OAE Mini-Review

Remote Observing

Publications of the
IAU Office of Astronomy for Education

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

Session Organiser:
Eduardo Penteado.

Authors:
Sascha Hohmann, Michele Gerbaldi, Alice Hopkinson, Michael Fitzgerald, Nayra Rodríguez Eugenio, Mary Dussault, Priya Hasan, Josina Nascimento, and Eamonn Ansbro.

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

The IAU Office of Astronomy for Education (OAE) is hosted at Haus der Astronomie (HdA), managed by the Max Planck Institute for Astronomy. The OAE's mission is to support and coordinate astronomy education by astronomy researchers and educators, aimed at primary or secondary schools worldwide. HdA's hosting the OAE was made possible through the support of the German foundations Klaus Tschira Stiftung and Carl-Zeiss-Stiftung. The Shaw-IAU Workshops on Astronomy for Education are funded by the Shaw Prize Foundation.

The OAE is supported by a growing network of OAE Centers and OAE Nodes, collaborating to lead global projects developed within the network. The OAE Centers and Nodes are: the OAE Center China–Nanjing, hosted by the Beijing Planetarium (BJP); the OAE Center Cyprus, hosted by Cyprus Space Exploration Organization (CSEO); the OAE Center Egypt, hosted by the National Research Institute of Astronomy and Geophysics (NRIAG); the OAE Center India, hosted by the Inter-University Centre for Astronomy and Astrophysics (IUCAA); the OAE Center Italy, hosted by the National Institute for Astrophysics (INAF); the OAE Node Republic of Korea, hosted by the Korean Astronomical Society (KAS); OAE Node France at CY Cergy Paris University hosted by CY Cergy Paris University; and the OAE Node Nepal, hosted by the Nepal Astronomical Society (NASO).

Remote Observing

Session organiser: Eduardo Penteado, Office of Astronomy for Education/Max Planck Institute for Astronomy, Germany

Session overview

Remote observing is a powerful tool to inspire and engage students in science, as it enables them to pursue scientific projects with real data. With the availability of remote telescopes sprayed over the world offering educational programs, the possibilities for teachers and students to take part in remote observing projects is a reality.

The aim of this session was to explore the key topics about remote observing applied to the scholar community. Contributions by a bunch of experts in the field were delivered in the format of talks and posters, sharing experiences and valuable information about how to engage with educational projects involving remote observing.

The first talk contribution was from Sascha Hohmann, who provided an overview of what is required for having an effective remote telescope education program. Michele Gerbaldi explained the importance of having a well structured management of a student project that includes remote telescopes observation. Alice Hopkinson explored ideas of using interactive challenges and character narrative to approach younger audiences, while Michael Fitzgerald described the reasons that might stop teachers using robotic telescopes in their teaching. Nayra Rodríguez Eugenio spoke about advantages and disadvantages of a variety of approaches, which can be used when working with robotic telescopes, and Mary Dussault spoke about how intentionally-designed remote observing experiences can produce positive learning outcomes. This session also included three interesting and important poster contributions. Priya Hasan highlighted some successful activities with students getting in contact for the first time with live astronomical data obtained with remote observing. Eamonn Ansbro told us how important it is for students to perceive their own projects, which is possible to be done with remote observing. Josina Nascimento shared details about a successful project of remote observing provided by amateur and professional astronomers, which mobilized hundreds of people in each event.

We hope that the information available in this session may instigate and be helpful for those who intend to take part in remote observing projects.

How to Set Up a Remote Telescope in Education

Speaker: Sascha Hohmann, Leibniz Institute for Science and Mathematics Education, Germany

With the spread of the Internet in remote locations, there is now the possibility of setting up high-quality telescopes in good locations that can be used for educational purposes. However, it is not enough to just set up the telescope in a good location and offer high-quality pictures. Equally important is the provision of a user-friendly interface and coordinated, tried-and-tested teaching materials like worksheets and additional information, since teachers often have neither the time nor the specific background knowledge to develop appropriate materials in everyday school life. This paper presents important aspects of setting up a remote telescope using the example of the Stellarium Gornergrat in Switzerland, including the possibilities of international collaboration.

Talk link: https://youtu.be/LjHoLRcy0-o

Remote Telescopes in Education: The level of light pollution is increasing worldwide, making astronomy in cities more and more difficult. Further observations in the field of astrophysics require additional expensive equipment, which is available at very few schools. Therefore, opportunities for students to record their own data in astronomy and astrophysics are often very limited. Even though there is a large amount of freely available data online, the entire acquisition process - including technical aspects - is part of understanding scientific process [1].

Thanks to the increasing spread of the Internet - even to remote locations - new opportunities for astronomical education are opening up. Even places with very good observing conditions are now often connected to the Internet, including many places that were previously used for astronomical research.

These places often no longer meet the demands of state-of-the-art research, but still offer excellent conditions - and the infrastructure needed to operate a telescope. There is now an increasing number of remote telescopes dedicated to education and citizen science [2].

Remote telescopes in the educational field can either be directly remote controlled or automatically perform observation tasks and provide the images. The former has the main advantage of giving observers more freedom, while feeling more like classical observations. However, one is dependent on specific times, depending on where the telescope is located. In addition,

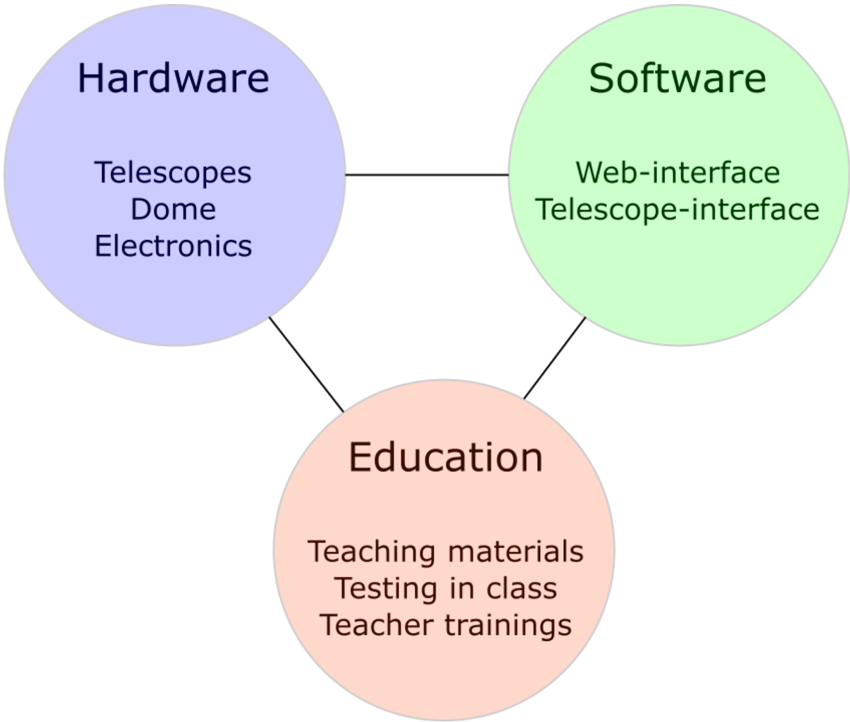

Figure 1: The three fundamentals of setting up a remote telescope in Education.

the observations may take a lot of time. Automated observation is much more efficient, both in terms of telescope utilization and observer time. This procedure also corresponds to the procedure in modern astrophysics. Both possibilities, however, require a certain degree of abstraction from the learners, so that most remote telescopes are rather unsuitable as an introduction to astronomy [3], but offer great potential for more advanced problems, for example in Project-Based-Learning units [4].

First Steps: Conception, Hard- and Software and Money: Building and operating a remote telescope is a big project. With the experience of building a remote telescope in the educational and citizen science area - the Stellarium Gornergrat (https://stellarium-gornergrat.ch/) in Switzerland [5] - some important points to consider are explained here.

The first steps are mostly conceptual and technical, the main aspects can be found in Table 1. After these questions are answered, one must think about the financing. The possibilities range from local sponsors and the local university to national or international donors, although this depends strongly on the respective situation.

From a Remote Telescope to a Remote Telescope in Education: Learners and teachers are not astronomers or astrophysicists, so one cannot generally assume any special knowledge. Accordingly, they need more than just the data, a key element is also provided materials. These enable work with the recordings, providing not only worksheets but also additional texts for the learners and solutions and further information for the teachers. It is important to provide the materials in the native language [6]. The materials should also be adapted to the respective curricula in order to facilitate their use in the classroom.

Additionally, easy access to the telescope is important. Both learners and teachers must be

Points to consider	(Some) Aspects
Control of the telescope	Direct control or automatic observing?
Target group	Primary School, Secondary School, University, Citizen Science, etc.
Expertise in the team	Technical, software, astronomical, pedagogical knowledge
Hardware	Different telescopes (magnification and field of view), dome, weather sensors, server etc.
Software	Remote control of the server, dome control, telescope control, observation control, camera control
Access	Easy control, customizable presets
Materials	Teaching materials, worksheets, further information texts for teachers and students, back-up-data for unsuccessful observation

Main aspects to consider for a remote telescope in education.

able to obtain good images without any special prior knowledge, for example by using preset settings, which however can be adjusted by advanced users.

In summary, a remote telescope in education is therefore also based on three fundamentals: hardware, software and education (see Figure 1). International collaborations with other remote telescopes are recommended, especially during the setup, but also in the long term.

References:

1. Duschl, R. & Grandy, R. (2013): Two Views about explicitly Teaching Nature of Science. Sci & Educ, 22: 2109-2139.

2. Gomez, E. L. & Fitzgerald, M. T. (2017): Robotic Telescopes in Education. Astronomical Review, 13:1, 28-68.

3. Slater, F. (2018): To Telescope or Not To Telescope. In: Fitzgerald, M., James, C. R., Buxner, S. & White, S. (Eds.): Robotic Telescopes, Student Research and Education Conference Proceedings, San Diego, California, USA, Jun 18-21, 2017 Vol. 1, No. 1, 40-45.

4. Krajcik, J., McNeill, K. L. & Reiser, B. J. (2008): Learning-Goals-Driven Design Model: Developing Curriculum Materials That Align With National Standards and Incorporate Project-Based Pedagogy. Sci Educ, 92:1, 1-32.

5. Ekström, S., Frey, J., Gschwind, S., Hohmann, S., Müller, A., Riesen, T.-E., Ruffieux, S. & Schlatter, P. (2021): Stellarium Gornergrat – A Swiss Robotic Observatory for Education and Citizen Science. SPG Mitteilungen, 63, 36-41.

6. Slater, T. F., Burrows, A. C., French, D. A., Sanchez, R. A. & Tatge, C. B. (2014): A Proposed Astronomy Learning Progression for Remote Telescope Observation. Journal of College Teaching and Learning, 11:4, 197-206.

Management of a Project Involving Observations with Remote Telescopes and Data Reduction

Speaker: Michele Gerbaldi, Institut d'Astrophysique de Paris (IAP), France

In the inquiry-based Astrolab program, undergraduate students plan observations with remote telescopes from Las Cumbres Observatory, and transform them into a scientific result. It is a learning-by-doing tutorial to understand the complexity of practical work through the interdisciplinary aspect of Astronomy. The students take an active role in determining how to collect and analyze data to fulfill the goal of the lab. Thus, students engage more thoroughly in the scientific process. But it is also more challenging for the tutor, as these labs can be harder to supervise. Students lacking experience in the process may require significant coaching and assistance. However, the positive learning experiences are considerable. Therefore, a project management for tutors was developed.

Talk link: https://youtu.be/Y4-Mw-H_TSc

To get undergraduate students involved in science studies, lab activities are a necessity, but often scarce funding limits the capacity to implement it. In that context the enquiry-based lab Astrolab was developed, with support from the Office of Astronomy for Development (www.astro4dev.org), one of the IAU Offices. It is mainly implemented in the Sub-Saharan Africa, but activities in Peru and Nepal are starting up.

The tutorial has primarily been developed for undergraduate science students in order to emphasize the interdisciplinary nature of astronomy, and its natural links with technology and instrumentation.

In doing Astrolab, students in sciences plan and perform real-time observations with remote/robotic telescopes, and transform those observations into a scientific result. It is a learning-by-doing tutorial to acquire research competences and to understand the complexity of practical scientific work.

The access to a telescope is the core for this program. The remote telescopes used are those from the Las Cumbres Observatory (https://lco.global/). Telescope time has been granted through the Global Sky Partners program. 10 telescopes of 40 cm can be used located in both the Northern and the Southern hemisphere. Altogether, the allotted time covers about 20 hours of possible continuous observations.

The challenge for students in the project is the planning of the dates of the observations to enable them to construct the light curve from the data obtained, taking into account the period of their target. This is the most difficult part of Astrolab as the knowledge of the student on periodic phenomena is essentially limited to oscillating functions. The students know such variable phenomena from electromagnetism studies. The rich pedagogical aspects of the astronomical variable phenomena are often neglected.

However, for eclipsing variable systems the concept of Ephemerid is an obstacle and requires understanding. Indeed, to fix the observational dates the student has to understand the meaning of the Ephemerid of a periodic phenomenon in astronomy to perform observations at well-chosen dates to cover the phase at best. It means understanding the relation between the phase, the date of a potential observation in Julian Date, and the civil date, and the accessibility of the telescope at that date, including the Moon phase.

In Astrolab, the students have an active role in determining which eclipsing binary system to observe, how to collect and how to analyze the data. This engages the students more in the scientific process, but it is also challenging for the tutor.

As the students lack experience in this process, it requires significant coaching and assistance. However, the positive learning experiences are considerable. Consequently, an Astrolab project needs educational management.

The learning process runs from idea to conclusion: Starting from basic principles of astrophysics, we let young people discover the thrill of doing science by going themselves through the complete research cycle, including hands-on observations planned by themselves.

The tutoring is not monitoring. The management consists of careful supervision, respecting the students' previous undergraduate knowledge in STEM activities.

Just an example of the difference between Monitoring and Supervising for telescopic observation. In Monitoring: pre-designed observations of pre-selected objects are given. In Supervising: the tutor will guide the student to select the "best" target in the framework of her/his timetable, by asking questions or making comments, but not giving a solution.

Therefore, the management process of the project requires the supervisor for each student to:

- verify that all aspects of the student project are on track, according to agreed plans and schedules (often imposed by the university calendar)

- verify the data collected by the student: the student must have the habit to check each image as soon as taken, not to accumulate the images till their analysis

To conclude, project management enhances student engagement continuously. The effectiveness of the project lies in the supervising challenge. The tutorial is based on computer games characteristics that attract but are difficult to manage: autonomy, possibility of failure, learning by doing.

The supervision requirements, detailed above, apply evenly well to inquiry-based activities at high school level.

Engaging Young Audiences in Remote Observing: A Case Study with "Serol's Cosmic Explorers"

Speaker: Alice Hopkinson, Las Cumbres Observatory, UK

Currently, many robotic telescope projects require prior astronomy knowledge and scientific skills. These investigations appeal mainly to older students. Reaching younger audiences requires a different approach. One technique is to introduce remote observing and astronomy through interactive challenges and character-based narrative. Journeying through missions with clear goals and simple follow-up investigations makes observing accessible to new audiences. Incorporating many materials - such as videos, workshops and games - can create a cohesive, simple and fun environment for learning. In this talk I will discuss the practical elements of this approach, using our project "Serol's Cosmic Explorers" as a case study.

Talk link: https://youtu.be/HPMMe-tHYMU

In general, many education projects using robotic telescopes are aimed at older students. These projects are often research-based and technically complex. However, robotic telescopes provide opportunity for hands-on experience with astronomy that can also inspire and benefit younger audiences. Enabling children to take their own pictures of space can give a sense of agency in astronomy learning which leaves a lasting impression.

At Las Cumbres Observatory, Serol's Cosmic Explorers (serol.lco.global) is an education program we created to make robotic observing accessible and enjoyable for children and audiences without prior astronomy knowledge. The key points of the talk are as follows and are summarised in Figure 1.

Do not assume knowledge: Primarily, we cannot assume any prior knowledge of the subject. Explanation of the observing process should be kept simple and enjoyable.

Clear structure: The observing program should be clearly structured, whilst still giving the user some agency. With Serol's Cosmic Explorers, we provided structure through missions and challenges. The missions grouped astronomy themes, and the challenges focused on specific astronomical objects within each theme. The user is still given some agency within this structure through choices such as the target to capture.

Guided analysis: Including guided analysis after the user has received their image can help them learn more about the object they have captured. In Serol's case, we guided the analysis through questions and multiple choice answers. In this way, encouraging the user to consider certain aspects within their images can help them to start thinking scientifically about these observations.

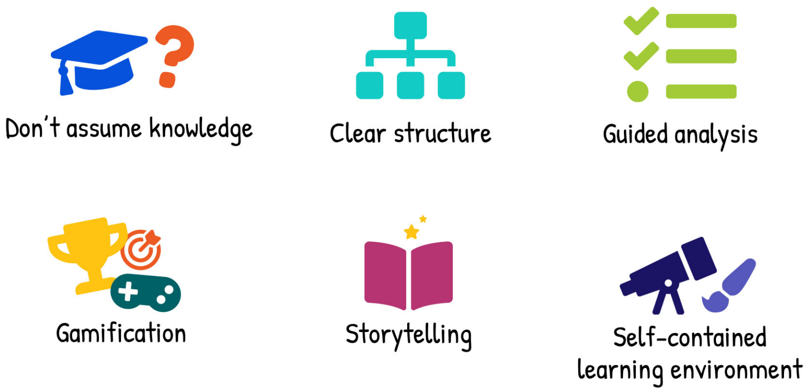

Figure 1: A summary of the key points to consider when creating a remote observing program for young audiences.

Gamification: To further increase engagement and retain the interest of a young audience, you can incorporate some aspects of gamification. For Serol, we used badges, with a new badge unlocked after every challenge is successfully completed. We included a progress page to view all badges obtained as well as an option to review all images taken. In general, you want project rewards to excite the user so that they remain engaged in learning.

Storytelling: It can be engaging to use storytelling, for example through video animation, as a way to disseminate important information relating to the topics of your project. Using anthropomorphised characters in these stories can be particularly engaging for children. As an example, we created animated videos that help set the scene for the missions the user will undertake. These stories and the theme of the observing process all work together to create a friendly atmosphere that encourages exploration, and frames learning and observing as a fun journey.

Self-contained learning environment: Lastly, it is helpful to place the observing project in a self contained learning environment, where everything needed is readily available in one place. For younger audiences, combining narrative content with practical tasks for the project can provide a cohesive and enjoyable learning experience. Incorporating multiple mediums for learning can further improve this self-contained educational environment. To meet this need for Serol, alongside the observing missions and the videos, we also included printable activities such as 3D models and colouring sheets, a video game, and workshops.

Things that Stop Teachers Doing Robotic Astronomy Education

Speaker: Michael Fitzgerald, Las Cumbres Observatory, California and Deakin University, Australia

Teachers are the gatekeepers of access to students and also direct activity undertaken by students in the classroom. If we are to embed this technology into schools beyond the gifted and talented, we need to address the needs of everyday teachers. These needs are amplified for schools in poorer, rural and under-served communities. In this talk, research on the needs and blocking factors identified by teachers for robotic telescopes usage are outlined and some examples of how to address these needs are identified. This talk is particularly suited to projects attempting to engage multiple schools.

Talk link: https://youtu.be/W2Jp7YpRm0I

STEM Education with Robotic Telescopes: Lessons from a Multi-approach Project

Speaker: Nayra Rodríguez Eugenio, Instituto de Astrofísica de Canarias (IAC), Spain

Within the field of educational projects with robotic telescopes there is a variety of approaches: activities or research projects with pre-observed data, pre-designed observations of selected objects, guided research projects and authentic astronomical investigations, using either remote-controlled or automatic observations. The Educational Project with Robotic Telescopes (PETeR) of the Instituto de Astrofísica de Canarias offers all these types of models through collaborations with institutions owning robotic telescopes. In this talk I will review the advantages and disadvantages that we have identified of each approach, the type of user that prefers each of them, and the resources, training and support that users of educational projects require to be able to develop them effectively.

Talk link: https://youtu.be/v0hs9_dabt4

When setting up an educational project with robotic telescopes, we must consider which format is best suited to the specific needs of our target audience, the objectives pursued and the resources available: telescopes and instrumentation, amount of observation time, staff dedicated to the project, etc.

The IAC is a Spanish R&D center in astrophysics that operates the Observatories of the Canary Islands, which host the telescopes of some 60 institutions from more than 20 countries. Thanks to the Agreements on Cooperation in Astrophysics [1], the IAC receives a percentage of the observing time on these telescopes and, in 2004, decided to allocate part of its guaranteed time on some robotic telescopes to education. To this end, the IAC created the Educational Project with Robotic Telescopes (PETeR) [2], an online inquiry-based lab that allows schools to carry out their own observations and research projects in astronomy. The availability of observing time on several telescopes, which also offer different types of observations through user-friendly portals, has allowed us to open the project to the entire Spanish educational community, from primary to secondary school and vocational training.

Our users, regardless of their educational level, have access to the full set of resources and educational approaches we offer: pre-defined observations of selected objects, activities and research projects with pre-observed data, guided research projects and open astronomical investigations, using both automatic and remote-controlled observations. This makes PETeR a unique laboratory to evaluate the suitability of each of these models to the type of user, as well as their strengths and weaknesses.

Approaches:

Pre-defined Observations: Our model consists of obtaining and analyzing one- or three-color images of different types of objects that can be selected from a list. The observing interface sets, for each object, the appropriate instrument, filter(s), and exposure time. Therefore, this is the easiest option to integrate into teaching practice, as it requires less prior knowledge and is less time-consuming.

For this approach we use the Liverpool Telescope and the observing portal of the National Schools' Observatory (NSO) [3], which allows observations of regions of the Moon, planets, nebulae, stellar clusters and galaxies, and also provides information about the selected object. To visualize and analyze the images, software specially designed for education is also offered.

This experience can be carried out on its own or integrated into a research project, and is mainly chosen by primary and secondary school teachers with little or no previous experience in astronomy. The major weakness of this approach, when undertaken as a stand-alone activity, is that it does not involve an inquiry-based learning process by itself.

Didactic Units: Each Unit introduces several astronomy concepts related to primary and secondary school curricula, and provides one or more practical activities, which make use of pre-observed data and serve as a practical introduction to the different tools of the image processing software.

Didactic Units are designed for structured or guided inquiry, but can serve as a first step in an authentic research process by complementing the activities with the planning, acquisition and analysis of new observations, either pre-defined or open-ended.

The type of users who tend to choose this format are 5th-6th grade primary teachers (8-10 year old students), secondary school teachers of STEM subjects with no or little previous experience in astronomy, and also high school astronomy clubs.

Among the advantages that our users highlight about this approach are that it does not require previous knowledge of astronomy, and that they do not have to spend a lot of time on preparation because the teaching materials are already adapted to the curricular contents.

Guided Research Projects and Open Astronomical Investigations: These approaches correspond to authentic research processes, either guided or open inquiry. In the first case, we propose to the teachers the type of research to be carried out and the possible methodology to follow to select the objects, observe them and analyze the data obtained. Some examples of guided research projects we offer are the characterization of variable stars and exoplanets with transits, the detection of Supernovae, and the confirmation of asteroid orbits. In the open approach, it is the group of students plus teacher who decide what they want to investigate. In both cases we provide scientific and technical advice when required.

The open observations required for these types of projects can be performed directly by our users through the observation portal of Las Cumbres Observatory (to which we have access through the Global Sky Partners program [4]), The Open University's public portal [5], and the advanced interface of the NSO portal. They can also be done remotely and supervised using the SARA telescopes [6].

These projects are usually developed by teachers who attend our specific training courses. In these trainings they learn basic concepts of astronomy and telescopes, how to use the observation portals of the different telescopes, how to work with astronomical images, and they also develop some of the activities and guided research projects we offer.

The strength of these approaches is that students experience the scientific process in all its phases. And the disadvantage would be in the time required both from teachers, who have to be trained beforehand, and from the project coordinator, since it is normal for schools to request individualized advice at some point.

Teachers who participate in PETeR and attend our training courses highlight the enormous potential of these approaches to develop active learning in STEM areas, and to foster scientific thinking in their students and collaborative work.

References:

1. https://www.iac.es/sites/default/files/documents/2018-05/intergovernmentalagreement.pdf

2. PETeR website: www.iac.es/peter

3. National Schools' Observatory website: https://www.schoolsobservatory.org/

4. LCO Global Sky Partners website: https://lco.global/education/partners/
5. OpenScience Observatories (OU) public observing portal: https://www.telescope.org/
6. The Southeastern Association for Research in Astronomy: https://www.saraobservatory.org/

Broadening Participation in Remote Observing: Strategies Gleaned from 25 Years of MicroObservatory

Speaker: Mary Dussault, Center for Astrophysics | Harvard & Smithsonian, USA

Collaborators: Alaalden Ibrahim, Frank Sienkiewicz, and Erika Wright (Center for Astrophysics | Harvard & Smithsonian)

The Micro Observatory telescope network has been in continuous use by hundreds of thousands of learners worldwide since 1996. From more than 2 decades of research and development facing many challenges and some success, we report on: 1) findings from research that provide actionable evidence for what works; 2) some new tools and promising techniques (ours and others') for engaging new audiences in remote observing; 3) a practitioner's perspective on how and why the incredible potential of authentic STEM learning through remote astronomical observing platforms has not (YET) been realized; and 4) how participants in this IAU workshop can help to meet this potential through the broadening of participation to communities of learners that have been marginalized from deep STEM engagement

Talk link: https://youtu.be/D16P1L5aTAw

Session attendees may find the following resources useful. Most are referred to in the talk.

Relevant Articles, Actionable Findings – What Works?:

- Gould, R. Dussault, M. & Sadler, P.(2006). What's Educational about Online Telescopes?: Evaluating 10 Years of MicroObservatory. https://access.portico.org/Portico/show?content=E-Journal%20Content&cs=ISSN_15391515&auId=ark%3A%2F27927%2Fpgg3ztfbdch&auViewType1=PDF - 15 years old, but still some relevant insights and information.

- Gomez, E. L., & Fitzgerald, M. T. (2017). Robotic telescopes in education. Astronomical Review, 13(1), 28-68. https://www.tandfonline.com/doi/pdf/10.1080/21672857.2017.1303264 - An article everyone interested in this session should read.

- Krumhansl, R., Busey, A., Krumhansl, K., Foster, J., & Peach, C. (2013, September). Visualizing oceans of data: educational interface design. http://oceansofdata.org/sites/oceansofdata.org/files/Visualizing-Oceans-Data-Report-Dec2013.pdf - An incredibly useful set of research-informed guidelines.

- Schibuk, E., Wright, E., & Dussault, M. E. (2020). Illuminating the Universe. Science Scope, 43(9), 22-31. https://www.nsta.org/science-scope/science-scope-julyaugust-2020/illuminating-universe - A Boston teacher's description of YouthAstroNet in action.

MicroObservatory Links:

- MicroObservatory: https://mo-www.cfa.harvard.edu/MicroObservatory/

- Observing With NASA portal to MicroObservatory: https://mo-www.cfa.harvard.edu/OWN/

- DIY Planet Search portal to explore exoplanets: https://waps.cfa.harvard.edu/microobservatory/diy/index.php

- YouthAstroNet Program: https://www.cfa.harvard.edu/research/youthastronet

- YouthAstroNet poster of preliminary research findings (findings presented in talk are yet to be published): https://mo-www.cfa.harvard.edu/OWN/pdf/YAN_Poster2017_AAS.pdf

Promising Tools and Techniques:

- Messier Bingo — first step engagement for novice observers from Las Cumbres Observatory — https://messierbingo.lco.global/

- Browser-based Image Analysis Tools: Js9 (created by developers of DS9) https://js9.si.edu/, Js9-4L ("for Learners" – Js9 adapted for MicroObservatory users) https://waps.cfa.harvard.edu/eduportal/js9/software.php, Afterglow Access (created by IDATA project in collaboration with Skynet @ UNC): https://idataproject.org/resources/ and https://afterglow.skynetjuniorscholars.org/

- Exoplanet Watch – "next step citizen science engagement" for robotic telescope users. https://exoplanets.nasa.gov/exoplanet-watch/

Broadening our Perspective on Broadening Participation: Bevan, B., Calabrese Barton, A., & Garibay, C. (2020). Broadening perspectives on broadening participation: Professional learning tools for more expansive and equitable science communication. https://www.informalsc ience.org/broadening-perspectives *A STEM Toolkit from the Center for the Advancement of Informal Science Education (CAISE), to help STEM education practitioners and science communication groups reflect on and strengthen their efforts to broaden participation.*

Acknowledgments: This material is based on work supported by the National Science Foundation under Grant Nos. 1433431, 1433345, & 2049012, with additional support from the National Aeronautics and Space Administration under Award No. NNX16AC65A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the NSF or NASA. We acknowledge that MicroObservatory telescopes, and the authors' astronomical institutions, are located on the traditional territories and stolen land of Indigenous peoples, including the Tohono O'odham and Hia-Ced O'odham Nations in Arizona; and the Massachusett, Nipmuk, and Wampanoag Nations in Massachusetts. We invite you to join us in reflection and action to engage with communities that have been harmed or marginalized by some of the dominant practices of science.

The HR Diagram with Remote Telescopes at LCO

Presenter: Priya Hasan, Maulana Azad National Urdu University, India

With the lack of dark skies, the pleasure of doing astronomical observations with telescopes has been very strongly affected. The experience of obtaining live astronomical data is a very important step in Data Analysis. In partnership with the Las Cumbres Observatory, we are training students to observe star clusters, open and globular. We teach them processing of the images and photometry. They finally make Hertzsprung-Russell diagrams of the clusters to study stellar evolution.

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

The Las Cumbres Observatory has a set of 0.4m robotic telescopes placed all over the world. We, as Shristi Astronomy are Global Sky Partners and have access to these telescopes. We also have an ongoing IAU-OAD Project "AstroSprint" which is a guide to projects using archival data in astronomy. The purpose of this work is to provide hands-on experience to students in astronomical data from telescopes.

Star clusters are groups of stars that formed from the same molecular cloud, at the same distance, of the same age, varying only in mass. They are unique objects for which we can find stellar parameters using the Hertzsprung-Russell diagram. We will train students on the fundamental concepts of photometry, magnitude scales, airmass, stellar evolution and the HR Diagram. We shall also submit observation proposals and train students to do photometry and plot HR diagrams.

The Sky at Your Home: Remote Observing Talks to the Public while Observing the Sky

Presenter: Josina Nascimento, Observatório Nacional / Ministério da Ciência, Tecnologia e Inovações, Brazil

Collaborators: Ricardo Ogando, Alba Lívia Bozi, Eugênio Reis (ON/MCTI), Leandro Guedes, Wailã Cruz (Planetário do Rio), Wagner Corradi, Mariângela Oliveira-Abans, Adriano Messala, Saulo Gargaglioni (LNA/MCTI), Claudia Mattos (MAST/MCTI), Gabriel Hickel (UNIFEI), James Solon (AstroPE), David Duarte, Romualdo Caldas (CEAAL/UFAL), Marcelo Domingues, Maciel Sparrenberger(CASB), Erick Couto (AstroAra), Ariel Adorno de Sousa, Jean Carlos Rodrigues (CAR), José Carlos Diniz (CANF), Sérgio Lomônaco (NGC 51/Espaço Ciência Viva), Carlos Palhares (Observatório Zênite), Heliomarzio Moreira, Ednardo Rodrigues (Seara da Ciência/CASF), Daniel Raimann (UDESC Oeste/Apontador de Estrelas), and Thales dos Santos (Clube de Astronomia de Roraima)

Opening domes and offering the sky through telescopes has always been one of the moments of greatest encounter between researchers, students, educators, family members and for everyone who wants to know a little bit about the universe. Because of the pandemic caused by SARS-CoV-2, we teamed up with amateur astronomers from various locations in Brazil, which is vast in latitude and longitude, to show the sky through their telescopes. Since June 2020 until now they have formed 19 remote observation lives of the sky, where we show the moon, planets, star clusters, nebulae, galaxies and comets.Both amateur and professional astronomers are involved in the project and some of them are teachers as well.Lives last about four hours and have hundreds to thousands of people watching and interacting.

Poster link: https://youtu.be/zpQ8OL6-1oA

The Observatório Nacional (ON) is one of the oldest scientific institutions in Brazil. Among our events, one of the most beloved attractions is when the students, educators and the general public gets to observe the sky alongside the researchers, which brings about a great deal of connection between both parts. When the SARS-CoV-2 pandemic came about we could no longer be with our beloved public, so we started promoting online events in our social media. In April 2020 we started to seek out partnerships with amateur astronomers throughout the country and, in June of that same year, we held our first virtual meeting with the public in the project "The sky at your home: remote observation", in which we streamed live the sky while talking to the public, just as we had always done when meeting face-to-face. Later on, professional astronomers and astrophysicists as well as elementary and high-school level teachers joined the project. This greatly enlarged the scope of the project and reinforced national integration.

At 16 months old, the project has had 20 editions, one each month and 4 special editions. Live Streaming has been such a wonderful experience for all of us that we have not been able to keep it under 4 hours. Those have been lovely hours that we spend together, showing the sky and talking about the astronomical instruments, formation of the Universe, the evolution of stars,sky phenomena, light pollution, sky by different cultures and so many other subjects that the public bring to the conversation. The fact that our partners are spread out geographically over the entire country allows us to show the same phenomenon from different angles. We have also made possible that a phenomenon would be seen in real-time even when impossible for a certain place, due to either weather instability or simply not being night in that area while the event was taking place.

The live streams recorded on our YouTube channel, allowing people to watch them even after the event. A typical live stream ends with about 1 to 2 thousand views and usually gets up to 10 thousand views afterwards, but the live streaming of the Mars occultation by the Moon (9/5/2020), the conjunction of Jupiter and Saturn (12/21/2020), the Total eclipse of the Moon (5/26/2021) and Annular eclipse of the sun (6/10/2021) has, respectively, 44, 265, 73 and 13 thousand views. These eclipses were not visible from Brazil, but we started live streaming from other areas of the planet at 5 am. On both occasions, teachers joined us with their students. That was fantastic! This project has been of utmost importance to educators, students and their families, as said spontaneously by the attendees themselves, as well as neuro-pedagogues who work with special education. It will have its continuity guaranteed even when face-to-face activities return, due to its unprecedented success and reach.

Appreciate the Awesomeness of the Universe

Presenter: Eamonn Ansbro, Kingsland Observatory and Space Exploration Ltd., Ireland

Students can be encouraged to astronomy by what I call the 'Amazing Astronomy Program Initiative'. It is important that students own projects and feel connected in an exciting new way of using remote observing. Students carry out astronomy observations and research projects using robotic telescopes from there schools and colleges. Projects of interest can be adaptable with hands-on activities focusing on concepts in astronomy, digital imaging, light & colour, etc. These elements alone are designed to support authentic inquiry: e.g., requesting images with a robotic telescope; using image processing software to enhance and make measurements of images; asking questions; connecting science to everyday life.

Poster link: https://astro4edu.org/siw/p68

Awe of the Universe: Awe is felt when our mind begins to comprehend something that we did not comprehend before. This can be as simple in marvelling at the immense expanse of space, pointing a telescope towards the sky to capture galaxies, nebulae, and star clusters. Students' images stay with them and bring a feeling of greatness whenever they need.

Every child at some stage is in awe with the universe. Students can be encouraged to astronomy by what I call the 'Amazing Astronomy Program Initiative'. It is important that students own projects to discover the universe and feel that connection and excitement in a new way of using remote observing.

Owning the telescope requires immersion: The main key tool in remote observing is the telescope. The telescope, although remote from the classroom, should be presented as not just a tool to request images, but an integral experience of using the telescope that feels fun to use, so the student is fully immersed. This approach is different from the conventions in protocols for remote observing.

Technology and Vision: The use of recent vision technology significantly provides a reality that is not normally provided in conventional remote observing. The idea is for the student to own both the telescope and a suggested project. We emphasize real vision when using our telescopes. This means that the observer is connected to the telescope with a vision system that portrays itself as if the observer is within the observatory. This way the experiential connection becomes a new experience than the conventional disconnection as if the telescope is remote and does not feel real to the student observer.

The observer operates the telescope similar to a flight pilot's cockpit. Multiple cameras achieve this goal. Motion detection synchronises the camera with the telescope movement, so the pilot has the controls, has the visual front view of the scene. This provides the special, emotional aspects, providing "spatial" experience similar to real world experience and therefore a spatial cognitive experience. This leads to more excitement because of initiating this awe.

Connectivity and authentic inquiry: Students carry out astronomy observations and research projects using robotic telescopes from their schools and colleges. Projects of interest can be adaptable with hands-on activities focusing on concepts in astronomy, digital imaging, light & colour, etc. These elements alone are designed to support authentic inquiry: for example, requesting images with a robotic telescope; using image processing software to enhance and make measurements of images; asking questions; connecting science to everyday life. In this way, you can enable them to participate and experience the thrill and excitement of scientific observation and discovery.

Discussion summary

Both remote observing sessions were followed by live discussions with the speakers going deeper in the topics addressed during their talks and following up with questions and comments presented by the public.

It was a consensus that remote observing based projects have an enormous potential to engage students in science, but need to be constantly improved in order to serve more people, mainly those in underprivileged areas and countries.

Funding opportunities were therefore addressed as a bottleneck for long term observing projects, making it difficult to scale the projects at national or even international levels. Nevertheless, it was reminded that some projects are for free or at low-cost for the participating schools and therefore, opportunities are available to engage in such projects.

Another topic discussed concerned how to start engaging with remote observing projects. For education use, it seems to be a consensus that the best thing to do is to engage with the Las Cumbres Observatory through the Global Sky Partners program: https://lco.global/education/partners/. Nevertheless, all speakers mentioned that those interested in joining remote observing projects should get in contact to start a conversation. Another point raised by the attendees was that it would be useful if there was a master catalog listing the available remote observatories. It was mentioned by the speakers, however, that there were already attempts in this direction, but it is hard to keep these lists up-to-date. Big projects, such as Las Cumbres Observatory, SkyNet and iTelescope, tend to keep their data updated, which might not be the case for the smaller ones.

Finally, another topic addressed by the panelists concerned the need of having educational material in different languages, which could benefit many teachers and students. As for now, most material is in English, some in Spanish and even fewer in other languages. Preparing all the material in multiple languages is not that straightforward, but definitely something to be pursued in the future.

http://astro4edu.org

@astro4edu

IAU OFFICE OF ASTRONOMY FOR EDUCATION

OAE