EDUCATION IN ASTRONOMY: AN INTERNATIONAL PERSPECTIVE*

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I. INTRODUCTION

The health of astronomy is profoundly affected by the quality and quantity of astronomy education, in the schools and universities, and among the general public. Education plays a direct role in attracting and training the next generation of astronomers. It contributes to awareness, understanding and appreciation of astronomy among the taxpayers who support us. This review focuses on three topics: the educational activities of the International Astronomical Union (IAU), some notable astronomy education projects and programs worldwide, and some actions which you and your colleagues could take to promote more and better astronomy education in your city, your country, and the world. For a comprehensive view of astronomy education worldwide, see Pasachoff and Percy (1990), and the triennial national reports in the Newsletter of IAU Commission 46 (The Teaching of Astronomy).

II. THE IAU AND ITS EDUCATION ACTIVITIES

The IAU is a non-governmental scientific union founded in 1922 to "promote and safeguard astronomy, and to develop it through international cooperation". The IAU also acts as a liaison by representing astronomy on about 20 other unions and commissions. There are currently 65 countries adhering to the IAU—up from 51 three years ago, primarily due to political events in Europe. Individual membership is by nomination, and is free (so there are no economic barriers); it is based on qualifications—usually a Ph.D. and some years of experience. There are 7301 members (10.5% women); the number doubles about every 12 years. IAU headquarters is based in Paris, and is administratively "lean". Most of the IAU's funds (which come from formula funding from the adhering countries, as with the UN), support meetings, including General Assemblies, Regional Meetings, Symposia, and Colloquia, held in geographically-diverse locations, and the participation of young and/or needy astronomers. The IAU is governed by an Executive Committee, composed of a President, six Vice-Presidents, a General Secretary, and an Assistant General Secretary. The membership is organized into 40 commissions, or interest groups, of which only one is concerned with education. The last few issues of the IAU's semi-annual Information Bulletin have contained some interesting statistics about IAU membership, and some controversial proposals to restructure the commissions.

III. IAU COMMISSION 46 (THE TEACHING OF ASTRONOMY)

This commission serves "to further the development and improvement of astronomical education at all levels, throughout the world". It has about a hundred members, including representatives from each country adhering to the IAU, consultants from countries not yet part of the IAU, and other interested persons. It is governed by a President (currently Lucienne Gouguenheim, France), a Vice-President (currently me), and an Organizing Committee of individuals responsible for specific projects and programs. These include: liaison with other unions; a Newsletter, with triennial national reports; meetings associated with IAU General Assemblies and Regional Meetings, including a one-day workshop for local teachers at each General Assembly; IAU Colloquium #105 (The Teaching of Astronomy", held in Williamstown USA in 1988 (Proceedings: Pasachoff and Percy 1990); the Visiting Lecturers Program, which sends experienced astronomer-educators into "target" countries (currently Paraguay and Peru) for up to several months to give courses and develop collaborations; the International Schools for Young Astronomers (cosponsored by UNESCO)— intensive three-week schools held every year or two for advanced students and young astronomers and teachers in different parts of the developing world (currently India in early 1994); the Traveling Telescope, a Celestron-8 telescope and research-grade instruments to be used in countries (currently Paraguay) where astronomical research is in a developing stage. The national representatives play an important role in coordinating astronomy education in their countries, and in providing a two-way communication channel with the IAU.

Note that most (but not all) of these activities are designed for developing countries. The IAU also has a Working Group on the Development of Astronomy, and a Commission 38 (Exchange of Astronomers), which also promote and facilitate the development of astronomy.

IV. ASTRONOMY EDUCATION WORLDWIDE: AN OVERVIEW

Readers should realize that there are two main systems of education, typified by the "European" system in which, through a national curriculum and standard exams, a subset of students are specially selected and prepared for university studies while the rest are provided with more job-oriented training; and the "North American" system in which curricula are local (but comparable) and most students can— for better or worse— gain access to tertiary education. For a more eloquent and less simplistic account, see Wentzel's introductory paper in Pasachoff and Percy (1990).

In elementary school, basic topics in astronomy are usually taught but, as much research has shown, not understood. This is partly because the topics are usually boring, and taught by rote, and partly because elementary school teachers seldom receive much training in science in general, and astronomy in particular. The challenge is to develop an interesting curriculum (which should not be difficult, given the students' interest in astronomy), to teach it in a "hands-on" way, and to provide teachers with support through in-service workshops and other resources. It is in senior elementary school that students (especially girls) are "turned on or turned off" by science, so this level is critical.

In secondary schools, astronomy can be taught as a science, and many science teachers are interested in and knowledgeable about astronomy. In Europe, most physics teachers have received some training in astronomy. In North America, science teachers are more likely to teach astronomy because they enjoy it as a hobby. In the USA, a new generation of astronomy programs and materials are being developed, thanks to the...
education division of the National Science Foundation. In Canada, there is no
compulsory astronomy in the secondary schools of some provinces; if optional, it is often
bypassed in a very overcrowded curriculum.

At the university level in North America, hundreds of thousands of non-science
students take astronomy as a "science requirement" annually. Textbooks, teachers'
guides, and resource material (slides, videos, computer software, lab exercises . . . .) are
readily available. These courses provide an excellent way of reaching the influential as
well as "the masses" since, for instance, there is a good chance that any influential person
will have taken an astronomy course! Astronomy courses for science students are much
less common but, again thanks to the NSF education budget, they have increasing
access to telescopes, CCD's, photometers, computers, and other teaching and research
tools.

It is from this pool that future astronomers come. Unfortunately, the pool is
shrinking in North America (and elsewhere) because science is seen as difficult,
unpractical and unlikely to be financially rewarding. One way in which the pool can be
expanded (and equity achieved) is to attract more women and minorities to science.
Despite these efforts, women astronomers in North America still work in a "chilly
climate", recent surveys have shown. It is interesting to look at IAU statistics on the
percentage of women astronomers in different countries, and in different fields of
astronomy. New Zealand is lowest, with 0% women among its IAU members; Australia
is not far ahead. In the "romance language" countries like France, Italy, Spain and Latin
America, the fraction of women is much higher—typically 30%.

Among the general public, there is considerable interest in astronomy though, as
research shows, the level of understanding is limited. In North America (and now in the
former Soviet Union), there are the additional "problems" of creationism and
pseudo-science. These may herald a general backlash against traditional science.
Planetaria and the media play an important role in public awareness of astronomy, as do
amateur astronomers, who number at least a million in North America. These "volunteer
astronomers" make important contributions to education and research, as well as by
providing public support for astronomy. But there is concern (perhaps unjustified)
about the "dumbing" of amateur astronomy as these individuals flock to computerized
telescopes, and software akin to video games.

V. ASTRONOMY EDUCATION WORLDWIDE: FROM A TO Z

The following representative items have been culled from the 1990-93 National
Reports which have been received as of November 1993 (the deadline was July!).
These are only a tiny fraction of the programs and projects in astronomy education
worldwide.

Argentina: In Esquel, astronomers are developing an astronomy center in a town
square, with both educational (e.g. a sundial) and recreational (e.g. an Earth-Moon
carousel) components.

Australia: One state has developed a pre-matriculation "distinction" course in
cosmology, to challenge the most talented students in the system.

Belgium has experienced an increase in public interest in astronomy as a result of the
first flight of a Belgian astronaut, and programs offered by planetaria, the Euro Space
Camp, and public "schools for astronomy".
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Brazil: Since 1971 over 18,000 people have taken 370 public education courses at the Sao Paulo Planetarium and School of Astrophysics.

Bulgaria now has a separate astronomy course in grade 11 high school.

Canada: Toronto is home of the Youth Science Academy, in which high school students organize seminars and field trips on science, and the University of Toronto Mentorship Program, which enables outstanding senior high school students to work on research projects with faculty such as me.

China, in 1992, hosted both an International School for Young Astronomers, and a conference on Teaching Astronomy in the Asian-Pacific Region.

Colombia experienced an increased interest in astronomy as a result of the July 1991 solar eclipse; geographical accidents can leave a positive legacy!

Finland: University astronomy enrollment has risen as a result of Finland's more active role in space research.

France: The long-standing Comite de Liaison Enseignants et Astronomes (CLEA) organizes very successful summer schools for teachers, and a journal Les Cahiers Clairaut.

Hungary: As elsewhere in eastern Europe, the education system is in a state of flux, with the creation of new private schools and universities.

Japan reports growing public interest in astronomy, but there is concern about light pollution in this densely-populated country.

Malaysia: The "lone astronomer" has been responsible for a new planetarium complex in Kuala Lumpur, in addition to her many other duties.

Mexico: The institute of astronomy of the national university has an active outreach program to schools and the public, through books, newspaper articles, and even "science in the subway stations".

New Zealand, as part of the 1993 RASNZ AGM, held a one-day workshop for schoolteachers—an event which should be part of every scientific meeting!

Nigeria is developing a national space policy, and this may have a positive effect on astronomy education, and may stimulate the development of collaborative astronomical research.

Norway has a planetarium which specializes in the projection of Northern Lights in a wide screen movie format.

Peru: the Boletin Informativo SAA (Seminario de Astronomía y Astrofísica) for 1993 list an impressive array of activities and accomplishments.

Poland has hosted two recent science education conferences with an astronomical flavor: Cosmos: An Educational Challenge, and Frames of Reference.

Portugal: Much effort has gone into the development of a high-quality graduate program in astronomy at the University of Porto.

Russia: Positive advances in astronomy education have been compromised by political and economic factors, and by the growth of pseudoscience—"the backside of non-intelligent human rights".
South Africa: Within the turmoil of political events, astronomy is seen as an inexpensive way to "turn on" a multiracial population to the cultural and economic benefits of science.

Spain: "Permanent Seminars" for teaching astronomy have been established in several locations, and have produced effective astronomy activities for school classes.

Sweden has brought astronomy to the attention of students and the public through an essay contest, sponsored by the European Southern Observatory, in which the prize is a night of observing time on an ESO telescope!

Switzerland is home to the Saas-Fee courses, given each year by three lecturers to about a hundred European doctoral and post-doctoral students; the lecture notes are published by Springer-Verlag.

United Kingdom: the Open University, which specializes in distance education, has developed an astronomy course which will enroll more students than all other astronomy courses in the UK!

United States: Of the many astronomy education projects funded by the NSF, the largest is Project STAR: Science Teaching through its Astronomical Roots, which includes a textbook, teachers' manual, inexpensive apparatus, and a well-researched approach.

Yugoslavia: The Youth Research Station in Petnica organizes a variety of courses and project work for students interested in astronomy.

Zimbabwe: Astronomy is alive and well at Prince Edward School— a government school in Harare; it has an observatory, and is headquarters for the local astronomy club.

VII. THE DEVELOPING COUNTRIES

Of what value is astronomy to developing countries? Perhaps the most obvious is its educational value. With its appeal to young people, it can attract students to the sciences and engineering, rather than to law and politics. It is deeply rooted in the culture of almost all societies, so it can also raise the general level of scientific literacy. To paraphrase the words of Mazlan Othman (Malaysia): "Astronomy is the stuff of dreams and youthful fascination. This is true for us in the developing countries as much as in countries like the USA. Our youth are interested in astronomy and space as much as youth elsewhere. And when you in the developed countries achieve your dreams, we hope not to be too far behind you."

A common phenomenon in the developing countries is "the lone astronomer"—one individual who facilitates astronomy at the university, school, amateur and public level. Their achievements are remarkable. What are their needs?

One is to visit and be visited, and many of the IAU's programs are designed with this in mind. If you have the opportunity to spend a few days in such a country, please do so; I can put you in touch with the appropriate person. Another need is for books and journals, and several organizations (such as the Canadian Astronomical Society) have programs of this kind. It is necessary to identify a "target person" in the country concerned, and to set up a channel for communication and delivery; again, I can provide advice. There is a need for equipment and observing facilities; the Traveling Telescope is a modest step in this direction.
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VII. HOW YOU CAN IMPROVE ASTRONOMY EDUCATION

It would be unreasonable to expect every astronomer to devote a large fraction of their time to education (although some of us do). A better approach is to stress organization, coordination, and communication.

a. Make education a part of your organization (RASNZ, ASA or .....). Establish an active education committee, with an active chair/coordinator, which will (i) provide a regular education column in your journal, (ii) organize an education session, public lecture and teachers' workshop at your AGM, (iii) maintain a network of information about education topics for your members, (iv) work with education authorities and other groups in your country to promote astronomy education.

b. Be aware of developments in astronomy education, as well as education in general, using channels such as those mentioned above. Is the science curriculum changing? Make sure astronomy is not left out! Looking for new teaching material? Be aware of what exists; don't re-invent the wheel! Convene a meeting on astronomy education every few years, inviting people from the educational authorities, teachers' associations, and the media. Lobby for more funding for science education; the annual education budget of the US NSF is half a billion dollars!

c. Help get more and better astronomy in: day and night schools (teaching a general-interest course in the evening is fun!); museums, science centers and planetaria; parks and conservation areas ("star parties"); radio, TV and print media. Lobby for, and help develop a new planetarium, science center or public observatory.

d. Support astronomy in the developing countries. Broaden your perspective by learning about astronomy worldwide, and about the specific needs of the developing world. Find out about programs to send surplus books and journals there; support and use these. Locate and communicate with "the lone astronomers"; find out how you can help. If you visit a developing country (or any country), consider meeting with astronomers, teachers and students there; make arrangements ahead of time by consulting with IAU Commission 46. Support the IAU and its activities.

e. Do your bit for education. Pass on your knowledge and enthusiasm for astronomy; students especially must be shown that scientific careers are exciting! Give the occasional public lecture or school visit, and write the occasional article for a magazine or newspaper. Encourage interested students, especially under-represented groups such as young women. Publicize astronomy, and its practical and cultural value.

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IX. REFERENCES