Bringing Science into Schools through Astronomy. Project ASTRO, Tucson.

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Abstract:

We report our experience in bringing science into US and French classrooms. We participated in the US scientific educational program Project ASTRO. It is based on a partnership between a school teacher and an astronomer. They together design and realize simple and interesting scientific activities for the children to learn and enjoy science. We present four hands-on activities we realized in a 4th-grade class (10 yr-old kids) in Tucson (USA) in 2002-2003. Among the covered topics were: the Solar System, the Sun (helioseismology) and the Galaxies. We also present a similar experience done in two classrooms in 2005, in Châtenay-Malabry (France) in partnership with an amateur astronomy association (Aphélie), and discuss future activities. This is a pleasant and rewarding activity, extremely well appreciated by the children and the school teachers. It furthermore promotes already at a young age the excitement of science, and provides concrete examples of the scientific methodology.

1 Introduction

Many astrophysicists worldwide have experienced the joy of talking about the physical Universe and their fascinating work to the public, in conferences or in schools. They might have then felt the enthusiasm and the great demand from children, their teachers and parents to talk about science. The scientific education, an important cornerstone in modern societies, faces, nevertheless, several difficulties in practice despite national requirements for science classes. The difficulties to teach science in schools (for students younger than 17) are sometimes related to the teachers' lack of confidence in their own expertise. Science might appear complex, too conceptual and not enough concrete to some teachers and students. The lack of motivation might also be an issue. There is thus a clear need to bring science in the classroom, so that more teachers and students can enjoy it. We describe our involvement in different educational programs in the USA and in France to promote science among teachers and students.

2 Project ASTRO, Tucson

Project ASTRO[1] was developed in 1994 by the Astronomical Society of the Pacific. The goal of this program is to improve science education in the classroom from the first year of

[1]http://www.astrosociety.org/education/astro/project_astro.html

elementary school to the last year of high school (6 to 17 yr-old). Project ASTRO is based on a partnership between a teacher and an astronomer. The astronomer commits to visiting the teacher's classroom at least four times during the school year. The main focus of Project ASTRO is hands-on activities related to astronomy that put students in the position of acting like scientists. Each year about 1000 partnerships bring science through astronomy to ∼100,000 students over 12 project ASTRO sites across the USA.

We were part of Project ASTRO in Tucson[2] during the 2002-2003 school year. We were paired with a 4th grade teacher (10 yr-old kids) at the Sewell Elementary School in Tucson (Arizona, USA). The topics of the activities were chosen in consultation with the teacher. We designed ourselves these activities, but extensively used existing material from the book[3] "The Universe at your fingertips", and were inspired by some NASA Education web sites. We decided to focus on a few simple concepts only in each one-hour visit. The typical visit starts with an introductory 10-minute slide show, and is followed by 40 minutes of hands-on activity. The last 10 minutes are used for a debriefing and questions. We put online[4] all our material.

• First visit: "Who is an astronomer"
Our first visit to the classroom is dedicated to talk about who an astronomer is and what an astronomer does. We first ask the children to draw what they think an astronomer is, and then we use the drawings to address the misconceptions they might have about this special job. It is a good opportunity to mention that an astronomer, thus a scientist, is not always an old man! We also tell the students that an astronomer does not work every night by looking the sky with the eyes on a telescope. We introduce them to the concept that observation, careful analysis, modeling, theory and simulation complement each other and are required to address a scientific question.

• Second visit: "The Solar System"
The goal of this activity is to learn the different planets of our Solar System and the relative sizes of the planets. Each kid makes a sphere of the proper diameter with clay. We then put together this clay Solar System, describe each Planet's average temperature and emphasize the diversity of planet sizes (Fig. 1). We also explore the physical differences between gaseous vs telluric planets, and discuss the differences between the Planets, the Sun and the stars.

• Third visit: "The Music of the Sun"
This activity, dealing with the Sun and helioseismology, illustrates that we can get informations about the interior of an object by "listening" to it. The students have to probe three "mystery boxes". We ask them to shake each box to study its content. They estimate if the content is light or heavy, composed of small or large pieces, in small or large number. They write their observations in a table. We put rice, small rocks, and a tennis ball in each box, respectively. We then explain that helioseismology uses the Sun's vibrations (like music) to probe its interior. This activity shows that it is possible to talk about complex subjects in a simple way (Fig. 2). The last part is an illustration of the Doppler shift (also used in helioseismology): listening to the sound emitted by an object allows one to determine if it is moving or not. We use a bell for this purpose. We first introduce them to the bell's sound when it is still, but also when it is rapidly spinning – the beating effect is then easily heard. Then the students close their eyes, and we ask them to guess, while listening the sound, if the bell is spinning or not.

[2]http://www.noao.edu/education/astro/ It is managed in Tucson by the Education and Outreach department of the NOAO (National Optical Astronomy Observatory).

[3]http://www.astrosociety.org/education/astro/astropubs/astropubs.html

[4]http://lully.as.arizona.edu/∼hdole/vulgarisation/ProjectAstro200203/

Figure 1: Solar System activity: comparison of the Planet's sizes.

Figure 2: Helioseismology activity: probing the mystery boxes.

Figure 3: Galaxy activity: classifying the galaxies in the Hubble Deep Field.

• **Fourth visit: "The Galaxies"**
The goal of this activity is to have the children realize the diversity of the galaxies and their incredible quantity. Using images of the famous Hubble Deep Field, the students sort the bright sources in the images by shape and color. They separate foreground stars from far-away galaxies, and get to realize that the galaxies have various shapes and colors, mainly due to their different content and evolution stage (Fig. 3). Then, on a small image cell, they have to count the galaxies. With the appropriate provided number to multiply with, they have an estimate (lower limit) of the number of visible galaxies in the universe. Classifying the galaxies was a success, but the counting part proved to be too complicated for this level, since orders of magnitude and powers of ten are not well understood.

3 Our Other Experiences in France

There are many other ways to bring science into schools. As members of the amateur astronomy association Aphélie[5] (near Paris, France), we are used to receiving lots of requests from schools to come and talk about astronomy. In May 2005, we visited two classrooms[6] in two of Châtenay-Malabry's schools located in socially disfavored areas. The level is CE2 and CM2 (8 and 10 yr-old, respectively). We wanted to apply the concept of a Project ASTRO visit. We choose to try "**the Venus topography box**" activity from the Project ASTRO book[3], in agreement with the teachers. The goal is to show how scientists get information about the surface of a planet hidden by a thick atmosphere (this could also apply to Titan). After an overview of the Solar System, we tell the children that ESA wants to send a spacecraft to Venus and needs their help to choose the best landing site. The surface is modeled inside a shoe box, hidden

[5]http://www.astrosurf.com/aphelie
[6]http://lully.as.arizona.edu/~hdole/vulgarisation/ecoles/

Figure 4: Venus topography box activity: probing the hidden surface.

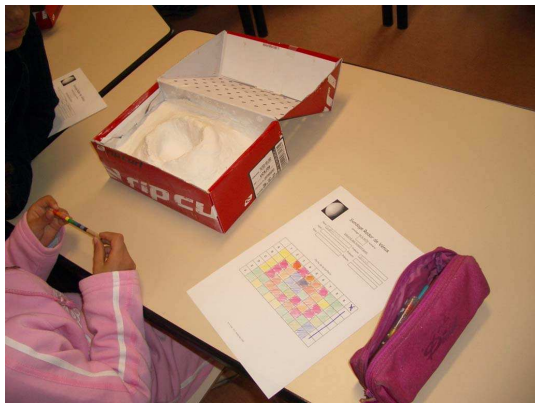

Figure 5: Venus topography box activity: at the end, comparing the measurements (color map) and the real Planet surface model.

by a cover. By probing the holes with a color-encoded stick, the students draw a topographic map of the modeled Venus surface (Fig. 4 & 5). Fig. 5 shows the model crater (top left) and the beautiful result, the crater appearing in pink-orange in the topographic map (lower right). We then asked each student to present in front of the class their best landing site, if any. This activity is very interesting because it deals with different concepts: variety in the Solar System, thick atmospheres, remote information gathering (e.g radar technique), contour map. During this activity the students really act like scientists by getting the data, and then analyzing, interpreting and presenting them.

4 Conclusion

Some professional astrophysical institutions are also involved in bringing science into the classrooms through specific educational programs for the teachers, like the Observatoire de Paris[7] (dedicated workshops, summer schools, observations, ...) or the Université Paris Sud 11. There are also many successful programs like "la main à la pâte[8]", Hands-On-Universe[8], or the CLEA[8], among others.

Finally, we want to emphasize that visiting schools, discussing with the teachers, interacting with the students, and designing such educational projects is a rewarding, interesting and very useful activity. Astronomy is a very efficient way to teach science. Furthermore this is less time-consuming that one might think. We warmly recommend that our colleagues try to be involved in such activities, on their own or by joining an existing program in their country.

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[7] http://www.obspm.fr/∼webufe

[8] http://www.lamap.fr/ – http://www.handsonuniverse.org/ and http://fhou.cicrp.jussieu.fr/ – http://www.ac-nice.fr/clea/