

Closing Remarks

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Abstract. This symposium has highlighted key first steps made in addressing many goals of the IAU Strategic Plan for 2020–2030. Presentations on initiatives regarding education, with applications to development, outreach, equity, inclusion, big data, and heritage, are briefly summarized here. The many projects underway for the public, for students, for teachers, and for astronomers doing astronomy education research provide a foundation for future collaborative efforts, both regionally and globally.

1. Introduction

This symposium, the first fully virtual one of the International Astronomical Union, provided a positive experience in a year otherwise marred by the global pandemic. While we all missed a face-to-face gathering, this online meeting allowed a much larger audience to share ideas about education, astronomical heritage, and big data than would have been possible in person, with more than 600 participants from around the globe.

The IAU, initially founded a century ago to share scientific ideas among astronomers, has evolved to include a much broader perspective. This is reflected in its expanded mission statement to “promote and safeguard astronomy in all its aspects (including research, communication, education and development) through international cooperation,” as stated in the Strategic Plan for 2020–2030[†]. In her opening remarks, President van Dishoeck noted that our research-based efforts represented by nine scientific Divisions and dozens of Commissions and Working Groups are linked to four outward-looking essential and interconnected cornerstones of the IAU, which are the Offices of Astronomy for Development, for Education, Outreach, and Young Astronomers. Global initiatives such as IAU100 have engaged several hundred thousand people in education, heritage, and outreach activities.

IAU Vice President Hearnshaw reflected on the deliberate evolution and transformation that the IAU has undergone, particularly over the last half century. The five main strategic goals of the IAU include worldwide coordination, fostering communication, dissemination of astronomical knowledge, inclusive advancement of astronomy, using astronomy as a tool for development, engaging public through access to astronomical information, and using astronomy for teaching and education. A new Code of Conduct includes an ethics policy and an anti-harassment policy, applicable to all IAU functions so that everyone feels welcome. The Strategic Plan provides a blueprint both for social revolution in astronomy, and for using astronomy to make progress in society. This symposium has taken the first steps in addressing many of these goals, and in paving the way for future collaborative efforts both regionally and globally.

[†] <https://www.iau.org/administration/about/strategic-plan/>

2. Highlights

Highlights of the symposium included discussions about astronomy as a tool for development through human capacity-building, astronomical heritage and culture, databases and online resources, teacher training and student workshops, women, diversity, and inclusion in astronomy, OAE strategic plans, astronomy education research, engaging through museums, planetaria, astro-tourism, eclipses and citizen science, and astronomy as a STEM gateway. Brief summaries are listed below, with invited speakers noted whose papers appear in this Proceedings.

OAE Director Pössel described the newly formed Office of Astronomy for Education, headquartered at the Haus der Astronomie, and National Astronomy Education Coordinators (NAECs; already 300 in 80 countries), along with OAE centers and nodes. Efforts are underway to provide teachers with access to high-quality resources, hold schools for astronomy education, define standards and create databases for resources and disseminate best practices for teaching and evaluation, as well as foster connections among teachers, astronomers, and the astronomy education research community. Division C President Deutsua described the IAU strategic plan for educational efforts, and the reorganization of the division (which includes education, outreach, and heritage) and its Commissions and Working Groups to complement OAE efforts. The Network for Astronomy School Education (NASE) teacher training schools and newly formed Astronomy Education Journal are housed in the division.

A comprehensive review of astronomy teaching over the past century points to avenues for future astronomy education research, such as methods to develop cognitive and spatial skills in addition to knowledge content (Fitzgerald). An AER database has been developed as a resource to the community. In teaching astronomy and engaging with the public, it is important to respect and be aware of cultural and social diversity, non-Western as well as Western heritage, and archaeoastronomy to emphasize that astronomy connects all of humanity (Camino, López, Gangui, González-García). Recognition of cultural and social roots of astronomy is a key for engaging local communities in development. IAU-UNESCO efforts are underway for the designation of astronomy heritage sites.

Research and public engagement in solar eclipses were discussed, with a view towards the eclipse at the conclusion of this symposium (Pasachoff, Young). Posters and oral contributions highlighted pandemic-driven efforts to develop online learning methods even in remote regions. STEAM activities, multidisciplinary and interdisciplinary approaches to teaching astronomy, robotic telescope observations, museums and planetaria (some online), virtual observatories, heritage sites, astro-tourism, hackathons, and the IAU International Schools for Young Astronomers (ISYA) are all areas of ongoing activities.

Data-driven activities play important roles in astronomy education, outreach, and public science literacy (Soonthornthum, Li). Open access to data is vital for public communication and education as well as for astronomical research. The free and open source platform desktop planetarium program Stellarium (Zotti) provides multi-language support and multi-cultural constellations and mythological figures as well as vantages from archaeoastronomy sites. For teaching and outreach there is a wide variety of online resources, including free online textbooks, lab activities, videos, sky-viewing tools, interactive simulations, image collections, citizen science projects, podcasts, and virtual worlds (Impey).

Discussion of diversity and inclusion in STEM activities included the fact that less than 30% of scientists worldwide are women (and the percentage of astronomers who are women is half this value), so a global cultural change is needed to achieve equity (Hallberg). It is also important to have diverse role models so that everyone can see

themselves reflected in real scientists. This is critical, since a diverse astronomical community fosters ideas and advancement. The future is in the hands of young astronomers, who connect with subsequent generations through their outreach efforts (Ödman).

One impediment in science involves career moves, and ASTROMOVES is a project that examines the associated issues and impacts (Holbrook). Posters and discussions on these topics included STEM for girls, and girls & women networks to provide role models and foster connections. There are many activities and exhibits designed for the hearing-impaired and visually-impaired to make astronomy more accessible to all. There are also outreach activities in such diverse settings as children's hospitals, homes for the elderly, and institutions for youths. Furthermore, lifelong learning is a key to addressing many challenges that communities face, so ongoing accessibility to knowledge is crucial (Hammer).

Astronomy for development touches on many of the United Nations Sustainable Development Goals. Because astronomy is a source of inspiration, astronomy education is a primary contributor to development by leading to many other technological and scientific interests (Soonthornthum, Ödman). New ideas have arisen at the boundaries between astronomy and other fields, and engagement in research develops skills that lead to progress through interdisciplinary approaches to problems. When people are better educated about science, they can make informed decisions about policies, which can have positive impacts on their communities.

3. Key Messages

The activities and efforts presented at this symposium had many commonalities. The inspiration of astronomy leads to further STEM and STEAM interests because it is multidisciplinary. Astronomy is a tool for capacity-building through training and development of skill sets applicable to many problems. Teacher effectiveness requires training, databases, education research, and resources. Teaching the use of data and data analysis develops critical thinking, which in turn leads to progress on many of the UN Sustainable Development Goals. Engaging in astronomy improves scientific literacy, which leads to better-informed global citizens who can make a positive impact in their communities. Internet activities and data connect us globally and encourage collaborative efforts, which is at the heart of the IAU. Spreading the message of astronomy requires inclusive, accessible, and multi-lingual resources, activities, and opportunities. Finally, linking astronomy to our various heritages and cultures emphasizes that astronomy unites all humankind.

We leave the symposium enriched by the contributions of all the symposium speakers and participants, and look forward to further progress and collaborations as we employ the message and methods of astronomy for the betterment of society.

4. Acknowledgments

We are very grateful to the SOC, chaired by Beatriz Garcia and Rosa Ros, for planning this informative and enlightening symposium. We also thank the LOC for making all the arrangements for this virtual symposium, and the session chairs for coordinating the meeting. We appreciate the important contributions by the invited speakers and oral and poster presenters, as well as the participants whose questions stimulated discussions. Finally, we thank the many sponsors who made this free symposium possible.

Conclusions

The symposium's aim to present a global vision of astronomical education and heritage was a resounding success. The many great talks, papers, posters, and workshops made this a reality. These trying times with the Covid-19 pandemic led to this being the first all-virtual symposium of the IAU. The pandemic has affected everyone around the globe – limiting travel, limiting interpersonal relationships, and has caused much suffering. Considering such circumstances, the results of IAUS 367 were remarkable with 635 attendees spread across six continents. There were 23 invited talks, 50 oral presentations, 110 poster presentations, four public conferences, three workshops, and one roundtable discussion. The Local Organizing Committee did an amazing job, first in organizing a superb presencial symposium, but then even more so when they took what had been created and reworked the event to be entirely virtual. These proceedings represent this great achievement.

The virtual symposium left us without informal discussions and kept us from renewing relationships with our colleagues. We were not able to experience the wonderful local culture in Bariloche and we did not get to see the 2020 total eclipse of the Sun! On the other hand, being virtual made the symposium available to so many around the world who otherwise might not have been able to attend. Attendance exceeded expectations and there were great contributions of talks and posters from scholars representing countries seldom represented in the past. Becoming better acquainted with the state of global astronomy education initiatives at these locations was a tremendous benefit that resulted from being online. Being virtual also allowed us the privilege of having the current IAU president and the IAU president-elect as our opening and closing speakers. At traditional face-to-face events it is possible that one or both of them would be unable to attend in-person. Another positive factor of being online was in the way that time management was enhanced in the virtual format. This worked very well and the talks of the symposium stayed on time!

We now know that IAU symposiums can be very successful online, and this bodes well for the future. It is our desire to reach out to and include as many as we can from anywhere in the world, and the virtual format of the symposium proved that this can be done most effectively. Our results underscore that all such IAU events in the future should include a virtual element in a hybrid format. We certainly want to meet with each other in person again, but we also want to continue to draw collaborations and contributions from the many colleagues we otherwise might not come to know because they are unable to attend in person. We will take the lessons learned here and apply them in the future as we refine the format to work both onsite and online simultaneously. Hybrid events are the future!

The global initiatives in astronomy education highlighted in this symposium are exciting! Restrictions due to the pandemic will eventually end and when they do it will allow

us to share our research directly with each other once again. Including virtual participation as well will enable greater collaboration with additional colleagues around the globe.

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