The Universe for all to discover

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Abstract

In the title of this paper, we have changed the slogan of the International Year of Astronomy, "The Universe yours to discover" to "The Universe for all to discover" in order to emphasize the need to think about broader audiences when we plan astronomical activities at school or during outreach events. The strategy we propose follows what is known as the Universal Design for Learning (UDL). UDL allows to reach to the general public as well as to audiences which might be regarded as "special" because they have some disability. It has been shown that everybody has a preferred style of learning (some remember better what they see, others what they hear or what they touch) and therefore, everybody is more or less able under the different styles of learning.

Through this talk I am going to outline some of the principles of the UDL that can be applied in the teaching and communication of Astronomy, along with an example of its implementation in the project "A Touch of the Universe".

1 Introduction

During the International Year of Astronomy (IYA 2009) an immense global effort to reach all people in the world was carried out by the astronomical community so no one would be left out in the thousands of activities organized worldwide. This event also showed that most of the big planning was done without taking into account that some of the activities were not accesible to publics with special needs.

To help improve this situation, our team developed some accesible activities that were carried out in Spain during IYA 2009. This work has been extended after 2009, and nowadays there is a growing interest in this matter. Astronomers without Borders has a working group devoted to activities for people with disabilities, and also the International Astronomical Union's Commission 46 has recently created a working group on this topic.

2   Are we ready for a diverse audience?

The main question here is that we need to think as broad as possible in terms of audience abilities when we develop an outreach activity or a class. And this is where the Universal Design for Learning (UDL) comes to help us.

UDL is "an educational framework based on research in the learning sciences, including cognitive neuroscience, that guides the development of flexible learning environments that can accommodate individual learning differences" [5]. This is done by using learner-centered technologies, which support multiple learning modalities, including visual, auditory, kinesthetic, and tactile, as well as accessible field experiences [2]. In this frame the focus is not onto a disabled person but on a disabling environment.

2.1   UDL basic principles

UDL has three basic principles [4], which can be summed up in the word "multiplicity": provide multiple means of representation, provide multiple means of action and expression and provide multiple means of engagement.

2.1.1   Provide multiple means of representation

Learners differ in the ways that they perceive and comprehend information that is presented to them. For example, those with sensory disabilities (e.g., blindness or deafness); learning disabilities (e.g., dyslexia); language or cultural differences, and so forth may all require different ways of approaching content.

Therefore all contents and materials should be available in formats that allow access to them through different perception channels, for example.

2.1.2   Provide multiple means of action and expression

Learners differ in the ways that they can navigate a learning environment and express what they know. For example, some may be able to express themselves well in written text but not speech, and vice versa. Therefore the materials should be accessible for all and there should be different options for expression.

2.1.3   Provide multiple means of engagement

To care is crucial for the final success in the learning process. Learners can have very different interests or reasons to be interested in learning. The lecturer needs to know which are his/her public's interests or which they might be, and use different ways to motivate the audience.

3   Strategies to develop educational materials and activities in the frame of UDL

The *Alliance for Students with Disabilities in Science, Technology, Engineering, and Mathematics* has proposed a list of eight methods for incorporating UDL principles when developing educational resources [1]:

- Inclusiveness. UDL should use methods that make learning easy and accessible for everyone.

- Physical Access. Ensure that activities, materials, and equipment are physically accessible to and usable by all students.

- Delivery Methods. Use multiple accessible instructional methods. Use a variety of modes to deliver content, motivate, and engage students, such as lectures, collaborative learning options, hands-on activities, Internet based communications, educational software, field work, etc.

- Information Resources. Ensure that course materials, notes, and other information resources are flexible and accessible to all students.

- Interaction. Encourage effective interactions between students and the instructor. Ensure that communication methods are accessible to all participants.

- Feedback. Provide specific feedback to the students/audience on a regular basis.

- Assessment. Regularly assess student progress using many accessible methods and tools, then adjust instruction accordingly.

- Accommodation. Plan for accommodations for students for whom the instructional design does not meet their needs.

3.1   A general protocol

When developing teaching or outreach activities for an audience with different abilities in the UDL frame there are three main points that you need to address:

- Give the contents according to the main four different styles of learning: visual, auditory, kinesthetic, and tactile. Studies show that people remember and learn better when they receive the contents through their favorite learning method.

- Teach/communicate to strengths. Take advantage of the audience's strengths and natural talents to engage them in the activity. Emphasize what they can do rather than what they cannot. This improves their self-steem and gives them more chances to learn.

- Use many different ways to obtain feedback from the public to check if they are grasping the main ideas and contents. This can be done passively, by observing the public's response and body language, or by questioning them in oral or written forms, for example. The results will also give hints about their abilities and the communication strategies that work or otherwise with this particular public.

4 An example of a UDL activity: Campus Inclusiu at the University of Valencia

Every year the University of Valencia organizes public visits to different University institutes and faculties for groups of high school students with disabilities. This is done with the goal of encouraging them to pursue a University degree.

The main characteristic of the groups is that they show all kinds of physical disabilities, therefore it is mandatory that the visit follows the UDL frame. We make sure that elevators are working for those in wheelchairs, and all the contents are given through visual, audible and tactile means.
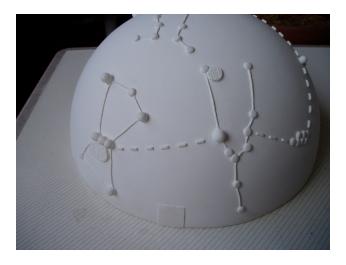

Figure 1: The tactile support for the planetarium program "The Sky in Your Hands": a half-sphere with the constellations engraved on it.

In particular, we adapted the planetarium program "The Sky in Your Hands" to reach a wider audience. This program is a planetarium show first designed for a blind public. It consist on the projection onto the planetarium's dome of the night sky. A soundtrack narrates a story related to different constellations, while specific sounds are played in relation with particular objects. The sound track is divided into seven channels. If an array of speakers is distributed through the dome, the sound corresponding to each astronomical object will be played from the speaker closest to its projected image. This gives the public audible information about the distribution of the objects through the dome.

There is also a tactile element in the show: A half-sphere with the constellations en-

graved on it (see Fig. 1). It lets the public feel the shape of the constellations and objects while they listen to the script. A separated narrator guides the user through the half-sphere, taking her from one constellation or object to the next. Larger balls represent brighter stars, solid lines show the constellation shape, and dashed lines guide the user from one object to the next according to the show's script.

The show in this form is inaccessible for deaf people. Therefore, we created a slide presentation in which images and short texts were providing the same information that was being given in audible form.

We also used astronomy books and prints which are printed both in Braille and in normal print. These can then be explored by all the students alike.

5   Tactile astronomy: the project "A Touch of the Universe"

"A Touch of the Universe" [**?**] is a non profit project with the goal of creating and delivering 30 boxes of tactile materials to communicate astronomy to children and adults, including blind people. They have been distributed among informal educators and teachers in underdeveloped countries of America, Asia, and Africa (see Fig. 2). Our goal is to help children in these countries to learn about astronomy, even if they are visually impaired. There is a lack of educational material, specially for the blind, in these regions that needs to be addressed.

Figure 2:   Places where the kits have been sent: India, Chile, South Africa, Argentina, Brazil, Colombia, Venezuela, República Dominicana, Nepal, Tanzania, Colombia, Costa Rica, Zambia, Iran, Ethiopia, Cuba and Bolivia.

5.1   Who?

This kit has been the result of the collaboration and support from a number of institutions, mainly from the International Astronomical Union's Office of Astronomy for Development. We received funding and support also from EU-UNAWE, the Astronomical Observatory of the University of Valencia, INAF-Osservatorio Astronomico di Brera, INAF-Osservatorio Astro-

nomico di Padova, NASA-CXO, Eurastro, Sociedad Española de Astronomía, Galileo Teacher Training Program (GTTP), Galileo Mobile and Astronomers without Borders (AWB).

The working team of the project is composed of Amelia Ortiz-Gil (coordinator) (Observatorio Astronomico - Universidad de Valencia), Kimberly Arcand (NASA-CXO), Caterina Boccato (Osservatorio Astronomico di Padova / INAF), Lina Canas (Nuclio / AWB / Galileo Mobile), Rosa Doran (Nuclio / Galileo Teachers Training Program), Héctor Espinós (IPL - Universidad de Valencia),Thilina Heenatigala (UNAWE), Mariana Lanzara (Observatorio Astronomico - Universidad de Valencia), Maria Jesús Moya (Observatorio Astronomico - Universidad de Valencia, Javier Navarro (IPL - Universidad de Valencia), Pedro Russo (UN-AWE), Stefano Sandrelli (Osservatorio Astronomico di Brera / INAF) and Mike Simmons (AWB).

5.2 What is in the box?

The kit contents are the following (see Figure 3): an introductory letter, a half-sphere with engraved constellations, a document explaining the planetarium program "The Sky in Your Hands", a tactile moon model, a guide to using the tactile moon, three constellation models, an activity book in Braille and normal printing with some suggestions on how to use those materials, prints from the "From Earth to the Universe" (FETTU) project by NASA's Chandra X-ray Observatory, a document with FETTU activities and a book "The little Book of the Moon Phases" by Noreen Grice. A DVD with the soundtrack of the planetarium program in Spanish, Portuguese and English versions; FETTU audible: audible version of the FETTU prints; different PDF versions of the kit guides in various languages. There is also a feedback form intended to give us information about how the kit is used.

Figure 3:   "A Touch of the Universe" box in 'deconstructed' mode.

Here follows a short description of the contents in the kit that have not been described above.

5.3   The tactile moon model

We have developed and produced a tactile model of the Moon that can be used in outreach activities, museum exhibits and planetarium shows, addressed to public with and without visual impairments [3].

Figure 4:   The tactile Moon model.

To help with the distribution, we designed a 3D model that can be printed at any 3D printing service around the world so anybody can replicate it easily and use it in outreach activities.

The final model is an sphere with a diameter of 20 cm, representing a simplified version of the lunar surface, with the main maria and craters (see Fig. 4). The goal is to convey in a tactile way the visual impression that we gather when looking at the Moon. Therefore, it is not a mere topological representation. For example, crater rays have some relief in the model, although in the real Moon they are flat.

The different features can be labeled with a Braille letter. One can print a separate

Braille document with the name of the feature corresponding to each Braille letter. Also, the names of the features can be written on the surface, for the benefit of those who are not totally blind.

The North pole has been marked by a 'T', and the vertical line of this 'T' is pointing to the near side of the Moon. A meridian marks the separation between the near and far sides. The South pole is marked by a smooth cap.

The prototype model has been tested by blind and visually impaired people all around the world, from Puerto Rico, Argentina or Brazil, Spain, Ireland, to India. Their feedback has been used to create the final model.

5.4   3D constellation models

These are hand-made models of constellations in which the relative distances among the stars are represented, as measured from Earth. It is a visual and tactile way to explain how the stars in a constellation, which seem to be close together when we look at the sky usually are very far away from each other and from us in the Galaxy. The length of each star's pole is proportional to its distance to Earth (which is represented by the rectangular support).

5.5   The Activity book

This book contains a few activities that can be carried out with the box contents, but it is also a guide to help educators to create their own activities.

5.6   "From Earth to the Universe" (FETTU) project

This is a IYA 2009 cornerstone project lead by NASA. They produced a number of Braille prints with tactile images about different topics in Astronomy, from the electromagnetic spectrum, to stars and nebulae. The files can be downloaded from the project's web site for free.

They provide also an Activity Guide and audio files for the five panels.

5.7   "The little Book of the Moon Phases"

The kit also includes a book on astronomy for the blind by renowned author Noreen Grice. It explains the moon phases using Braille text and tactile figures.

5.8   A DVD with several audible and pdf files

A DVD provides the user with the soundtracks (in stereo and in 7 different channels) of the planetarium show "The Sky in your Hands", in English, Spanish and Portuguese. The pdf files of the guides of the Moon, the planetarium and FETTU activities are also included, as well as the FETUU audible files.

6 Conclusions

The Universal Design for Learning provides the means to reach a diverse audience, including people with disabilities. It is an inclusive tool that helps developing communication strategies that are more efficient precisely because they take into account the variety of ways in which a person can learn, focusing on their abilities and using them for the outreach or learning process.

Developing materials under the UDL paradigm is a very creative process. For example, one must try that all the contents be available through different perception channels (audio, visible, tactile or kinesthetic), and provide for feedback mechanisms that allow us to check if the messages or contents are reaching the audience. There are a few examples related to astronomy in the book "Space Science is for Everyone" by NASA.

We have presented a couple of examples of UDL activities that we have developed: a UDL version of the planetarium show "The Sky in your Hands" and a box with astronomy related activities from the "A Touch of the Universe" project.

I would like to encourage the readers of this paper to think about UDL next time they develop any outreach or teaching activities. With UDL one achieves better results with everyone plus the inclusion of those with a disability.

7 Acknowledgements

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