

those years. There was a lot of money around and some was put to good use. Research and education developed in México as never before. It appeared that it was a matter of a few decades to catch up with the developed countries. But the mirage did not last long. Oil prices dropped again and now, very close to 1990, we have gained only a few more astronomers with respect to 1980 and are nowhere near 100, the expected number had the trend of the seventies continued. It turns out that in México the salaries in education and research are tied to the nation's economy and seem to reach reasonable levels only in epochs of bonanza. Some countries have had the good fortune of having visionary leaders who valued and supported education and research even in the worst of circumstances, knowing that this is the only way to build a strong country. We have not shared this fortune.

Nevertheless, even in our limited situation, a lot is being done and the second major need that I see can be satisfied at no cost (that is, money). By the peculiar structure of our universities (research and education are considered as totally separated activities, with institutes and centers doing the first and schools doing the second), teaching is considered as a less "intelligent" activity than research. Popularization does even worse, and can be valued as a negative component in one's *curriculum vitae*. It is true that teaching and popularization can be done disastrously, but the same is true for research. A manifestation of this scale of values was the creation by the government of the program of "scholarships" (actually, a supplement to our meager salaries) that is based mainly on our research publications. We need our scientific community as a whole to recognize education activities as important, as long as they are made seriously and professionally.

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A healthy astronomical education system can exist only if there are active research groups in a given country. I will discuss some of the cultural and economic problems that astronomical research groups face in developing countries.

In every country, in general, the higher the level of education, the smaller the group that benefits from it. This pyramid is immensely steeper in poor countries, where elementary education is not even available to all children, and where the higher levels of education are reached by only a very small fraction of the population. In atmospheres where frequently there is a general lack of culture and scant official interest in science, and where the mass media continuously advertise fantasy and escape from reality, it is difficult to promote and supervise science education at any level (including astronomical education). Even in those developing countries with a rich historical background, modern scientific research and science education are only incipient activities.

In underdeveloped countries, most of the scientific research and scientific edu-

education are carried out in state-supported universities. In the last 5 or 10 years, with the increased world economic imbalance against the poor countries, many governments are demanding that the universities become self-supporting or assist directly in the economic development of the country, extending their demands to scientific research groups. For a basic research discipline such as astronomy, the possibility of becoming self-supporting is out of the question since, by nature, astronomical research has no direct application to the country's economic welfare.

I am convinced that, in order to establish satisfactory astronomical education at all levels, there has to exist, within the country, some activity in astronomical research. Although, in principle, the research group does not need to interact directly with all levels of astronomical education, it can act as a catalyst and promote sound scientific material at schools (and to a lesser extent supervise the material that is presented on radio and TV programs); it can also create an interest in the topic among the population. Of course, the scientific structure at all levels is self-propagating, because how can an active group be established if the proper bases have not been laid out previously?

For a successful education program in astronomy at university level there are several basic resources that should be available: human resources, observatories, laboratories, libraries, and computing facilities. Each one of these items is important in its own right. To train astronomers, a group of active scientists must carry out the training programs. To have active scientists, they must have available some research facilities that include data-gathering equipment (observatories), laboratories for data measurement, data handling systems (computing facilities), updated library facilities, and accessible publication means.

Training of astronomers can also be carried out through scholarships to study in advanced countries. In some cases it has worked very favorably, and it has helped establish astronomical communities with a modern outlook. This process, although slow, is probably the best investment that poor countries can make; however, it is not necessarily foolproof, since there are many instances that, once the student has been trained, he does not want to return to face the unfavorable conditions of his own country.

Regarding observing facilities and equipment, it should be pointed out that a few years ago the working hypothesis was that, through hard work and shrewd planning, poor countries would eventually reach the same levels of facilities as the developed ones (at least in a few specialized areas). In the meantime, developed countries have improved their astronomical equipment at a very fast rate through the application of modern technology, and the use of this equipment has increased our knowledge of the universe and has enlarged the scope of astronomical problems. Alternatively, the astronomical future for developing countries has become uncertain. It is very expensive to obtain modern equipment; it requires a technological background not always available, even to buy the most convenient piece of equipment and to put it into operation. And in general, it is my personal feeling that the opportunity of giving significant contributions to the general knowledge of astronomy by developing countries is becoming more and more difficult. Thus the

previous working hypothesis does not seem to apply any longer. The technological gap, instead of disappearing, is widening at an ever-increasing rate. Even trying to maintain a few well-stocked libraries with modern journals, books, and astronomical catalogues can be beyond the resources that most developing countries have allocated for this purpose. A meeting such as this — IAU Colloquium 105 — can only address the question of improving astronomical education in the countries, mainly through interaction with the professional astronomers, who themselves can have an indirect influence in their society. Given the enormous needs of the developing countries, that touch all aspects of society and that cannot be met by a small community such as that of professional astronomers in the world, perhaps it would be simpler to attempt to establish a one-to-one relationship between an astronomical institution in a developing country and another one in a developed country. From it, a personal relationship can be established to further astronomical training, selection of equipment to be acquired, and assistance to obtain astronomical materials to advance a specialized field of research of interest to both institutions. Commission 46 of the IAU could act as a clearing house to help establish contacts among institutions. Young astronomers should be encouraged to advance their astronomical training; the exchange of astronomers of different institutions should be extended to astronomers of developing countries.

In spite of the drawbacks described above, I consider it very important for astronomy to be advanced in all countries since: a) it is an important part of human knowledge and culture, b) astronomy is one of the basic sciences and its advance is related to that of other basic and applied sciences and to the advancement of technology that can lead to economic development, c) citizens of all countries have the right to do research in all areas and contribute to science development; this activity in turn can help them establish their national identity.

Efforts are being made and we should continue to pursue astronomical research to the best of our abilities. At the same time, public awareness of modern astronomy, communication of the fundamental ideas of astronomy to school children, and the strengthening of higher education programs have to be carried out.

Conclusions

Astronomy education cannot exist if there are no active astronomical research groups in a given country. The difficulties of carrying out modern astronomical research are enormous and are growing. However, groups should be encouraged to continue their efforts to promote astronomical research.
