

POPULARIZATION AS AN AID FOR FORMAL EDUCATION

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1. Introduction

In the following article we present the way in which professional astronomers are trying to influence the general understanding of astronomy in Mexico. The long-term goal is to have a population that includes science as part of its culture. The paper is mainly a list of some of the many things that can be done to enhance understanding of science, descriptions of the different items can be found in the references, which include the proceedings of three meetings on astronomy education and magazines dedicated to the teaching of astronomy.

Popularization can be a great aid for education. It has proved useful in several ways, specially in developing nations:

1. It is a mind-broadening experience.
2. By promoting hands-on experiences it enables students to learn more effectively how to construct objects and to complete tasks
3. It can sensitize a community towards the importance of science and be a tool for everyday life.
4. It can serve as a link between science and technology.
5. Since astronomy is carried out by people working together towards a common goal, talking about the way in which it is done can teach poor nations that when resources are scarce it is better to have common projects instead of fighting over them.

One must bear in mind that understanding produces great satisfaction, so outreach programs can use this particularly in order to have a greater impact. In spite of all the advantages of popularization one must always be aware that it cannot replace formal astronomical education.

To succeed in a popularization project, one must use a great variety of media and procedures. For example: books, magazines, newspaper articles, public lectures, workshops, science centers, planetaria, television and radio programs, multimedia and theater plays on science, for all age levels and several educational backgrounds. One must try to incorporate, when possible, local culture so people have something to build on.

When an international committee interviewed graduate students in Mexico in order to find out why they had decided to do research, most mentioned they had attended a public lecture or had read a book or magazine on astronomy.

2. Public Programs

We will describe different aspects of public activities dedicated to the enhancement of formal astronomical education, emphasising what we have done in Mexico and could equally well be done in other developing nations. It is important to keep in mind that it is easier to convey knowledge by taking into account what people already know and by drawing on local culture.

2.1. BOOKS

It is important for countries to have astronomy books on all levels written in the local language. Having books in Spanish, spoken in Latin America, encourages students to study science because they feel it is not something that is only done abroad. There are very few general astronomy books

like those published in the USA, because in our college system we have no compulsory science courses for all students; science subjects are taken only by a few students and producing that kind of book would not be attractive to publishers. Nevertheless, about fifty astronomy books written by Mexican astronomers are accessible to the general public.

2.2. MAGAZINES

Magazines on education are extremely important because they provide access to updated astronomical information and new ways of teaching, emphasizing hands-on activities. Unfortunately in Mexico science magazines have problems because their publication is interrupted after a few years. The main problem is that the general public does not read very much. Publishers are willing to produce only magazines that are not very expensive, which are therefore unattractive so even fewer people read them.

2.3. NEWSPAPER ARTICLES

Newspaper articles are convenient because they can be read in a relaxed environment. Sections for children are important and, in my experience, are often read by adults and elementary schoolteachers, who feel more comfortable tackling science that is written about more informally.

2.4. OTHER WRITTEN MATERIALS

Other written materials to promote science are extremely useful. For example, in The Netherlands the sides of milk cartons have been used to convey astronomical facts to children. These small articles include an e-mail address to which children can write and ask questions or suggest new topics. Once enough written materials are available in a community, it is a good idea to hold book fairs where not only stands with books, magazines, slides, videos, software and toys are set up but also astronomical exhibits and other informal educational activities.

2.5. EDUCATIONAL TELEVISION

Television and radio programs on science help teachers with their science lectures, providing them with up-to-date information and guides to alternative ways of presenting materials. Recently we have undertaken the task of teaching astronomy for middle-school teachers and elementary-school pupils by video.

For such projects to succeed three conditions are required:

1. Pupils must learn to watch television differently, not exclusively for entertainment or information.
2. Teachers who give the courses must get acquainted with the variety of options such media, to feel comfortable lecturing before a camera to a remote audience.
3. Teachers who use videos must learn how to get the maximum advantage out of them. For instance by interrupting several times and asking students what they think about it, discussing the video afterwards, trying to reproduce some of the hands-on activities, etc.

The UK Open University has created excellent teaching-at-a-distance materials.

2.6. RADIO PROGRAMS AND HOT-LINES

Brief radio programs are a very convenient way of popularizing astronomy. We have broadcast 5 and 2 minute programs for several years from various radio stations. It is specially convenient if this can be done over the telephone, requiring less effort for the astronomer to record them. A hot-line with up-to-date information is extremely useful when an important astronomical event occurs such as a comet, an eclipse, a meteor shower etc.

2.7. MUSEUMS

Science centers offer unique hands-on experience. They are specially convenient for developing countries where few schools have laboratories. Educational research has shown that the more we participate in an activity the more we remember. The following table gives us the percentage of what we retain after doing a few things:

Science centers can be very simple. It is important for developing nations to emphasize traveling

TABLE 1. How Much do We Remember

when we read	10%	enact	50%
listen	20%	manipulate	60%
look at	30%	create	70%
TELL	40%		

exhibits and workshops, if such activities are being planned for small communities. New science centers must have strong links with local universities. Science centers can have a wide variety of activities including plays that appeal directly to sensual qualities which are very useful for developing pleasure in learning science.

2.8. LINKS WITH TEACHERS

Outreach programs should aim at a target audience of teachers. They need updated materials and should be encouraged to use informal and hands-on activities when introducing science in order to make a more lasting and exciting experience for their pupils. A French group in the *Liaison d'Enseignements et Astronomes* has generated many examples of the ways in which such programs can be carried out.

2.9. PLANETARIA

So much has been written on the use of planetaria that we will not comment on their great utility. In Mexico there are 16 large ones; in the cities where they are located all grammar-school children must attend, at least once, one of their shows. I believe that portable planetaria are the convenient choice for popularization of astronomy in small communities, due to their low cost and versatility.

2.10. SOFTWARE AND WWW

More and more schools have access to teaching by computer, so software in local languages must be developed in order to meet the needs of this increasing demand. Take advantage of the pupils' interests in order to encourage them in broadening their knowledge by learning science. In the USA, statistics have been compiled comparing children who have access to computers and those who do not, and have shown that having such equipment contributes substantially to children's performance at school. Now connections are available to the World Wide Web for people in developing countries. Unfortunately these are from the upper classes. The Web is a great place to get all kinds of information. Most of the problem with poorer people is that most of them speak neither English nor computer and scientific language but, more important, many places have no electricity and, therefore, no computers.

2.11. PUBLIC LECTURES AND WORKSHOPS

Both these activities are extremely popular, but very few people have access to them. Workshops are extremely useful because they promote several pedagogical qualities such as:

1. Students participate in hands-on activities, which have a very high retention coefficient.
2. They learn they can build things on their own.
3. They understand that they are able to complete a task (a quality greatly needed in developing nations such as Mexico).

It is very important to learn how to *listen* to the questions people ask, specially students. One can learn about their preconceptions, one can get new ideas about what teaching is all about and how to give better lectures. One must keep in mind that science is built on what we do not know, on the unsolved questions. To say "I do not know", at a public lecture encourages people to find out for themselves; one is not only teaching how science is constructed but is setting an example for teachers who might be in the audience.

2.12. SUMMER WITH A SCIENTIST AND OLYMPIADS

Programs such as *Spend a Summer with a Scientist* have been running in Mexico for several years. Statistics show that most students decide to continue their careers as scientists or at least are not negatively prejudiced against science once they complete their stay. Olympiads on astronomy do not exist in Mexico, they do in Israel. The ones devoted to mathematics, chemistry and physics have induced students to study science. The disadvantage they have is that some of the students *feel* they already know enough and do not take school seriously for some time.

2.13. AMATEURS

Amateur groups can be a great aid in promoting astronomy. It is important that professional astronomers keep close contact with them in order to provide them with updated information and guide them to understanding what scientific research is all about. Some amateur astronomical groups have people that have spare time and enthusiasm that can be used to enhance outreach programs. In several countries the only astronomy that is done is by these groups. Amateurs are specially gifted at giving star parties that are excellent for promoting astronomy.

2.14. TOYS

Unfortunately, there are very few scientific toys available in the developing countries. Most of them are imported, and hence very expensive, and have instructions in foreign languages. It is good to have this kind of toy at schools. Sometimes it is possible to find local industries that are willing to invest in such toys. When developing countries create science centers they should have shops where such items can be available.

3. Conclusion

If a group of astronomers in a developing country wants to start a popularization program on astronomy there are many ways in which it can be done. A very general suggestion is to start with a simple program and increase the number of projects gradually.

A good way to start is to take advantage of some astronomical event, such as a total solar eclipse, and create an amateur group. The International Astronomical Union has sponsored several symposia on teaching of astronomy where many good ideas can be found. Popularization of science can be a useful tool for formal education. One of the goals of developing countries is to provide a scientific culture for its population. The more ways science is promoted the more likely such a project will succeed. If we could give as many people as possible a clear example of the way science works as opposed to magic it could make a difference in their life.

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