Astronomical Data Analysis Software and Systems XX
ASP Conference Series, Vol. 442
Ian N. Evans, Alberto Accomazzi, Douglas J. Mink, and Arnold H. Rots, eds.

Astronomy Visualization for Education and Outreach

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Abstract. About 50 participants came to a discussion on the benefits and potential obstacles of using astronomy visualization tools for education and public outreach (EPO). Representatives of five different EPO organizations shared information on their project goals and outcomes. Public users need support to learn how to use these programs effectively for education, but the efforts are worthwhile because the thrill that comes from working with real data and the natural beauty of astronomical imagery are great attractors for new science enthusiasts.

1. Introduction

Scientists and educators have an opportunity to engage the public and improve science education through the use of freely available professional data visualization tools. These tools, coupled with vast archives of data, give educators the potential to reach any demographic, anywhere in the world, so long as the users have a computer and an internet connection. Klahr et al. (2007) have shown that on several different measures, children were able to learn as well with virtual as with physical materials, and the inherent pragmatic advantages of virtual materials in science may make them the preferred instructional medium in many hands-on contexts.

The main obstacle to widespread use of these tools by the public and in classrooms is the learning curve associated with them. Primary and secondary school teachers sometimes require support in astronomy content as well. Appropriate training for teachers and lay-users, whether by the scientists themselves, or by designated instructors trained by the scientists is essential to success of these programs.

2. Education and Outreach Programs Using Astronomy Visualization Programs

During the BoF, we heard about five organizations around the world that use astronomy visualization tools in education and public outreach. Here we summarize the contributions from each program presented during the BoF.[1]

2.1. WorldWide Telescope Ambassadors Program (Alyssa Goodman)

The WorldWide Telescope Ambassadors (Goodman et al. 2010) are astronomy experts who use WorldWide Telescope (WWT) to educate the public about astronomy, space, and physics. Ambassadors and learners alike use WWT to create dynamic Tours of the Universe, and they share them in schools, public venues, and online.

In spring 2010, we began a pilot with 6th graders at a middle school near Boston, MA, where students used WWT to supplement their traditional textbook materials while studying curricular subjects like Earth/Sun/Moon relationships. Students also used WWT during a 6-week independent research project, creating Tours to share what they learned with classmates. The students we worked with showed measurable gains in interest in astronomy and science, and in their ability to visualize complex 3-dimensional relationships. The gains found were in comparison to another group of 6th graders at the same school who did not use WWT. In a survey, 71 out of 72 students were highly positive about WWT, telling us that "learning about our Universe by actually seeing and exploring it makes it easier to contemplate and more fun," and "it gave me a better mental map of the universe." One particularly enthusiastic student described working with WWT as "awesome, amazing, cool, incredible (repeat 30 times.)" We are now expanding the program to additional schools in Boston and beyond.

We are currently building a collection of WWT Tours that spans across a broad spectrum of astrophysics topics. The Tour collection will be integrated with WGBH Teachers' Domain, a freely available online service including 500,000 registered users.[2]

2.2. The European Virtual Observatory for Students and Teachers (Riccardo Smareglia)

The EuroVO-AIDA project (Ramella et al. 2010) aims to extend the benefits of the Virtual Observatory for professional astronomers to students and teachers. The core of our products are a) professional software tools adapted to the special needs of schools and young users (Aladin, Stellarium, SimPlay) and b) a library of use cases presenting simple astronomical problems (such as celestial coordinates, distance determinations, and stellar evolution) and a step-by-step guide to their solution with VO data and tools.

Our products have been developed in two one-year cycles. During the first cycle we used an initial adaption of Aladin and Stellarium and a first set of use cases for a total of more than 200 hours in classes of selected middle- and high-schools. During the second cycle we tested the ability of teachers to use our products autonomously. At the end of the school year we implemented as many suggestions of our testers as possible and released our products to the public. In the end, more than 1000 students and 150 teachers participated to the development of our software and use cases.

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[1] Speakers at the BoF are listed in parentheses after each group; contributors to the proceedings text are in the author list; program websites and key members of the organizations are listed in the References.

[2] www.teachersdomain.org

At the Trieste Astronomical Observatory we complement VO tools and use cases with observations at our remotely controlled telescope.[3] The combination of the two activities gives an involving glimpse of the "real" astrophysical research.

2.3. HelioLab (André Csillaghy)

HelioLab aims to create awareness among the public that the Sun is actually an object of current research, and that many scientific products are freely available to all (Sathiapal et al. 2010). HelioLab consists of three interlinked modules: the weblab, the schoollab and the expolab. These are linked to online resources such as near real-time images from the Solar Dynamics Observatory (SDO) or the Solar & Heliospheric Observatory (SOHO).

The schoollab is a kit with observation instruments and activities that a scientist brings into the classroom. It supports scientists working with young children, encourages elementary school teachers without a background in science to teach science subjects, and provides an opportunity for K-6 students to get to know a scientist as an active partner in a school project over an extended period of time. The expolab is a similar collection of ready to use educational material for public events. The weblab is a webpage that introduces heliospheric science to the general public. It contains instructions for building a simple observatory at home and provides access to a variety of information related to research in heliophysics. The weblab will be translated into several languages in order to increase the bridging effect to the online resources. HelioLab is an EPO service by HELIO — The Heliophysics Integrated Observatory funded by the European Commission's 7^{th} framework program.

2.4. ALFALFA and Google Sky (Brian Kent)

The Arecibo Legacy FAST ALFA Survey (ALFALFA) has utilized Google Sky as an environment to disseminate radio astronomy data for education and public outreach. Upon processing by members of the spectroscopic survey collaboration, galaxy catalogs and spectra are exported to a database that can be called via the project website, web services, or external applications including Google Sky (Kent et al. 2008). The size and transparency of data symbols can be manipulated in Google Sky KML (Keyhole Markup Language) files to represent quantities such as luminosity and mass. Users can also click on a galaxy to retrieve database information, images, and spectra. The radio data are an excellent complement to the underlying imaging as they show the nearby gas-rich universe within 250 Mpc.

Undergraduate students participating in the ALFALFA program use Google Sky in this manner to study HI mass functions of spiral galaxies. The interactive program environment allows students to engage immediately with the data.

2.5. Network for Astronomy School Education (Carlos Gabriel)

The International Astronomy Union's Network for Astronomy School Education (NASE) provides astronomy training to primary and secondary school teachers in developing countries (Ros et al. 2010). The NASE group organizes courses to train teachers in different regions of the globe, giving them an opportunity to learn the astronomy content and perform hands-on observations at their schools. During a typical course, 40–

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[3] `http://scuole.oats.inaf.it`

50 school teachers are taught by 6 NASE and IAU members during 4 days of classes. The teachers who attended then receive support from NASE to reproduce the training they received in their own region or country. Courses have recently been completed in Argentina, Peru, Nicaragua, and Colombia. The educational resources and course materials are currently available in English and Spanish, and translations into Arabic, Portuguese, and French are planned.

3. Conclusions

Several noteworthy points were raised during the discussion. Participants observed that publicly funded astronomical collaborations around the world are required to allocate a certain percentage of their budget to EPO work. However, the reality is that EPO work frequently remains understaffed, and we can make more progress if scientists dedicate time and resources to helping the public understand what we do. Some members of the audience pointed out that there are language and other international barriers to accessing educational content from different countries. We note that several of the organizations here already have translated or have plans to translate their materials into multiple languages. Finally, we discussed the fact that astronomy is frequently left out of "essential" curriculum topics, making it a challenge to engage teachers willing to devote time to it. We argue that astronomy's universal ability to excite, amaze, and inspire, makes it an essential gateway to the study of science, and crucial scientific skills such as observation, and hypothesis making and testing, can be learned through astronomy as well as any other science.

Acknowledgments. The WWTA team would like to thank Microsoft Research for funding the WWTA pilot project discussed in Section 2.1, and we thank all the BoF participants who shared information on their projects and everyone who participated in the discussion.

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