Tactile Sun:
Bringing an Invisible Universe to the Visually Impaired

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Keywords
Science Literacy, Public Outreach, Adapted Materials, Visually Impaired, Braille

Summary

A tactile model of the Sun has been created as a strategy for communicating astronomy to the blind or visually impaired, and as a useful outreach tool for general audiences. The model design was a collaboration between an education specialist, an astronomy specialist and a sculptor. The tactile Sun has been used at astronomy outreach events in Puerto Rico to make activities more inclusive and to increase public awareness of the needs of those with disabilities.

Introduction

The University of Puerto Rico is currently pursuing strategies to adapt its Descriptive Astronomy course for students who are visually impaired or blind (Isidro, 2013). Making elective science courses available and accessible to all college students is very important as a means to improve science literacy and give a foundation in the scientific method and in general scientific concepts (Hobson, 2008). Astronomy in particular is a course that attracts the interest of many students and can serve to inspire them to learn about science and technology (IAU, 2010).

The resources typically available for presenting astronomical concepts to the visually impaired are limited to three-dimensional figures, tactile plane figures and some Braille lessons. Some academic institutions, public places and museums have a limited selection of adapted materials that can be used to elaborate astronomy concepts, and are available to be used by visually impaired visitors and students.

Figure 1. The artist Luis Felipe Passalaqua working with the tactile Sun during the sculpting workshop Hands that See (2014). Credit: Isidro.

Learning to present astronomy concepts according to individual needs in this way not only enhances the individual's appreciation of the concepts and access to scientific knowledge, but also promotes a culture of respect for the differences of others.

From the Moon to the Sun

The tactile model of the Sun was developed after collaborating with the design and evaluation of the 3D tactile model of the Moon, a project directed by Dr Amelia Ortiz Gil from the Astronomical Observatory of Valencia, Spain[1]). This experience highlighted the importance of listening to the visually impaired when working with tactile models.

To design a tactile model of the Sun with an appropriate level of detail the team at the University of Puerto Rico were advised by the blind artist–sculptor Luis Felipe Passalacqua[2] and the group of blind participants at the sculpting workshop Hands that See (*Manos que Miran* in Spanish). Passalacqua was a medical illustrator and

Figure 2. The artist Luis Felipe Passalaqua exploring the tactile comet (Kowal et al., 2010) and a blind participant of the Hands that See workshop exploring the tactile Sun (2013). Credit: Isidro.

Figure 3. Tactile Sun model with an approximate indication of the size of the Earth with the head of a pin stuck in cork at the left side. Credit: Isidro.

artist before losing his sight several years ago. In addition to his work as a sculptor he is actively engaged in introducing diverse audiences to the arts and increasing public awareness of people with disabilities.

Isidro worked as a volunteer for the Hands that See workshop at the Museum of Art, Puerto Rico. The workshop was developed with the assistance of five volunteers and a member of the museum staff. The participants included totally blind, visually impaired and paraplegic individuals. The tactile Sun project was developed over a period of ten weeks and concluded with a display of the students' creations[3] at the museum in May 2013.

Designing a tactile model of the Sun

The tactile Sun was created on a styrofoam sphere coated with a metal mesh screen. The texture of the Sun was made using cold porcelain and it was then painted with acrylic paint. Cold porcelain is an easy-to-prepare and inexpensive material that is used in crafts.

The tactile Sun consists of a sphere with a radius of 10.9 cm and its rough texture represents the granular appearance in the visible images of the Sun. The grains in the tactile Sun correspond to the movement of gas in the convection zone of the Sun. In visible images, the bright areas of the Sun represent gas that is ascending and the dark areas are the descending gas. In the tactile Sun, the high reliefs represent the ascending gas and the low reliefs represent the descending gas.

The surface of the sphere has two arcs that are protruding from the surface. These arcs represent two prominences — jets of gas ejected from active regions on the Sun's surface with the shape of arcs. In addition, the tactile Sun has three flat surfaces representing three solar flares — jets of gas ejected from active regions of the Sun's surface shaped as flames.

In the centre of the sphere, there is a small hole that represents a sunspot — a region where the temperature is lower than adjacent areas. Some sunspots are comparable in size to the size of Earth.

Some uses of a tactile model of the Sun

The team have used the tactile Sun model at different events[4] developed in consultation with blind people. It was displayed at an exhibit during the celebration of White Cane Day[5]: *Dare to See the World with Your Eyes Closed*, at the University of Puerto Rico (15 October 2013). The model has also been used at teacher workshops with science and mathematics teachers and with special education teachers, as a resource with sighted students at all levels in an activity about the scale of the Solar System, and to present concepts and at the same time display different resources developed to make astronomy more accessible.

When discussing the Sun at outreach events it is very important to remind the public to never look directly at the Sun without proper protection because direct sunlight may cause permanent damage to our eyes.

Conclusion

The design and development of tactile materials as an education strategy offers blind students or students with special needs the opportunity to become interested in learning science and mathematics. The tactile Sun is an example of how to create tactile resources in the classroom and at astronomy outreach events that are made using easy-to-find materials.

It is very helpful to include the blind during the process of design and elaboration of the models to be used with this community and to synchronise activities with events already organised by the community. This strengthens the activity's relevance to the community, enhances the quality of the output in communicating key concepts and helps to establish stronger bonds with the blind community.

Other resources for engaging the visually impaired with astronomy

- A printed guide (in large print and Braille) to using the tactile model was created by the University.
- The tactile Sun can be complemented with images from the book *Touch the Sun* by Noreen Grice (2005).
- There are several Braille books with tactile images available. These include *Touch the Earth, Touch the Sun, Touch the Universe, Touch the Invisible Sky, Touch the Stars, The Little Moon Phase Book* and *Our Place in Space* (Grice, 2006).
- There is a tactile/Braille exhibit that was developed during the International Year of Astronomy 2009 (Arcand et al., 2010).
- At events where the setting allows for the use of computers, assistive technology with software such as JAWS[6], or Earth+[7] can be used alongside other tactile-adapted materials to allow the blind to participate actively and independently in the demonstration.

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Notes

1 http://astrokit.uv.es/downloads/The-MoonatYourFingertips_Guide.pdf (retrieved on (19.3.2014)

2 http://www.youtube.com/watch?v=fBpNNeh1NzA (retrieved on 18.2.2014)

3 http://www.youtube.com/watch?v=rznx1GxHTQo (retrieved on 18.2.2014)

4 http://materialdidacticoparaciegos.blogspot.com/ (retrieved on 3.6.2012)

5 http://www.nfb.org/ (retrieved on 3.6.2012)

6 http://www.freedomscientific.com/products/fs/jaws-product-page.asp (retrieved on 18.2.2014)

7 http://prime.jsc.nasa.gov/earthplus/ (retrieved on 20.2.2014)

Biographies

Gloria M. Isidro obtained her PhD from the Education Faculty of the University of Puerto Rico, San Juan campus. Dr Isidro is from Colombia. She completed her undergraduate studies in Mathematics at the Universidad Industrial de Santander in Colombia. She completed a Masters degree in Mathematics at the University of Puerto Rico. She has worked on developing strategies to make the learning of mathematics and astronomy accessible for blind students.

Carmen A. Pantoja is the first Puerto Rican woman astronomer. She completed her Bachelor and Master's degrees in Physics at the University of Puerto Rico (UPR), and obtained a PhD at the University of Oklahoma using the Arecibo Observatory for her research. She is an Associate Professor of Physics at the Department of Physics of the Natural Sciences Faculty (UPR, San Juan). Dr Pantoja is interested in the large-scale distribution of galaxies in the Universe and in the emission properties at radio and infrared wavelengths of galaxies. She has worked in the development of strategies to make astronomy accessible for persons who are visually impaired or blind.