Making Astronomy Accessible for the Visually Impaired [1]

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The Professional is a member of CienciaPR

CienciaPR Contribution:

Wanda Liz Diaz-Merced [2]

CienciaPR Author:

Scientific American [3]

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A couple of years ago, one of my thesis mentors sought visually impaired scientists working at a major space science agency in the United States. I was surprised when he reported that there were several visually impaired engineers, but almost no visually impaired scientists like me [4].

Physics, mathematics and astronomy are often regarded as highly visual fields, limiting these disciplines to individuals who learn visually or who are able to see.

Astronomy in particular has the ability to dazzle young and old, which can help enhance outreach to the lay public and improve education, from informal to primary to post-secondary. For example, involvement of astronomy in schools and in higher education can help foster students' interest in careers in science, technology, engineering and mathematics (STEM).

The International Astronomical Union (IAU) has recognized the potential of astronomy to contribute to education and creating a better world. To fulfill this potential, however, astronomy must be accessible to everyone, regardless of background, learning styles or ability. By becoming more inclusive, the field of astronomy can help ensure that everyone interested has access to information and, technological resources, and can become involved in astronomy if they set their minds to it.

To leverage astronomy's capacity as a tool to inspire, amaze and foster inclusion, on April 2011 the IAU established the Office of Astronomy for Development (OAD) [5] in Cape Town, South Africa.

Two years later, OAD sponsored the "A Touch of the Universe" [6] project, led by Dr. Amelia Ortiz-Gil, from the University of Valencia in Spain, to bring astronomy to the visually impaired. The project developed an innovative kit that included tactile educational resources directed to bring concepts about the moon to visually impaired persons of all ages. This year, OAD is moving a step further towards "leveling the playing field" in astronomy and space science. OAD's most recent efforts involve teaching astronomy concepts to the visually impaired, as well as developing new methods to summarize massive astronomical data sets into simple, more easily interpretable forms, such as audio [7].

To this particular end, in April 2014 OAD established AstroSense [8]. This project—which I am proud to lead—aims to involve everyone interested in astronomy and space science at all levels. Currently we are working on several initiatives that include the development of tactile astronomy resources and 3D prints of astronomical objects, as well the development of methods to make astronomical data accessible to people of all abilities.

Improvements in astronomical data resolution and the ever increasing power of computing, both in speed and storage space, have made it possible to perform simulations with increasingly large amounts of data for longer running times. This means that today's astronomical data is incredibly complex and contains much more information than can be effectively displayed for study and interpretation using currently available technologies.

How do scientists display such complex and large volumes of data so that their features can be appropriately discerned? That is, how can we display data in a way in which it can be perceived, sensed and understood appropriately?

The use of color is a standard method to address this demand. This presents at least two problems. The first is that due to the limitations of the human eye and of spatial resolution, the standard methods available to present astronomical data can reduce the amount of information that can be displayed and interpreted. This in turn may lead to discoveries being missed, simply because we can't "visualize" the data. The second problem is that currently used standard methods make astronomy inaccessible for the visually impaired.

OAD has started developing multimodal tools in astronomy to help address these two problems. These tools facilitate the presentation, inspection and analysis of data in more than one way and using more than one sense. They can improve data analysis, which would help foster cutting-edge research capabilities and enhance the possibility of discoveries and bringing everyone on board by making astronomy more accessible and inclusive.

AstroSense is currently developing ways to summarize astrophysical data in more interpretable forms to increase researchers' ability to detect significant astronomical events such as solar flares. During my doctoral research, I helped develop sonification [9] methods that allowed us to "listen" to the stars. As a story for NPR [10] earlier this year explained, sound offers a way to increase sensitivity to visually ambiguous events embedded in the kind of data space scientists

and astronomers analyze. Radio waves are conveyed by drums, x-rays by the harpsichord, and so on:

Sonification of astronomical data can also help professionals who, like me, developed late onset blindness (I lost my sight when I was an undergraduate student at the University of Puerto Rico). Late onset diseases that affect the visual system, such as diabetes and glaucoma, are among the leading causes of blindness in adults. Unlike children who develop blindness before their careers are set, those who develop late onset blindness presumably have successful careers and therefore must be retrained to use technological accommodations that would allow them to remain in their jobs. This is the case for adults (like astronomers and astrophysicists) who have unique visual expertise prior to blindness, say because they were engineers, scientists or medical professionals at the time their sight was lost.

Through the AstroSense initiative, current data analysis techniques for the sighted could be enriched. Those that were traditionally excluded from careers in astronomy or underserved could find an open door. This will hopefully motivate diverse individuals to persevere in pursuing scientific careers, particularly in astronomy.

Personally for me, it would be perfect to find diversely abled physicists, mathematicians and astronomers who can use their ability to adapt to the data, team up with their peers and contribute as equals. As a visually impaired scientist, I daydream about not being underestimated. I wish for people to regard those with disabilities (or other learning styles, as I prefer to call it) as capable of contributing to my field (any field!) at the same level as their sighted peers.

There are many people around the world who are committed to bringing basic astronomical concepts to learners with different learning styles, and OAD and we at AstroSense would like to involve them in our projects. If you are part of this type of effort and have not been in contact with us yet, please get in touch. We would appreciate your input and involvement in our future endeavors. For more information about AstroSense or to send your ideas email us at info@astro4dev.org [11] or visit www.astro4dev.org [12].

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