aspects are essential for its realisation, we conducted a literature review, based on publications in astronomy education, which allowed us to build elements and organise them in three moments, allowing the necessary planning for its success.

Talk link: https://youtu.be/5ddRWltSA0g

The activity of observing the sky dates back to Antiquity and is one of the ways in which knowledge in astronomy is acquired. According to researchers in the field, astronomy was "born" from the observation of the sky with the naked eye [1] and progressively established to meet the social and religious needs of humanity [2]. Moreover, the observation of the night firmament can lead to the realisation of the beauty inherent in this scenario and is capable of arousing feelings such as enchantment and fascination [3].

The presence of sky observation in basic education is advocated by different researchers as a didactic strategy to broaden the perception of the astronomical environment and of the phenomena that are part of everyday life. These authors indicate that the feelings and sensations caused by celestial phenomena in students can be used to spark interest in science classes [4]; that teaching only using textbooks does not provide the construction of spatiality [5, 6]; and that the teaching of astronomy should start by observing the sky [7]. However, the success of these activities requires careful planning, considering that sky observing activities demand time (duration and timing of the activities) and spaces that are outside the traditional school system, especially the Brazilian one, in addition to the need for the right atmospheric conditions. Therefore, the formulation of activities of this type requires that some parameters are established, and for this, it is necessary to identify and understand the fundamental elements for the composition and realisation of the activity in a school environment.

**Materials and Methods:**
With the intention of building references that support the creation and analysis of sky observation proposals, a set of elements was developed from a bibliographic review, with a qualitative approach, guided by Bardin's content analysis [8]. Astronomy education publications that involved didactic proposals or reports of celestial observation activities were selected. For the bibliographic survey, we searched for research published until the year 2015 in the electronic domains: Latin American Journal of Astronomy Education (RELEA) and the Bank of Theses and Dissertations on Astronomy Education (BTDEA). Other materials from the research area of astronomy education were added to the corpus for analysis, such as those of Néstor Camino and Nicoletta Lanciano, as long as the publications discussed, described or reported observation proposals, or even books oriented celestial observations, such as the publications of Romildo P. Faria, Rodolpho Caniato and Ronaldo Rogério de Freitas Mourão. With the selected materials, deeper readings were performed, identifying how the sky observation activities were designed, looking for similarities and/or differences.

**Results and discussions:**
With the data, it was possible to structure categories that cover three major moments: before, during and after the sky observing activity, which correspond respectively to the stages of pre-observation, observation and post-observation. Pre-observation is the moment when the student is prepared to carry out the activity. It is during this phase that the students' previous knowledge is gathered; to define what will be observed and the concepts involved; to define the focus of the investigation, the period of the day in which the observation will occur and its respective duration. During the observation, data collection takes place. This phase includes the criteria of strategies to observe and follow the stars or phenomena, such as instruments, records, measurements, and references. Finally, the post-observation phase is the moment to calculate and analyse the measurements recorded in the previous phase, and to resume and discuss the concepts based on what was observed.

**Considerations:**

Therefore, the frameworks built in light of the elements obtained in astronomy education research can be systematised into three major steps – Pre-observation, Observation and Post-observation – and, in this way, support the sky observation activities, allowing to give meaning to what is learned and leading the students to broaden their view of the sky as it keeps them active from the pre-observation phase until afterwards. In addition, these elements make it possible to build didactic proposals, to analyse existing proposals, and can also help teachers plan these activities. However, the structuring presented here should not be understood as a mandatory sequence, because each class, each school and each teacher is immersed in a universe of specificities that may go beyond the elements discussed here.

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# Classroom Activities Related to Equinoxes and Solstices: Examples From the Astronomy Day in Schools

Speaker: Akihiko Tomita, Wakayama University, Tokyo, Japan

Equinoxes and solstices are not only astronomical events, but they are also important phenomena connected to cultural events in various regions, making it a good gateway to the world of astronomy and science for teachers. The Astronomy Day in Schools (ADiS) project is organised by the sub working group (WG) of ADiS, under the WG of Astronomy Education Research & Methods, Commission C1, IAU. The project website is hosted by the National Astronomical Research Institute of Thailand. On the website, the project has called for records of practice related to equinoxes and solstices. The project has also organised online meetings on occasion of the equinoxes and solstices. We will introduce examples of the records, and we hope this will help develop a network of students and teachers.

Talk link: `https://youtu.be/wUARARERUtg`

With the Astronomy Day in Schools project, we want to help schools around the world share their astronomy education practices and interact with each other. Please visit our project website and do share short videos or photos of your practice. We would also like to maintain a repository of your valuable inputs, which we are now developing, to help create a network of teachers and students all over the world.

Many activities took place in different countries. For example, the middle school students in Romania were given 60 minutes after school to represent the autumnal equinox by painting. On this day, day and night are 50-50 for the entire planet. The resulting paintings made by students were so impressive and beautiful that it was hard to believe that these are the works of 12 to 14 year-old students. At the autumnal equinox of 2021, students tried to determine the latitude of the observation site by measuring the altitude of the Sun when it was due south. This activity took place in Puerto Rico and Chile.

The Astronomy Day in Schools project is not just a repository of teaching material but it aims to create a strong network of students and teachers by organising quarterly live programs for students and teachers, around the time of March equinox, June solstice, September equinox, and December solstice. We started a pilot program in 2021 and have communicated various practices by teachers and students from many countries.

On September 30, 2022 we held another event during the September equinox, which is the autumnal equinox in the northern hemisphere and is also celebrated as Mehregan, one of the four important ceremonies in Iranian calendar. Several classroom activities from Japan were introduced. An elementary school teacher took photos of the sunset location changing every day and using these photos, students discussed the changing position of the sunset. Many activities for students organised by the National Astronomical Research Institute of Thailand were introduced, including building a portable planetarium. Japanese high school students who joined this live program were also working on planetarium building as the school club activity. It is likely that high school students and the National Astronomical Research Institute of Thailand will exchange information on the portable planetarium in the future. This is one of the great results of this live program.

From Iran, a series of photos of sunset before and after the autumnal equinox were presented, taken by the teacher and then by the students. This is teaching material to help students understand that the angle of the sunset is related to the latitude of the observing site, that the angle does not change from day to day, and that the position of the sunset changes from day to day. The educational environment in Iran is currently threatened, especially for women and girls. Iranian school girls are also standing up against the political power over women and girls. In response to the domestic protest movement, the internet is currently not freely available in Iran. Despite this, Iranian teachers managed to connect to this live program to introduce the material and the activities of their students. It was a powerful message from the Iranian teachers to continue education, to continue education network with the world, no matter what happens.

From Bulgaria, Ivo Jokin, NAEC Bulgaria, introduced the student activities and teaching materials shared at the European Research Night. Ivo encouraged the participating Japanese teachers and students to join the various campaigns organised by European teachers. It seems that the Japanese students have gained a new and unique window to the world. From Romania, there were presentations from nine schools. They introduced Romanian events and cultural aspects of the autumnal equinox, as well as what goes on in their schools. They told us very enjoyable stories and cultural customs, such as they do not pick the last fruit from the tree in the harvest to thank mother nature on this day, and they do not scold their children on this day. Many students joined the live program along with their teachers. From Egypt, Dr. Somaya Saad of NAEC Egypt, gave an introduction to teacher training for female teachers.

This live program was recorded and will be edited and made available to the public. The online program was two hours long. There were many students and teachers present. The goal was to create a bridge between teachers and students. In order to have this kind of an exchange, the world must be at peace, and we must be able to keep in touch with each other without anxiety.

Iranian students have given many presentations at previous online meetings. Together with their teachers, they have also created national and international networks. The fact that Iranian students were not able to participate in this time shows that our activity and astronomy education in general are deeply affected by the political situation. We hope that Iranian women and girls will be safe and that their pursuit of academic, cultural and human rights values, together with their network with the rest of the world, will open a new era for Iran and the world.

## Syrian Astronomical Association: A Trip of Success

Speaker: Turkieh Jbour, Syrian Astronomical Society, Syria

We are highlighting the Syrian experience of educating children on the sciences of astronomy and space during war and crises. As we always considered the sky our safe and sacred place during war, observing it and reading about its planets and stars helps to forget all about the sound of the bullets. And lets the Syrian children be well aware of how life will keep going by learning and working hard to achieve our goals. We are talking about our experience since the very beginning of the Syrian Astronomical Association and how we worked on astronomy outreach for the whole society, focusing on educating children. We worked on introducing astronomical sciences in a fun, simple and easy way based on thinking out of the box, by giving real life examples of scientific information, and through experiments and games which consolidate the information. We cooperated with the national curriculum development center to introduce astronomy in the curriculum as part of some subjects like geography, biology and physics starting from primary school until high school. Since the establishment of the Syrian Astronomical Association in 2005 we aimed to introduce astronomy and space science in every house in Syria. We are working to cooperate with every national, Arabic and international institution to make the future a better place for every child on this Earth, to live safely under one sky. The Earth is for everyone and the sky is for everyone.

Talk link: https://youtu.be/OePwN_Ss76w

The Syrian astronomical Association was established on 31/8/2005. Its goal was to do astronomy outreach in the Syrian society. At the beginning, its name was Syrian Amateur Astronomers Association. It started its astronomy outreach activities with public stargazing events and regular lectures at many cultural centers for all kinds of social classes, making astronomy and stargazing accessible for everyone. It also made sure to participate in most of the Arabic astronomical conferences and events like the Arabic conference in 2006 hosted by the SAA and an international conference in 2010. The association participated particularly in the Arab Union for Astronomy and Space Science conferences, and youth conferences in many countries like Algeria, Tunis, Jordan, Oman etc.

Through its journey, the association worked with many of its members to build telescopes and CCD cameras. From the very beginning of the associations' history, the SAA focused on educating children about astronomy, holding a special program for them and made sure to visit schools and educational centers all over the Syrian governorates.

2009 was a very important year for us, since it allowed expanding the association activities both in the Arab world and internationally. It was the real beginning of the association when it participated in projects that were proposed during the international astronomical year. Along with participating in “100 hours of astronomy” event, universal diaries, and “She is an astronomer” project that aimed to outreach astronomy between women and girls, the association also worked on “The little astronomer” project. We ended up creating a special page for the little astronomer in our website.

Through these events and activities, the association had worked on placing telescopes on the streets, restaurants and public places and organising many trips to the other Syrian governorates and introducing people to its work. However, it was not enough nor satisfying to organise events and lectures alone. The goal was much bigger than that, it is to work on reviving the Syrian astronomy heritage by trying to renovate the sundial of Ibn al-Shatir.

Since the beginning of the crises in Syria, the conditions have changed. The events are limited and more restricted. It is difficult to travel to other governorates and the international restrictions limit our interactions/collaborations with the international community.

Despite all the difficulties, the voice of the bombs, the view of our destroyed country, we tried to open a new window and see the world from it again and even let it see us. “In one orbit they swim" a program prepared and presented by Dr. Muhamad AlAssiry, the association’s president since 2013, reached the episode 401 last week.

In 2012, the name was changed to the Syrian Astronomical Association SAA. We participated in the contest that the IAU held for naming exoplanets and we succeeded in naming the planet that was orbiting around the shepherded star “Tadmor” after the Syrian historical city (palmyra in English) that was facing war at that time. We also named one of the asteroids “Al Tantawi” after a Syrian astronomer.

2017 was the year of a big leap in our journey, we build the Syrian astronomical observatory despite the difficulties and lack of resources and opened it to the public. We also organised activities for the blind and people with other disabilities. The observatory contains a lecture hall, 3D cinema, and hologram rooms in addition to the dome and an open space for observing nights.

We also established many sections in the other Syrian governorates like Aleppo, Homs, Hama, latakia, Masyaf, Tartus and Rif-Dimashq. We revived the little astronomer program through the quarantine in 2020. During Covid-19, we started teaching astronomy using WhatsApp; encouraging children to use their imagination and better understanding their surroundings. We also taught them the proper way of searching for new information on the internet and helped them write simple articles that were age appropriate. We continued with our activities and events after the quarantine period. We also made a schedule for new volunteers to master preparing and presenting lectures.

The association has been participating in local science conferences and events. For example, the Arabic conference for science history for the Arab that took place in Aleppo. To encourage children who are interested in astronomy we prepared a special national television program called “the scientist of the future” to increase their passion for astronomy. We were able to introduce astronomy to the curriculum in collaboration with the National Curriculum Development Center.

We also launched a contest between children for the best scientific article and best drawing representing the state of the Earth during Covid-19 and the global warming. This helped teach them the importance of keeping our cities clean and using clean energy resources and to also raise awareness about climate change.

## Bringing Astronomy and Science to the Public Using "The Velogyaneshwari" Bicycle

Speaker: Rupesh Labade, Inter-University Center for Astronomy and Astrophysics, Pune, India

Collaborators: Maharudra Mate and Samir Dhurde (Inter-University Center for Astronomy and Astrophysics, Pune, India)

Science and astronomy subjects are taught in schools only theoretically due to the absence of teaching aids, costly materials, and availability. So we introduce here the concept of "The Velogyaneshwari" (The Bicycle science). Its main objective was to connect students with basic concepts of astronomy and science. We did a lot of simple observational experiments using low-cost material and using android phone applications, which are attached to this bicycle. One can simply take this bicycle to schools, playgrounds, gardens, etc., and demonstrate experiments attached to it. These low-cost experiments helped students understand science as a whole process while reconnecting them with the observation of natural phenomena.

Astronomy has a great potential to awaken children's curiosity for science and improve their scientific literacy. However, it has a small presence within the school curriculum worldwide and is mainly descriptive and restricted to Earth-Moon-Sun topics. Currently, the interdisciplinary science of astronomy (or space science) is seriously under-taught in most primary and secondary schools. Instead, the core sciences of physics, chemistry, and biology are typically emphasised. These science subjects are mostly taught in schools theoretically due to the absence of teaching aids, costly materials and availability.

**Purpose:** So we introduce here the concept of "The Velogyaneshwari" (The Bicycle science). Its main objective was to connect students with basic concepts of astronomy and science, showing that it is possible to locate yourself spatially, calculate the size of the Earth or even estimate the size of the Sun and observe the night sky. Everything is achieved through observation of nature, basic geometric concepts and some low-cost experiments attached to this bicycle.


Figure 1: The Velogyaneshwari: wheels of knowledge

**Methodology:** We did a lot of simple observational experiments using low-cost material and using android phone applications, which are attached to this bicycle. One can simply take this bicycle to schools, playgrounds, gardens, etc., and demonstrate experiments attached to it. Also, students enjoy this kind of learning using their own bicycles. Low-cost instruments like a magnetic compass, bottle telescope, Windmill generator, geoboard etc. are attached to this bicycle so that students can learn science anywhere anytime.

These low-cost experiments help students understand the science as a whole process while reconnecting them with the observation of natural phenomena. They use knowledge of different areas and make a connection between astronomy and basic sciences. To their surprise, they discover that astronomy and maths are interconnected. Our experience shows that doing this kind of activity can help students improve academically in many subjects and change their idea of scientific methods.

**List of Experiments that we can perform with Bicycle:**
Gyroscope, Pin hole projector, Umbrella constellation, Windmill Generator, Solar power lamp, Pedal power generator, Sound Horn, Newton colour disc, Centrifugal force, Star dial, Projectile motion, CD spectroscope, sundial, Brain cap, Geoboard, Gas law, Cycle valve tube geometry, Constellation map, Bottle telescopes, Stargazing using astronomical lasers, Concave and Convex mirror, Cycle gear mechanism, Cycle geometry, Solar cap, Bottle rocket, Stethoscope, Solar Goggles, Foldscope, Magnetic Compass, Optical Illusion pattern, Experiments using android applications, and many more.

**Results:** The Velogyaneshwari seems simple at the first glance but helps to introduce very difficult concepts. This promotes motivation for students and teachers, practical demonstrations, and models and analogies in teaching. It helps to get a deep understanding of the process of learning through a hands-on approach. It helps students feel like the protagonist of their learning process. It also promotes the highest comprehension of students and is useful in all the countries: with different degrees of technological advancements. It can be used by young as well as experienced teachers since using a bicycle is also good for a healthy life.

The approach involving students also creates an even deeper understanding of astronomy itself. Moreover, the fact that the students not only understand the topic, but build their own materials attached to their own bicycle and makes it the Velogyaneshwari, which does foster creativity, resourcefulness, and the experience and gratification is empowering.

**Resources:**

- www.arvindguptatoys.com
- www.stellarium.org
- https://phyphox.org
- https://www.real-world-physics-problems.com/bicycle-physics.html

## CLEA's Propositions for Introducing Astronomy into the French "Science Plan for Primary School"

Speaker: Frédéric Pitout, Midi-Pyrénées Observatory, Liaison Committee between Teachers and Astronomers (CLEA), France

French education authorities have (finally!) realised that primary school teachers are not properly trained to teach science. To overcome the issue, they have initiated a "science plan for primary school", which consists a series of teacher training sessions focused on science, as well as teacher support. They also issued a call for participation in this science plan. In this contribution, we detail the notions of astronomy present in the French primary school curricula, how they can benefit other topics (maths, Earth science, French, history, etc.) and how the Liaison Committee between Teachers and Astronomers (CLEA in French) responded to the call for participation in the science plan.

In most French primary schools, there is a single teacher per class who teaches all topics including science, technology, engineering, and mathematics (STEM). Yet, most of them are quite uncomfortable with teaching STEM. The reason is that the majority of primary school teachers (∼80%) studied literature or human sciences, but not STEM at a university level. Another issue is the over-representation of women (84%) among primary school teachers. The consequences are the following:

- Teachers feel lost and lack self-confidence when it comes to teaching STEM subjects,
- STEM are not properly taught in primary schools,
- The probability is very high that pupils only have female teachers not knowledgeable about STEM over their school years,
- Women representation and course guidance in science for young girls are highly questionable.

Unfortunately, the trend is not improving as, in 2022, 86% of pre-service teachers are women and only 14% studied STEM.

To remedy the problem, the Ministry of education has put up a programme called “Science plan for the primary school”. It consists of:

- Short training sessions (1-2 days typically) for in-service teachers,
- Educational support all along the school year.

The goal is to allow the teachers to catch up and gain confidence with teaching STEM. However, it is still not clear who is supposed to organise and take care of those training sessions and educational support.

We, the Liaison Committee between Teachers and Astronomers (CLEA, in French), have decided to take the opportunity to offer our help. The first reason is that promoting astronomy in education has always been the goal of CLEA since the association was founded in 1977 (for more information about CLEA, please watch my recorded presentation from the 2nd Shaw-IAU workshop). The second reason is that we are convinced that astronomy is a good way of teaching STEM, and we try to convince our local education authorities. The third and last reason is that astronomy finds itself in the French primary school curricula in the two following themes:

- “Matter on macroscopic scale, motion, and energy”, which includes observation of the sky (motion of planets and moons) and the Sun as a light and heat source.
- “Planet Earth as a place of life”, which includes locating Earth in the Solar System, habitability, Sun and planets, motions of the Earth (day and night, seasons), "direct" observations (eclipses, constellations, Venus, Jupiter), evolution of knowledge about Earth since Antiquity.

Practically, CLEA proposes short 3h-sessions on dedicated topics for up to 20 participants. Each session will consist of a $\sim$1h lecture, a $\sim$1h30 activity, and about 30 minutes of discussion. Six of those sessions are envisaged on the following themes:

- **Seasons:** axial tilt of the Earth, effect on duration of the day and solar flux.
- **Phases of the Moon and eclipses:** movements of the Moon, Sun-Earth-Moon trio, notion of a cast shadow.

- **Solar System:** geocentrism/heliocentrism, Sun and planets, properties, model of Solar System.

- **Constellations and stars:** notion of star, their colours, their distances.

- **Exoplanets and habitability:** basics of exoplanet detection, notion of habitability.

- **Astronomy and critical thinking:** critical reading of texts or images, common beliefs about astronomy.

CLEA have already developed a wealth of activities so we shall select those we want to share (no need to reinvent the wheel).

It is not clear yet how this science plan is going to work but it could be a good opportunity for us to reach out the teachers. At CLEA, we are convinced that astronomy can encourage teachers to do science in class, through multidisciplinary projects, among other things. CLEA has a long experience of astronomy education and is ready to help, even modestly. We have made propositions to national and regional education authorities.

# Science Meets Storytelling in the Primary Classroom: We Share the Same Moon

Presenter: Megan Argo, University of Central Lancashire, The United Kingdom of Great Britain and Northern Ireland

Astronomy provides many avenues for teaching aspects of the primary curriculum – from science topics such as physics, biology and the climate, to maths, geography, and even art. Working with a storyteller and experienced primary teachers, we developed a set of creative teaching activities based on astronomy topics. Each activity provides background for non-science specialist teachers, a “science story”, detailed instructions, uses simple materials, has cross-curriculum links, and is paired with one or more cultural folk tales which can be used to introduce the topic in a primary classroom. This contribution will illustrate the project, its resources, how we tested the activities, and show how the resources have been used in different contexts.

Poster link: https://astro4edu.org/siw/p91

We Share the Same Moon was a unique collaboration between astrophysicist Megan Argo and storyteller Cassandra Wye, with the aim of bringing together creativity and science in both formal and informal learning contexts, and of promoting cultural understanding through the use of sky lore stories from different traditions. Its aim was to help children, parents and teachers understand why science is important, using stories and creative activities. In addition to a STFC Spark Award, the project received financial support from the Arts Council England, the International Astronomical Union, and the Royal Astronomical Society.

The UK primary curriculum contains some basic astronomy as part of the science strand, and children are often fascinated by the subject and have lots of questions. For teachers without a STEM background, who may not have the confidence to answer children’s questions, this can present an additional challenge when teaching these topics. If science is not taught well at primary level, this can lead to pupils being less engaged in the subject in secondary school and beyond, so support is needed to help teachers deliver science lessons in creative and engaging ways (Wellcome Trust, 2017). We Share the Same Moon was developed to help address this problem.

To celebrate the 50th anniversary of the Apollo 11 Moon landing, we developed, tested and evaluated 21 educational curriculum-linked resources linking stories and science, delivered a series of pilot workshops in schools and informal settings around the country, and produced a publicly-available website, https://www.wesharethesamemoon.org/, of fully-accessible educational resources. The science activities covered aspects of the primary science curriculum such as Earth and Space, Forces, Evolution and Light, as well as linking with several other aspects across the wider primary curriculum (e.g. geography, art, materials), enabling teachers to introduce science topics in an engaging and creative way. Each resource included background for the teacher to provide those without a strong STEM background some extra information and give them confidence in using the resources. We also collected more than 40 Moon folktales representing 19 different cultures, with each activity linked to one or more story which could be used as a gentle introduction to the topic in the classroom.

During the project we reached an in-person audience of almost 2000 people, mainly primary school children and their teachers, through testing and evaluation of our activities involving schools in deprived neighbourhoods and with high numbers of special educational needs (SEND) pupils, as well as family audiences at public events and festivals. The website has since received over 10,000 visitors and more than 35,000 page views, with the science activities alone being downloaded over 4,000 times. It remains freely available.

**Resource:** Wellcome Trust (2017), 'State of the Nation' report of UK primary science education, Wellcome Trust, London [online]. Available at: https://wellcome.org/sites/default/files/state-of-the-nation-report-of-uk-science-education.pdf (accessed 10/11/2022).

## Stardust Hunters

Presenter: Sarah Roberts, Swansea University, The United Kingdom of Great Britain and Northern Ireland

Collaborators: Emma Wride (AstroCymru), Chris Allton (Swansea University, Oriel Science), Jana Horak (National Museum of Wales), Paul Smith (National Botanic Gardens of Wales), Rich Johnston (Swansea University), and Mark Coleman (Swansea University)

Every year, approx. 3,000 tons of cosmic dust falls to the surface of the Earth – in this contribution we present our project called 'Stardust Hunters' which aims to engage and enthuse school pupils aged 8-14 years in the relatively new research area of urban micrometeorites. The 'Stardust Hunters' pilot project enables school children in Wales to carry out searches for these tiny particles using a specially designed 'Stardust Hunter's Toolkit'. The overall aim of the 'Stardust Hunters' project is not only to involve school students with real research and help them develop their scientific research skills, but we also aim to contribute to this growing field of study.

Poster link: https://astro4edu.org/siw/p92

Every year, approx. 3,000 tons of cosmic dust falls to the surface of the Earth – in this 18-month STFC-funded pilot project, we aim to enable school children to carry out searches for these tiny particles, and using equipment in Swansea University's Advanced Imaging for Materials (AIM) facility, we will analyse these potential micrometeorites and contribute to this growing field of research. To date we have reached just under 1000 school pupils in various educational settings both in-person and online, and over 4000 members of the public via stands/talks at online and in-person events.

**Aims:** The Stardust Hunters project aims to:

- Provide school pupils with the opportunity to genuinely contribute to real research
- Inspire and engage school pupils
- Provide under-served communities with the opportunity to participate in real research
- Enhance the educational ambitions of young students

**Materials and Methods:** Schools are provided with a 'Stardust Hunters toolkit', which includes strong magnets, sorting sieves, a USB microscope, plastic bags and a sample micrometeorite (MM). Once potential MMs are found, the schools send these to Swansea University, and working with scientists and undergraduate projects students at the AIM facility, an analysis is carried out using a Zeiss EVO LS Scanning Electron Microscope and a Zeiss Xradia Versa 520 X-ray microscope.

**Results:** We have reached 9 Primary schools, 6 secondary schools, 1 pupil referral unit, 1 hearing and speech impediment unit, 1 learning pathways centre, 12 online schools workshops, 5 online talks to general public/educators, and 3 in-person workshops to general public (incl. 2 science festivals).

**Future Work:** We are currently in the process of analysing the potential MMs collected at our workshops and results are expected in the next few months. The overall aim of the 'Stardust Hunters' project is not only to involve school students with real research and help them develop their scientific research skills, but also to contribute to this growing field of study. If you would like to collaborate or give feedback, please contact the author.

# Summary of Community Cosmos Workshop Project

Presenter: William H. Waller and Denise Wright, US-NAEC, Endicott College, Rockport Public Schools, USA

We report on our IAU-OAE Teacher Training Pilot (TTP) workshop for K-8 educators. Sited at Halibut Point State Park (HPSP) in Rockport, Massachusetts, USA, this one-day workshop introduces the teachers to the following astronomical topics: Exploring Earth from Earth, where teachers consider the shape, geology, and biology of Earth; Exploring Earth from Space, where teachers use Google Earth and other visualisation tools; Exploring Space from Earth, where teachers use star wheels along with desktop and smartphone apps to navigate the day and night sky. Direct and remote telescopic observing culminate this component; Exploring Space from Space, where teachers imagine and design robotic spacecraft that could enable them to explore specific worlds in our Solar System.

Poster link: https://astro4edu.org/siw/p93

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Let us begin with a question: "How can we get teachers to incorporate Earth & Space Explorations as part of their standard curricula?". One way is to get them out of the classroom and into more natural settings that are rich with Earth & space educational resources. That is what we did recently with a teacher training pilot workshop called **Community Cosmos**.

In this one-day program, we hosted elementary and middle-school educators at Halibut Point State Park in Rockport, Massachusetts – where Earth, ocean, air, and space processes converge in unique and enriching ways. By making use of the park's recently refurbished Visitor's Center as well as its fascinating natural environs, we introduced educators to exploring:
- *Earth from Earth* (mapping, discerning shape, size, geology, and biology),
- *Earth from Space* (using Google Earth and ISS Above),
- *Space from Earth* (using star wheels, planetarium software, smartphone apps, and remotely-controlled telescopes), and
- *Space from Space* (designing robotic spacecraft to sense diverse worlds).

Visitor's Center at Halibut Point State Park and the view from the tower of the Visitor's Center

Further information is provided in our poster titled “Community Cosmos: A Park-based Forum for Empowering Educators in Astronomical Exploration”.

## Astronomy Teaching in Primary Schools: Underrated Pupils

Presenter: Shao Faxian, Chongqing Academy of Education Science, China

We believe that the global science curriculum standards for astronomy education underestimate the actual ability of pupils. We conducted interviews with 54 students from grades 1 to 6 about the moon phase concept. It revealed that few students are working from naive mental models, and most can put forward their own guesses and carry out simulation experiments to verify. Students in grades 5-6 can even use the balls of different sizes and flashlights provided by the teacher to deduce the reason for the moon phase and refine their mental models of the Sun-Earth-Moon system. We have successfully helped grade 3 students establish the concept of the moon phase change law and the distance between the Sun-Earth-Moon by combining the embodied cognition with concrete models and mathematical reasoning.

Poster link: https://astro4edu.org/siw/p94

The teaching and learning difficulties peculiar to astronomy education make the science curriculum standards of most countries and regions continuously reduce the depth of astronomy. They mainly study factual knowledge and seldom discuss causal explanations or mechanisms. For example, as for the study of lunar phase, the Korean science curriculum clearly puts forward that the focus is to observe and confirm the periodic changes of the shape and position of the moon, regardless of the causes of the lunar phase. Some countries and regions even fail to incorporate astronomy into the primary school science curriculum standards (e.g. Finland and Singapore). China’s science curriculum standard has raised the number of years of study related to the content, reducing the depth of astronomy teaching. Such settings and adjustments may underestimate the ability of primary school students to learn astronomy.

In order to assess whether the curriculum standards underestimate the students’ learning ability and make clear how the pupils understand the changes in the moon phase, We conducted problem-solving interviews with 54 students from grades 1 to 6 in Chinese Mainland about the moon phase concept that most people find difficult both to understand and explain (Lelliott & rollnick, 2010).

**Results:**

1. Pupils basically know that the shape of the moon will change;

2. Pupils' understanding of the law and cycle of the moon phase changes increased with the grade;

3. Grade 1-2 students are prone to work from naive mental models, such as the moon becomes smaller when moon thirsty, and the moon gets smaller when it takes off its clothes; The most common explanation for the phase change is that it is covered by tall buildings, clouds, and the Earth. Some pupils also think that part of the moon cannot be seen because the Earth blocks the sunlight that shines on the moon. Through physical modelling, pupils can basically rule out the guess of being blocked by objects. Grade 5-6 students were able to successfully construct an explanation model to explain that the reason for the formation of the moon phase was related to the size and its orbit around the Earth.

4. Compared with the contents in other fields of science curriculum, astronomy education can better cultivate students' modelling ability.

The study revealed that few students are working from naive mental models, and most students can put forward their own guesses and carry out simulation experiments to verify. Students in grades 5-6 can even use physical model to deduce the reason for the moon phase and refine their mental models of the Sun-Earth-Moon system. In the science class, we have successfully helped grade 3 students establish the concept of the moon phase change law and the distance between the Sun, the Earth and the Moon by combining the embodied cognition with concrete models and mathematical reasoning. As long as the method is appropriate, pupils can also carry out simple model reasoning.

# An Implementation Case of Astronomy Curriculum in Elementary School

Presenter: Li Chunyu, Beijing Haidian District Tuqiang No. 2 Primary School, China

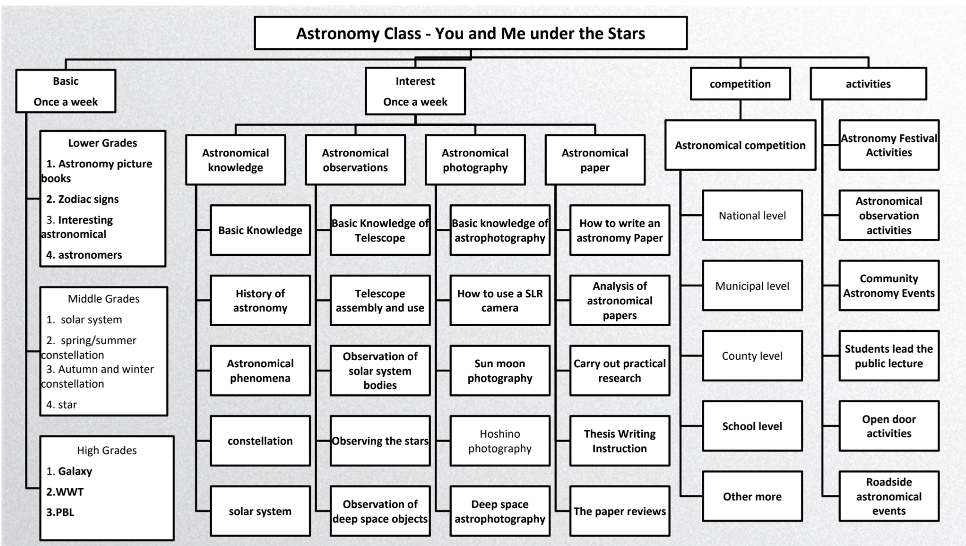
Astronomy is included in the curriculum for primary school students, and all students in grades from 1 to 6 learn basic astronomy courses. The school provides students with a variety of after-school activities, including astronomy knowledge, astronomy photography, astronomical paper writing and other interesting courses to help students develop their interests. The school organises various observation activities, photography activities and roadside astronomical communication activities for personalised and in-depth astronomy club courses for students. The Astronomy Festival is organised every year, through science and technology activities, art performances, music and other forms to carry out astronomy theme festival courses lasting for one week.

Poster link: https://astro4edu.org/siw/p95

In this contribution, I summarise how astronomy education is carried out in the Beijing Haidian District Tuqiang No. 2 Primary School.

1. Astronomy is included in the curriculum for primary school students, and all students in grades from 1 to 6 learn basic astronomy courses.

2. The school provides students with a variety of after-school activities, including astronomy knowledge, astronomy photography, astronomical paper writing and other interesting



courses to help students develop their interests.

3. Organises various observation activities, photography activities and roadside astronomical communication activities for personalised and in-depth astronomy club courses for students.

4. The Astronomy Festival is organised every year, through science and technology activities, art performances, music and other forms to carry out astronomy theme festival courses lasting for one week.

5. Organises a university-level astronomy competition with the participation of the whole school every year.

## "Little Astronomers" and the Milky Way of Chinese Traditional Sky: Example Analysis of Teaching Astronomy in Primary Schools

Presenter: Liu Jing, Science and technology counselor of Guangxi Science and Technology Museum, China

This contribution takes the content of the sixth grade Chinese Distant Altair Star of the Guangxi edition of the primary school people's education edition as an example, expounds the basic principles of developing activities with textbooks, analyses the characteristics of the development and design of such activities and the specific operation and implementation of such activities. The full text discusses and analyses how to use the methods of "role theory" and "situation creation" to turn the virtual into the real. It constructs the situation and ignites the students' interest, stimulating exploration and promoting thinking, and emphasises hands-on exploration and personal experience.

Poster link: https://astro4edu.org/siw/p96

The galaxy occupies a very important place in Chinese culture, and there is a famous Chinese story – meet each other across the Milky Way. The Milky Way is only visible on sunny nights and is caused by the light of countless faint stars (stars). The primary school Chinese curriculum contains many scientific elements, and the Science and Technology Museum uses the characteristics of such texts to develop astronomical science education activities.

1. **Create contexts, astronomical history**
   China's starry sky, covering ancient myths, historical allusions, social mats and humanistic

customs, is almost a reproduction of a world in the sky according to the pattern of the Earth on Earth. According to the text, explore the mysteries of the stars and explore the traditional culture and sing ballads.

2. **Role theory, cooperative inquiry**
   Traditional Chinese horoscopes are the reflection and epitome of ancient society and culture, and the most typical and vivid embodiment of traditional Chinese philosophical thought "the unity of heaven and man", which uses stories to string together the history of human exploration of the sky. In the starry sky story of "Altair", the ancients looked up at Altair and Vega, thought about the distance of 16 light-years between them, experienced how far this distance was, and thought about the contrast between myths and legends and the real world.

3. **Observation guide, starry sky appreciation**
   What is the Milky Way? Why is the Milky Way a loop? On a summer night, look up at the starry sky which has a large triangular sign as the main line, swimming in the sea of stars in the fusion of space and time.

4. **Sharing and exchange, astronomical expansion**
   Human beings really understand the scientific structure of the galaxy in only a few dozen times, and the Chinese ancients limited by history, could only make reasoning and associations, enjoying a high status in the minds of the ancients. Legends and historical allusions are all scientific and humanistic. Observe the starry sky at night and write down the results of your observations. Know the history can reach the present, let us travel through history, and reveal the astronomical culture and astronomical mysteries of Chinese national characteristics.

# Construction of the Mobile Planetarium Cosmodom

Presenter: Gilbert Sánchez and Oscar Alvarado, Science and Technology Museum Mirador de la Ciencia, Venezuela

Our main objective was to design a low-cost planetarium with local resources that would allow its easy mobilisation and which will be integrated into a three-phase educational project called astronomy in the classroom, which consists of a phase of stimulation and awareness of the participants, a second pass of playful experience through the observation and visit of the planetarium and the third to capture the knowledge learned through exhibitions and practical activities.

Poster link: https://astro4edu.org/siw/p97

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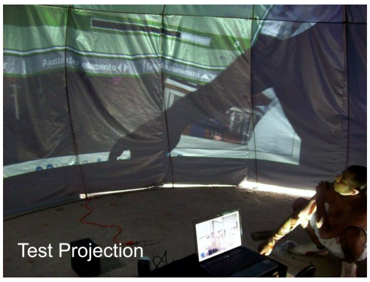
Every dream begins with a longing and this is the case of the first Planetarium in Barquisimeto, capital of the state of Lara - Venezuela. This planetarium with great economic, technical and operational efforts has undoubtedly become an informative tool for the Larense society, especially for children and young people. But how was the idea born? In Venezuela there was no commercial house that offered planetariums and the offers at the international level were extremely expensive, not having the economic resources to acquire it. Given these circumstances, I decided to carry out an investigative work to find a way to replicate in some way the necessary foundations to achieve its construction, see which design was the most suitable, the local materials that could be obtained, the projection method and the construction site.

To achieve the objective, together with Mr. Oscar Alvarado who, with his experience in mechanics and having a place with adequate space and tools, we began the construction of the Cosmodom planetarium. We decided after several tests with different materials to build it with our own exoskeleton design that would allow us to keep the structure suspended, unlike the classic inflatable planetariums. For the coating we use black out fabric that is used in clinics or health centers for windows and that has two layers and is waterproof. We designed an “orange slice” type mold to give it a spherical shape. The inflation system was made by adapting an air


Test Projection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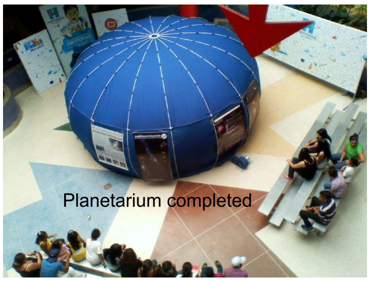
Planetarium completed

conditioning turbine and a washing machine motor that allowed enough power to inflate the structure.

Even for the assembly and disassembly of the planetarium we devised a hydraulic method that takes advantage of the inflation force. Finally, we solved the projection system with a truck rear-view mirror adapted in distance with a DLP multimedia projector that gave us a 160-degree projected image of acceptable quality.

## Astronomy Education in Primary Schools: Characteristic, Discrepancy, and Implementation

Speaker: Jin Zhu, Beijing Planetarium, China

Astronomy is a very important but quite different subject for school education, because of the characteristic of astronomy with the vast scale of universe. The frequently-appeared new discoveries and astronomical phenomena with grand observability make astronomy the most suitable tool to keep and improve the curiosity (and even integrity) of students. A text book on astronomy course in schools would be different with other subjects like language, art, math, and physics. Some special considerations for astronomy education in primary school should be noted.

Talk link: https://astro4edu.org/siw/p98

Although astronomy is one of the fundamental subject of natural sciences together with mathematics, physics, chemistry, geology, and biology, it is rarely implemented in the normal curriculum of the current educational system of primary and middle schools like other subjects. The explanation for this inexplicable situation must be closely related with the characteristic of astronomy itself. The emphasis of school education could be accumulation of well-known knowledge and development of different capacities, with obvious purpose of direct benefit of students and societies for a better future on the Earth.

Astronomy is not like other subjects, which concern mainly the human and/or the Earth. The essential interest of astronomy is of that far beyond the Earth with no direct connection with people. Considering the broadest scope of the universe and the extremely complex physical conditions which are impossible to achieve in labs on Earth, it is understandable that much more new discoveries appear more frequently which sometimes exceed our imagination in the field of astronomy. Such feature makes astronomy a science more closely related with observation, where an astronomer is in a objective position to watch and try to understand and find out how the universe operates under the physical laws, which is quite different with other subjects where scientists involve deeply with objective actions (e.g., changing experimental conditions with adjusting different test parameters) in the labs on Earth. Astronomical phenomena such as solar and lunar eclipses, meteor showers, conjunction of planets and the Moon, etc. could be easily observed with naked eyes usually in a very large area under clear skies, which is different from events in other fields where we can only learn from media without in-person experience. The usually unreachable long distance of the objects and phenomena for astronomy also make it a really simple and concise topics without additional complex consideration like possible benefits or ethical issue. This makes astronomy a suitable tools for keeping and improving the curiosity (and even integrity) of students.

However, such characteristic of astronomy would also raise some specific considerations for astronomy education, especially for the case of primary school students. Many observations involve night time and field activities, which should be performed safely with extra security considerations by both students and teachers or parents. The environment of free expression of opinions during astronomy activities may more or less conflict with the tradition of obeying the orders from authorities for kids from some cultures.

As the basic elements of scientific qualities from my personal opinion, curiosity and integrity are not only needed for the fundamental science researchers, but also necessary for everyone for a higher happiness index. Astronomy education might be the simplest way to help make the situation better in some places, but it must be performed together with all other necessary subjects and with some balances for the time of initiation and contents. Different from the textbooks mostly with absolutely correct contents in other fields, the most interested aspect of astronomy is no doubt the rapidly emergent new discoveries (which are not presented in any textbook and may still be under discussion) and the astronomical phenomena yet to be observed (with uncertain results to be determined) next week or next month. So the content of astronomy education should be different from year to year. A textbook in the traditional sense may not be suitable for the case of astronomy. Based on our practise of astronomy education for 20 years in China, we are investigating the possibility to promote such content for astronomy education via a monthly journal of astronomy outreach.

# Representations of Astronomy in Children's Storybooks

Presenter: Alison Allen, Rockman et al. Cooperative, USA

Collaborator: Julia D. Plummer, The Pennsylvania State University, USA

Storybooks are widely used in schools as an entry point into science learning. As a result, storybooks should provide an accurate and equitable representation of science and scientists. Therefore, we conducted a content analysis of 32 astronomy storybooks published between 2001-2021. While about half the books include characters using at least one science practice, few portrayed characters investigating an astronomical phenomenon. Half the books contained inaccuracies. Gender representation was relatively balanced. The sample includes a relatively even distribution of characters' racial background; yet, this balance disappeared when books from Diverse Book Finder were removed from the sample. Our study suggests that there are limitations in how current children's books represent astronomy.

Poster link: https://astro4edu.org/siw/p119

Storybooks are widely used with early elementary learners at home, in school, and in informal learning environments, such as museums and libraries, as an entry point into science learning and discovery. The Next Generation Science Standards (NGSS[1]) proposes that children learn content integrated with science practices, therefore, this should be reflected in children's storybooks if these books are to provide accurate representation of how scientists do science and are being used as tools for educators when preparing students for more than factual knowledge of science through textbooks. Storybooks allow children to engage in scientific discovery, career exploration, and gain a better understanding of natural phenomenon in the world around them; therefore we sought to understand the landscape of astronomy-based storybooks.

To do this, we conducted a content analysis of astronomy storybooks for early elementary learners. We started our search using notable book lists such as WorldCat, American Library Association, and Diverse Book Finder (DBF). We filtered for books published between 2001-2021, narratives and biographies, reading levels for 3–8 year-olds, and astronomy content that excluded blackholes, astronauts, and space travel. This resulted in the analysis of 32 astronomy storybooks. A codebook was created to include how the storybooks portrayed the NGSS framework for the eight science practices; scientific accuracy of text and illustrations; engagement in scientific investigations; characteristics of the main character(s) (i.e., human/animal, gender, age, & race); and whether the author or illustrator used their own voice (i.e., term coined by Corinne Duyvis to describe books featuring characters from underrepresented and/or marginalised groups in which the author shares the same identity).

[1] NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

Fourteen storybooks included at least one science practice, with “asking questions” as the most frequently found practice. Of the 32 selected books, 23 were coded as having accurate text, 3 with partially accurate, and 6 books where the premise did not portray accurate science throughout the narrative. Seventeen storybooks had accurate illustrations throughout, 10 were partially accurate, and 5 were deemed to be not scientifically accurate. Only a few of the selected books portrayed characters engaged in scientific investigating of an astronomical phenomenon throughout the entire narrative (3) or included characters investigating scientific phenomenon as part of the narrative (4). Most storybooks in the selection presented a phenomenon without an investigation (10) or delivered a collection of astronomy facts (12). Humans were the most common main characters (23). There were slightly more female characters (16) than male (13), with an additional 5 characters where the gender could not be identified by context clues. The storybook characters were primarily children (25). When the selection of books from DBF (10) was included, the racial background of human main characters was close to even between white (9) and Persons of Colour (POC) (13). However, without the DBF portion of the sample, the selection was less diverse (9 white to 6 POC).

While we were interested in investigating the extent to which astronomy storybooks align to the goals of NGSS, and to what extent storybook have a diverse set of characters to which students can relate and see themselves as scientists, there were limitations to our storybook sampling and analysis. We continue to be interested in how teachers can leverage storybooks to create hands-on, scientifically accurate, investigations where students engage in and investigate with natural phenomena.

# Discussion summary

The session focused on teaching Astronomy in Primary school (pupils up to 12 years old). Different contributors discussed the importance of direct observation of the sky at this school level as a tool of the construction of knowledge. Through the description of relevant activities carried on in Italy, we started an interesting discussion about the meaning and the possibilities opened by the learning that builds knowledge from experience, not only in terms of literacy but also as profound engagement with science and its mechanisms. Obviously, this reflection cannot be detached from the one related to the teachers' and educators' educational design requirements needed to achieve those important results. Scientific analysis has been carried out in some interesting case studies, and bibliographical datasets should be taken into account.

From different scholastic systems and general conditions, we reviewed some of the best practices to open up to children a scientific point of view about the natural world: in particular, we hosted a session dedicated to Syria, before and after the war, and a session dedicated to STEM activities in Hong Kong. These active practices should be encouraged in schools worldwide.

Eventually, we discussed the importance of developing networks of students and teachers and allowing them to reconstruct knowledge together as done in the Astronomy Day in Schools (ADiS) project organised by the sub-WG of ADiS, under the WG of Astronomy Education Research & Methods, Commission C1, IAU.

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