IAU

OAE Mini-Review

Online Formats for Astronomy Education

IAU OFFICE OF ASTRONOMY FOR EDUCATION
OAE

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:
Samir Dhurde.

Authors:
Chris Impey, Amit Dhakulkar, Edward Gomez, Andrew Fraknoi, Áine Flood, Christine Hirst Bernhardt, and Denise Wright.

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).

Online Formats for Astronomy Education

Session organiser: Samir Dhurde,
Inter-University Centre for Astronomy and
Astrophysics, India

Session overview

The internet and its associated technologies have together provided a wealth of opportunities, expanding the reach and approaches of not only science but more importantly science education. In the context of astronomy education this has led to a great increase in the number of resources available online. It can be challenging for novice educators (even experts) and students to filter through these and select the better ones. This session brought together a range of talks and posters, which provided a small snapshot of not only what is available in the context of online resource repositories and formats, but also some of the best practices and solutions related to taking astronomy education online. Some of the resources include e-books, e-course websites, citizen science projects, lab activities, sky viewing tools, and various repositories. The session aimed to show the ease and also the hurdles faced by those who have actually tried their hand at this. It is hoped that it will give the audience enough information and confidence to use an online resource for teaching or starting their own platform. The session mentioned mostly open-source and free content that can address a key barrier related to equity and accessibility. These have to be considered when developing online resources for astronomy education.

Online Resources for Teaching Astronomy

Speaker: Chris Impey, University of Arizona, USA

The growth of the Internet has facilitated the easy availability of resources for teaching astronomy, particularly at the introductory level. This overview concentrates on resources that are free or open access. Basic materials like textbooks, lab activities, and large numbers of astronomical images can be found, along with higher-level items such as concept inventories and interactive instructional tools. Instructors can find teaching guides and tips for interdisciplinary approaches to astronomy. There is also a small but growing research literature on astronomy instruction to be found online. Taken together these resources are of great value to both novice and seasoned instructors.

Talk link: https://youtu.be/tB3-KvJE01I

- -

This brief summary of (mostly free) online resources accompanies an oral presentation for the Online Platform theme at the 3rd Shaw-IAU Workshop on Astronomy for Education.

The Internet has transformed the teaching of astronomy. Before 1995, instructors were mostly reliant on a printed textbook, 35-mm slides, and their own lecture notes. Depending on local resources, they might also be able to incorporate labs, hands-on activities, and the use of small telescopes. Now, they can choose from a wide, and occasionally bewildering, array of online resources to augment what they do in the classroom. The challenge is to find the tools that are either evaluated in peer-reviewed publications or have proven their efficacy in other ways.

Textbooks: A free, open-source textbook introductory astronomy is Astronomy by Andrew Fraknoi, David Morrison, Sidney Wolff, et al., published by Open Stax (http://openstax.org/details/astronomy). Another comprehensive online book, consisting of 520 articles, organized into 19 chapters, is Teach Astronomy by Chris Impey, et al. (www.teachastronomy.com).

Laboratory Activities: A listing of both full collections of lab activities (from university astronomy departments) and a set of individual activities is Compilation of Free Astronomy Lab Activities by Andrew Fraknoi (http://www.fraknoi.com/wp-content/uploads/2017/12/Laboratory-Activities-for-Astro-101.pdf).

Instructional Tools: ComPADRE is a digital library of educational resources in physics and astronomy intended for instructors and students, sponsored by the American Association of Physics Teachers and the American Astronomical Society (https://www.compadre.org/astronomy/). Merlot has college-level educational resources in a wide range of academic disciplines, with about 800 astronomy items (https://www.merlot.org). Hosted by NASA's JPL, the Center for Astronomy Education (CAE) features a large collection of resources that have been tested and validated by fifteen years of research on pedagogy and student learning (https://astronomy101.jpl.nasa.gov/).

Concept Inventories: A concept inventory is a research-based assessment that probes a student's understanding of key concepts in a subject. Typically, it is administered with a carefully defined curriculum, and learning is measured before and after the concept has been covered in class. Key astronomy concept inventories are at https://www.physport.org/assessments/. One early inventory, the Astronomy Diagnostic Test (ADT), can be found at: http://solar.physics.montana.edu/aae/adt/.

Short Videos: Videos can provide useful augmentation or enrichment for an astronomy class. Astronomy has long been well served by long format (video from national media producers such as PBS/NOVA and National Geographic. But a relatively new phenomenon is short format video, often made by individual scientists, NASA or ESA missions, or educators, often with inexpensive equipment. YouTube is the place to find many excellent videos on astronomy; a web search for astronomy returns 2.9 million results, with about 5000 new videos added every day. A few noteworthy resources in this arena include: the Astronomy Crash Course series, hosted by Phil Plait and distributed by PBS Digital Studios (https://www.pbs.org/show/crash-course-astronomy/), the 110 videos made by the AGV team (https://www.youtube.com/ActiveGalacticVideos/), short videos to go with sections of an introductory astronomy course, curated by Andrew Fraknoi (https://www.oercommons.org/authoring/18222-short-videos-for-use-with-each-chapter-of-openstax), collected from space agencies, public TV, observatories, and science museums.

Interactive Tools: Kevin Lee at the University of Nebraska has created a set of interactive materials on astronomy for use at the introductory college level or the high school level. The materials include dynamic think-pair-share questions with 500 items in 22 topic modules (http://astro.unl.edu/classaction/) and 15 online lab modules built around simulations of physics and astronomy phenomena, with students able to set up initial conditions and vary parameters (http://astro.unl.edu/naap/).

Sky-Viewing Tools: The number of programs and apps to help students learn the sky has grown astronomically in recent years, with new and powerful versions coming out regularly. The exemplar of integrating images from ground- and space-based telescope with a view of the night sky is the WorldWide Telescope (WWT), an open-source collection of applications and data, hosted on GitHub, with the data available in the cloud (http://www.worldwidetelescope.org/webclient/). The project provides over 50 examples of "tours" that instructors can use in the classroom to give students a sense of the richness of the night sky. As an extension of its detailed maps of the Earth, Google makes available sky maps (https://www.google.com/sky/), and zoomable maps of the Moon and Mars, including 3D models and 360-degree views. The best open-source planetarium software is Stellarium (http://stellarium.org/), which is supported on all major operating systems.

Citizen Science: Citizen science has millions of volunteers working on thousands of projects across all fields of science, without formal training. For a database of projects, see https://scistarter.com/. The archetypal citizen science project in astronomy is Galaxy Zoo (https://data.galaxyzoo.org/), where non-scientists classified 900,000 galaxies with a reliability similar to that of professionals. Galaxy Zoo expanded a few years ago into Zooniverse (https://www.zooniverse.org/). The site has a million registered volunteers. Astronomical projects include looking for solar coronal mass ejections (Solar Stormwatch), detecting ISM bubbles (Milky Way Project), detecting extrasolar planets (Planet Hunters), analyzing Mars images (Planet Four), looking for stars where planets are forming (Disk Detective), and finding previously undiscovered asteroids (Asteroid Hunter).

Image Collections: The iconic site Astronomy Picture of the Day (APOD) started at the same time as the Internet, in 1995 (https://apod.nasa.gov/apod/astropix.html). Its first post had 14 views, and by 2012 it had reached one billion views. With over 8000 images plus explanatory captions, it is one of largest repositories of astronomical imagery on the Internet. Hosted by the Infrared Processing and Analysis Center (IPAC) and sponsored by NASA, Astropix is an archive of over 7000 images from the world's major observatories (https://www.ipac.caltech.edu/outreach/project/astropix). The largest source of images outside the United States is the archive of the European Southern Observatory (ESO). There are over 12,000 images on their site, plus over 3300 short videos and animations, all free to use for educational purposes (https://www.eso.org/gallery/).

Platforms to Create your Own Online Astronomy Courses

Speaker: Amit Dhakulkar, North-West University, Mahikeng, South Africa

Several online platforms are available for teachers to use, create and host their own Open Educational Resource (OER) courses. But how does one choose which platform to use? To answer this we review some of the common free and open-source platforms that can be used to develop and deliver courses using a rubric developed for this purpose. We discuss the features of the platforms for pedagogical features with a special focus on the requirements of astronomy education. We also discuss technical and infrastructural requirements of the platforms. We will also look at features of the platforms which offer free hosting services for online OER courses. Finally, some aspects of open licensing and its implications specifically for the educational context will also be elaborated.

Talk link: https://youtu.be/G40sWGfqXaE

Online learning has become very significant in the past decade due to increase in computing devices, connectivity and Open Licensing framework. With Covid-19 pandemic, online learning has assumed special significance. Various institutions and individuals offer online courses in the form of Massive Open Online Courses (MOOCs). Creating and deploying courses has become increasingly simple for authors with the rise of several online platforms which allow MOOCs. Several platforms exist offering multiple ways to create and deploy online courses. We discuss some major platforms, their features in the context of Astronomy Education.

Several online platforms are available for teachers to use, create and host their own Open Educational Resource (OER) courses. But how does one choose which platform to use? To answer this, we review some of the common free and open-source platforms that can be used to develop and deliver courses using a rubric developed for this purpose.

We looked at three major free platforms - **Moodle** (GPL V3; https://sandbox.moodledemo.net/), **P2PU** (MIT; https://course-in-a-box.p2pu.org/) and **OpenEdx** (AGPL & Apache; https://studio.edx.org/) - for developing and deploying online courses with the following criteria: Free and Open-Source licensing (not proprietary), Wide usage and Customisable, Self-Management, and Available Support.

The talk presents the basic anatomy of an online course with detailed sharing based on platform features like Learner Interface, Authoring area, Assessments and Analytics that are useful to know for anyone planning to host a reasonably large online course.

Most important for the educators in this session, there is a discussion on the features available for authors and also tips about how to decide on content. In brief, it always helps to have a basic outline which can be modified as required. These platforms may help you better if you have your Learning Objectives clear and also a Course Outline. Some amazing assessment types are available now, which can make the author's life easier and even improve the students' experience.

The above three platforms are also reviewed based on these, as well as their Technical and Infrastructural requirements. These platforms allow you to host the course (or multiple courses) off your own server and so these are important to consider. Of course they also offer free or paid hosting services for online OER courses so that you do not have to worry about the maintenance.

Finally, some aspects of open licensing and its implications specifically for the educational context are also elaborated. Open Educational Resources refer to content which is licensed in a manner which allows for (re)use, remix, adaptation, and distribution with certain conditions. Releasing content with an open license allows for more access and the content can be reused to build other resources. Several astronomical image and data repositories are available as OERs. IAU's astroEDU also has peer-reviewed science education activities. These and many more relevant OERs exist which can help create your course by using, adapting, remixing them. Thus to end, we stress that licensing is important: Please make and release your course as an OER so that everyone benefits!

Create Better Interactive Apps

Speaker: Edward Gomez, Las Cumbres Observatory, California and Cardiff University, UK

Interactive websites and apps are a highly scalable way to share a research topic or educational concept. Before starting on a new project of this sort, you should consider 4 basic principles to ensure your app has the maximum impact. During this talk I will discuss the meaning and importance of these 4 principles. They are "Goals first", "Who is your audience?", "Time is precious" and "Thinking Technology". Finally I will give 2 case study examples of how I used these in projects I have worked on, namely "astroEDU: a peer review platform for astronomy education" and "Star in a Box: an interactive app to explore the lifecycle of stars".

Talk link: https://youtu.be/IyCP-S3_lr0

Starting a new project always holds a lot of excitement, particularly if it is to create an interactive website or app. Be careful not to confuse your excitement for the project with how others will perceive it. I have developed many interactive websites in my career, some have been successful and others, less so. The projects which have both been popular and endured have been ones in which I did not let my, or my team's, excitement run away with the development. We want to maintain enthusiasm for the project but we also do not want to get lost in the details. I use four basic principles for planning projects, see Figure 1.

Goals First: Before you start coding, graphic design work, or content creation, sit down with your team and discuss your goals. What do you want to achieve with this app? Make them concise and few in number. For a small project 1-2 goals are good. For a larger project, setting 3-5 goals is appropriate. Make them general, not too specific. You want the majority of people who engage with your app to achieve their goals.

Who is your audience?: Understanding who your audience is, is crucial to the success of your project. Trying to make your app appeal to everyone is not a good idea, particularly for an educational project. You should at least have a primary audience, e.g., high-school students. It is acceptable to have multiple groups, because there are synergies between different audiences in education, e.g., high-school students and teachers. Refer to your goals to make sure the audience you identify can achieve your goals.

Time is precious: Even if you have done an excellent job of making your app entertaining, there will be an initial threshold the audience needs to get through to get to the interactive part. Make sure that the background information or set up is concise and easy to follow. If your app requires your audience to do a lot of reading, this will turn away some of your audience. If your app is tedious, this will also limit the number of people who complete it, and who achieve your goals. This step is very important to consider in your design and development phase.

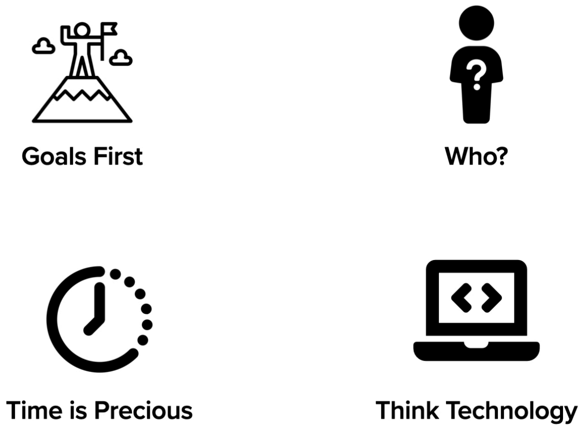

Figure 1: The four basic principles of better app design.

Think Technology: There are many different considerations to consider when developing your project. The audience you have identified may have technological limitations. For example, if your audience is schools in the developing world, you should make sure your website can be viewed using mobile internet and on mobile devices. Your project may also have a life longer than the anticipated lifetime. Plan for who will maintain your app, otherwise technology advances may make your app defunct (e.g., Flash websites are not compatible with modern web browsers). If you are invested in your project, you will become the de facto maintainer.

There are potentially many other stages that you will need to consider to make your app a success, including taking input from your supporting institution or funders. Remember that just because you find your app entertaining and inspirational does not necessarily mean anyone else will. These four basic principles give you a good starting place when developing website content, interactive websites, virtual or augmented reality apps.

A Free Online, Open-source, Introductory Astronomy Textbook

Presenter: Andrew Fraknoi, Fromm Institute, University of San Francisco, USA

The non-profit OpenStax project at Rice U. publishes free, on-line, open-source, textbooks in every introductory field in college/university. The astronomy textbook in their series, by senior authors Andrew Fraknoi, David Morrison, and Sidney Wolff, now has over 1,100 faculty adopters, and has been used by half a million students worldwide. So far it has saved North American students more than 40 million dollars in astronomy textbook costs. The book's development was aided by almost 70 astronomers, who helped with making sure the science was accurate and pedagogy effective. The book is easily updated and has links to a wide variety of web pages and apps. The book's Open Education Resources Hub has over 35 free ancillary materials. See: http://openstax.org/details/astronomy.

Poster link: https://youtu.be/-Xo-SqVE0Gk

The non-profit OpenStax project at Rice University, supported by a group of major US charitable foundations, is working to produce a free, professionally-edited, open-source, on-line textbook in every field in which college students take introductory courses. Currently, they have over 40 such books published.

My coauthors, David Morrison and Sidney Wolff, and I had been writing textbooks for commercial publishers for a while. The publisher of our last book became such a large conglomerate, that they found themselves publishing six competing lines of astronomy textbooks simultaneously! Ours was neglected and left to wither as a result. So, we were delighted to be approached by OpenStax to spearhead the project to write their free introductory astronomy textbook.

The book, cleverly entitled "Astronomy," was published in 2017, and despite the fact that our publisher has no money for publicity or sales reps, it has been found by astronomy instructors looking for ways to reduce the cost of their courses. Today, the book is being used at over 1100 institutions, and has had over half a million student readers. The publisher calculates that this has saved US students more than $40 million in astronomy textbook costs so far. Anyone can read or download the book at: http://openstax.org/details/astronomy.

In producing the book, we had help from over 60 colleagues in astronomy and astronomy education – both with making sure the science was up to date and with assuring effective pedagogy. Among these colleagues are: Debra Fischer (Yale), Heidi Hammel (JWST), Steve Kawaler (Iowa State), Lloyd Knox (U of California Davis), and Martin Elvis (CfA). Available for

Textbook senior authors: Sidney Wolff (NOAO), David Morrison (NASA Ames), and Andrew Fraknoi (Foothill College), seen a few years ago.

on-line reading, and downloadable for all devices (including an OpenStax phone app), the book is being updated regularly. The nice thing is updates only require moving electrons around, and not chopping down trees.

Among the features of the book that colleagues have told us they find useful are:
1) mathematical formulas and worked-out examples are in boxes, so they can be included or skipped as the instructor wishes;
2) each chapter includes a summary, plus review questions, thought-provoking questions, numerical problems, and collaborative group activities;
3) recent web resources (including videos, animations, and apps) are provided as live links throughout the book and more are given at the end of the chapter;
4) profiles of astronomers (past and present) are included in the chapters as boxes;
5) short sections point out connections between astronomy and other fields students know.

A key aim of the book is to present astronomy in ways that are accessible to non-science majors, who make up the vast majority of the students who take intro astronomy in North America. The chapters are filled with analogies taken from the student's own lives; with clear discussions of HOW we know things, not just WHAT we know; and with occasional touches of humor.

The book has an Open Education hub of free shared resources at: https://www.oercommons.org/groups/openstax-astronomy/1283/?__hub_id=27. Adopters can use the hub to get ancillary materials developed by the authors or by fellow instructors, such as: a list of free short videos on the web to go with each chapter of the text, a guide to free lab manuals on the web for introductory astronomy courses, a list of science fiction stories with good astronomy, organized by topic, a guide to including more multi-cultural astronomy in your course, a primer on things a first-time Astro 101 instructor needs to know and do, a resource with many links to the contributions of women to astronomy, a guide to how instructors can respond to pseudo-scientific claims brought up by students (such as moon-landing denial, creationism, astrology, UFOs, etc.), a summary guide to using the free planetarium software called Stellarium, PowerPoint slides with all the book figures, etc.

A new Learning Management System, keyed to the free textbook, has recently been developed by one of OpenStax's partner companies. The system, called Expert TA Astronomy, includes: more than 1100 multiple choice questions, more than 1100 true-false review questions, 276 calculation questions (with different values for different students), 234 graphical questions (including ranking, sorting, labeling, and chapter review.

All of these are automatically graded by the system. In addition, the roughly 800 essay questions from the book are now also included. You have to grade answers to these yourself, but then the grade is added to the gradebook being kept by the system. Expert TA: Astronomy has other security and convenience features that make homework, tests, and grading easier to manage. See: http://theexpertta.com/astronomy.

We encourage you to take a look at the textbook when you have a chance. While it is only available in English at present, we hope one day to see it translated into other languages and used in other parts of the world. If you have any thoughts about the book and how else it can be useful, please feel free to contact the author.

Astronomical Midlands: Engaging Rural and Online Communities in Ireland with Radio Astronomy

(What we have learned from running a variety of online events - Top Tips!)

Presenter: Áine Flood, Trinity College Dublin, UK

We will discuss tried and tested methods for communicating astronomy concepts in an online format. We have used and will examine the pros and cons of various ways to interact with and engage participants and audiences through live video calls. This includes stepping back from the screen for hands-on, tactile demonstrations and activities specifically developed or modified to work in a remote or at-home setting, keeping interest and attention with younger audiences by changing formats and allowing for multiple forms of interaction to suit various learner types, ages and ability levels.

Poster link: https://youtu.be/dlcft1fUNLQ

The AstroLands team at I-LOFAR ran online Astro Camps open to different age groups during school holidays, first in summer 2020, again at the spring/Easter break in 2021 and most recently this summer. The participants were divided by age, and the themes of astrophysics and space science were explored over the course of the camps, running daily from 10am to 1pm.

The sessions were varied to keep interest and focus. Key tips are to be organised, very organised! Test and check all parts of your event, test and become familiar with the platform you are using, have backup options for any technology features and options if participants have trouble with their internet connection, or other issues.

We had an online timetable to hand with links for all materials. Whatever you will need, have it all in one place, so it can easily be found if anything goes wrong or crashes! Also have a backup option for everything. We had all resources for the camps shared and accessible to all facilitators, so that the leading presenter for each section could change at the last minute if necessary.

Wherever possible, have a flexible timetable! "Live" does not always go according to plan, and when it is online there are extra challenges to changing plans on the spot. We did include guest speakers for these camps, but for the most part had them on in the first morning slot, so that if the questions ran on we could modify our own activities to the available time left. The facilitators also kept in touch to communicate any issues or delays using a separate chat platform such as Slack.

Know your capabilities and keep numbers restricted if necessary. For these camps, numbers were strictly limited to allow for an immersive and interactive experience. With three facilitators, we restricted the capacity to 21 participants per camp. This allowed for all to have a chance to ask questions of guest speakers and participate in group discussions, and three breakout rooms with small groups of seven participants, ideal for all to be fully involved in the activities. Do make use of helpful technology features, such as breakout rooms. This is especially helpful with a young audience to keep things moving and fresh.

It is important to keep the structure varied. For these camps we switched between listening and discussing to more involved hands-on activities. Typically, we would have a guest speaker come to chat to the group and answer any questions they had. We followed the talk with an activity, split into breakout rooms and got hands-on with a building, designing or creative task. The aim with this was to step back from the screen as much as possible for a more tactile experience. This was followed by a short break allowing for the breakout rooms to finish at slightly different times without impacting the next session.

With all guest speakers it is important to arrange a call prior to the event. This goes for all events, but was vital for the online Astro Camps. A short informal chat allowed us to get across the type of event we were creating, the tone and level it should be pitched at to create the right atmosphere, and also do practical checks such as screen sharing and presenter access on the video call platform. For these camps a casual, informal but of course well informed tone worked best.

It is important to remember there are benefits to running camps and workshops online. Although different to an in-person experience, it does allow people to join from wherever they are, and with younger participants we found that some with anxiety issues or different learning needs were more comfortable participating from the safety of their own home, and the option to interact and ask questions via the chat box instead of speaking up was appreciated.

Astronomy and Remote Learning: A Stellar Combination

Presenter: Christine Hirst Bernhardt, University of California, Santa Barbara, Endeavor STEM Teaching Project, USA

Next Generation Science Standards (NGSS) aims to bring Earth and space science to K-12 standards since now this comprises nearly 25% of all science content in US education system. This poster will spotlight several remote astronomy investigations, which are embedded into NGSS courses, while providing curricular justification. Spotlight lessons include: Satellites and Social Justice, Satellite Dynamics, Starlight, Solar Observations, Investigating Lunar Craters, and Citizen Science Aboard ISS. Participants will gain access to over a semesters' worth of take and go remote astronomy lessons for grades 7-12, in any NGSS course. Lessons can be taken as a sequence or a snapshot, and are ready to embed into a LMS.

Poster link: https://youtu.be/uvi1c42YlgA

Every child looks up at the moon in wonder and curiosity, yet for years astronomy education has had no place at the roundtable of K-12 standards. Fortunately for space enthusiasts, the advent of NGSS has changed that trajectory. Earth and space science have been elevated to National importance, and comprise nearly 25% of all science content in new standards. Despite this drastic shift, few teachers have the necessary background or resources to integrate these new topics. Further, many teachers are currently adapting their entire practice, including new topics, into remote environments. This setting is fortuitous for astronomy education; many resources can be easily integrated into remote settings, and even allow for greater investigation than in a face-to-face setting. Astronomy education has the capacity to empower students to investigate and design solutions to real world problems, while the space environment presents evidence for global patterns of change. This session will spotlight several remote astronomy investigations which are embedded into NGSS courses, while providing curricular justification. Spotlight lessons include: Satellites and Social Justice, Satellite Dynamics, Starlight, Solar Observations, Investigating Lunar Craters, and Citizen Science Aboard ISS. Participants will gain access to over a semesters' worth of take and go remote astronomy lessons for grades 7-12, in any NGSS course. Lessons can be taken as a sequence or a snapshot, and are ready to embed into LMS. Each lesson focuses on the value of studying space, and the implications for society. Lessons address equity in STEM, and are scaffolded to multiple modalities of learning, while utilizing real-time data (solar observations). Each lesson is free, and requires only internet access. Teaching remotely may present new challenges, however teaching space content should not be one of them. This workshop will provide resources for easy integration of topics, to maximize student engagement.

References: www.astrolessons.com, stellarium.org.

Teaching Online K-12 Astronomy in the USA

Presenter: Denise Wright, NASA Johnson Space Center Houston, NASA Playground, ISTE, USA

Schools across the United States have explored online learning options due to a shortage of K-12 teachers who specialize in physics/astronomy. In some schools astronomy is not offered because it is considered an elective course. Recently, a rise in online learning has occurred in the US due to the virus COVID 19. This has caused many students and teachers to pivot from face to face teaching to the online learning model. When designing and planning an online astronomy course, there are many considerations, for example, what type of learning management system will be used to deliver the course content? What units will be developed in an online high school astronomy course? This session will highlight the creation of a US high school level astronomy course using open education resources (OER) to educate students in an online learning model.

Poster link: https://youtu.be/ecTFFHg-jW4

In the United States, many K-12 schools are exploring the option of astronomy online education. Three reasons that astronomy is being offered through online learning are the shortage of earth science educators, the worldwide spread of COVID 19, and astronomy being considered an elective course, and thus, in some cases, not fitting into the public school schedule. Online learning has the opportunity to remove many of these barriers for students.

When designing an online astronomy course, a learning management system is required to develop the content. Moodle is the open-source learning management system that was chosen for this course. Moodle allows for a variety of online activities that may include forums, quizzes, tests, drag and drop items, and interactive assignments created and integrated by third party software such as H5P (https://h5p.org/). Moodle has many accessibility options for learners, such as screen reading, a consistent course layout, and multiple ways to provide written, audio, and video feedback on assignments.

Each unit for this online high-school astronomy course was created with a backwards design unit plan. This unit design pedagogy was originally published in the book "Understanding By Design" by Wiggins and McTighe. The overall goal of the backwards design unit plan is for educators to create each unit with the end goal and work backwards to design the learning experiences. In this high-school level astronomy course, the units that are included are: Unit One: Observing Our Night Sky, Unit Two: Nature and Light of Telescopes, Unit Three: Life and Death Of Stars, Unit 4: Incredibly Massive Objects and Gravity, Unit 5: Our Amazing Sun, Unit 6: Earth and Its Satellite , Unit 7: Planetary Motion and Gravitation, Unit 8: Our Solar System: Terrestrial and Jovian Planets, Unit 9: Comets, Nomads, and Exoplanets, Unit 10: Galaxies, and Unit 11: Cosmology.

The individual course lessons have been designed for students to learn about the foundations of astronomy. Some of the assignments include virtual labs, free mobile/ipad astronomy apps, open-source software, such as Stellarium, and close captioned videos from NASA. The students become citizen scientists by participating in several Zooniverse (https://www.zooniverse.org/) projects that are embedded in the course. Citizen science projects allow everyday people to help astronomers conduct simple scientific research. A few examples of citizen science projects that students participate in through the course are locating comets in a picture taken from a telescope, searching for exoplanets based on light curve data, and classifying galaxies based on their shape. Another exciting opportunity for students is that they have the ability to view the night sky with the South Carolina State Museum Observatory (http://scmuseum.org/explore/observatory/) distance-learning telescope. The telescope is a 1926 12 $\frac{3}{8}$ inch Alvan Clarke Refractor. It was retrofitted with a web camera and Sky Net, so that classrooms can go into live virtual meetings and have lessons on the moon, stars, and visible planets. The addition of the distance-learning telescope adds a higher level of engagement in the astronomy online course. The opportunity for high-school students to take an astronomy course online, provides an experience they may have not had and creates a modern understanding to this gateway science that inspires people of all ages and every culture.

Discussion summary

Some pertinent issues raised during the discussion included how to get new teachers and audiences into online learning, how to make content engaging and interactive, and how to provide feedback to students in relevant and familiar ways. A basic solution of a web-based free repository, along with live video calls, has been tried by some. More advanced solutions like hosting an online course may require some specialised help, for which teachers can refer to this session's content and also take help of any local tech experts or IAU OAE. Here it will be best to use open-source tools, which are also easy to get support for. The issue of engagement could be addressed by including exciting things like hands-on activities, astronomical images etc. Some teachers will find this shift daunting, due to lack of confidence, time or infrastructure. These could be reduced by tying up with local education/tech experts or through a community of practice. Resource producers could engage teachers at their local conferences, use live demos and support them to use online formats/resources for astronomy education. There are also the barriers of accessibility, including access to the internet itself. It was noted that there are examples of resources like an online course, running via a locally stored offline version. Other sessions in the workshop have also discussed accessible, low-cost and low-tech teaching ideas, which could be referred to in this case.

http://astro4edu.org

@astro4edu

IAU OFFICE OF ASTRONOMY FOR EDUCATION

OAE