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Dishoeck, E.F. van

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Opening Session

Introduction

IAU President, Ewine van Dishoeck, gave enlightening remarks to open IAUS 367 Education and Heritage in the Era of Big Data in Astronomy. She began by recognizing this as the first IAU symposium dedicated to education and also that it is the first to be fully virtual. She said that while far away, we were more connected than ever. She discussed the IAU and its organization, including the roles played by its offices, divisions, commissions, and working groups. Ewine continued with outlining worldwide IAU networks and programs such as the Office of Astronomy for Development (OAD), Office for Astronomy Outreach (OAO), National Astronomy Education Coordinator (NAEC) teams, and the Network for Astronomy School Education (NASE). She emphasized that these groups help to educate the next generation of astronomers. She provided a most fitting opening to a groundbreaking symposium.

The IAU and Education: Introduction

Ewine F. van Dishoeck , IAU President

Leiden Observatory, Leiden University,
P.O. Box 9513 NL-2300 RA, Leiden, the Netherlands
email: ewine@strw.leidenuniv.nl

Abstract. This paper provides a brief overview of the many facets of astronomy education and heritage, and how the IAU stimulates them. Activities range from training in astronomy through scientific meetings and schools for young astronomers, to using astronomy as a tool for development and for stimulating science education at school level. Communicating astronomy with the public and engaging in outreach activities with children to inspire curiosity is yet another way of how astronomy can help build a literate society and install a sense of global citizenship. The involvement of many people at all levels is key to success.

Keywords. Astronomy education, Outreach, Development, IAU Strategic Plan

1. Introduction

The mission of the IAU is to “promote and safeguard astronomy in all its aspects (including research, communication, education, and development) through international cooperation,” as approved the XXXth General Assembly of the IAU in Vienna (Elmegreen & van Dishoeck 2018). The text in parenthesis is new and makes it explicit that the IAU has branched out beyond its original purpose of sharing astronomical knowledge and fostering communication among professional astronomers. Education is at the heart of many of the IAU activities.

The IAU is organized in Divisions, Commissions and Working Groups. Of particular relevance to this symposium is Division C on *Education, Outreach and Heritage* with 2385 members of the total ~12000 IAU members. Specifically, Commission C1 on “Astronomy Development and Education”; Commission C2 on “Communicating Astronomy with the Public”; and Commission C4 on “World Heritage of Astronomy” are active on the topics of this symposium. Big Data is part of Commission B2 of Division B on “Facilities, Technologies and Data Science”.

Over the last decade, the IAU has created four Offices that enable the expanded vision (Fig. 1):

- *OYA*: The *Office of Young Astronomers*, hosted by the Norwegian Academy of Science and Letters, focuses on the training of young astronomers at University level, and organizes the International School for Young Astronomers (*ISYA*).
- *OAD*: The *Office of Astronomy for Development*, hosted in Cape Town South Africa in partnership with the NRF, focuses on the use of astronomy for development by capitalizing on the field’s scientific, technological and cultural links and its impacts on society.
- *OAO*: The *Office for Astronomy Outreach* is a partnership with the National Astronomical Observatory of Japan, and focuses on providing access to astronomical information and astronomy communication with the general public.

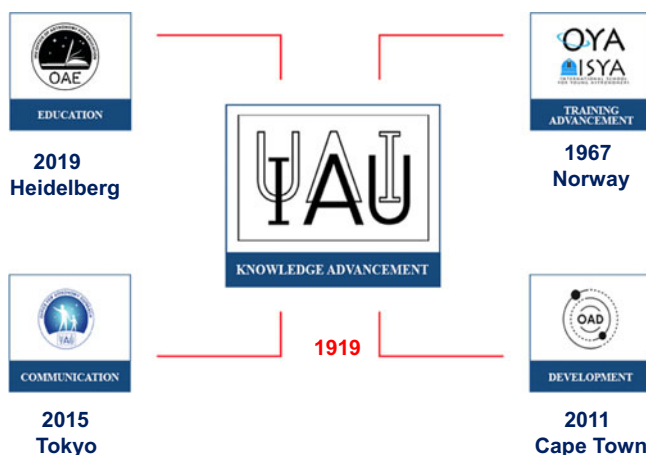


Figure 1. Offices of the IAU and their main missions. All of them have connections to education and there are many interactions between the Offices.

– *OAE*: The *Office of Astronomy for Education*, hosted at the Haus der Astronomie in Heidelberg Germany, focuses on providing resources and training for using astronomy as a stimulus for teaching and education from elementary to high school level (astronomy and science education).

Each of these Offices also have their own networks of coordinators worldwide, such as the National Outreach Coordinators (NOC) and the National Astronomy Education Coordinators (NAEC) networks and the regional nodes of the OAD (ROADs). These networks bring in huge additional manpower and resources to carry out the mission of the IAU. The IAU Strategic Plan is described in more detail in the paper by Hearnshaw (this volume). See also Andersen *et al.* (2019) for the first 100 years of the IAU and van Dishoeck (2019) for a vision of the IAU as it enters the second century of its existence.

2. The IAU and Heritage

The night sky is available to everyone anywhere in the world, and forms an integral part of the environment that is experienced by humankind. Cultural heritage related to the night sky is therefore a vital component of cultural heritage in general. Across the world, there are an impressive number of astronomical records, sites and landscapes providing testimony to the diverse ways in which humans have viewed their connection with the universe from the earliest times to the present day (Ruggles 2015). The IAU through its Commission C4 works with UNESCO to recognize and raise awareness of the importance of astronomical heritage worldwide and to facilitate efforts to identify, protect and preserve such heritage for the benefit of humankind[†]. This includes protection of the visibility of the night sky itself. Heritage and education go hand in hand through the fascinating stories that are associated with historical records and sites.

3. The IAU and Education: astronomy training

Education is embedded in the IAU at many different levels. Starting at the top, most IAU members are also educators at their universities by teaching classes at undergraduate and graduate level and training students in astronomy research. This includes teaching astronomy to non-science majors, providing them with a formal exposure to science.

[†] <https://www3.astronomicalheritage.net/>

Many excellent textbooks are available, some of them now also open source or accessible through on-line websites and videos. A role for the IAU could be to curate and raise awareness of the available material, provide access to reviews of best practices in college education, and help getting material translated into other languages. Some of this work is being undertaken by Commission C1.

PhD students and young astronomers further benefit from international meetings, including the IAU Symposia, Regional Meetings and General Assemblies which stimulate worldwide attendance and enable participation through travel grants. The IAU Junior Members (at postdoc level) have an active working group that organizes activities to stimulate personal development. The annual IAU PhD Prizes honor the best PhD theses in each Division, whereas the annual Gruber fellowships support high quality research of young astronomers, notably from countries in difficult economic conditions.

At MSc and beginning PhD level, the ISYA schools have played a key role in the development of astronomy worldwide. These three week schools, about 3 every 2 years, take place in developing countries and provide lectures and hands-on training at telescopes to about 30–50 students each. Since their start in 1967, more than 1600 students have been trained in total, many of which have gone on to become professional astronomers and leaders in their countries. They also build lifelong connections during the schools.

Progress in astronomy goes hand in hand with new large facilities. A key advantage of astronomy compared with other disciplines is that the bulk of the astronomical data are publically available, with major organizations having invested billions of dollars, Euros or Yens to make this possible. This means that anyone in the world can carry out frontline astronomy provided she/he knows how to access and work with the data. Starting late 2022, the IAU plans to organize annually two workshops to provide hands-on training through the I-HOW (IAU Hand-On Workshops). These workshops are aimed at PhD students, postdocs and young staff members in developing countries.

The OAD also regularly supports regional schools for BSc and MSc students on specific scientific topics, which often include a component of hands-on training in observations or working with Big Data sets. Astronomy for development can only happen if there is also development of astronomy in a country. Examples include the West African International Summer School for Young Astronomers, the Guatemalan School of Astrophysics, ArAS school for astrophysics in the Arab world, and the Joint Exchange Development Initiative for Africa (JEDI).

4. The IAU and Education: astronomy for development

Training in astronomy prepares students for much more than a career in astronomical research or instrumentation. The skills acquired in analyzing big data sets, performing large scale simulations, building and working with front-line technology or solving inherently complex and multidisciplinary problems makes astronomy students attractive to a wide range of sectors in society. Such a flow of talented people from astronomy to society is healthy and should be stimulated.

The OAD was established to promote the use of astronomy as a tool for development in every country. The OAD uses the UN Sustainable Development Goals (SDGs) as the global definition of development, for example in its annual call for proposals. The Regional Offices (ROADs) form the global core structure of the OAD, recently strengthened by the establishment of ROADs in Europe and the US. Interactions between them stimulate synergies, educate each other on tools and activities, but also raise awareness about cultural differences. Collaborations with fields other than astronomy are also included, such as the space sector, ICT, branches of social sciences and humanities, relevant industries and NGOs, art and cultural organisations. In this regard, the OAD serves as a ‘hub’ for collaborations across disciplines.

The OAD is currently developing a number of flagship projects that can serve as “signature dishes” and which have educational and/or heritage aspects. The first flagship centers on Astronomy for Socio-economic Development through Astrotourism: the use of small telescopes or mobile planetaria to stimulate the development of eco-tourism and create livelihoods in remote villages, with the dark night sky serving as the natural asset. The second one highlights Astronomy for Peace, Diplomacy and Global Citizenship with a particular focus on the Pale Blue Dot program (see below). Flagship 3 uses Astronomy Knowledge and Skills for Development, most notably using Big Data. This includes a fruitful partnership with the DARA Big Data project (Scaife & Cooper 2020).

5. The IAU and Education: astronomy for education at schools

The OAE provides a natural platform for promoting the use of astronomy as a gateway to STEM (science, technology, engineering, and mathematics) fields for young people. The OAE supports the astronomy community and educators in bringing the fascination of astronomy into schools at primary and secondary level. A worldwide network of National Astronomy Education Coordinators (NAECs) and Regional Education Offices are being established. Together, they promote astronomy in national curricula, identify accessible materials and set astronomy literacy guidelines (and liaise with education offices at ministries and with curriculum experts), support teachers with evidence-based education research and material (e.g., the “Big Ideas in Astronomy” booklet), encourage standards for teacher training activities, and help the community with its professional development (see Pompea & Russo 2020 for review).

The IAU is active in various other educational activities at school level. For example, Commission C1 has started the bi-yearly AstroEDU conferences and supports the AstroEDU website with peer-reviewed educational activities. In the context of its 100yr celebration[†], initiatives included the Einstein schools, Astronomy Day in Schools, and support for teacher trainings (inherited from IYA2009) such as the Galileo teacher training, Network for Astronomy School Education (NASE), and Open Astronomy schools. Some of these activities will be embedded in the OAE in the future.

6. The IAU and Education: communicating with the public

Education also takes place more informally by communicating results to the general public and through engaging in outreach activities with them. This is the mandate of the OAO, and its long term vision is that that all people throughout the world will have access to knowledge of frontline astronomy; that all countries will have good access to astronomical research, culture and experiences to help build a literate society; and that astronomers are a strong part of the global citizenship.

The OAO generally does not create material itself, but works with the IAU and other organisations to increase the impact of its activities in education and public outreach. As such, it reaches the general public from the youngest children in kindergarten to families and senior citizens. Outreach is a strong component of many different units within the IAU, and the OAO interfaces with all of them. For example, the OAO works with Commission C2 to edit the “Communicating Astronomy with the Public” (CAP) journal as well as an Astronomy Outreach Newsletter, and co-organizes the biennial CAP conference. The OAO also provides easily accessible public-friendly information on astronomical terminologies and objects in the universe, and coordinates some of the worldwide citizen-science projects and campaigns, such as the public exoplanet naming IAU100 competition.

[†] www.iau-100.org, www.iau.org/static/archives/announcements/pdf/iau100-final-report-ann20019.pdf

The OAO NOCs are also the formal point of contact for engagement with amateur astronomy groups within each country. Amateurs, in turn, educate the general public in astronomy through the many events at their public observatories. Science museums and planetaria can also play a major role in this. Furthermore, the NOCs play a role in educating the public about the importance of the dark and quiet skies, including the recent threats that increased light pollution and the launch of satellite constellations pose not just for scientific exploration but also for public health and as cultural heritage[†].

The OAD and OAO collaborate on the Pale Blue Dot Flagship, an education project that uses astronomy to promote a sense of global citizenship in young children. It is targeted at disadvantaged children aged 5 to 8, and builds on the “Universe Awareness” program led by Leiden Observatory. The fragility of our planet Earth as seen from space also provides an entry point to educate children about sustainability and climate change. As highlighted by Minister Pandor at the United Nations GA 75 Dialogue on “Astronomy: A unique educational tool for furthering the SDGs and stimulating a global perspective” (September 2020): “*Astronomy, more than any other science, inspires curiosity, optimism and hope in children*” (paraphrased).

7. The IAU and EID

Equity, inclusion and diversity (EID) are embedded in all IAU activities and are stimulated through the promotion and implementation of policies, structures, and programs such as those described above. The IAU has two working groups, on Women in Astronomy and on EID, that report directly to the Executive Committee. Following IAU Symposium 358 on “Astronomy for Equity, Diversity and Inclusion - a roadmap to action within the framework of the IAU centennial anniversary” held in Tokyo in 2019, a Springboard to Action[‡] was published in early 2021. This booklet sets out recommendations to IAU National and Individual Members to work towards the more diverse and representative global astronomical community it envisions.

Recent highlights of the IAU’s efforts on EID include “Inspiring Stars”, an itinerant exhibit on astronomy for inclusion, “Hands in the Stars”, the first international comparative list of astronomical words in sign languages, and several projects on astronomy for the visually impaired. As part of IAU100, global projects were carried out in 143 countries under the specific IAU100 theme “Inclusive Astronomy”, which supported events like the IAU100 “Women and Girls in Astronomy”, “NameExoWorlds”, and “Astronomy Day in Schools”, and more recently the OAO “Telescopes for All” projects.

8. Concluding remarks

This brief introduction has highlighted the many facets of education and heritage, and the role that astronomy and the IAU play in them. Education continues throughout people’s lives and requires at each stage not just good teachers and high quality materials but also the skills to engage with students. The words of Benjamin Franklin resonate with what the IAU aims to establish: “*Tell me and I forget; teach me and I may remember; involve me and I learn.*”

To make the IAU dream into a reality requires involvement from everyone, from research professionals to educators and students. The IAU is therefore grateful to its Offices, their Networks and Regional Offices, its membership and the many other people who have contributed as volunteers to “*use astronomy to make the world a better place*”

[†] www.iau.org/news/announcements/detail/ann21002/

[‡] www.iau.org/static/publications/springboard-booklet-150dpi-2page-view.pdf

(Govender, priv. comm.). This includes the organizers of this symposium! Let's make sure to harness the inspiration of astronomy for science education: together, we can make it work.

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