INTERNATIONAL SYMPOSIUM ON ASTRONOMY AND ASTROBIOLOGY EDUCATION:

theory, methods, impacts and future directions

IAU ISE2A EUROPEAN ASTROBIOLOGY CAMPUS EAC

July 3-7th 2017 - Utrecht, Netherlands

KONINKLIJKE NEDERLANDSE AKADEMIE VAN WETENSCHAPPEN

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SKALNATÉ PLESO

Welcome

This international symposium, co-sponsored by the International Astronomical Union (IAU) and the European Astrobiology Campus, is designed to bring education research in astronomy in general, and in astrobiology in particular, to the professional scientific community.

Education has always played a large role in the field of astrobiology and in part this workshop is a follow-up to the successful International Workshop on Education in Astrobiology (IWEA) held in Höör, Sweden, in 2013. On the other hand, education research has seldom been the main subject in IAU events, yet the scientific results from this field have a great potential to improve the teaching and learning of astronomy for students of all ages. New results and research methodologies from the cognitive and learning sciences domains can, however, be of large influence on the work of educators but generally, professional astronomers are not fully aware of the results from astronomy education research.

With this first meeting in astronomy education and in combination with the growing subdiscipline astrobiology, we aim to strengthen both fields through cross teaching collaborations. The symposium is designed specifically to expand awareness of the results of the cognitive and learning sciences, as well as to provide a forum for active scholars in astronomy and astrobiology education.

Inge Loes ten Kate (chair LOC)
Beatriz Garcia (co-chair SOC)
Muriel Gargaud (co-chair SOC)

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Jaakko Lamminpää (Finland), University of Turku

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Chair: Wolf Geppert, Inge Loes ten Kate

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Chair: Inge Loes ten Kate

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Thinking big in a small country – astronomy outreach and education in the Netherlands

Marieke Baan
Netherlands Research School for Astronomy (NOVA)/NOVA Information Center, University of Amsterdam, the Netherlands

As a small country, the Netherlands has managed to create an excellent outreach and education program in astronomy, by a coordinated approach via the Netherlands Research School for Astronomy, NOVA. NOVA is the alliance of the astronomical institutes of the universities of Amsterdam, Groningen, Leiden, and Nijmegen. NOVA's mission is to carry out frontline astronomical research in the Netherlands, to train young astronomers at the highest international levels, and to share their new discoveries with society. With a small team of three very experienced people (two former journalists and one teacher) and some 10 freelancers the NOVA Information Center communicates scientific results of national/international importance to the press and the general public, runs three mobile planetariums for schools and public events, develops educational materials, and collaborates with educational publishers in producing textbooks for secondary schools. The NOVA Information Center (NIC) uses a mix of channels to realize their ambitions and has developed into an expertise center, for schools, the press and for the general public. In this talk I want to focus on the benefits of our coordinated approach, and our strategy to emphasis mainly on high impact projects and activities in engaging our target groups.

Other stars, other planets

Emanuele Balboni, Simona Romaniello, Marco Brusa
Infinito – Planetarium of Turin, Museum of Astronomy and Space

"Other stars, other planets" is a planetarium show, completely produced by the education Staff of Infinito - Planetarium of Turin, Museum of Astronomy and Space. The search for extrasolar planets is a new frontier of scientific research, a fascinating challenge that combines interdisciplinary topics such as astronomy, biology, climatology, geology etc... It represents the daring search to find signs of extraterrestrial life, from the simplest to the most complex and evolved forms, with the mission to answer the question: are we alone in the Universe? Using the immersive and three-dimensional reality of a digital Planetarium, one can travel toward newly discovered planetary systems and observe their 360 distribution in the Cosmos. In this operational mode the Planetarium is a powerful educational instrument, since it allows to develop and understand a three-dimensional map of planets in the Galaxy and to evaluate their distances in relation to the size of the Milky Way. More than still images or simple videos, the Planetarium is a helpful and strategic tool to facilitate the difficulties in understanding abstract concepts such as position, distance and size in the Universe. The show represents an creative way to explain the methods to detect exoplanets and to illustrate how and where the current missions devoted to this research operate on Earth and in space.

"How do we know planets are common?": a coherent content storyline for exoplanets

Daniel Barringer[1], Chris Palma[2] Julia Plummer[1]
[1]*Department of Curriculum and Instruction, Penn State*
[2]*Department of Astronomy Astrophysics, Penn State*

We detail the design and development of a new astronomy course, ASTRO 850, on exoplanets to be offered through Penn State's online M.Ed. in Earth Science degree program. ASTRO 850 is designed around a coherent content storyline (Roth et al., 2014), and will engage pre-service teachers in project-based learning through activities designed using the Claims, Evidence, Reasoning framework (McNeill Krajcik, 2012). The course theme will be exploring the abundance and diversity of exoplanet systems in order to show how these objects have forced us to reconsider some ideas in our model for the formation of the Solar System. Because the course is designed to give high school teachers lessons and activities that they can use in their own classes, it is particularly important that our lesson design meets the latest iteration of United States' state science standards (NGSS Lead States, 2013). This presentation will focus on the development of the curriculum with a coherent content storyline, with a particular emphasis on how the storyline contributes to the lesson planning and design. Course materials will be made available through Penn State's open courseware initiative and will be promoted to teachers throughout PA through the Pennsylvania Earth Science Teachers' Association (PAESTA).

Adapting astronomy labs for the visually impaired

Allyson Bieryla[1], Wanda Diaz-Merced[2]
[1]*Harvard University*
[2]*Office of Astronomy for Development, South African Astronomical Observatory*

Harvard University's astronomy lab is equipped with a heliostat for observing the sun and a 0.4-meter DFM telescope both of which are dedicated to teaching undergraduate lab courses. We are working to adapt the methods used to collect and analyze data to accommodate students with a visual impairment. Using sound and thermoform printing technology, we have begun to adapt our labs so that students with a visual impairment can participate in data collection and data analysis at the same time as other students in the class. This is an important part of the learning process and it allows for collaboration and discussion between students. Some of the tools that we have used include: sonification, arduino technology, and 3D and thermoform printing. We present the tools and methods developed for our labs.

Traces of life

Stefano Boccardi, Marco Brusa, Simona Romaniello
Infinito – Planetarium of Turin, Museum of Astronomy and Space

Some of the most exciting questions in Science are: "What LIFE is? How LIFE is originated on the Earth? Is there LIFE in other planets? In the last decades we discovered a huge amount of extrasolar planets. Even though we can't still see them directly, we can know the main characteristics of the entire system. Some of those planets are hostile worlds but others could be similar to our Earth. In the "Traces of life" lab , five teams of students come face to face with five extrasolar system models. Distances, size of the planets and the spectral class of the stars are already modelled. Teams have to find out what kind of measures are usefull to distinguish rocky planets from gas planets and understand which rocky planets are in the so called" Habitable Zone". They can collect data with simple tools such as rulers, thermometers and solar panels. In the end, if they find the "right" planets, they can collect and analise the biological data from the planet surface with a microscope, looking for the presence of extremophiles.

The impact of teaching computational astronomy on the development of students' computer skills

A. L. Boldea [1,2]
[1] *National Institute for Nuclear Physics and Engineering, Bucharest, Magurele, Romania,*
[2] *University of Craiova, Craiova, Romania*

Some blended methods of teaching-learning were successfully used for teaching the astronomy and astrometry of asteroids to students in their final years of Computer Sciences at University of Craiova, using real astronomical data about celestial objects from our Solar System, data obtained from the Astronomical Observatory Isaac Newton (La Palma, Spain). The students was asked to develop some small scripts in order to facilitate the detection and the analyze of the data for new discovered asteroids, request that improved their capacities to understand and apply various modern concepts of Computer Graphics, Data Base and Web design. This approach to learning brings new challenges and new opportunities for the process of profes-sional training of Computer Sciences students and proved good result at very short term, the students acquir-ing very fast the necessary skills to approach the modern research area of computational astronomy.

Keywords: Blended learning, Computational methods in astronomy
PACS: 01.40.gb, 95.10.Jk, 95.75.Mn

4-year astrobiology teaching experience in an astronomy department

Zeynep Bozkurt
Ege University, Turkey

Astrobiology is a multidisciplinary field related with the sciences of astronomy, chemistry, biology and geology. An optional Astrobiology course has been teaching in Astronomy department of Ege University (Turkey) since 2013. The main objectives of this introductory course to introduce and familiarize the astronomy students to the fundamentals of astrobiology. In this study 4-year teaching experience of Astrobiology course has been examined. Course objectives, teaching methods, learning activities and evaluation methods were discussed. To evaluate the students' learning experiences and knowledge gains anonymous surveys and knowledge assessments were used. Furthermore, additional surveys were made to understand the interests and tendencies of the student chosing this optional course.

Eight years after IYA2009: a project on astronomy education and its impact on selected countryside towns in Mexico

H. Bravo-Alfaro, C. A. Caretta, F. Macias, E. M. Brito, P. Campos
Universidad de Guanajuato, Mexico

We present the highlights of a multidisciplinary project, triggered by the International Year of Astronomy (IAU-UNESCO, 2009), including astronomers, sociologists and environment biologists. This work was initially focused on children and young students living in rural zones of the Mexican State of Guanajuato. This region presents one of the highest rates of people migration towards the USA. Shortly after IYA2009, the goals of this project were enlarged, having important results on different aspects like social development, environment recovering and education. Astronomy plays a central role within this project, mainly through activities like stargazing, workshops, science courses for teachers, and conferences.

Astronomy education research: impact and future directions

Paulo S. Bretones
DME/UFSCar

The goal of this talk is to reflect about the achievements and challenges Astronomy Education Research (AER) up to the moment. Initially the answers given to simple questions asked for members of IAU CC1 and WG on Theory and Methods in Astronomy Education are discussed. The answers are briefly given as follows: about the achievements and impacts of AER in the last decades, effective techniques for teaching astronomy; construction of a variety of concept knowledge inventories; strategies for alternative conceptions assessment and development of classroom techniques to overcome them; development and evaluation of active learning, creation of journals, publications of theses dissertations, conference proceedings and journal articles are addressed. About the challenges of AER for the next decades, deeper treatments dealing with epistemological questions; increasing the methodological rigor; development of models to connect new technologies in a variety of contexts and instruments to probe student attitudes; astronomy to improve science education and to know links with other branches of culture; investigate the roots of astronomy in each nation because of the multiculturalism are discussed to improve the situation of AER. Next, the goals of astronomy teaching are discussed considering contents, methods, levels, resources and purposes. Given the demands and complexity of education today and the role of astronomy in this context, the potential of education research is also evaluated, taking into account knowledge, practices, policies and the training of teachers. Finally, graduate studies are encouraged, new lines of research, and surveys to identify and advertise the dispersed AE literature seeking to raise the visibility of authors and institutions suggested. Much of the work already performed remains unknown by astronomers, because the latter may belong to a different area of theoretical and methodological framework, and because it occurs in specific different contexts of production, culture, curriculum, materials and application. Moreover, advertising AER in universities and schools to professors and teachers should consolidate this community and establish links between astronomers and educators in general, allowing future collaborations.

Travelling butterflies

Néstor Camino
Complejo Plaza del Cielo– CONICET-FHCS UNPSJB Esquel, Patagonia, Argentina

An speculation is presented about life span of different species, here on Earth and in the galaxy as well, and the possibility for each one to travel in spacetime, with the natural and artificial resources at their disposal at present (not science fiction). At least two important questions arise: Why should it be possible for human species to travel through astronomical distances and times?, Wouldn't it be another anthropocentric way of worldview, this time for the whole universe and living beings in it? Some comments about reactions of children and general public to this speculation will be discussed.

The Astrobiology Academy: four years of resource development for primary and secondary schools

Rosemary Cane, Charles Cockell, Liam Perera
UK Centre for Astrobiology, University of Edinburgh

The Astrobiology Academy, now in its 5th year, is an exciting initiative to introduce teachers and trainee teachers to astrobiology and develop curriculum-based lesson plans. As a very interdisciplinary science, we recognise that astrobiology poses some of the most fascinating questions within many areas of science that can be used to teach fundamental curriculum concepts in schools. The Astrobiology Academy runs three main programmes. The first is an annual short duration Continuing Professional Development (CPD) course, which in 2017 will run from July 10-12th. This introduces attendees to our range of lesson plans and Astrobiology in a Box educational resource; containing the equipment and lesson plans necessary for hands-on classroom activities such as investigating extremophiles and exploring the limits of life. The second programme consists of one primary and one secondary CPD event in collaboration with the National Space Centre. This day-long initiative is designed to introduce teachers to astrobiology in the classroom and collaborate ideas to create additional lesson plans and activities. The third programme is Life Beyond, a course focused on taking astrobiology into the prison environment. Following a successful trial with several Scottish prisons, the programme is now being taken on as a full 4-week course with the aim of designing a settlement on Mars. The programme has already played a part in providing relevant educational books to prisons across Scotland and is looking to further improve science education in prisons. In conclusion, the Astrobiology Academy is looking to inspire people from all backgrounds with this exciting, cutting-edge science and focus on the link between astrobiology and curriculum as a principal method to create new lesson plans and activities for schools across the UK.

Evaluation research using astronomy theatre suggests good promise for young hispanic women to choose science majors

Christopher J. Corbally[1], Margaret Boone Rappaport[2]
[1] *Vatican Observatory, University of Arizona*
[2] *The Human Sentience Project, LLC*

NRC's 2010 Decadal Survey emphasizes the social utility of astronomy. There is also an advantage of knowing colleagues well because the astronomy workforce worldwide is not large. These two factors may help to correct the manpower problem of low percentages of females and Hispanics in the fields of astronomy and astrobiology. Our goal was to evaluate a new form of interactive medium to interest young adults in astronomy and astrobiology. The authors' book publishes a dozen theatre packages that introduce astronomy concepts in five-minute scripts featuring players in working scientist roles. The efficacy of instructional packages was evaluated at a private high school in Arizona, in a 100As expected, a substantial proportion of students were interested in science-math, but unexpectedly, equally for males and females. A large percentage self-identifying as "humanities" or "science-math" students showed interest in BOTH. We suspected there might be "crossover" opportunities especially for young Hispanic women who self-identified as "humanities" students. This proved true, with a surprising result: The jump in interest among females skewed their remembrances of previous attitudes toward science! Recall of PAST feelings were MORE negative as the morning of astronomy theatre progressed. Current attitudes were so improved that past attitudes seemed comparatively worse. To summarize, seventy-three percent of seniors showed an interest in a science-math major or career, after exposure to performances of three astronomy theatre scripts (all on supernovae in 1054, 2054, and 3054 AD). A series of data at four time points was collected. Of note were: (1) broad overlap in self-identified interests in science-math and humanities, for both sexes, (2) upswing in interest and affectedness of "mainly humanities" responders, in science-math, and (3) general openness to change from humanities to science, as suggested elsewhere (Mervis 2014). Presenters will demonstrate an astrobiology theatrical script, time permitting.

The sky observation in Brazilian textbooks

Gleice Kelen Dornelles Costa[1], Cristina Leite[2]
[1]*Inter-unities Postgraduate Program in Science Teaching, University of São Paulo,*
[2]*Inter-unities Postgraduate Program in Science, University of São Paulo Teaching*

The activity to observe the sky dates back to the antiquity and its presence in the basic education is defended by distinguished researchers. However, the activity of direct sky requires time (duration and timetables), and space (open skies and outside of the classroom), which differentiates from the traditional school setting, and also favourable climatic conditions for such. To determine the nature of the proposed activities, nine collections of text science books were analyzed, approved by the Brazilian Government and distributed (no cost) to the Brazilian public school system, which reaches more than 10 million of students. The category of analyses was constructed from the central elements, which involved a construction of the sky activities, classroom teaching (prior knowledge, discussion of data, and monitoring of the activities) until the specific characteristics of activity observation occurred (type of observation, record usage, references, calculations, star observations, time and duration). The analysis has led to the understanding that most collections have at least one proposal. Although, the collections are set in short time periods, hindering the perception of the cyclic phenomena. In addition, the activities that were conducted outside the school setting hindered the participation of the teacher in loco requiring greater detailing of the student's proposal and autonomy. It was also noted that the period of pre-observation where the student could experience his conceptions or expectations were practically nonexistent disregarding his experience with the sky. Moreover, the same occurred during post observation in which it would allow for the evaluation of the activity, possible difficulties faced or further deepening of the content, in addition to establishing a relationship with the expectations or perceptions that the pupil has had before the activity.

Data driven astronomy education and public outreach

Chenzhou Cui
National Astronomical Observatories, Chinese Academy of Sciences

With the development of many mega-science astronomical projects, for example CTA, DESI, EUCLID, FAST, GAIA, JWST, LAMOST, LSST, SDSS, SKA, and large scale simulations, astronomy has become a Big Data science. Astronomical data is not only necessary resource for scientific research, but also very valuable resource for education and public outreach (EPO), especially in the era of Internet and Cloud Computing. IAU Inter-Commission B2-C1-C2 WG Data Driven Astronomy Education and Public Outreach (DAEPO) is hosted at the IAU Division B (Facilities, Technologies and Data Science) Commission B2 (Data and Documentation), and organized jointly with Commission C1 (Astronomy Education and Development), Commission C2 (Communicating Astronomy with the Public), Office of Astronomy for Development (OAD), Office for Astronomy Outreach (OAO) and several other non IAU communities, including IVOA Education Interest Group, American Astronomical Society Worldwide Telescope Advisory Board, Zooniverse project. The working group has the major objectives to: Act as a forum to discuss the value of astronomy data in EPO, the advantages and benefits of data driven EPO, and the challenges facing to data driven EPO; Provide guidelines, curriculums, data resources, tools, and e-infrastructure for data driven EPO; Provide best practices of data driven EPO. In the paper, backgrounds, current status and working plans in the future are introduced.

Astronomy and science education in intercultural education contexts

Flávia Cristina de Mello
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This presentation intends to approach experiences of astronomy and science education in intercultural contexts, reporting on the activities of education indigenous teachers to teach science in the indigenous schools in which they work. These activities, linked to the Astronomical Observatory of the State University of Santa Cruz (UESC), belong to research field called "Cultural Astronomy". They are developed in the indigenous schools of the southern region of the state of Bahia, Brazil, in between the ethnic groups Tupinambá, Pataxó Hahahae and Pankaru indians peoples. Understanding that astronomy is a science that brings countless and fruitful elements to work in intercultural contexts, astronomy education to indigenous teachers allows us to address the challenges and wealth of teaching astronomy and science to students who bring many different cultural understandings about nature and its phenomena, the heavenly stars and their importance for daily life in the indigenous villages. The concepts of cosmology and cosmogony are worked to deal with the diversity of ways of thinking the sky, celestial bodies and the universe for each culture. The analytical yield of these concepts helps to think about cultural contexts of contemporary indigenous peoples and to support reflections on American cultural systems of pre-colonial peoples, addressed by archaeoastronomy, such as the Mayan, Aztec and Inca peoples, for example, considering that there are cosmological elements that are transcontinental, such as the importance of major gods, Sun and Moon, for example. And to note that there is a relevant temporal continuity in the way of thinking of celestial bodies, natural phenomena, solar and lunar calendars and their interference in social, agricultural, hunting calendars, among other things (if we think of astrobiology perspective), informs us about the sophistication of cosmology and astronomy of the american people, despite extreme cultural changes and historical-cultural innovations experienced by the native peoples of America and indicates the importance in advancing these intercultural dialogues in education.

Looking for stars, the sun and exoplanets in the educational core standards: the Spanish case

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Although Astronomy is engaging and motivating for both precollege and college students, it is often difficult to fit it within the formal educational core standards. In this work, we present an analysis of the Spanish educational curricula for primary school to look for opportunities to adapt the tools and the science behind the most notorious discoveries about the sun, the stars and the promising field of exoplanetary research. In this way, we attempt to find chances to explain concepts such as: energy, electricity, magnetism, dynamics, astronomy, data analysis, algebra, arithmetics, geometry, language and communication skills, music, cooperative working, computing, the use of new technologies and problem-based learning.

Development and validation of a learning progression of basic astronomy phenomena

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We present a Learning Progression (LP) that ties together three basic astronomical phenomena: change of seasons, solar and lunar eclipses and Moon phases. In order to design a first version of a LP for the three addressed astronomical phenomena, we developed an open questionnaire, based on previous studies, submitted to 189 students at the beginning (13-14 years old) and the end (18-19 years old) of the secondary school, and to undergraduate astrophysicists students at the University (about 10). Starting from the open questionnaire results, we design a first version of LP for each astronomical phenomenon, identifying a suitable number of levels (around 2-3) of increasing sophisticated explanations. To empirically validate the hypothesized LPs, a 48-items mixed true/false, multiple-choice questionnaire was developed. The items of this questionnaire were designed and grouped so to correspond to the LPs' levels. Students' answers to the mixed true/false, multiple-choice questionnaire were analysed using Rasch analysis providing evidence that only partially supported the initial hypothesized LPs. The single LP about the three phenomena was revised by grouping items by their difficulties, as emerged from the Rasch analysis, and new levels were revised in order to be coherent with student's achievements. This revised version of LPs seem to better describe progression of students' understanding from secondary school to graduate level. Our analysis also led to construct cluster levels of LP, which contain common features of the original singlephenomenon progress indicators, thus contributing to the development of a LP about the Celestial Motion big idea. Finally, findings support that spatial reasoning is a key cognitive factor for building an explanatory framework for the Celestial Motion big idea, and but also suggest that causal reasoning based on physics mechanisms underlying the phenomena, as light flux laws or energy transfers, may significantly impact a students' understanding.

A teaching-learning module on stellar structure and evolution

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Research in science education increasingly promotes the use of Learning Progressions (LPs) to describe and interpret how students develop their understanding of a given concept. We designed a LP, focused on "Stars" big idea and, drawing on this LP and previously literature in astronomy education results, we designed an a Teaching Module (TM) about stellar structure, functioning and evolution. From the literature, it emerges that students' difficulties in understanding stars formation and functioning are mainly related to a scarce knowledge of the underlying physics mechanisms. We identified three key ideas around which content knowledge about stars can be reconstructed: (i) mechanical and thermal equilibrium; (ii) spectral analysis; (iii) energy and nuclear reactions. Our TM activities (20 hours) was designed in order to help students to combine previously learned laws in mechanics, thermodynamics, and electromagnetism meaningfully to get a complete picture of processes that happens in stars. The TM is divided into four phases: (i) inquiry discussion to identify stellar quantities that can be measured (radius, density, chemical composition etc.) and estimation of Sun's radius (using the equation for the fundamental frequency of Sun pressure waves) and Sun's mass; (ii) spectral analysis of Sun's light to estimate its surface temperature and chemical composition; (iii) study of mechanical and thermal equilibrium (estimation of forces acting on a Sun's volume element and Sun's rotational speed); (iv) inquiry discussion on energy balance in the case of Sun and introduction of basic nuclear reactions and of the difference between chemical and nuclear reactions. The module was piloted with two classes of secondary school (N = 59 students, 17–18 years old). A questionnaire was used to evaluate the effectiveness of the proposed activities. Implications for the teaching of advanced physics topics using stars as fruitful context are briefly discussed.

Teaching about mechanical waves and sound with a tuning fork and the Sun

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Literature in Physics Education has shown that students encounter many difficulties in understanding wave propagation. Such difficulties lead to misconceptions in understanding sound and light, often used as contexts to teach wave propagation. To address these issues, we present a teaching module in which the students are engaged in computer-based activities dealing with sounds produced by a tuning fork and the Sun. The main reason underlying this choice is to show how the same measurement technique (spectral analysis) can be used to obtain information about very different phenomena. The activities was build on a formal analogy to determine the fundamental frequency of sounds emitted by the two sources (tuning fork and Sun). Using a digital audio editor, the sounds are analysed using three types of graphs: intensity versus time (waveform), intensity versus frequency (spectrum), and frequency versus time (spectrogram). The aim of the activities is to address students' alternative conceptions about the frequency and propagation of mechanical waves using a multi-representation of the same phenomenon. Examples of frequency measurements for the analysed sounds are reported, as well as paper-and-pencil tasks to determine velocity of sound in the two phenomena. Implications for the teaching of waves and sound are finally discussed.

Data exploration through the sonorization: an opportunity of multiple learning

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In general, it is thought that exploration of data of the Space Sciences is an exclusivity of the people who do not have severe cognitive, perceptual or sensorial disabilities. This has been so even after Diaz-Merced (2013) revealed that sound makes astronomy data, and scientific research using such data, accessible for blind astronomers, but also helps the traditional astronomer to increase their sensitivity to events in data that would go undetected. A set of user centered designed tools to ensure a multimodal approach to knowledge is not a prerogative or exclusive need of astronomers or certain selected groups of society.This proposal, which integrates multidisciplinary and interdisciplinary astronomers, engineers, computer specialists, software designers, educators, disability specialists, bioengineers, neurobiologists, sociologists, both blind and sighted, aims to address the following topics:1. Accessibility to astronomical data, from observations made on Earth or with instruments on board satellites (available in databases / Simbad, NASA, ESA, etc.)2. The possibility of providing access to the bibliographic databases (ADSABS, among others)3. Upgrade the prototype of multi-modal access developed by Diaz-Merced in 2013 and without new adaptations to date.4. Creation of a user centered designed computer-interface suitable for access, collection, sonification, 3D print, and analysis of astrophysical data.5. Testing in different culture environments the efficiency, utility and effectiveness of the resource.In this contribution, we present the first results related to the creation and application of the techniques and tools proposed, taking into account that this research can be scalable to different areas of the human activity in a way that people with other learning styles can have "equal opportunities". Finally, this proposal is framed into the postulates of the fundamental research towards addressing technical challengers to achieve the promised benefits of the Big Data, an strategic topic of worldwide interest.

The European Astrobiology Campus – towards a comprehensive training of astrobiology students in Europe.

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Training students in astrobiology faces several challenges but also offers unique chances. The multidisciplinarity of the field brings about differences of terminologies and confronts lecturers with the task of teaching a audi-ence with very diverse scientific backgrounds. The necessary training expertise usually is not available within a sin-gle institution or country. This is unfortunate, because teaching astrobiology would promote a holistic, deeper understanding of the scien-tific view of the world. In addition, it would enable a new generation of scientists to interact with colleagues from different fields of sciences. Thus, cooperation between institutions and lecturers across the boundaries of countries, institutions and disciplines seems the obvious way forward. Unfortunately, a European comprehensive astrobiology training programme was, for a long time, lacking. The European Astrobiology Campus (EAC) aims to amend the above-mentioned shortcoming by providing a training entity for students and early career scientists offering a cornucopia of different activities. Firstly, the EAC organized several summer schools per year at different European venues. Herein, it could build on the successs of the Nordic Network of Astrobiology [1]. These events often have included real scientific field work, and after three of them participants launched follow-up expeditions to carry on with the research on their own initiative by raising their own funding. This shows that innovative courses can lead to real research projects which, apart from their scientific merits, even train young researchers in management and leadership skills. The EAC also organised outreach activities including exhibitions on astrobiological themes (e.g. an exhibition ti-tled "The River of Time" and the "TimeTrek" path in Turku. Additional activities include summer camps for under-graduate students and a conference for early career astrobiologists. I will report about the experiences and challenges encountered with the programme offered and preset future strategies for European training in astrobiology.

Astronomy across cultures: reporting experiences on GalileoMobile education activities in the Paiter Suruí indigenous community

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This work is the report of an astronomy non-formal education expedition carried out by the GalileoMobile initiative in the Paiter Suruí indigenous communities of the Rondonia State, in the Brazilian Amazon, that took place in November 2016. This ethnic group remained "officially uncontacted" by non-natives until the late 1960's, when the population dropped significantly, being decimated by diseases and facing deep changes in their way of living and traditions. Nowadays, the Paiter are seeking ways to maintain their cultural identity and land. Thus, differently from previous GalileoMobile itinerant projects, which had the goal of bringing modern astronomy closer to youngsters of regions with little or scarce access to science outreach actions, this particular expedition had the goal of establishing an exchange of knowledge related to astronomy, promoting a dialogue with the members of this group to understand and record their relationships with the sky. The ground team, which was comprised of three astronomers, one filmmaker and one anthropologist undertook the study of various academic works on ethno and cultural astronomy, as well as specific texts on science education in traditional communities and ethnography of Brazilian indigenous peoples. During the expedition, interviews with the elder members of the Paiter were held, having as a starting point the astronomy outreach activities promoted by the astronomers such as the sky observation with telescopes. We were able to collect three myths related to the Sun, Moon and rainbow. The result of activities, interviews and transcripts yield in a series of videos that will be presented in this talk and will be returned to the community, so that they can use in schools and the community centers as educational material and for the preservation of the Paiter culture, as well as a resource for a detailed ethnographic study of their astronomy.

Online astronomy courses for formal and informal learners

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An increasing amount of formal and informal education is being delivered online. A majority of college students in the U.S. are now taking one or more courses online or flipped (video lectures online, hands-on activities or labs in the classroom). Meanwhile, massive open online classes, or MOOCs, are transforming the landscape of informal science learning. In contrast to university classes, MOOCs have low completion rates and involve "free choice" learners who are typically adults with jobs, rather than full time students. Based on several years of experience of teaching astronomy online, lessons have been learned on how to engage students in the asynchronous and "disembodied" environment. For non-science students taking an introductory astronomy course, flipped models optimize interactions by putting the lectures online and allowing classroom time to be used entirely for labs, discussion, and small group activities. Research has shown that normalized learning gains are greatest in such learner-centered classes. We have enrolled over 110,000 learners from 150 countries in two astronomy MOOCs: a Udemy course called "Astronomy: State of the Art" and a Coursera course called "Astronomy: Exploring Time and Space." The core content is video lectures, augmented by quizzes, activities, and peer writing assignments. We have a large amount of research data on learner demographics and motivations, and on the types of engagement that correlate with completing the courses. In the peer writing assignment, the learners comment on recent discoveries in astronomy. A rubric and a model answer are provided, and each person grades the writing of three other learners. Learners who complete either the first activity or the first peer writing assignment are highly engaged in online discussions and social media, and they complete the course at a rate ten times higher than average.

Science literacy, belief systems, and sources of scientific information of young adults in the United States

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The results of a 27-year survey of over 13,000 college students are presented. Science literacy was measured in a way that allows comparison with the U.S. general public and international audiences. Basic scientific knowledge of undergraduates has not improved over this time span, and it only improves by 10% over four years in college. American young adults have alarming gaps in their comprehension of basic astronomy and on a number of issues of great societal importance. Their support of the scientific enterprise is, nevertheless, very strong. Among the surprising results is the fact science literacy is weakly correlated with susceptibility to pseudoscience, superstition, and religious belief systems. Also, very little of the variance in student science literacy is accounted for by how many science courses they have taken. Students rate instructors and textbooks as the most reliable sources of scientific information, but they turn overwhelmingly for such information to often un-vetted sources on the Internet. In the context of lifelong learning, educators can help advance science literacy by writing articles and blogs, using social media, and improving the quality of crucial online sources of information like Wikipedia. The challenges of fostering a scientifically informed electorate are discussed.

Videos for astronomy education and outreach

Chris Impey and Matthew Wenger,
University of Arizona

Young people represent the "video generation," for whom video viewing has eclipsed broadcast television, and recreation and entertainment are increasingly delivered by videos over the Internet. Education is heading in the same direction, with online and flipped classes growing steadily. We have five years of experience with video-based astronomy instruction and outreach, allowing an evaluation of its efficacy with formal and informal learners. The usage patterns of over a thousand short instructional video clips are presented, along with the viewing of video lectures by 110,000 learners taking two massive open online courses (MOOCs) on astronomy. There are over 50 hours of live QA sessions posted on YouTube, and we have created a "video FAQ" web tool where a visitor can type in any astronomy question and a match is made from among over 1200 questions within 50 hours of video. We have formed a video group from a dozen students who have astronomy, filming, video and sound editing, and journalism skills. For the past year, 3-4 short videos a month have been released on themes that include: Five Fun Facts, Observatory Tours, and Einstein Out West. Upcoming series will include Student Misconception Dialogs, Scientist Profiles from the Large Binocular Telescope, and Profiles in Diversity. Lesson plans are being developed so the videos can be incorporated into introductory astronomy classes. All these resources are freely available on the Teach Astronomy web site.

Undergraduate student's understanding of moon phase change in a course for trainee teachers in compulsery education

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The authors conducted a seriesof questionnaire studiesonpreservice teachers in SY2015 and SY2016. The resultsshowthat their understandingof the Moon phase are as follows; they understandsun light shineson half of the Moon, they can explain how lunar eclipsesoccur, they may not recognize a schematic diagram of the Moon orbit as a concept model, they may not have knowledgeof a period of the Moon model experiment of change of the Moon phase would not improve understanding in science classes. In short, inadequate study in science classes at elementary and/or junior high schools might cause less achievements in understanding of change of the Moon phase. After the questionnaire analysis, the authors conducted two classes for the students divided in two groups.Aim of these classes is to find better way to reduce the number of students withmis-conceptionsrelated to Moon phase change. To make deep knowledge of the Moon phase change, one class carried out practical work utilizing the conceptual model kits and another class performed the work utilizing scale sizemodel kits. Applying Fisher's exact testwas used to comparethe proportion of students having mis-conceptionsin the pre-surveywithpost-surveyand was found to be significantlylower (p=0.0085) after the class utilizing the scale model kits. Finally, we foundthat the scale size model kits canreducethenumber of students who believe Moon phase change occursdue to lunar eclipse.

Astrobiology education in Russia: problems and perspectives

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Astrobiology has tremendous potential for revolutionizing science education. The Russian Space Agency plans future space programs including astrobiological experiments of a great value in cooperation with ESA and NASA experts. It will require groups of highly qualified experts and scientists who would have sufficient knowledge in the field of practical astrobiology and fundamental ideas on novel technologies in this field both in EU and in Russia. The crucial decision is the realization of the joint educational project with the European academic and scientific organizations in field of astrobiology. Now, none of Russian universities has multidisciplinary up-to-date graduate program in astrobiology and only few of them offer lectures on astrobiology as a part of the basic courses such as Space Researches or Biology of Extreme Environments. The first initiative was the joint proposal of Russian, European and American colleagues in field of education in astrobiology in the framework of TEMPUS program. EU now made a great progress in developing astrobiology. Different education and scientific programs are prepared and working groups are created within departments in European universities. Annual meetings, summer schools and internet courses in astrobiology are conducted to increase the level of the researches involved in this problem. This is a valuable experience for Russian astrobiologists to be adopted for perspective developing this discipline in Russia. The most progressive way is to improve cooperative work in both education and research and to pay a special attention to the joint achievements of EU and Russia in the field of space exploration with their historical significance and perspectives of their application in national economies The initiative for strengthening of interactions and creation of associations between researches in Russia, Asia and South America as regions having many unexplored ecosystems well related to astrobiology and their valuable contribution is also discussed.

Learning theories and planetarium environment for astronomy education

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How people learn? Without appropriate theory it is not possible to develop a coherent educational policy. Do we believe that learning consists of the incremental addition of individual "bits" of information into the mind or do we think that learning is an active process that transforms the mind of the learner? Among different theories on how people learn are: Behaviorism, Neuroscience, Right Brain vs. Left Brain, Communities of Practice, Control Theory, Observational Learning (Social learning theory), Vygotsky and Social Cognition, Learning Styles, Piaget's theory, Constructivism, Brain-based Learning, Multiple Intelligences. These theories are described in brief. All above mentioned learning theories may be applicable to some extent in case of planetarium environment. But the Multiple Intelligences theory should be taken into more thorough consideration and can be tested perfectly while teaching in Planetarium. It is discussed what planetarium may offer to the audience with different types of intelligences, according to Multiple Intelligences approach.

Audience survey at Kyiv Planetarium: public beliefs and most common misconceptions in basic astronomy

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Results of Kyiv Planetarium audience survey are discussed. Kyiv Planetarium holds a "Big Zeiss 4" projector and fulldome projection system, has a 23 meters across dome, 300 seats, and about 150,000 visitors yearly. Having presented a program to up to 300 visitors at once, it is not easy to examine the general public understanding of basic astronomy, to get feedback on the program, and to estimate the educational impact on public. Strategically designed questionnaires were used to find out what are visitors' personal experiences and previous knowledge. Each questionnaire included 23 questions that can be conditionally divided into such groups:

- personal data (age, education);
- astronomical knowledge and observational experience (attendance of astronomy lessons at school, observation of interesting astronomical events such as eclipses, comets, meteors, experience of watching the sky through a telescope, age of the Earth and the Universe, reasons for seasonal changes and Moon phases, the brightest star, constellations that the visitor knows, number of planets in the Solar system, the biggest planet in the Solar system, how often do visitors read about space related topics);
- visitors' personal beliefs like their attitude towards horoscopes and extra-terrestrial life;
- visitors' attitude towards planetarium itself, likes and dislikes, topics for future programs, expectations, sources of information about Planetarium, and number of their visits to planetarium. 147 questionnaires were gathered back, results are discussed, most common misconceptions and public beliefs are revealed.

Inter-, multi- and trans-disciplinary approaches in astronomy education research

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The Western-style knowledge has created the disciplines related to human and natural realities that present complex experience and understanding. These disciplines have developed, in turn, different languages and methods in relation to their objects of study. Their separation, useful in some stages of study and the punctual development, was often simplistic and damaging scientific elaboration, to meet the challenges that nature and the future lay there, also in the didactic transposition. In fact, the reality is complex and rich of inter-relationships. On the other hand, studies on general education, cognitive psychology and, more recently, neuroscience show how aspects of different disciplines are trained and stimulated in parallel, as well as aspects of movement and cognition are linked in the brain. Research confirms that cognitive experience is linked to the body (embodied cognition) and to emotions, often, more than the school organization has wanted to recognize. Therefore, Inter-, multi- and trans-disciplinary approaches are related to the substance but also the teaching-learning methodologies and content, and teaching research methods. In educational research it is necessary to observe and reflect on the same assets and themes from the perspective of different disciplines points: for example, the general teaching, pedagogy and teaching discipline contribute to addressing skills development that required by a specific job, the role of a certain theme and its inclusion in an educational course, the specific and epistemological difficulties and coherence of language around a theme. To analyze these themes, I present some reflections started from learning experiences in Astronomy with students of different ages, in Italy and beyond, and I present open questions about teaching, in school and out of school, and teacher training. I reflect on the contributions and the role that the different arts and techniques, the activation of the body all, the handicraft construction and the fantastic production, the attention given to the emotions can have in a responsible, ethical, ecological and effective didactic on a cultural level as well specifically cognitive. I introduce examples of specificity of Astronomy, linked to the geographical conditions of the various countries and their impact on perceptual aspects, cognitive-educational and cultural differences that affect individual national or local communities, which is the field of ethno-astronomical research.

Assessment for learning in 1st year astronomy and astrobiology courses

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Assessment in astronomy and astrobiology units usually consists of formative assessment (e.g. problem sets), where students form and practice application of their new knowledge and summative assessment, (e.g., tests, exams) where they can demonstrate their level of mastery. Besides teaching astronomy-related content and skills, we also aim to provide our students with transferable skills, such as critical thinking, problem-solving, communication skills and team work. Assessment and feedback are the vital part of this learning experience. However, research indicates that roles of assessment and feedback vary, and that assessment is too often used as a measurement tool or for grade justification rather than for learning purposes. Research also indicates students have difficulties identifying in full the skills they are being thought (Burke et al 2005). More importantly, most assessment tasks are independent of each other, so how does feedback help students? Feedback given to students should involve a loop, a chance to practice, and Biggs (1999) suggested a combination of consistent assessment rubrics and repeated problems works to be employed in order for students to have a clear notion on where they need to improve. I will present examples of assessment for learning in my 1st year astronomy and astrobiology courses that use the principles of constructive alignment, where the course assessment is driven by the learning outcomes and incorporates students' reflection on their learning achievements. I will also discuss an importance of teaching creativity in astronomy through open-ended assessment and how that allows students to engage deeper and more meaningful with the course material.

Delivering astronomy and astrobiology courses designed for all students

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We will present approaches and challenges in teaching large 1st year astronomy and astrobiology courses through studio-based workshop delivery. Two courses, ASP1010 Earth to Cosmos, and ASP1022 Life in the Universe, are not pre-requisites (but can contribute) for the major/minor in astronomy or astrophysics, and thus have a good mix of students: from science and engineering, to music, history, education, medicine and business disciplines. Therefore, the aim of these units is to be accessible to students at all levels, but challenging enough for those wanting to study astronomy further. In 2014, the first-year laboratories at the School of Physics and Astronomy at Monash University were overhauled in-line with the SCALE UP educational approach to create the Physics and Astronomy Collaborative Environment (PACE), which comprises of two teaching studios that seat up to 108 students per session, with 9 students seated per one table. The studio-based teaching is a departure from a standard "lecture+lab" delivery, with an aim to improve learning experience and learning gains of students. The new teaching approach has led to lower failing rates and increased number of students enrolling into 2nd year units.

How astrobiology helps learners appreciate the Earth

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We will present lessons learned from our interdisciplinary astrobiology-based MOOC (Massive Open Online Course) course "How to survive on Mars". The main aim of the course is to motivate young high-school students to enroll into university science courses. Besides teaching basic facts about Mars, the course covers elementary necessities (water, oxygen, energy sources, food) that colonist on Mars will have to produce using basic scientific principles. As a by-product of intended learning outcomes for our course, we noticed that our learners frequently reflect on Earth's natural resources, showing mindfulness that such resources need to be managed responsibly and not be taken for granted anymore. Furthermore, some learners have come to realisation that a seemingly frivolous and expensive activity such as setting up a human colony on Mars does indeed have benefits for humans back on Earth. As expressed by one of our learners: "It sounds like the learning is going to end up going the other way... Earthlings learning how to live and care for our planet from the Martians we send there, who have to be awesome (sustainable) in order to survive." We will also discuss challenges in designing an open astrobiology course that a vastly diverse MOOC audience, consisting of various ages, countries, background knowledge and course expectations.

Celestial Calendar-paintings and culture-based digital storytelling: cross-cultural, interdisciplinary, STEM/STEAM resources for authentic astronomy education engagement

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In D(L)akota star knowledge, the Sun is known as Wi and the Moon is Han-Wi. They have an important relationship, husband and wife. The pattern of their ever-changing relationship is mirrored in the motions of Sun and Moon as seen from our backyards, also called the lunar phases. The framework of the cultural teaching is storytelling and relationships. Cultural perspectives in astronomy such as this remind us of how indigenous ways of knowing are rooted in inclusion, engagement, and relevancy. Designed by A. Lee in 2007, the Native Skywatchers initiative seeks to remember and revitalize indigenous star and earth knowledge, promoting the native voice as the lead voice. The overarching goal of Native Skywatchers is to communicate the knowledge that indigenous people traditionally practiced a sustainable way of living and sustainable engineering through a living and participatory relationship with the above and below, sky and earth. In 2012 two indigenous star maps were created: the Ojibwe Giizhig Anung Masinaaigan-Ojibwe Sky Star Map (A. Lee, W. Wilson, C. Gawboy), and the D(L)akota star map, Makoce Wicanhpi Wowapi (A. Lee, J. Rock). In 2016, a collaboration with W. Buck of the Manitoba First Nations Resource Centre (MFNRC), produced a third star map: Ininew Achakos Masinikan-Cree Star Map Book. We aim to improve current inequities in education for native young people especially through STEM engagement, to inspire increased cultural pride, and promote community wellness. Presented here will be recently created resources such as: astronomical calendar-paintings and short videos that exist at the intersection of art-science-culture. As we look for sustainable ways to widen participation in STEM, particularly in astronomy education, part of the conversation needs to consider the place for art and culture in STEM.

eTimeTrek: digital deep history of the Universe

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The deep history of the Universe, the Earth and the biosphere is the most exciting story that we can think of. This story seeks to explain how this world has developed and evolved, through separate steps, small and large, and through causes and consequences. It is a fascinating story for anyone who wants to understand how the world functions, what are the natural laws and forces that keep it running, and what are the scales and dimensions of all its events. In the TimeTrek (www.timetrek.fi) project we have set up a physical framework to portray this big story. TimeTrek is a 13,8 km long timeline and walking trail, where every kilometer corresponds to a billion years, and every meter to one million years in the history. The most important events have been marked along the trail with brass plates, and plenty of additional materials are also available on the website. The aim is to illustrate the continuum of events and their mutual interactions, and the cosmic and geological timespans of these large processes. The original route was established in 2011 as a collaborative outreach with several scientists from the Turku University and the Åbo Akademi. Recently we have been developing its contents into AR/VR-type illustrations. We have also started a project to convert the TimeTrek concept into a comprehensive set of digital, gamified and interactive materials. These are planned to serve as phenomena-based learning materials for interdisciplinary education of different natural sciences. The materials illustrate the different stages of the history in multiple levels, including animations, interactive 3-D models and games. Also additional readings will be included to cover the scientific backgrounds, and e.g. the societal and philosophical meanings and impacts of these topics. These pilot materials will be presented.

40 years of astronomy education research in schools: misconceptions, interventions and a future agenda

Anthony Lelliott
University of the Witwatersrand

This presentation updates a recent review of astronomy education research carried out among school students, teachers, and museum visitors over a 40-year period from 1976 until 2016. 170 peer-reviewed journal articles were examined (67 in the past eight years), the majority of whose research dealt with conceptions of astronomical phenomena. The review used a conceptual framework of "big ideas" in astronomy, five of which accounted for over three-quarters of the studies: conceptions of the Earth, gravity, the day–night cycle, the seasons, and the Earth–Sun–Moon system. In the past eight years there has been a small resurgence in research conducted in planetaria (eight new studies), the solar system and stars comprised 14 new studies, while nearly one third of the studies focused on Earth-Sun-Moon. Although seasons, Earth conceptions and day-night cycle studies attracted some recent research, there were only two studies involving gravity. The findings of the review have implications for the future teaching of, and research in, the discipline. Conceptions of the Earth and the day–night cycle are relatively well-understood, especially by older students, while the Moon phases, the seasons, gravity, stars and the solar system are concepts that most people find difficult both to understand and explain. List of misconceptions about astronomy, while useful early in the review period in order to build the field are of less significance now. Lelliott Rollnick (2010) suggested that thoroughly planned interventions are likely to be the most effective way of implementing conceptual change. One third of the research in the last eight years involved interventions aimed at changing people's understanding of astronomical phenomena. An increasing number (54In line with current educational strategies, it is recommended that future research should focus on how both teachers and learners engage with astronomy concepts. Research on interventions with learners across the disciplinary boundaries of astronomy education at school and teacher education levels are key to progressing the field over the next decade.

Data driven astronomy education in primary schools

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Worldwide Telescope (WWT), originally developed by Microsoft Research and now managed by American Astronomical Society, is a visualization environment aggregates scientific data from major telescopes, observatories, and institutions in the world. The WWT is an ideal information processing tool and also a collaboration tool for astronomy public outreach and astronomy teaching. Using advanced Astronomy data visualization techniques, the WWT gives the public and students an opportunity to access the latest astronomical observations, whether they have astronomical backgrounds. Chinese Virtual Observatory (China-VO) is the national VO project in China initiated in 2002 by Chinese astronomical community leading by National Astronomical Observatories, Chinese Academy of Sciences. China-VO became a member of the International Virtual Observatory Alliance (IVOA) in 2002 and plays an important role in the promotion of WWT in China since 2009. We organized seven teacher trainings in different cities and three WWT Guided Tour Contests to encourage students participate in this interactive astronomy platform. In 2014, an astronomy experiment class specially designed for primary students (grades 4-6) based on WWT called The Virtual Astronomy opened in Shijia Primary School in Beijing. In this class, we introduce the WWT platform and connect it with the basic astronomical knowledges, to help the students to learn and understand fast and correctly. Our practices demonstrate that introducing the WWT into astronomy teaching in primary school can help improve students' learning interests, participation passions, innovations and practical skills.

Astronomy education in Mozambique

Dinelsa Machaieie
Eduardo Mondlane University- Mozambique

Astronomy in Mozambique is a young science. The initial steps were given in 2004 during the preparation of the International Year of Physics. However, the activities in the area evolved considerably in 2009, the International Year of Astronomy. Since then there has been realized many activities to reach young pupils also people of so many areas. These activities includes talks, sky observations at some schools and other public spaces, and other astronomical activities related with UNAWE, GTTP, JEDI, and DARA. In 2010 the Eduardo Mondlane University introduced its first astronomy module, "Introduction to Astronomy and Astrophysics" and now the introduction of a complete course of Astronomy is underway. It is being formed a team in Msc and PhD in South Africa, Portugal and Brazil in collaboration with the SKA project-South Africa and some students are willing to get support to study Astronomy. Mozambique has been proposed as a host for one of the future SKA stations in Southern Africa and it is being developed the Mozambique Radio Astronomy Observatory (MRAO), which will be the first milestone towards development of radioastronomy in Mozambique.

The best skies on Earth: How to link astronomy and cosmology to local development in the Argentinean Puna

Clementina Medina[1] and Beatriz Garcia[2], on behalf of QUBIC Collaboration
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The Argentinean Puna is placed at the Northwest of the country, not far from the Atacama dessert. Even though it has similar sky quality as Atacama it's until now that it's considered for installing several astronomical facilities. In particular, the region near San Antonio de los Cobres, in the province of Salta, was a very well study site because was one of the proposed cadidates to install the Cherencov Telescope Array (CTA Project); one of the social goals after the CTA actions, is the Sky Protection ordinance, which assures the dark skies in the zone. In 2016 this site has been chosen for the installation of QUBIC, an instrument to observe the Cosmic Microwave Background polarization in order to study the very first instants of the Universe. We're aware that this will have an important impact on the local population and we start to work on stablishing the link with schools and community. This a priority for the collaboration behind QUBIC. Different activities and exchanges are going on, taking advantage of the experience gained with other scientific installations as the Pierre Auger Observatory and different educational programs already operational. Through astronomical observations, cosmology conferences and the possibility to interact with the scientists involved on the project will be the first step to bring young and adult people closer to science.

The role of interactive visualization in teaching of astronomy

Dusan Marceta
University of Belgrade

Significant number of students face problem to materialize different astronomical phenomena when they are presented in a traditional way. This holds for the students of astronomy but even more for the students of related sciences. During my teaching experience in the different fields of astronomy and astrophysics, I noticed that for literally all students there is a tremendous improvement of remembering and understanding of variety of astronomical topics when they are presented by using of interactive animating tools comparing to traditional way of presentation. These interactive tools allow not only effective and direct way of presenting some astronomical phenomenon, but also give an opportunity to the students to examine them in detail by adjusting different parameters which have influence on them. In this way students are motivated to take active role in the teaching process which significantly raises the quality of the outcome. In this presentation, the effectiveness of the interactive visualization tools, developed on contemporary visual platforms, will be presented on some basic and more complex astronomical phenomena.

Computing across the physics and astronomy curriculum

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The Department of Physics and Astronomy at Northern Arizona University in Flagstaff, AZ has implemented a program to integrate scientific computation into the upper division curriculum for both physics and astronomy majors. Although we had earlier created a required course on scientific computing for all majors at the end of their second year, we had not consistently required the students to use those skills in their advanced courses. The first phase of the four--year program consisted of training the faculty. The level of faculty competency with Matlab was increased from 18to 92through summer workshops and self--study. Ten of twelve upper division faculty members ultimately incorporated computation applications into 75of the upper division physics and astrophysics courses taught by the department. Eventually 84 computation applications were developed for use in various upper division courses and were classified under seven distinct types. These applications have been made available to other faculty at http://www.physics.nau.edu/ capc. Student satisfaction regarding computation instruction and student confidence to solve problems using computation increased significantly during the course of this project. Half of the instructors reported covering more content material with greater depth using computation. Student satisfaction regarding computation adaptations in upper division courses was highest in courses where instructors covered more content using computation. Statistically significant increases in reported peer interactions were also realized. Qualitatively, there was evidence that the incorporation of computational elements significantly enhanced the students' content knowledge. Unfortunately, due to complications we were not able to answer this question quantitatively.

Demonstrating the principles of aperture synthesis with the very small radio telescope

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Many undergraduate courses at the undergraduate level are unable to give a detailed treatment of interferometry and aperture synthesis due to time constraints and limited math backgrounds of students who may not have been introduced to Fourier transforms. We have taken a laboratorybased approach to teaching radio interferometry using a set of college-level, table-top exercises. These are performed with the Very Small Radio Telescope (VSRT), an interferometer developed at the Haystack Observatory using satellite TV electronics as detectors and compact fluorescent light bulbs as microwave signal sources. The hands-on experience provided by the VSRT in these labs allows students to gain a conceptual understanding of radio interferometry and aperture synthesis without the rigorous mathematical background traditionally required. The data are quickly and easily processed using a user-friendly data analysis Java package, VSRTIPlotter.jar. This software can also be used in the absence of the equipment as an interactive computer activity to demonstrate an interferometer's responses to assorted surface brightness distributions. The students also gain some familiarity with Fourier transforms and an appreciation for the Fourier relations in interferometry using another Java package, the Tool for Interactive Fourier Transforms (TIFT). We have successfully used these tools in multiple offerings of our radio astronomy course at Union College.

Astronomical concepts in bilingual deaf education

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In this study we discuss the teaching-learning process for deaf students learning of basic astronomy concepts regarding lunar phases. In general, science teachers consider this topic difficult to teach due to its abstractness and, particularly to deaf students, the difficult is centred on the absence of signs referring to the concepts. To better understand this issue we scrutinized a teaching-learning sequence developed by a novice teacher in a bilingual Brazilian school where the curriculum is structured on Brazilian Sign Language as first language and written Portuguese as second one. The research was conducted in late 2014 in a Brazilian elementary school with a ninth-grade cohort of 17 deaf/hard-of-hearing students. We use qualitative methods with data gathered along with teacher and students, focusing on video recordings in classroom. Using video analysis, we are able to portrait a picture of deaf students learning processes and their multiple mediations. We draw our analysis of the teaching-learning processes on the cultural-historical activity theory (CHAT), which have two major theoretical underpinnings: activity is the unit of analysis and the human action is always mediated. Finally, we concluded that approach to astronomical concepts for deaf students should acknowledge the significance of sign language, notwithstanding the lack of specific signs or low proficiency must not be taken as obstacle in itself. Our research results indicate that language skills remains a significant factor for scientific concept formation, educational activity development and students engagement. Furthermore, teacher is dealing with deaf students, what somehow bind all students under the same category of deafness; it is a mistake to ignore the great deal of heterogeneity, though. The complex educational activities have in its bases a multi-mediational process, which enables students appropriating of abstract concepts and collectively creating signs referring to new concepts they learn.

Gaming to learn astronomy, an innovation approach, two study cases.

Margarita Metaxa, Philekpaideutiki Etaireia,
Greece

Gaming to learn has been around for a decade but it is only recently that gamification's possibilities in the realm of education truly have been appreciated. If indeed humans think immeasurably better as part of a network than on their own, then games are an obvious terrain in which to set minds free and let them wander around. The system of points, badges, rewards and leaderboards featured in most games can be replicated in an educational context, to account for people's different motivations and needs for interaction or self-expression. Despite its popularity, an assessment of its effectiveness as a learning or a training tool is still unclear. In this paper I am going to present you two study cases we created at school 1. The board game StarStrorm 2. The construction of a Galaxy Garden. I will also attempt to discuss evaluation on these two cases.

A sustainable culture of tardigrades (Hypsibius dujardini) for astrobiological experiments

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The tardigrades, also denominated water bears due to its general appearance and its slowness when moving, are microscopic organisms that have gained importance in Astrobiology in recent years, and today are considered one of the most extreme organisms on the planet. They have extreme survival ability, and can enter a state of latency for several years called cryptobiosis that can be present in different types, namely, anhydrobiosis, quist, anoxybioisis, osmobiosis, and criobiosis (Nelson and Marley, 2000, Freshwater Biology, 44, 93), making them to survive to different extreme changing conditions. Due to our interest in conducting experiments with tardigrades, to complement the practices with students for the course of Astrobiology 101; we went to the task of collecting samples of mosses and lichens in Ensenada, B. C., Mexico, without obtaining positive results. So, we decided to cultivate them in laboratory conditions. Tardigrades strain samples from bought flasks of lab were used, these organisms were in criptobiotic state. A sample of these were put in a small fishbowl, with aired system, and feed with spirullina algae, at room temperature (18oC) every week, in a low light room. Fresh water is added if necessary. In our results we obtain that in few weeks we had tardigrades out of criptobiosis state and then they were producing eggs normally. H. dujardini has been cultured before and it is a good species for culture as we observed. This procedure provides a good sustainable culture and an inexpensive and easy method to produce tardigrades for didactic purposes.

The teaching materials for teachers about small astronomical telescopes

Masamitsu Ohyama
Shiga University

Students learn characteristics of the Sun based on their observations and other data in the science of the junior high school in Japan. Observations using astronomical telescopes are recommended in the teaching guide for the Course of study, and most textbooks of the science show observations using small astronomical telescopes. But many science teachers have never used astronomical telescopes, and they do not know how to set up and use them. Counterweights of astronomical telescopes are heavy. If the heavy counterweights drop onto feet of teachers or students, they may be injured seriously. So teachers have to teach students so that students use astronomical telescopes and observe the Sun safely. Some teachers tried setting up astronomical telescopes using commercial books about astronomical telescopes, but they could not understand how to set them up, or they did not know if the way to use them was correct. Therefore, I produced video teaching materials and texts which show how to set up and use an astronomical telescope. The video teaching materials and texts were produced in consideration of safety when teachers use astronomical telescopes at schools. I have already held not only classes for students of a teacher training college but also workshops for in-service teachers of junior high schools on astronomical telescopes with the produced teaching materials. I report my videotraining materials and texts.

The use of digital technologies as a didactic resource for the teaching and learning of science for students of the last year of the fundamental education of public schools in Brazil

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The technological transformation of the last decades requires that teachers get a new look on how to teach. There is a demand that knowledge should be transformed in order to connect it with the new reality, lived in the everyday life. This work aimed to verify the insertion of digital technologies in the daily life of students of public schools in the state educational network. Four schools participated in the study, of which two were located in Divinópolis, State of Minas Gerais, Brazil, designated as A and B schools, with 68 surveyed students, and other two were located in the outskirts of the City of São Paulo, called C and D schools, with 62 tested students. A research questionnaire was used with six objective and discursive questions. The analysis of the given answers suggest the conclusion that more than 70with technologies. Other options such as the tablet or desktop computer have been rarely mentioned. When students were questioned about the use of digital technologies by the teacher, very diverse responses emerged. At school A, 30 students stated that the science teacher does not use digital technologies in their classrooms. In school B, the result was the opposite, because all of the 36 students affirmed the use of technologies by teachers. At school C, 22 students stated that they did not use technologies in their classrooms while at school D, only 17 made this statement. It is concluded that the students live in a world full of digital technologies in their daily life, but the school representing the teaching action does not follow this technological trend, which contributes to the permanence of the traditional lectures and the predominance of the students' mechanical learning. Digital technologies; Teaching; Sciences

ScienceIES, a distinctive way to teach astronomy

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We introduce that innovative ideas are always welcomed to improve learning in educational environments, mainly in those areas or spaces where students can manage with diverse and strong experiences aimed at developing their own identities outside the school, and therefore helping them to seek their future and appreciating more their teachers and classroom activities. Going to basic proposals coined by renowned educational leaders, learning is a process of Peripheral Participation in Communities of Practice (Wenger, 1999). Thus, new formulas to allow students from High Schools to practice what they learn in classrooms, awakening their hidden skills (Weick, 2005), and letting them know that Science is closer than what they could imagine, have to be issued to gain a future inhabited by educated citizens. Under this premise, the Project for the Initiation of Research and Innovation at High School ScienceIES was created, and after seven years of history, we conclude that is distinctive because it allow students to: experience a social learning environment outside the school; get involved in projects led by renowned scientists in a real context, over an extended period of time; have a first contact with research and find out first hand what research is like; benefit from a rich "all-in-one package" methodology; reflect their views and experiences along the way in their own words in "My own ideas"; learn to communicate scientific concepts in English, the international language of Science; organize their thoughts and better understand the different areas of scientific study available to them; to be cited in the acknowledgements of research articles; dispel the myths prevalent in society about how scientific knowledge is gained and be instrumental in increasing enrolment in scientific education at both the secondary and tertiary level across Europe. Also will help to create a new generation of enthusiastic, more scientifically literate students, many of whom will play a role in the future of European scientific endeavour. We also would like to present, as a study case, a ScienceIES project conducted in 2014. A 24 undergraduate-student group reproduced the scientific discovery of the accelerated expansion of the Universe; i.e., the discovery of the Dark Energy in the Universe. To cope with such an ambitious goal, students were divided in 4 interconnected working-groups (Cosmology, Astrophysics, Computation Observations). Although each group started working individually, they converged to a global final picture by means of a continuous feedback between groups. The project, awarded by the Spanish "Ciencia en Acción, Adopta una Estrella" in 2015, was carried out under the methodologies, learning social atmosphere, materials and aims of the ScienceIES context.

Spectral cometary researches of 41P/Tuttle-Giacobini-Kresak, C/2015 V2 (Johnson) and C/2014 Q2 (Lovejoy)

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The researches of comets 41P/Tuttle-Giacobini-Kresak, C/2015 V2 (Johnson) and C/2014 Q2 (Lovejoy) on the basis of optical spectra with an average resolution ($\lambda/\Delta\lambda \approx 1200$) in the wavelength range $\lambda\lambda 3600 - 8000 \mathring{A}\mathring{A}$ are presented. The spectra were obtained on March 2017 (for comet C/2014 Q2 on February 2015) with the help of the telescope AZT–14 ($D = 0.48m, F = 7.7m$) and the spectrograph ASP–9 at the station Astronomical Observatory of Taras Shevchenko National University of Kyiv "Lisnyky". The comparative analysis of the spectral peculiarities of comets has been presented. On the basis of obtained spectral material was carried out the identification of spectral emission bands. The distributions of general and reflected energy along the slit of the spectrograph for the near nucleus regions of comets were built. With using the Shulman and Haser models were calculated the physical parameters of neutral dust and gaseous temporary atmospheres of the comets (fluxes, the number of molecules, gas productivity, relative dust productivity, velocities of gas expansion, lifetime of molecules C2, C3 and CN and other parameters).

The original course of astronomy for the physics and mathematics lyceum

Vasyl Ponomarenko, Andrew Simon
Taras Shevchenko National University of Kyiv

Abstract: Despite the dependence and vulnerability of our civilization from outer space, astronomy is not teach as a compulsory subject in every country. And even enters for extracurricular education not pay enough attention for Astronomy. Perhaps it is the reason that we have a small number of professional astronomers, although interest in astronomy as a science is consistently great. There are very few countries in which astronomy is taught, as a compulsory course. In some countries, astronomy appears nowhere in the curriculum. In Ukraine the "average" situation is that astronomy is taught once a week at grade level 11. But there are exceptions. In one of the best physics and mathematics schools in Ukraine (UPML of Taras Shevchenko National University), the subject of astronomy is taught for 2.5 years with one lesson per week. The program include a unit on astronomy at grade level 9-11. It gives pupils deep and fundamental knowledge of the subject and also prepares children for competitions of different levels. This course of astronomy includes such thematic blocks: the basic concept of astronomy; information about the celestial sphere and coordinate systems; constellations; time measurement and calendars; information about the Solar System; the foundations of celestial mechanics; stars; the structure of the galaxy; extragalactic astronomy and cosmology. In this course there is still something to work on, namely on motivation of students for which astronomy is perceived far from the realities of life. It is also necessary ensure full complianceto of equipment to the given course. Classes are conducted once in a week, that's why in order to achieve a high level of mastering knowledge, we need to improve teaching methodology. But still the powerful course of astronomy for our students thanks my efforts, the efforts of my colleague and administration of lyceum successfully works and develops.

Education in computational astrophysics with the astronomical multipurpose software environment

Simon Portegies Zwart
Leiden Observatory

The popularity of the computer as a virtual telescope is gradually growing. Still, our education in astronomy rarely allows students to experiment with large-scale simulation environments, for two reasons 1) these software packages can only be used by experts, and 2) students have no access to large computing facilities. With the Astronomical Multipurpose Software Environment we address these issues. The first problem is solved by making large professional astronomical simulation software available with a practical astronomer's friendly interface. The performance issue is in part solved by incorporating a range of numerical solver at a gradual increasing complexity and with an equally gradual increasing performance footprint. In our experience, AMUSE allows MSc students to reproduce in a couple of hours simulation results from recent publications.

Non-science majors doing inquiry with robotic telescopes

Michael Reid
Department of Astronomy and Astrophysics, University of Toronto

Helping students overcome their self-doubt is a critical part of teaching astronomy to non-science majors. Many students self-identify as "not science people", and then have this impression amply confirmed when they struggle to learn from boring, overly technical lectures. In this talk, I will describe an inquiry-based approach we have developed to help first-year nonscience students see themselves as scientific discoverers. Our approach begins with day-one exposure to the use of robotic telescopes, in an environment where failure is nearly impossible. It progresses through more and more difficult observing challenges and culminates in a fully selfdirected research project exhibited at a research fair. I will show some of the students' work and the results of our research into the effectiveness of the method.

Space videos on YouTube: what the audiences really likes

Maarten Roos
Lightcurve Films, Portugal

Nowadays it is easier than ever before to make films and videos available to any audience via platforms such as Youtube. The European Space Agency, the European Southern Observatory, NASA, and other agencies constantly produce videos aimed at the general interested audience and post them on their Youtube channels. Different formats are presented: educational, informative, news style, science stories, scientist profiles, behind-the-scenes, animations, and others. Without trying to find out what a Youtube audience is composed of, as an independent filmmaker I am interested in understanding what such an audience really goes for. Which of the formats do really stick and why do they stick? In my paper I present a systematic analysis of video content found on Youtube channels of several astronomy and space related organisations to see which of their content is popular and propose a reason why this is case.

Evaluating quality in education; the NASE ISO experience

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The Learning Services Management System of the Network for the Education of Astronomy in the School (IAU WG2-NASE) has been developed following the guidelines of the SO 29990: 2013 Standard, which understands on the "Learning services for non-formal education and training – Basic requirements for service providers", and which aims to improve quality of learning services and facilitate comparison on worldwide basis. This presentation describes the challenges involved in this task and the achievements, taking into account that NASE has performed 90 courses on the Globe between 2010 and 2016. The benefits arising from the work under this International Standard ensure not only quality in teaching-learning processes, but also a method to evaluate the service and continuous improvement. Based on specific indicators we analyze quantitatively the impact of the activity under different contexts and cultures.

Astronomy pre-tertiary education at Leiden Observatory: beyond universe awareness

Pedro Russo, Tibisay Sankatsing Nava, Audrey Korczynska, Wouter Schrier, Jorge Rivero González, Michael de Korte, Anne Kerkhoven, Thilina Heenatigala, Paulo M. Cruz, Maria Vicente, Paulo J. Lourenço, Vaclav Ehrlich, Christian Eistrup and George Miley
Leiden Observatory, Leiden University

During the last decade, Leiden Observatory's Astronomy Society Group has built up tremendous experience in managing and disseminating European and global astronomy education programmes. Its most well-known initiative is the educational programme Universe Awareness (UNAWE), founded in 2006. Until the advent of UNAWE, there were no large-scale attempts to use astronomy as a tool for inspiring and educating young children. UNAWE, aimed at children aged 4 to 10 years, has established a consolidated network in 61 countries that has reached 400,000 children so far and produced over 10,000 inquiry-based learning educational resources including the Universe in a Box or the Earthball. UNAWE also developed a coherent evaluation framework encompassing both formative and summative evaluation. However, the activities of the Group expand beyond the UNAWE programme. For instance, the Space Awareness project, which uses the excitement of space missions to engage children and teenagers with science and technology, has developed hundreds of educational resources based on a study to identify entry points for space in the curricula of 10 countries in Europe and South Africa. The project is also implementing an extensive evaluation strategy, which aims at a better understanding of the career aspirations of space-related workers, the vision that children have of space and space science, and the identification of best practices towards stimulating the next generations of space scientists. Other initiatives include the open-access platform for peer-reviewed astronomy education activities IAU astroEDU, citizen science projects as well as the development of open learning spaces for STEAM education to foster sustainable development of local communities. The talk will provide an overview of the astronomy educational projects carried out by the Astronomy Society Group at Leiden Observatory, discussing details about implementation, impact, evaluation, lessons learnt and sustainability.

Storytelling in a revolutionary way: fulldome production for planetariums

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The City of La Plata's Planetarium is a joint project between the Faculty of Astronomy and Geophysical Sciences and the National University of La Plata. Its goal is to become a hub of University science outreach, and to be a touch point for science, its discoveries and the community. The Planetarium is one of the most moderns of Latin America, its 4K digital projector and 17 metres dome for 175 people, offers the incredible sensation of the inmersive experience. We are currently producing fulldome shows with contents of national interest, local profesionals, and telling the stories in such ways that any kind of audience can be atracted. Multidisciplinary groups are necessary in order to make very high quality and profesional outreach. We are working with experts on different subjects: astronomers (own staff), moviemakers, animators, sound engineers, screen-writers, photographs, etc. The main projects are "Belisario, the little big hero of the cosmos", a fulldome animated series, and "The endless road", a documentary film. We also have made a fulldome movie called "Luminaciones" (art cinema), many short films, and educational shows. This last are a series of 'interactive' shows for schools (separated by age), conducted by students formed for the task. Aswell, we give great importance to astronomical events and receive other Facultys of the University to make joint events of all kind. A series of events where made since 2014 (actual team), and offering such thing, we have opened the place to thousands of people each year. Finally, we exploit the social networks. They give us a proliferation of the events, productions, and articles, as fast as never. It seems a great opportunity to spread all our news and share Astronomy, Art, and Science with the people.

An analysis of college students' understanding of planet formation before instruction

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The topic of solar system formation has become essential to astrobiology due to the discovery of approximately 5,000 exoplanet candidates, and even more recently due to the discovery of the TRAPPIST-1 system with 7 Earth-size planets, 3 of them potentially in the habitable zone. The architecture of planetary systems is more easily understood when students are able to comprehend how solar systems form to begin with. To date, there has yet to be a study conducted that addresses the topic of planet formation at the college level with a statistically significant number of introductory astronomy students. Thus, we presented students in 13 introductory astronomy and planetary science courses (n = 1050 students) with one of six short answer questions on the topic of planet formation. The questions were administered on the first day of the Fall 2016 and Spring 2017 semesters before any relevant material was taught. As a preliminary analysis, we coded the responses to the most general short answer question, "Describe how the Solar System (planets) formed to the best of your ability." For this question, we received responses from 170 students, 39 of which had taken a previous astronomy course. Nearly 45provided "novice-level" responses, meaning they did not understand how the Solar System formed at all, or they attributed solar system formation to the Big Bang. For this presentation, we will present our findings from the entire dataset (all six short answer questions) and discuss any common themes, ideas, and misconceptions that appear in the dataset. These responses will lend to the development of the Planet Formation Concept Inventory that will be used by ASTRO 101 instructors to evaluate students' understanding of planet formation before and after instruction.

The importance and justifications for astronomy teaching in Brazilian's research

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Many researchers in Astronomy Teaching in Brazil often refer to Astronomy as an object of great curiosity. In this research, we present a survey concerning the importance and justifications researchers have given to Astronomy Teaching. In a universe of 180 papers about Astronomy Teaching in Brazil, found in periodicals from the areas of Science, Physics and Astronomy Teaching between the years of 1998 and 2011, in 29 of them, discussions about the importance or justifications to Astronomy Teaching were found. As the main result of this work, all the elements related to the importance and the justification for the Astronomy Teaching in Brazil were organized and grouped in four categories of analysis, which indicate the nature of the justifications presented by the authors: Awakening of feelings and curiosities; Socio-historic-cultural relevance; World view and awareness expansion and Interdisciplinary. In each category, related elements were grouped. By doing so, we could produce an articulation among the elements taken from different papers, matching them in a way that enabled us to obtain new inferences not individually present in any of the papers. Furthermore, when all these Brazilian research was analyzed, it was also revealed that there were no papers that aimed at the investigation of the importance and justifications for Astronomy Teaching. It was still noticed that, in general, when Brazilian researchers invoke the interdisciplinary character of Astronomy, they make it superficially. Since the researches do not show how they get the idea presented to the justifications for teaching Astronomy, some questions could have surfaced, such as: would it be possible to exist a kind of "common sense" for teaching and disseminating Astronomy in Brazil, that would make researchers understand Astronomy as a differential science? Would the "born interest" in Astronomy - pointed by some people - be something real? Does Astronomy really differ from other sciences?

Application of spectrometer in research-based astronomy education

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Spectrometer for basic chemistry experiments can be used to obtain astronomical spectra with new adapter for telescope. Students are easily accessible to it without data reduction such as spectral extraction and wavelength calibration. Spectra of planets and bright stars can be obtained with 6-inch refracting telescope located in city. It yields student-centered research projects; 1) the comparison of spectra of terrestrial planets to Jovian planets, 2) color combination for human eye from continuous Mars spectra, 3) Stellar spectra depending on surface temperature. It will be helpful to develop self-motivated learning in the topic of light and electromagnetic radiation in the field of introductory astronomy.

Astrobiology: obstacles and possibilities in the science teaching scenario

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Astronomy education is among the current proposals of integrative interdisciplinary science teaching which strengthens science education. Nowadays, perhaps its most exciting aspect is astrobiology. This area investigates the origin of life, its evolution and distribution in the Universe, being considered by many researchers as ideally suited for teaching science. However, such approach implies a high scientific competence from well-educated teachers, the way science is taught and how teachers are trained to teach science. Aware of this situation, a question arises: can a proposal based on the great significance advances of the Universe and life sciences, with an interdisciplinary nature, distant from daily school, succeed in a still deficient science teaching scenario? The aim of this study was to investigate: the relationship between science teachers and the knowledge that composes the astrobiology subject through interviews, which were discussed supported by pertinent literature; What obstacles will have to be overcome and what real possibilities already exist in the current science teaching condition. The results discuss these raised obstacles and possibilities distributed at times in the hands of teachers and those which are independent of their control; Problems that have been widely discussed through science teaching researches and those which emerge in the recent context of the theme. Once the obstacles and the diagnosis of the teachers' needs are recognized, they can be overcome, especially if allied with the already existing possibilities, and in the future may lead to the planning of training processes, allowing teachers to make use of the life in a cosmic context as a tool in a more meaningful science education teaching.

Astronomy across cultures: reporting experiences on GalileoMobile education activities in the Paiter Suruí indigenous community

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This work is the report of an astronomy non-formal education expedition carried out by the GalileoMobile initiative in the Paiter Suruí indigenous communities of the Rondonia State, in the Brazilian Amazon, that took place in November 2016. This ethnic group remained "officially uncontacted" by non-natives until the late 1960's, when the population dropped significantly, being decimated by diseases and facing deep changes in their way of living and traditions. Nowadays, the Paiter are seeking ways to maintain their cultural identity and land. Thus, differently from previous GalileoMobile itinerant projects, which had the goal of bringing modern astronomy closer to youngsters of regions with little or scarce access to science outreach actions, this particular expedition had the goal of establishing an exchange of knowledge related to astronomy, promoting a dialogue with the members of this group to understand and record their relationships with the sky. The ground team, which was comprised of three astronomers, one filmmaker and one anthropologist undertook the study of various academic works on ethno and cultural astronomy, as well as specific texts on science education in traditional communities and ethnography of Brazilian indigenous peoples. During the expedition, interviews with the elder members of the Paiter were held, having as a starting point the astronomy outreach activities promoted by the astronomers such as the sky observation with telescopes. We were able to collect three myths related to the Sun, Moon and rainbow. The result of activities, interviews and transcripts yield in a series of videos that will be presented in this talk and will be returned to the community, so that they can use in schools and the community centers as educational material and for the preservation of the Paiter culture, as well as a resource for a detailed ethnographic study of their astronomy.

What does the general public expect from a night-sky observation?

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The night-sky observation program (POC, acronym in Portuguese for Programa de Observação do Céu) is the most traditional education activity run by the Museum of Astronomy and Related Sciences (MAST). It takes place twice a week and has an annual participation of 2,400 people. It starts with the brief talk " The Sky of the Month" and is followed by the observation with MAST's telescopes, one of them being over a century-old (Luneta-21) and other modern amateurs models. The present work is the first research conducted aimed at POC's evaluation according to the participants perspectives in its 32 years of existence. The data were collected using two instruments: a questionnaire, distributed to the participants prior to the activity, and an interview conducted after the observations. We analyzed the data using the Discourse of the collective subject methodology, which allowed us to understand thoughts and values of the participants on a given topic. We find that the participants have the habit of gazing the sky, even if for contemplation purposes only, and that the " The Sky of the Month" talk makes the public to feel more prepared to observe the sky. It was frequently mentioned, though, that the language of the talk should be more oriented to children. We also find that the public expects to observe planets, stars and constellations, and very few of them, gets disappointed with the whole experience. The participants also perceive the historical value of the old Luneta-21 and declare that the activity brought them wonderment feelings. We concluded that our instruments and methodology are suitable to evaluate similar sky-observation activities. As a next step, we will conduct a survey to identify worldwide institutions that also use antique telescopes in their public observations with the goal exchanging experiences and discussing the use of such instruments with education purposes.

Pursuing gender equality in astronomy in basic education: the case of the project girls in the Museum of Astronomy and Related Sciences

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It is well-known that the number of women in scientific careers is significantly lower than the number of men, especially in Science, Technology, Engineering and Mathematics (STEM) areas. A survey conducted by UNESCO points to a world average of active women in STEM of about 28of all, by excluding women from the production process of scientific knowledge, we are giving up of 50disregarding possible solutions aimed at the social well-being of part of the population. Thus, the Museum of Astronomy and Related Sciences, whose mission is to expand society's access to scientific knowledge, promotes the project "Girls in the Museum of Astronomy", aimed at the continuous education of seven high-school female students in topics of astronomy with the goal of stimulating them into liking science. Concurrently with the project, interviews were conducted to evaluating the initiative according to the participants' perspectives, as well as to understand their perceptions about science prior and after six months of the project. The content of the interviews was analyzed using the discourse analysis methodology proposed by Lefévre (2003). We found that the participants were satisfied with the format and content of the project, that comprised of theoretical talks and practical workshops. Additionally, we perceived a significant transformation in their attitude towards science and, more importantly, in the perception of their own capabilities. The resulting discourses show that they now view science as something closer to their reality and are more confident to promote scientific discussions. These results show the importance of providing young females with leading models they can look up, specially at the age when they are about making decisions about future career.

The outcomes of the Brazilian Olympiad of Astronomy and Astronautics (OBA) as an opportunity to develop successful outreach actions

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Every year, hundreds of thousands of students from all over the country take part in the Brazilian Olympiad of Astronomy and Astronautics (OBA). This has the aim of both spreading astronomy and astronautics-related concepts and training teachers about these topics. After being marked some of the exams are sent by participant schools to the Organizing Committee to select candidates for the international competition. The OBA exam archive thereby offers an unique opportunity to evaluate the teaching of astronomy in Brazil in relation to school level and content, as well as over time. Understanding the common sense conceptions about astronomical phenomena unraveled by the exams is of utmost importance to planning successful outreach activities. We present the results of one particular OBA question related to Sun and the stars that helped the Museum of Astronomy and Related Sciences (MAST) in Rio de Janeiro to develop an astronomy education kit aimed at teachers. The kit was designed in the context of the Olhai pro Céu (Behold the Sky) outreach project, that lends a Coronado Personal Solar Telescope and other gadgets to observe the Sun to schools. Since the beginning of the project in 2015, almost 12,000 students benefited from the astronomy activities organized by 45 teachers who borrowed the three kits available, showing that the cooperation between an academic institution as MAST, which develops its outreach actions based on astronomy education research results, and schools helps educators in their pedagogical practice to teach astronomy in the classroom. The number of students each educator is reaching when using the Behold the Sky kit indicates that a confident teacher becomes an independent astronomy outreach agent and a multiplier of such actions.

The impact on education of Astronomical Olympiads and the International Olympiad on Astronomy and Astrophysics

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Astronomical Olympiads and similar competitions for high-school students have been run in some countries for more than half a century, and last year marked the tenth anniversary of the largest such competition with global reach, the International Olympiad on Astronomy and Astrophysics. The effect of these has been to reach out to a large number of school students who might not otherwise have considered astronomy as a subject; help maintain a high, guided standard of astronomy education even in countries where astronomy is not (or no longer) on the curriculum; and to encourage those students who participate to strive harder and pursue astronomy further by giving them goals to aim for, rewarding their efforts with medals, recognition and participation in the international events in interesting locations and, above all, showing them that there are many other students just like them both in their own country and around the world. Many of the students go on to careers in astronomy education or research. We believe that Astronomy Olympiads are a very valuable element in the astronomy education framework which can be used to further the common goal of sustaining and growing the astronomical community.

Science and religion in undergraduate school education.

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In Romania, after several decades of atheistic scientific education, religion classes have recently been reintroduced in schools. As most Romanians are Orthodox (86.45 % of the population, of which 14.7 % are children under 14 years old, according to the 2011census), the religion classes are mainly aimed at the Orthodox students. There is no doubt that today's secularized society poses many additional problems for this discipline, although the classes are optional, upon parental request, and can be adapted to a specific confession. From the point of view of the scientists, a serious problem is the competence of the teachers to answer the questions raised by the children that arise from the apparent clash between what they are taught in the religion classes and what they are taught in the classes of sciences, particularly in mathematics, physics, chemistry and biology; notions of astronomy are included in these subjects, as astronomy is not taught separately. This state of affairs is not an exception worldwide: religion is taught in many countries, while in recent years astronomy has not been given much place in the curriculum, with very few exceptions. All this raises a number of questions: how can teachers of religion and science cope with the apparent discrepancy between the story about the origin of the universe told by astronomers and the story told by the Bible, what is the truth about the role of the zodiac signs, what is the truth about Darwin's theory etc.? That is why the good intentions of the national ministries of education can lead to unwanted side-effects, e.g. the proliferation of superstition, obscurantism, fanaticism, intolerance, etc. In this paper we intend to address these very delicate and extremely modern issues as objectively as possible and to propose some solutions based on a transdisciplinary approach in education to secondary school teachers.

EduCosmos, astronomical research in the classroom

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EduCosmos is a citizen science project that allows high- and medium-school students to participate in scientific research. The classes participating in this program perform astronomical observations remotely, from their schools. They use a 1-meter telescope belonging to the Observatoire de la Cote d'Azur (OCA - Nice, France), located at the Plateau de Calern (alt. 1280 m), 70 km away from Nice. Students get involved in the study of asteroids, performing mainly light curves that will be used by the OCA scientist to complete their research. A 2-day teacher-training is proposed to teachers involved in this program, and is carried out in partnership with the local education authorities. Teachers are formed to the scientific project, the observations and the data reduction. During the school year, the participating classes have the opportunity to meet the OCA scientists that will introduce them to the scientific program.

Teacher's misconceptions in curricular astronomy

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In Indian school syllabus, basic ideas of solar system and universe are introduced through a single chapter in grade 8 science curriculum. Unsurprisingly, the limited time and space afforded to the subject, results in only fleeting mentions of a number of concepts in textbooks and teachers are expected to elaborate on these concepts through their own knowledge. In the present study, we make an inventory of several such concepts with varying degree of complexities. For some of the concepts, teachers may gather information through extra reading. For some concepts, teachers would not require extra information, but would be required to analyse further the information available with them to draw inferences. For other concepts, the traditional knowledge of the teachers is likely to play a role in their understanding. We tested understanding of two groups of teachers on these concepts using 5-point Likerttype scale. First group of teachers consisted of 30 Indian teachers from a government owned system of premier schools and second group consisted of 17 teacher educators from Sri Lanka. In the present work, we present results from the sections pertaining to Calendars and motions of the Sun and Moon. The results reveal alarming gaps in understanding of teachers, which need to be addressed in the next round of curriculum revision.

Daily life astronomy activity and its contribution to children and educators in science education

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Daily life astronomy activity made in nurseries and preschools has many aspects to improve childrens and educators scientific views and skills. I present some daily life episodes; children were surprised at discovering the clouds moving in the sky by looking carefully; children were confused about stars motion by trying to mix with their own experience; teachers counted numbers of colours in rainbow by taking many photos and began questioning about the preconception of rainbows seven colours. Though these activities are usual and common ones for many nurseries and preschools, aspects of science education are found in many ways though reflecting the activity referring to the UNAWE Evaluation Guide as well. This indicates that if we intend to promote science education in nurseries and preschools, we do not necessarily have to introduce new activity but having formative assessment and evaluation to pick up science in daily life activity is sufficient, which will encourage educators to have their confidence for implementing the science education. The improvement of the confidence is also observed in pre-service primary and preschool student teachers during university class when they learn that they already have skills for daily life astronomy education. Thus, daily life astronomy education is not only interesting and exciting activity to children but also it contributes to improving the educators confidence and hence skills of science education.

Optical polarimetry in undergraduate education

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Polarimetry plays an important part in observational astronomy, but it is all too often given limited attention in astronomy textbooks. Coupled with a sometimes confusing mathematical introduction, students may feel that polarization is a difficult subject best left for study at a different time, or worst, not at all. Additionally, polarimetric observations and analysis are not typical exercises students are likely to engage in as part of an observational astronomy course. Over the past few years students at Virginia Military Institute have used an optical polarimeter, which was designed and constructed in-house, on the 20 cm Cassegrain telescope at the VMI Observatory to study the polarization of stars. These observations have enhanced their astronomical knowledge and allowed them the opportunity to gain valuable experience using this important technique. The subsequent analysis of stellar polarization has led to a better understanding of the mathematics of polarization, its interpretation, and statistical treatment. In this presentation I describe the design and construction of an optical polarimeter suitable for a small college observatory and outline the observing and data analysis strategies. I will also present observations that range from brief introduction exercises that can be included as part of an observational astronomy course to longer programs suitable for undergraduate research projects.

Learning Astrobiology 101 with experiments in Baja California, Mexico

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Teaching an interdisciplinary field, as Astrobiology, can take advantage of many experimental methods, from astronomical observations to growing extremophile organisms in the lab. Since 2004, we have taught the subject Astrobiology 101 (in Spanish "Introducción a la Astrobiología"), as part-time lecturers in the local University (Facultad de Ciencias, Universidad Autónoma de Baja California) in Ensenada (state of Baja California, Mexico). The academic richness of the campus plays an important role in the development of interdisciplinary courses, as Ensenada (500,000 hab.) have two centers of the National University (Institute of Astronomy and Nanoscience Center; UNAM), a campus of the state university (Faculties of Science, Marine Sciences, and Engineering; Institute of Oceanography; UABC), and the biggest federal science center from the Education Ministry (SEP-CONACYT), the Center of Scientific Research and Higher Education of Ensenada (CICESE), with departments in many fields of pure and apply sciences. Under all this influence, we designed a coursework based on material from classical books as well as news, academic papers, and internet sources. After seven editions of the course, we have found that making practical experiments (even "theoretical experiments") increases the understanding of concepts, ideas, and strengths the interaction between students with different majors. We have used our own exercises as well as those from the Project CLEA (Marschall et al. 2000, TPT, 38, 536), and even some experimental kits from Carolina Biological Supply Company. We have translated to Spanish some of the manuals of the CLEA software and the Carolina© kits with permission. The aims of this project are to compile a student (and teacher) manual of 16 weekly practices to be used in the Astrobio 101 course, in Mexico and in other Spanish-spoken countries. Here, we present the advances of the project.

Impact of a didactic sequence on basic astronomy concepts for graduates in physics of online and classroom modalities

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In the transition from elementary school to high school, the topics related to astronomy are studied within the curricular component of physics. In this context, at some point of time a Physics‘ teacher at this level of education will be faced with the need to work with the contents related to this science. In this way, it is important to broaden the discussion about teacher education, as well as to apply in practice the means for it. Therefore, this work has the objective to present the results, obtained by application of a questionnaire at the beginning (a pre-test), and at the final stage by a course for physics graduates of online and classroom modalities (completed with a post-test), which was organized through the Potentially Significant Teaching Units – PSTUs; and this work also presents the level of satisfaction of them in relation to the course. It is an applied and descriptive research, and the adopted technical procedures consisted of the survey and a participatory research. The data were organized in spreadsheets and the statistical analyzes were made in the sequence, with the objective of establishing comparisons between the studied groups, of their evolution of acquired knowledge and their level of satisfaction, resulting from the development in the course. The results indicate that there has been an evolution of the student‘s basic knowledge with relation to the proposed topics of Astronomy in the didactic sequences, i.e., the activities developed in the administered course created a favorable atmosphere for the learning, which is therefore contributing to the initial formation of these physics teachers. Teacher Training. Astronomy Teaching. Potentially Significant Teaching Units. Test of Hypotheses.

Astronomy: social background of students of the integrated high school

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Astronomy-related contents exist in almost all levels of basic education in Brazil and are also frequently disseminated through mass media. Thus, students form their own explanations about the phenomena studied by this science. Therefore, this work has the objective of identifying the possible social background of the Integrated High School students on the term Astronomy. It is a research of a basic nature, descriptive, and for that reason a quali-quantitative approach was adopted; the procedures to obtain the data were effected in the form of a survey. The results show that the tested students have a social background about the object Astronomy, which is on the one hand fortified by elements they have made or which is part of the experience lived by the respondents within the formal space of education, and on the other hand based on elements possibly disseminated through the mass media. Astronomy Teaching. Theory of Social Representations. Central Core Theory. Prototypic Analysis. Centrality Test.

Project watching the sky: a playful and constructivist approach in the practice of night sky observation for 2nd grade elementary school students in the city of Santo André

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The Johannes Kepler planetary, located at the SABINA Parque do Conhecimento in the City of Santo André, Brazil, has equipments that allow the teaching and diffusion of Astronomy. The attendances take place during the week for schools and at weekends for the public. The attending focus is on elementary students from Santo André's municipal schools, kids between 6 and 10 years old. The pedagogical team creates attendance models with specific matters for each age. The model is only incorporated into the planetary agenda after the municipal teacher's approval. This paper reports the establishment and approval of an attending project for 2nd grade students between September and November 2014. The workshops "My first spyglass" and "Creating my constellations" and the planetary session "Watching the Sky" were created. The Municipal Education Office received the project and passed it to the schools. From the 51 municipal schools, 13 took part sending 21 classes, totaling 521 students. The project included activities for the students, such as the construction of spyglasses out of cardboard which made them learn about constellations of year's seasons and enabled them to create their own constellations. During the schools permanency in the planetary, the teachers received a survey to evaluate the pilot project. The evaluation of the researched items allowed to classify them into satisfactory, partially satisfactory or unsatisfactory. The results were 95satisfactory, considering the following aspects: used script, applied workshops, participation, concern and content uptake by the students; and a satisfactory rate of 100 the used resources. Upon the approval, the pedagogical team included definitively this attendance into their agenda.

Teaching conceptions on the use of digital technologies as a teaching resource in physical education in public schools of Minas Gerais, Brazil

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Increasingly, digital technologies have been invading classrooms, providing more and more attractive teaching methods for both, students and teachers. The arrival of digital technologies in classrooms brings great advances, but also many uncertainties and insecurities to teachers. With current technologies, the school environment can transform into a meaningful learning ambience with a more active and interactive student. This research aimed to analyze the opinion of eleven teachers who teach in four public schools in the interior of Minas Gerais, about the challenges of using digital technologies at school everyday. The data were obtained from the application of a questionnaire with eight questions. One of those asked about the use of digital technologies in the classroom, ten professors claimed to use them, but in another question that inquired about their knowledge about simulation software for physics teaching, only six said they knew about this resource. When questioned about the lectures on the topic of technological development, only seven teachers stated that they use this technique, being a relatively small number. Out of the four surveyed schools, two had digital slates, but the teachers said they did not use them because they did not receive any training. It was concluded that teachers do not feel comfortable teaching physics using digital technological resources, apparently because they lack adequate training. In many schools either there is no equipment or the same exists, but the teachers did not undergo training to use them. It is noticed that in the XXI century teachers insist on the traditional teaching model, contrary to the current trends to which students are immersed in a digital and interactive technological world.

Outcomes from the IYL2015 quality lighting teaching kit program: Reaching for the Stars

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Poor quality lighting not only impedes astronomy research and our right to see a starry night sky, but creates safety issues, affects human circadian sensitivities, disrupts ecosystems, and wastes billions of dollars/year in energy consumption. It also leads to excess carbon emissions. How do you change the mindset of society that is used to turning night into day? You educate the next generation on quality lighting. As an outcome of the International Year of Light 2015, the U.S. National Optical Astronomy Observatory's Education and Public Outreach group has produced a Quality Lighting Teaching (QLT) Kit. The kits are designed around problem-based learning scenarios. The kit's six activities allow students to address real lighting problems that relate to wildlife, sky glow, aging eyes, energy consumption, safety, and light trespass. The activities are optimized for 11-14 year olds but can be expanded to younger and older. All materials are in both English and Spanish. Most of the activities can be done within in a few minutes during class or afterschool and as stations or as stand-alones. Everything you need for the six activities is included in the kit. Tutorial videos on how to do the activities can be found at www.noao.edu/education/qltkit.php. 90 out of 100 kits have been distributed in 32 countries to SPIE–The International Society for Optical Engineering, CIE–International Commission on Illuminations, OSA–The Optical Society, IDA–the International Dark Sky Association, and the IAU OAD–Office of Astronomy Development. Successful feedback is promoting a choice between commercializing the kit or gaining further grants to build more kits. The plan is to distribute kits to observatories around the world.

Teaching with astrobiology - enhancing science and technology-awareness in non-science university students

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In a preliminary empirical study of social-science and humanities students in teacher-training programs at two German universities, the authors found a disparaging view of technology and science among students. Outdated knowledge of science and technology coincides with preemptory moral and ethical judgements about the implications of scientific research and innovative technology, but also with a strong interest in technology and scientific developments. Here Astrobiology as an interdisciplinary academic field will show its merits. Astrobiology is the study of the origins, evolution, distribution, and future of life in the universe as an interdisciplinary field. It includes key questions the humanities and social-sciences have been asking for centuries. Astrobiology uses knowledge about life we know to extrapolate from there into unknown realms. Astrobiology teaches us how to approach the unknown in an exemplary fashion in a scientific way while at the same time including traditional philosophical, religious and social questions that come with learning about the future of life. This can be used to teach students about an unknown in their worldview, bridging the gap between science and the humanities and thus approach one of the key problems the authors have identified with their students' technology and science awareness. Our approach to teaching Astrobiology is using key concepts of Astrobiology research and analysing their underlying assumptions and scientific reasoning and connections to non-STEM fields. These are well suited to show the students how to bridge a perceived gap between the STEM subjects without having to resort to ethical or even moral evaluation and judgement. The paper will give practical examples, showing how the students' approach to science and technology will change from being a moralistic evaluation to learning from both sides of the coin.

Solar science education with use of the images and movies, its practice and evaluation

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The sun is the nearest star to us and indispensable for us. Therefore, the public are very interested in the sun and the solar activity. School students learn the sun in the science class. In astronomy education, it is efficient to use astronomical images obtained with the observations. Of course, solar images as well. The Solar Science Observatory of National Astronomical Observatory of Japan, archives solar data obtained with various instruments, and systematically accumulated more than one hundred years since 1910s. Solar mission satellite, Hinode reached ten's anniversary in 2016 since its launch and has obtained amount of scientific data. These solar observation data, including images and movies, are open to the public as online database and encouraged to use for not only research but also education. As an interesting example, "Look at the sun with Hinode" have been arranged several years. High school students have joint solar observations with Hinode, compare their own observation data and deeply study the sun. At junior high schools and science museums, we have a variety of practices with the solar data observed in multiwavelength such as visible light and x-ray. That results in enabling the students to understand solar phenomena such as sunspots, granulation, solar flares. Additionally, we carry out questioner survey after the practices how they understand the sun from the solar images/movies. In this talk, I introduce some practices with such the solar data and would evaluate the effects that the practices gave the students.

Astronomical live streaming based on the cloud service

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Live media has become more widely popular in recent years, allowing greater connectivity between users. It allows people to take part in educational events such as live courses and real-time QA. Astronomical live streaming provides online real-time astronomical webcasts, which not only gives amateur astronomers the possibility to view astronomical phenomenaonline, but also provides a new way of offering training related to astronomical observation equipment.However, live streaming service construction is demanding on networking infrastructure, computing servers and observation equipment, making it difficult for an ordinary amateur astronomer to conduct their own astronomical observation activitieslivein order to train or share data.To solve this problem, a new approach based on cloud service was proposed for lowering the bar of conducting astronomical observationslivings.In this approach, the Content Delivery Network (CDN) was imposed to overcome the low network band issue which caused low quality live streaming, and a series of technical requirements for live streaming were established, such as video encoding and content delivering. These were deployed on the cloud.With our approach, amateur astronomers could construct an astronomical observation living with their observational gear easily by using the software we provide. Then, the real-time communication between audiences on line and the hosts at observation sites could be conducted by the multi-chat feature.

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