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OAE Mini-Review

Low-Tech Astronomy Education

IAU OFFICE OF ASTRONOMY FOR EDUCATION

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

Session Organiser:
Rosa M. Ros.

Authors:
Beatriz Garcia, Tan Hoe Teck, Song In-Ok, Corina Lavinia Toma, Breezy Ocaña Flaquer, Deodatus Stanley Kiriba, Jorge Rivero González, Rupesh Labade, Hassan Baghbani, Akihiko Tomita, and Mahdi Rokni.

Compiled & Edited by:
Asmita Bhandare (Project lead), Giuliana Giobbi, Colm Larkin, Rebecca Sanderson, Eduardo Penteado, Niall Deacon, Gwen Sanderson, and Anna Sippel.

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).

Low-Tech Astronomy Education

Session organiser: Rosa M. Ros, Polytechnic University of Catalonia, Spain

Session overview

The general opinion suggests that poor technology is equivalent to poor education. After the two sessions of Low-Tech Astronomy Education, the general approach from many participants was completely different from the previous conception. Low-Tech seems simple at the first approach but helps to introduce very difficult concepts. Low-Tech promotes motivation for students and teachers, practical demonstrations, and models and analogies in teaching. Low-Tech helps to get a deep understanding in the process of learning through the hands-on approach. It promotes that students feel as the protagonist of their learning process. Low-Tech promotes the highest comprehension of the students and is useful in all the countries: with different degrees of technological advancements. Low-Tech is used with young and experienced teachers.

In this session, the invited speaker Beatriz Garcia, from Argentina, gave several examples of Low-Tech methodology and explained the philosophy of this project. Tan Hoe Teck from Singapore presented a simple planetarium constructed by his students. In-Ok Song from South Korea explained the successful example of the NASE course in her country. Corina Toma from Romania presented an example using Low-Tech methods in the classroom after many years of experience in this area. Breezy Ocaña showed an example of a NASE course in USA and Dominican Republic and presented results from a survey in order to show low- and high-tech comprehension of the students, and finally, Deodatus Kiriba, from Tanzania, mentioned the results of an example of the NASE course in his country.

Additionally, there were 5 posters contributions. Jorge Rivero from The Netherlands, explained a special project with Sahrawi Refugee teachers, Rupesh Labade from India, described a mobile-application used to teach astronomy, Hassan Baghbani from Iran introduced a festival for students with Low-Tech materials, Akihiko Tomita from Japan presented an adapted model from a NASE demonstrator, and Mahdi Rokni from Iran presented a relationship between astronomy, literature, and poems from a Low-Tech point of view.

This session was curated with the help of Boonrucksar Soonthornthum (Thailand), Noorali Jiwaji (Tanzania) and Beatriz Garcia (Argentina).

Inexpensive/Cheap/Low-cost Astronomy and Quality: Between Prejudices and Reality

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

Astronomy is the oldest scientific discipline to which Humans dedicated time in a systematic way. The knowledge grew exponentially in the last centuries and also the technological needs of the astronomers to decipher the Cosmos. But, is the knowledge and comprehension of the main concepts of the discipline also connected with the new technologies or you can teach and learn first level astronomy at a low-cost?. What really means "inexpensive" in a world where the technology is dominant, but has no sense for the most part of the people? The idea of this session is to show how understand big discoveries with low cost resources and discuss the impact, with some examples, of educating and developing the critical thinking in the new and overloaded with technology generations.

Talk link: https://youtu.be/dEU24GETAJk

Astronomy is the oldest scientific discipline to which Humans dedicated time in a systematic way. From the past to the present, the knowledge grew exponentially and also the technological needs of astronomers to pursue their objectives: to decipher the Cosmos.

New Methodologies are needed: Methodology in Education plays a fundamental role at the time to transmit concepts in Astronomy. The organization of knowledge starts with the first steps of humans to decipher the movement of the planets and the stars, until the Standard Model of the origin, evolution and possible future scenarios for the universe. In this sense, different approaches to the process of teaching/learning are important, mainly, if the idea is to assure that the students understand how nature works. The didactic of Astronomy can not be faced only in one way and must be thinking for all, in a frame of reference in which education is inclusive and sustainable.

Low-cost vs quality teaching: One question that a teacher can ask while preparing material for classes can be if quality teaching of the discipline is only possible using new technologies or if it is possible to teach high quality Astronomy at low-cost with inexpensive materials. Perhaps, we also need to define what really means "inexpensive", in a world where technology is dominant (and sometimes not very expensive), but where that technology has no sense for most people. The highlight of this contribution is to show that the understanding of big discoveries is possible

Figure 1: Material to prepare the activity for expansion of the universe and detection of radio wavelengths.

using low-cost resources and materials. The focus of the discussion should be on the teaching practices and the impact on educating new generations that are overloaded with technology.

Hand-on activities, learning by doing: We propose to make an approach, for different topics in Astronomy, through some examples to help understand what we say when we propose low-cost activities. These two examples are, a) the radio wave detection and b) the explanation of the Hubble-Lemaître Law. In both cases, we just need material that we have at home or are very easily available at a market (see Figure 1).

The approach presented in this contribution is based on the Network for Astronomy School Education-NASE Program (Ros, et al. 2018; `www.naseprogram.org`), a complete framework of didactics of Astronomy that allows to address all the topics in Astronomy, Astrophysics, Astrobiology and Cultural Astronomy.

Evaluation of Impact: After training a teacher on this approach, it is important to evaluate the impact of the activities. It is well known that if a teacher or a professor is not enthusiastic and does not have the appropriate knowledge, it will be very difficult to apply the activity in the classroom.

This evaluation was made through Satisfaction Surveys, and the intention was to answer questions, such as, "how useful are the activities", "how easy is it to implement the proposal in class", and "how good is the methodology?". In this way we explored the perception of the participants to a teacher-training program based on low-cost materials. In all cases, the answers were very positive, over 80% of satisfaction (see Figure 2).

Impact in the classroom: The other main topic is the real use of materials and resources and this exploration is carried out using a simple form to detail the evidence of the use of activities.

After positive results from the evaluation of the proposal, we revised our ideas about teaching Astronomy, and asked ourselves if the hi-tech and high-cost technology is really a need at the time to transmit Astronomy concepts in a classroom?

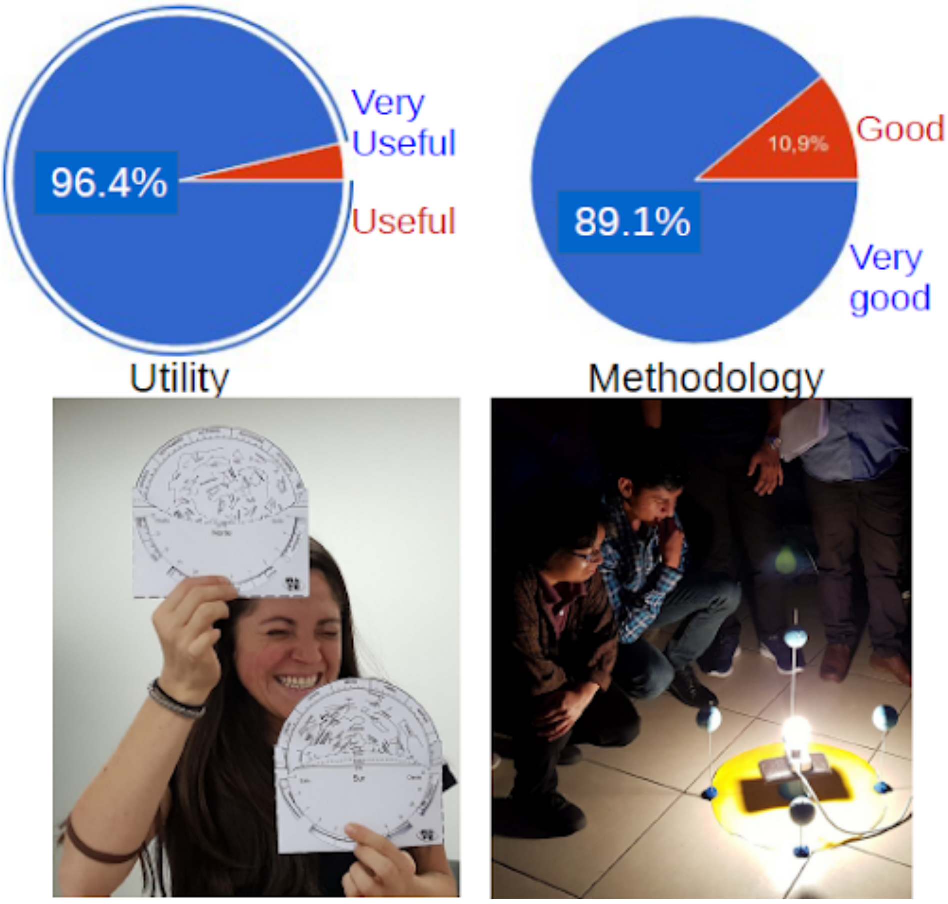

Figure 2: Satisfaction Survey results: average of evaluation of Utility and Methodology.

The low-cost, low-tech tools and resources are not correlated with low-quality education in astronomy. Using different approaches and upgrading contents, the proposal is useful not only for primary and secondary and high schools classes, but also in colleges.

The methodology based on learning by doing and using low-cost materials helps to understand concepts and contents, produce a perdurable knowledge, helps face more complex topics, ensures inclusion in economically disadvantaged audiences and much more!

Reference: Ros, R. M. et al, 14 steps to the Universe, Rosa M. Ros and Mary Kay Hemenway. Eds, Albedo-Fulldome, Spain, ISBN: 978-84-15771-46-3, 2015.

Development of Student's Planetarium for the Teaching of Astronomy

Speaker: Tan Hoe Teck, School of Science and Technology, Singapore

A home-made planetarium is a STEM project for presenting educational and entertaining shows about astronomy and the night sky, or for training in celestial navigation. The design that I am proposing is a 6-meter diameter dome, which can accommodate about 15 students comfortably at any time. Having the dome to conduct Astronomy Lessons reduces the need to have a perfect weather all the time for stargazing, which is a rare event in light polluted cities. The main advantage is student engagement: hands-on construction, planning and implementing a planetarium program. Besides the low cost and portability, the home-made planetarium can encourage sharing of ideas, problem solving and creativity amongst students.

Talk link: `https://youtu.be/alAKugM0ax4`

The design[1] that we are proposing is a 6-meter diameter dome, which can accommodate about 15 students comfortably at any time. Having the dome to conduct our Astronomy lessons reduces the need to have perfect weather all the time for stargazing, which is a rare event in light polluted Singapore night skies. The key parameter for successful learning is student engagement.

Hands-on Learning: Adoption of hands-on learning for the design, purchasing and building for the student leaders. The topics include geometry, cost benefit analysis, sewing, electrical wiring, and ventilation system designs.

Student Agency: Student teachers have to plan and implement an interesting Astronomy program for the audience / participants. The student teachers can plan their planetarium programs according to different themes (e.g. seasonal skies, planetary hopping, deep sky objects, stellar evolution etc.)

Immersive education for participants: Student participants will be engaged in Astronomy storytelling, engaging their senses (light, music, sound, temperature) in a simulated stargazing event even during the daytime.

Low Cost: The low-cost and portability of the Planetarium are not its only advantages: it is a student self-assembled planetarium that can encourage sharing of ideas by students, troubleshooting and creativity among students. In terms of pedagogy, such an engaging environment is ideally suited to a project-based learning (PBL).

[1]Brozis, Mirosaw and Widerski Kamil, 2018. Students' planetarium. Phys. Educ. 53 035029.

IAU-NASE Workshop in Korea

Speaker: Song In-Ok, Korea Science Academy, KAIST, South Korea

In South Korea, the NASE course first started this spring 2021. There are various approaches to teachers' training courses in our country and the NASE workshop is one important way to make comprehensive programs for all levels of training courses. Each has a different character and expectation, and the NASE program is expanding our training course to comprehensive programs at various levels. The lecture on astronomy covers most areas of basic astronomy and the hands-on session with materials that students can easily access. In addition, the organizational operation and philosophy of NASE are expandable and sustainable in their countries, so it will be helpful not only in astronomy perspectives but also in learning organizations.

Talk link: https://youtu.be/VNAmw-5dTXQ

There are various approaches to teachers' training courses in our country and the NASE workshop is one important way to make comprehensive programs for all levels of training courses. There are various teacher education programs in Korea. All teachers must have an official certificate to work at the school and the government controls the number of teachers in each province or city. Teachers can optionally receive various training courses according to their interests while working. There are two kinds of training courses, 1) professional driven by the astronomical society which is short and periodical, 2) amateur driven by amateur astronomical society. The training conducted by amateurs is also open to the general public as well as teachers. As NASE is introduced to our country, additional training methods have been created and will be comprehensive.

Each program of teacher's training is explained in detail and introduced in the NASE program. The NASE program was conducted online. It was first run in Korea in January of this year, and the second one was organized in July. If it is held again around January next year, all 10 workshops will be conducted. Most of the participants were high-school teachers, and about 20 teachers per workshop participated. It was supposed to be offline for 2-3 days, but it has been divided into 3 workshops and conducted for one year. Most of the local teachers are in science high-schools and science-gifted schools because every major city has science high-schools. It is expected that the workshop contents will be spread through them as bases.

NASE highlights:
1) simple and variety activities,
2) hands-on and activity-oriented,
3) communication, sharing and development of thoughts,
4) philosophy of the sustainable system.
Of course, the main power of NASE is the activity-oriented teaching style in our country and another point of view for the same content. It should be noted that communication and

sharing is also the key point of NASE. For example, since English is not our native language, an interpreter was needed. It is well facilitated with pre-translated powerpoint presentations used by instructors. Finally, organizing training sessions in the future makes the program expandable and sustainable in the country.

References:

- Astronomy Education around the World, NAEC Summaries 2020 (`https://www.haus-der-astronomie.de/oae/worldwide`)
- Gayab Yeol education program, private communication
- KASI teacher's education program, private communication

Understanding Space Travel

Speaker: Corina Lavinia Toma, Tiberiu Popoviciu Computer Science High-School
Cluj-Napoca, Romania

Astronomy means many difficult notions and the teacher must know the power of understanding of a child and to make space for real empathy and creative solutions. To achieve this the teacher must use intuitive models and experiments. I present a project achieved with my students about a travel in our Solar System. Why do we have to travel at first in a circular orbit? What is an escape velocity? What is a Hohmann transfer orbit? What is a launch window? These are some of questions the project answers. After many years of teaching I realize that most important are not the formulas, not the problems solving, not to use very sophisticated devices but to make students imagine, to see or to visualize, using simple objects and if it is possible the objects they have in the classroom.

Talk link: `https://youtu.be/7jm0JlrtCvc`

From the first successful orbital launch of Sputnik 1 mission on 4 October 1957, space travel has seen an unimaginable development. But such a journey means a lot of technology, many laws and physical principles, different types of trajectories in comparison with those on the Earth, only one fuel station at the departure and some "science tricks" to increase or decrease the spacecraft speed, to get rid of the gravitational influence of the Earth or to travel huge distances with minimum energy consumption, etc. To catch students' attention, videos, pictures, and articles about Huygens-Cassini Mission (`https://solarsystem.nasa.gov/resources/11776/cassini-trajectory/`) and science news about Rosetta mission were presented.

At first students were acquainted with scientific terms and principles and this was done using simple and intuitive models and hands-on activities. The students were told that the initial rocket trajectory is a curve because the velocity of the rocket has 2 components: a vertical one and a horizontal one. The true trajectory is not a parabola, but a part of an ellipse with the Earth as a focus. As an experiment, the students threw a ball in an oblique direction and filmed the movement and then they could study the parabolic trajectory. After that, they compared this type of trajectory with an elliptical one. In space the orbit is a balance between the force of gravity and rockets' tendency to move in a straight line. Because the distance to the Earth oscillates, the trajectory becomes an ellipse.

The students were amazed at how easily an ellipse with a piece of chalk and a string can be represented (see Figure 1). They chose the distance between the foci and so the drawn ellipse had different shapes. If the distance was 0 then the ellipse became a circle. Thus, the students easily understood the quantities that appear in the ellipse equation and its eccentricity. On each orbit, a spaceship has another speed, so to move from one orbit to another it must use propulsion systems to change speed. This means an orbital manoeuvre. On the other hand the

transfer orbit from one orbit to another is a Hohmann orbit (half an ellipse) and in order to travel on such an orbit, the spacecraft must change its speed twice: at the beginning and at the end.

Using Newton's laws, the students calculated all velocities of the planets on their circular orbits from the Solar System, all escape velocities and then the velocity variations for the Hohmann transfer orbits. On a Hohmann ellipse, the fuel consumption is set to minimum because this is where the changes of kinetic energy are smallest. When a spacecraft passes from a planet to another the configuration of the two planets in their orbits is crucial. The destination planet and the spaceship must arrive in their respective orbits around the Sun at the same point and simultaneously. This requirement for alignment gives rise to the concept of launch windows. Thus, the students understood that a spaceship cannot travel directly to a planet on a rectilinear trajectory. Finally, they calculated all the required orbital radii, velocities, and velocity variations and then developed a software that modelled interplanetary travels using the Hohmann trajectories from one planet to another [1]. Through it the students could analyse orbital manoeuvre velocities and necessary travel times between planets.

How to understand what is a fly-by (a slingshot or a gravity assist manoeuvre) in space without knowing what it means as a relative movement and how to increase or decrease the momentum of one body by colliding with another body? The students made experiments with collisions between balls with different masses, which were thrown in different directions and with different velocities. An interesting example was to let a tennis ball and a basketball fall at the same time like in Figure 2. After the collision with the floor, the tennis ball gained a higher momentum than the basketball and had a much higher speed and as a result reached a height much higher than the height from which it fell. This explains the fact that a spacecraft can save fuel and can be "powered", if it passes by a planet or another celestial body with a large mass. This experiment is inspired by the NASE course, where it was used to explain the simulation of a supernova explosion [2].

The most important thing is to make students understand that a computer is a tool that helps them calculate more easily or simulate a physical process, but if they do not completely understand the important phenomena, they cannot program and cannot become authors of valuable software. In the presented project it has been proven that the explanation and the understanding of space mechanics concepts are easier through simple experiments, intuitive examples or models and the using of cheap materials. Why is it so important to do this? Some answers are as follows: the students are eager to do hands-on activities; they like to work together and to find some answers alone; they do not forget what they see and experience. The students can create a software or use a ready-made one only after they understand very well the necessary new concepts and physical phenomena.

References:

1. ICT in Science Teaching, Space Travel, page 60, https://www.science-on-stage.eu/sites/default/files/material/istage1_en.pdf

2. 14 Steps to the Universe, page 115, http://sac.csic.es/astrosecundaria/en/cursos/formato/materiales/libro/llibre_angles.pdf.

The Low-Tech and High-Quality Correlation in Astronomy Education

Speaker: Breezy Ocaña Flaquer, San Diego State University, USA and Gabriela Flaquer, GenerAcciones, Dominican Republic

A Low-Tech Approach (LTA) to astronomy is highly beneficial for teacher training since the amount of technical knowledge and skills required can be intimidating. Regardless of the teacher's background, LTA in astronomy has an enormous impact in breaking down walls and making science fun, interesting and approachable. According to teachers from the Dominican Republic and the USA, two countries with different education systems and approaches to technology, LTA has been useful. To clarify, LTA does not mean low standards or low expectations. We have maintained a high-level of technical concepts and skills training, while providing hands-on materials and creating small learning communities through social media and WhatsApp, which combined, serve to boost confidence, maintain engagement, and provide platforms for clarifications and deeper levels of understanding.

Talk link: https://youtu.be/4dWwwH7E-34

A Low-Tech Approach (LTA) to STEAM education in general, and Astronomy education in particular, can be highly beneficial for teacher-training. An element that teachers sometimes find intimidating in these subjects, is the amount of technical knowledge and skills required. Motivation and positive relationships are key factors in attracting people to new areas of learning. In this sense, our experiences with didactic training in astronomy have had an enormous impact in breaking down walls and making science seem fun, interesting and approachable to teachers that otherwise might be intimidated by higher tech environments.

Modern Astronomy is a science that depends completely on technology. In some cases, it uses the technology already available, and when this is not available, it also develops technologies that are then used by the general public. But when we refer to astronomy in education, we need to start with the basics of astronomy - as done by ancient astronomers - where it does not necessarily depend on technology, but it is still able to reach new levels of knowledge. We need to learn how to observe our surroundings, to pay attention, to ask questions - just as it was done when astronomy began being a science.

LTA does not discard the use of a technological approach, but LTA brings many advantages. It allows a wider audience to participate in the understanding of the subject with a more hands-on and experiential approach, which also makes the learning accessible to any socio-economic level. Schools that have the capability of buying equipment, can also take advantage of LTA, which benefits students in so many ways. For example, they could develop their own tools, which facilitates another level/area of learning besides astronomy. Due to the approach involving students, it 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 does foster creativity, resourcefulness, and the experience and gratification is empowering. This goes hand-in-hand with the United Nations Sustainable Goal[2]: Quality in Education. Another important point is that, although being empowered is important for students in general, it is especially relevant for female students in particular, or students from underprivileged areas. These two points are closely linked with United Nations sustainable Goals, Gender Equality, and Reduce Inequalities.

We have offered didactic teacher training workshops in the Dominican Republic (the Network for Astronomy School Education (NASE) [1, 2] , Galileo Teacher Training Programs (GTTP) [3], and others) all of them offer LTA to Astronomy. The NASE workshop has been the most complete one, with material for astronomy, astrophysics, astrobiology, and cultural astronomy. Because NASE uses LTA, many teachers from different backgrounds and most of them with no experience with technology, were able to take, understand, and recreate the material from the course. After the workshop's conclusion, all teachers shared that the course was useful, with 95% of them saying it was very useful.

Interestingly enough, in the USA we offered the same NASE workshop. The material and the content were exactly the same for both countries. Here, we are including their opinion as a comparison sample, since the teachers in the United States, in general, have more access to technology than teachers in the Dominican Republic. The reaction of teachers was very similar in both countries. In the United States, they all found the workshop useful, with 83% finding it very useful. This means that even if we have access to technology, there is no doubt of how much we can gain, learn, and enjoy when we take a Low-Tech Approach to Astronomy.

[2] https://www.un.org/sustainabledevelopment/sustainable-development-goals/

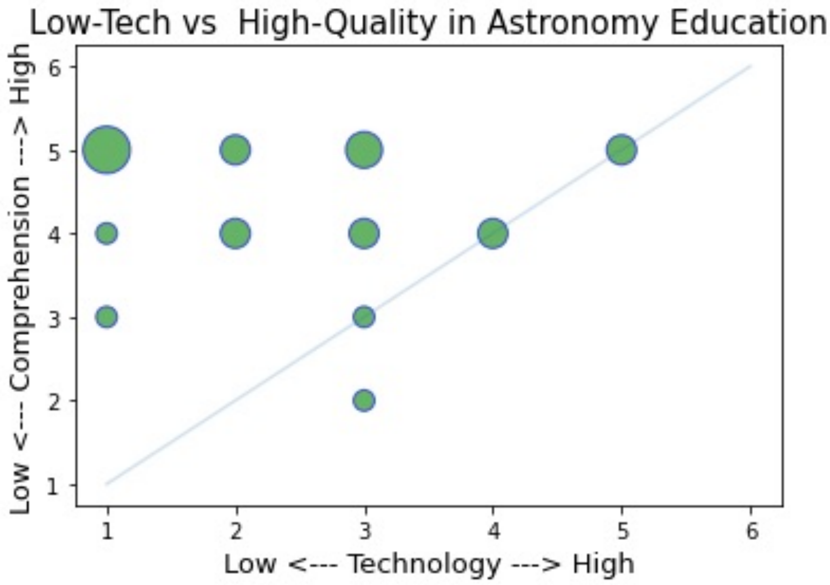

Figure 1: This plot represents the correlation between the level of technology used vs the level of comprehension of the students. The bigger the circle, the more data we had at that point. As can be seen, the biggest circle is the one that corresponds to the lowest technology with the highest comprehension.

We have asked the Dominican teachers, both, who have participated in these training sessions, and other astronomy teachers, for their experience. We can see in Figure 1, that where we have the most amount of data is in the lower-tech range with the highest comprehension of the material. In this plot, the amount of data is represented in the size of the circle; the bigger the circle the more data points were found. The biggest circle corresponds to the point where the teachers considered the technology used was the lowest and the comprehension of the student was the highest. We also note that there was data where the teacher considered the technology to be high and there was a high level of comprehension as well. This does not mean that by using a higher tech approach you do not generate high comprehension, but it does mean that you are not sacrificing the quality of the teaching by using a LTA. It also means that everyone benefits from a Low-Tech Approach, and not only the teachers/students who have already been exposed to technology and do not find it intimidating (which is the minority of the teachers/students).

In conclusion, a Low-Tech Approach does not mean Low Expectations or Low Standards. On the contrary, it means that without sacrificing the concepts and the quality of the materials that will be taught, it is accessible to a wider range of students and teachers who are exposed to and comfortable with technology, and also to the students and teachers with less access and less exposure to technology. Throughout all the activities we have maintained high-levels of technical concepts and skill training. We have provided hands-on materials. And small learning communities were created, which served to boost confidence, maintain engagements, and provide platforms for clarification and a deeper level of understanding.

References:

1. Ros, Rosa M.. Physics Education, Volume 47, Issue 1, pp. 112-119 (2012).

2. Deusta, Susana E.; Ros, R.M.; García, B. American Astronomical Society, AAS Meeting #223, id.449.03. January 2014.

3. Doran, Rosa,. 38th COSPAR Scientific Assembly. Held 18-15 July 2010, in Bremen, Germany, p.2.

Universe Observing Using Locally Constructed Instruments: A Case of Young Astronomer's Briefcase

Speaker: Deodatus Stanley Kiriba, Astronomy and Space Science Association of Tanzania (ASSAT) and Tanzania Agricultural Research Institute (TARI)-Selian Agricultural Research Center, Tanzania

Collaborator: Noorali Jiwaji (Astronomy and Space Science Association of Tanzania (ASSAT) and Open University of Tanzania, Dar es Salaam, Tanzania)

Astronomy links concepts in Science and a basis for understanding Geography. Its historical development provides teaching methods of Science and Mathematics. Hands-on activities provide exciting ways to understand science and guide students into Science and upcoming Astronomy careers being developed in Tanzania. We will describe the application of Young AstronomerŐs Briefcase (YAB) as a tool kit for carrying out hands-on activities for universe observation by using easily available materials around the school and home such as ruler, simplified quadrant and Spectroscope. YAB has been explored and tested through NASE Trainings and thus there is a need to scale-up such a tool kit during Astronomy training across Tanzania.

Talk link: https://youtu.be/wJMiyD3DoOk

Astronomy links concepts in Science and provides a basis for understanding Geography. Its historical development provides teaching methods of Science and Mathematics. Hands-on activities provide exciting ways to understand science and guide students into Science and upcoming Astronomy careers being developed in Tanzania. However, Astronomy training in Tanzania is very limited because it is not offered in Universities, so teachers enter the teaching profession with little understanding of Astronomy and often with misconceptions and lack confidence in those topics as part of the primary and secondary school curriculum.

In 2019 and 2020, the Astronomy and Space Science Association of Tanzania (ASSAT) in collaboration with the Open University of Tanzania organized a three-day IAU-NASE (Network of

Figure 1: Constructing and using the Ruler during NASE training in Tanzania.

Astronomy Schools Education) intensive residential training for 30 primary and secondary school teachers in rural outskirts of Dar es Salaam city, supported by NASE trainers from abroad with the local expert and also build the skills of local trainers to conduct wider local training. Among the several courses that were taught to the participants, one of the topics that was offered was the Young Astronomers Briefcase, which excited the attendees immensely.

Hands on activities:

Young Astronomer's Briefcase (YAB) consists of simple instruments such as ruler, simplified quadrant, spectroscope, simple horizontal goniometer, planisphere, map of the Moon, equatorial sundial, red light flashlight (torch), compass, wristwatch, paper, pencil and a camera. However, of these instruments, the first three, the ruler, simplified quadrant, and spectroscope caught the attention of the trainees due to their simplicity and low price and that it can be made locally and yet allows measuring difficult to view parameters in astronomy. During the training, the trainees were asked to perform different activities as highlighted below:

Activity 1: Use of a ruler to measure angles between any two objects within the classroom and hence a ruler can also be used to measure angular distance between two stars in the sky. The trainees had to cut a cardboard of 20x3cm using a scissor or a cutter, and cut a string of length of 65cm. A photocopy of a centimeter ruler was pasted on the cardboard using glue. Each trainee tied the string to the non-flexible ruler (cardboard) such as to set the string to a length of 57cm. To measure the angular distance between two points in the classroom (or two stars in the sky) they were observed with the end of string almost touching the cheek just below one eye so that each centimeter on the ruler becomes equivalent to 1 degree of angular separation between the two point or stars (i.e., 1 cm = 1°). The trainees were able to understand why it is not possible to measure distances in the sky and instead can use angles, which can be directly and easily measured (see Figure 1).

Activity 2: In this activity, the trainees were taught to use a simplified quadrant to find the altitude (angle of elevation above the horizon) of the stars. While working in groups of two trainees - one looking through the viewfinder and the other making the readings. To make the simplified quadrant, the trainees were asked to cut a piece of cardboard of 20x12 cm into the

Figure 2: Using the Quadrant during NASE course in Tanzania.

shape shown in the diagram below using a scissor or a cutter. A piece of string of 25 cm length and a stone (or any heavy object) knotted at the end of the string. A prepared photocopy of the angle scale on a quadrant was pasted on the cardboard and two round hooks were fixed on the upper edge. A high object or a star can be viewed from the back end of the quadrant and aligned to be seen through the both hooks so that the position of the string on the quadrant indicates the altitude (angle) above the horizon. Once again trainees were impressed that heights of trees could be measured using the quadrant and by applying trigonometry using the distance to the tree (see Figure 2).

Activity 3: In this activity a simple spectroscope was constructed to display the spectrum of sunlight. In making the spectroscope, the trainees were asked to paint the inside of a matchbox with black marker, then to cut a piece of CD (1/8 of CD) and paste this on the inside bottom of the matchbox (with the recorded side of CD facing up) and make a hole on the other side of the matchbox. Each trainee was asked to use the spectroscope with the sun or the lights of the classroom and hold the open end of the matchbox towards the Sun or the lights and view the image of the spectrum formed through the hole made on the other side of the matchbox. Trainees were amazed that a spectrum could be seen so easily using such an easy construction.

In this view, all these instruments and activities are practical and have been applied in the classroom during the NASE Trainings for primary and secondary teachers in Tanzania. It is expected that the teachers who participated can train their students at their respective schools to make their own instruments and organize instruments in an easy-to-use briefcase. With these activities, students will gain confidence in their measurements, take responsibility for their own instruments, develop their creativity and manual skills, understand the importance of systematic data collection, facilitate their understanding of more sophisticated instruments and recognize the importance of observation with the unaided eye, both in history and today.

References: Rosa M Ros (2019) Young Astronomers Briefcase, NASE publications, http://sac.csic.es/astrosecundaria/en/cursos/formato/materiales/conferencias/T4_en.pdf.

POSTER CONTRIBUTIONS

Lessons Learnt from e-Amanar Online Teacher Training through WhatsApp for Sahrawi Refugee Teachers

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

Collaborators: Sandra Benítez Herrera and Nayra Rodriguez Eugenio (Instituto de Astrofísica de Canarias), Andrea Rodriguez Antón (Instituto de Ciencias del Patrimonio - CSIC), Fabio del Sordo (Institute of Astrophysics - FORTH), Diego Torres Machado (Brazilian Center for Research in Physics), Eduardo Monfardini Penteado (IAU OAE), Mayte Vasquez (EUMETSAT), Felipe Carrelli (Oswaldo Cruz Foundation), Demetrio Rodrigues (Independent Filmmaker), Alba Fernández-Barral (Cherenkov Telescope Array Observatory), and Sarah Massalkhi (IFF-CSIC)

The e-Amanar pilot provided follow-up capacity building for teachers involved in the 2019 Amanar project at the Sahrawi Refugee camps in Tindouf, Algeria, through their phones via WhatsApp that is efficient to slow internet connection environments. e-Amanar responded to challenges raised by the COVID-19 pandemic in 2020 such as the closure of non-essential humanitarian actions at the camps affecting teachers' continuous education. By providing mobile internet data to 17 teachers we organised a 4-month training using audios, texts and slide images to foster discussion about the universe. The pilot resulted in a very successful asset for the continuous connection with teachers and thus supporting Amanar's long-term goals. In the talk, we will present the pilot's outcomes and lessons learnt.

Poster link: https://youtu.be/vlsRz4Wvs9c

In this summary, we present outcomes of the e-Amanar pilot that provided online capacity building to Sahrawi refugee teachers through the WhatsApp platform. The Amanar project [1] is an outreach initiative from GalileoMobile [2] that supports the long-standing refugees of Western Sahara. The Sahrawi refugee situation is one of the most protracted in the world, with refugees living in camps near Tindouf, Algeria, since 1975. Access to basic resources is very limited and UN agencies have identified urgent humanitarian needs [3]. In 2019, Amanar organised a summer program in the Canary Islands (Spain) with Sahrawi children spending the summer with host families there as well as activities in the camps, with 635 children, 66 teachers and 150 people from the general public participating in the project activities [1].

e-Amanar pilot: Amanar responded to the challenges raised in the Sahrawi camps by the COVID-19 pandemic in 2020, such as the closure of non-essential humanitarian actions affecting teachers' continuous education. Thanks to an IAU OAD grant, we organised the e-Amanar

4-month training pilot and provided mobile internet data to the 17 participating teachers. The platform used for the training was WhatsApp, which different educational initiatives have shown benefits as a platform to be used for educational activities in slow internet connection environments [4], including refugee context [5].

To make sure the content was relevant for them, the Sahrawi teachers picked the astronomical topics of the four modules of the training. For each module we relied only on audios, texts, and slide-images, producing all audios and texts in Hassaniya and Spanish. The implementation of each module was done through a 2-week period for teachers to go over materials at their own pace and to foster discussions. During the first week, we presented the theoretical background and in the second week we focused on how to introduce the topic in the classroom using as reference the GalileoMobile handbook of activities [6]. A typical day consisted of us sharing a couple of audios with 3-5 minutes duration, images, and short-texts along with them that would take the teachers 10-15 minutes to go over. We also started discussions and someone from the team was always around the chat to answer any questions.

Preliminary Lessons learnt: At the moment, we are still evaluating the impact of the pilot and here are some brief preliminary impressions: 1) Having a script for implementation of the modules was quite useful, but it was also important to be flexible and react to teachers feedback; 2) We found that it was also important to give some time between modules, for them to not be overwhelmed and to interact as well with topics outside astronomy to engage with them better; 3) Teachers were quite keen on asking questions about general topics in astronomy; 4) They were more eager to participate in discussions about the theoretical backgrounds than the implementation in the classroom. Once the evaluation of the project is completed, we will make the required adjustments to the methodology and materials to continue working remotely with more teachers in 2022-2023 [7].

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Bringing Astronomy to the Students and Teachers using "AppStronomy"

Presenter: Rupesh Labade, Inter-University Centre for Astronomy and Astrophysics, Pune, India

Nowadays we can see the evolution of science and technology worldwide. However, teachers and students in many developing countries are not fully aware of it. Also, they should know how to use this technology in the learning and teaching process. So in this poster I want to share my practices with all of them. I have done some low-cost experiments with mobile applications and used them in teaching and learning astronomy. We basically call it "AppStronomy". They proved to be effective during the COVID-19 pandemic, when students were away from their school laboratories and were missing their regular experimentation. We found these applications to be useful for students as well as for teachers to engage them in quality experimentation at home. Using these low-cost experiments they can better understand basic concepts in astronomy. These experiments are cost-effective and easy to make. We did several experiments using these applications and got good observations.

Poster link: https://astro4edu.org/siw/p54

The basic idea behind the concept of "AppStronomy" was to help students perform basic science experiments at home to better understand the scientific concepts that they learn in school. Low-cost experiments using mobile phone sensors can be easily performed to understand concepts such as light intensity, spectrum, magnetism, electricity, motion, acceleration, gyroscopes, sound intensity, frequency, Doppler effect, SONAR, and many more.

To get better and precise results using mobile applications, the sensors need to be calibrated and it is also important to understand how one can reduce manual errors. For this project I have used the following freely available mobile phone applications: Arduino Science Journal (Google LLC, https://science-journal.arduino.cc/), Phyphox (RWTH Aachen University, https://phyphox.org/), PhET Simulations(University of Colorado Boulder, https://phet.colorado.edu/), Zero Shadow Day by Alok Mandavgane (https://astron-soc.in/outreach/activities/zero-shadow-day/), and Stellarium (https://stellarium.org/).

Sky Exploration Festival, a Different Experience for Students

Presenter: Hassan Baghbani, Iranian Teachers Astronomy Union, Iran

Sky exploration festival is a time to objectify the science of astronomy Iranian Teachers Astronomy Union (ITAU) created this festival in 2013, which has since involved thousands of students. During this festival groups of students camp in nature and spend a day with astronomy leaders. They connect to astronomy combined with geology, biology, literature, art, hiking and sports. The most important and interesting point about this festival is that all of work, management and teaching are done by other students who have learned and experienced it before.

Poster link: https://astro4edu.org/siw/p79

The Sky exploration festival includes astronomy and environmental training. Tenting, observing the sun, photo galleries, info-graphics, making astronomical instruments, working with telescopes, observing planets and the Moon, bird-watching are among the most important parts of the festival. Over the last six years, 6350 students have participated, of which more than 5,500 were girls (see Figure 1). Each team consists of 4 or 5 students and they receive scientific projects every November. Student groups get five months to complete these projects in their school or village/city. Methods and structure of the sky exploration festival can be used now by all of the countries and schools around the world.

The best way to learn is to teach. In Kavoshgaran Festival, all the components of the program are performed by the students themselves (see Figure 2). This method has caused students to read the materials in such a deep way that they can teach, so they have the highest learning efficiency. On the other hand, some students who participate in the festival, try to participate again as a leader in the coming years. In order to gain such an honor, they can also gain the experience of a teacher, while they are students. This method is a kind of talent that has helped to discover more talents than today. Mehr Observatory and ITAU are run by the same talents and have been very successful. This method has also helped to carry out all activities with honor, which has been a great help in reducing the cost of the program.

They need to understand nature: These days the contact of children with nature and the planet is so limited that many students do not understand the connection between the excitement of spending a night in a tent. A night with classmates in nature and inside a tent is a sweet experience, held at the Sky Explorers Festival, which received the highest score by the participants. Also, the environmental problems that are increasing year by year on our planet is a serious danger and shows that we are performing poorly in implementing the geographical lessons, and when we correct this method. And in this case, a part of the geography lesson is to go to nature and touch it.

Figure 1: The girls at the festival.

Figure 2: Kavoshgaran Festival.

Finally, students understand being away from home for a day, and have the opportunity to find their own needs independently of the parents and it helps to better appreciate their parents.

Media highlights: https://mond.ir/module/news/21470, http://mond.ir/module/news/41407/.

Development of a Solar Demonstrator Projected in the Classroom Modified from the NASE Demonstrator

Presenter: Akihiko Tomita, Wakayama University, Japan

The diurnal motion and the different movements of the Sun throughout the year, which are studied in elementary school, are things that can be observed in daily life, but are not easy for students to understand. The teacher training program, NASE, has developed an excellent teaching material called the solar demonstrator, that can be easily constructed. By attaching a flashlight to the arm of the NASE solar demonstrator and projecting it onto the ceiling and walls of the class room, an elementary school teacher Yumine was able to show the movement of the Sun to the students in the entire classroom. The students and their teacher were able to observe and enjoy the movement of the virtual Sun throughout the classroom.

Poster link: https://youtu.be/W8CxTawqHXs

The teacher training program, NASE, has developed an excellent teaching material called the solar demonstrator, a paper-craft tool for explaining the movement of the Sun, that can be easily constructed. The teacher, Yumine, originally practiced projecting a simulated Sun on the walls and ceiling of the classroom by attaching a flashlight to an equatorial mount for the telescope. This is a very good teaching tool, but an equatorial mount is a rather large piece of equipment. It is also a specialized piece of equipment for children. He then used the NASE solar demonstrator as an equatorial mount specialized for the movement of the Sun, which led to the development of this new teaching material.

The students, along with the teachers, could observe the simulated movement of the Sun depending on the season throughout the classroom. The feedback from students was very positive; "The locations of sunrise and sunset are different depending on the season." "In summer, the days are certainly longer. I was able to confirm this once again." "In winter, the altitude of the Sun is so low. Also, the Sun's rays are at an angle, so in winter, the sunshine comes through the windows well." "In summer, near the time of sunrise and sunset, the northern wall is also exposed to sunlight."

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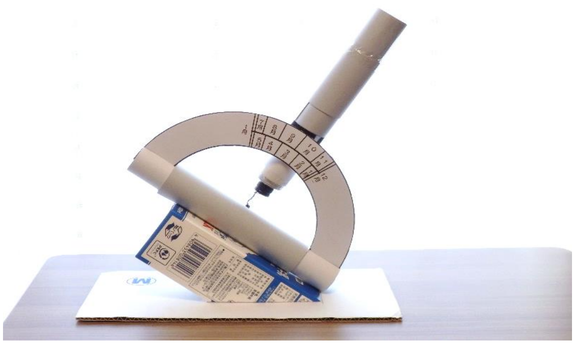

Figure 1: The newly devised solar demonstrator based on the NASE solar demonstrator. A bright flashlight, the model Sun, is attached to the arm which indicates the meridian in the sky. This photo shows an example of a latitude of 35 degrees north in Japan.

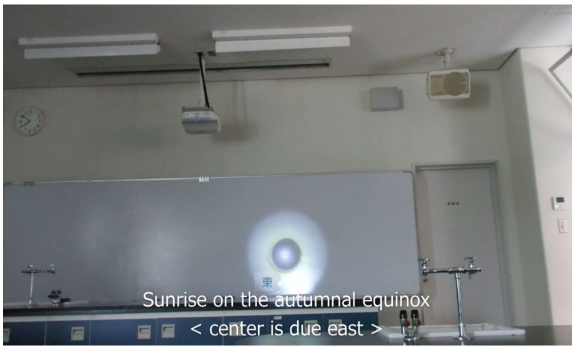

Figure 2: The diurnal motion of the model Sun projected from the flashlight on the wall and ceiling of the classroom is simulated by the motion of the arm. The photo shows the sunrise on the autumnal equinox day when the Sun rises from due east.

Impression of Astronomy in Persian Culture and History Inspired by Poems of Khayam and Attar

Presenter: Mahdi Rokni, Astronomy instructor at SINA, Iran

Collaborators: Fatemeh Abdoust, Maryam Hadizadeh, Melika Gonbadi, Reyhane Johari and Jalil Allahkhani Topkanloo (Iranian Teachers Astronomical Union (ITAU) members)

There is a huge connection between science, nature and literature with Persian culture in Iran. If you look into Iran's history and search in many places or read Persian poems you can find a lots of astronomy knowledge. Some of Iranian great poets have been also astronomers such as Khayam or they became mystics like Attar Nishaburi. This is about stories and people who lived in different ages or lived at the same age together and they have had a huge impression on Persian culture. it can also separate science, literature and mysticism from each other.

Poster link: https://astro4edu.org/siw/p57

Ghias al-Din Abu al-Fatah Omar ibn Ibrahim Khayyam Neyshabouri (Omar Khayyam) was a persian polymath, mathematician, astronomer, philosopher, and poet. In this study we review his personal life and achievements, relation between his poetry and astronomy. We also study

The Mausoleum of Omar Khayyam is a modern monument of white marble erected over Omar Khayyam's tomb located in Omar Khayyam Square, Nishapur.

Rubáiyát of Omar Khayyám is the title that Edward FitzGerald gave to his 1859 translation from Persian to English.

the architecture of his tomb. Omar Khayyam (1048-1131) was born in Zebar-khan in Mamorie village south of Ghadamgah- Neyshabur. He was skilled in politics, mathematics, philosophy, theology, mysticism, astronomy and literature.

Omar Khayyam knew the science of trigonometry and created Khayyam triangle, also known as Pascal triangle. He used the sphere and poles of Earth created by Abu-Ali Sina and the book "Remaining Signs of Past Centuries" by Abu-Rayhan al-Biruni to design Jalali calendar and also measured the length of a year 365 days and 5 hours and 48 minutes and 46 seconds; his calendar was precise; just 1 second every 30 years.

Omar Khayyam was a disciple of Abu-Ali Sina who was a disciple of Aristotle and Plato. Plato believed in idealism and rejected evidence of negation of God according to rationalism. Omar Khayyam not only believed that God is the creature of the whole universe but also believed in the power of nature in human destiny; He was a naturalist.

As Omar Khayyam was a disciple of Abu-Ali Sina and his philosophy stressed the impermanence of the world so he insisted on being happy. As he was an astronomer, astronomy had a huge influence on his poetry. Omar Khayyam's tomb was first built by order of Reza-Shah in 1934; 29 years later Hushang Seyhun, a very famous and experienced architect designed a new tomb for Omar Khayyam which was based on his thoughts. His tomb has a tower with a height of 32 meters with 10 bases which are represented by two-digit numbers. The court symbolizes the sun from the inside and the wine cup from the outside.

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Discussion summary

We thank everyone for the lively discussion following this session. Below we summarize some of the questions and answers.

Tan Hoe Teck was asked about the time it takes to build the planetarium. He answered that although the research paper is available, it is challenging to obtain all the parts simultaneously, and mistakes can happen. Generally, it took about 6 months, wherein each month, one session of 6 hours was carried out. He was also asked how the students have the time to do all this work? He clarified that the students spend their after-exam period to build this planetarium, as an extracurricular activity. About 50 members of the Astronomy Club were involved in the planning and construction.

Song In-Ok was asked how the content of the NASE course/workshop was evaluated effectively. She answered when the contents are new approaches, it inspires teachers a lot and that NASE has many creative approaches with low-tech. Song In-Ok was also asked how one can apply these activities into the school curriculum. She mentioned that it might not be in the school curriculum but that NASE programs are developed to fit into the content of classes and can for example, be used as demonstrations in the classroom. She was also asked about the certification in Astronomy in Korea and she clarified that teachers can have their certificate in the department of education of Earth-science. The final comment was that more NASE courses should be locally conducted so the benefit of its low-tech approach can also be seen by the governments.

Breezy Ocaña elaborated on the point that "low-tech does not mean low comprehension". Astronomy is a science that depends on technology, this might give the impression that if we do not have the technology we cannot teach "good astronomy". This is far from reality, including a low-tech approach is beneficial. It takes the student back to the basics allowing a deeper understanding, a more hands-on approach and they are the protagonists of their own learning process. This can also be seen in the result of the survey we carried out. Breezy was also asked if apart from the overall technology exposition, the socioeconomics were similar in the two cases in the Dominican Republic and the USA. She responded that for most of the teachers the reality was very different, with less access to education, information and of course, technology.

Beatriz García was told that using a rubber band to illustrate the expansion of the universe is very clever and thanked for sharing the idea. This experiment is an analogy rather than a "proof". Also, with analogies, we need to be very cautious and aware of their limitations. Do you explain those to your students? She clarified that yes, we can consider the experiment an analogy, the universe is not a rubber band, but the result is the same. You need to show without any doubt that the galaxies are driven apart by the expansion. Some demonstrations are not easy in the classroom, you need a model and to explain how to verify the model.

Beatriz García was asked about accounting for local cultures in the NASE workshops. She responded that in principle, the most important thing is that the NASE courses are given in the local language, this fact not only includes the translation from the original texts but also to adapt the language to each community. There is a complete workshop about Cultural Astronomy, and the content may change for each country. Please visit `www.naseprogram.org`.

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