Space education in developing countries in the information era, regional reality and new educational material tendencies: example, South America

Tania Maria Sausen*

Ministry of Science and Technology, National Space Research Institute, Av. dos Astronautas 1758, CP 515, CEP 12.201-970 São José dos Campos, SP, Brazil

Abstract

The initial activities on space education began right after World War II, in the early 1950s, when USA and USSR started the Space Race. At that time, Space education was only and exclusively available to researchers and technicians working directly in space programs. This new area was restricted only to post-graduate programs (basically master and doctoral degree) or to very specific training programs dedicated for beginners. In South America, at that time there was no kind of activity on space education, simply because there was no activity in space research. In the beginning of the 1970s, Brazil, through INPE, had created masteral and doctoral courses on several space areas such as remote sensing and meteorology. Only in the mid-1980s did Brazil, after a UN request, create its specialisation course on remote sensing dedicated to Latin American professionals. At the same period, the Agustin Codazzi Institute (Bogota, Colombia) began to offer specialisation courses in remote sensing. In South America, educational space programs are currently being created for elementary and high schools and universities, but the author personally estimates that 90% of these educational programs still make use of traditional educational materials — such as books, tutorials, maps and graphics. There is little educational material that uses multimedia resources, advanced computing or communication methods and, basically, these are the materials that are best suited to conduct instructions in remote sensing, GIS, meteorology and astronomy. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Space education; Educational material; Multimedia resources; Remote sensing

1. Introduction

The initial activities on space education begun right after World War II, in the early 1950s, when USA and USSR started the Space Race. At that time, space education was only and exclusively available to researchers and technicians working directly in space programs of these two countries, involving a totally new area of science and technology known only to a restricted group of professionals.

In fact, this new area was restricted only to postgraduate programs (basically masteral and doctoral degrees) or to very specific training programs dedicated for beginners. All these educational programs were prepared in a traditional way, with for-
mal groups or in laboratories and using educational material based on books, tutorials, or even notes taken in class.

On the other hand, in South America, there was no such kind of activity on space education — simply because there was no activity in space research. Just at the beginning of the 1960s, a small group of researchers from Argentina and Brazil showed interest in it and all members of this group had their training and/or gained postgraduate education mainly in the United States.

2. Graduate programs

At the onset of the 1970s, Brazil, through the National Institute of Space Research (INPE), created MA and PhD courses on several space areas such as astrophysics, space geophysics, applied computing, remote sensing, meteorology, engineering and space technology (mechanical space and control, space combustion and propulsion). Only in the mid-1980s did the initiatives to create educational programs on specialisation level started to appear. It was at that time that Brazil, after a UN request, created its specialisation course on remote sensing dedicated to Latin American professionals (Sausen, 1994, 1995).

At the same period, the Agustin Codazzi Institute (Bogota, Colombia) started to offer specialisation courses in remote sensing, in a partnership with ITC (Netherlands).

As can be noted above, in South America most educational curricula, which especially focused on training programs, were dedicated to remote sensing or meteorology. Education in other space areas was basically grounded on the masteral and doctoral levels (Sausen, 1992, 1999b).

3. Development of educational material

All these programs, however, failed to motivate the space institutions to create a team responsible for the development of a comprehensive educational material. This happened not only in South America but also in developing countries all over the world. This situation was in contrast to what happened in developed countries like USA, Canada, several countries in Europe, USSR, Japan, etc. These countries, since the 1970s and maybe earlier, were very concerned about developing an educational material for the space sciences. Usually, the educational material was in English. NASA, in particular, has a very important division that is responsible for educational programs and development of educational material in all space sciences.

In the 1990s, which ushered in the globalisation era and increased communication capabilities between countries, the UN Outer Space Affairs Division presented a new education vision — which, above all, stressed the necessity of preparing a new professional generation, and motivated a higher concern about educational space programs for elementary and high schools and universities. The accomplishment of this goal has been rendered possible due to the wide use of multimedia, computing and easy communication resources.

Thus, nowadays, it is possible to find among the developed countries several tutorials in remote sensing, satellite meteorology, astronomy, geoprocessing, image processing, and satellite programs, using CD-ROMs and WEB resources. Among these resources, several have made use of sophisticated computing resources and are based on long-term research and educational experience of university professors and researchers in space areas. They are rich in satellite images, like LANDSAT, NOAA, ERS, GOES or Hubble images, fieldwork photographs, colour figures to explain the basic principles of physics, mathematics, geography, climate, weather, constellations and stars, satellites, rockets, launchers, etc. It is impossible for the user of such tutorials not to get fascinated by the space activities.

NASA has a homepage with several tutorials dedicated to its several activity areas, all of very good quality. These tutorials are generally very easy to assimilate, understandable and clearly formulated, and they always present basic concepts and define technical terms, as well as make frequent use of helpful figures. There are educational programs dedicated to elementary school, high school and university students, and many of them use WEB resources, videoconference, teleconference and network computers. All of them are of excellent quality and are constantly updated based on the latest technological developments. Many of them are dedicated to long-
distance courses, allowing them to reach a larger number of students.

CNES (France), ESA (Europe), CCRS (Canada) and NASDA (Japan) also have tutorials dedicated to space education, which present their own activities.

The author has access to very good CD-ROMs and videos dedicated to space education and all of them have high quality as educational material but they are all in English. This is a problem for South American students who mainly speak Spanish and Portuguese. Furthermore, these materials cannot be incorporated in the space educational programs for high school students.

Table 1 shows the most spoken languages in the world.

As can be seen in Table 1, based on a current world population of 6 billion, Spanish and Portuguese is spoken by ca. 608 million people, i.e. about 10% of the world population. Eighty-five percent of Spanish and Portuguese speakers live in Latin America.

4. The situation in South America

In South America, educational space programs for elementary and high school and university students are also developed, but the author estimates that 90% of these educational programs still make use of traditional educational materials, such as books, tutorials, maps and graphics. There is little educational material that makes use of multimedia resources, advanced computer or communication methods. To give an example, only 2% of the Brazilian public schools (Brazil is the largest country in South America with 160 million inhabitants) have computers. It is possible to imagine the very low number of schools having multimedia, teleconference, videoconference, etc., capabilities.

In fact, the situation of space education in South America presents a very contradictory panorama. We can find very advanced sections that make use of internet, multimedia and computing resources in metropolitan centres like São Paulo, Buenos Aires, Caracas, Santiago, etc. — cities with millions of people, modern laboratories and universities of excellent quality. But not very far from these centres, just some kilometres away, very little developed regions can be found with no possibility of using computers as an educational resource in space education. Most people in these regions have never even heard about the space activities developed in their own countries.

In Bolivia, for example, there are schools with no electricity or running water. This also holds true in the northern and northeast regions of Brazil, like in the Amazonia, and in some regions of Paraguay and Peru. This problem occurs actually in every country of the continent. Facing this situation, the question arises — how to bring information on space activities to students in such regions. And one may ask himself: If they do not have even electricity or running water, why will they want to learn about space activities? Such knowledge would be very helpful because space activities — such as remote sensing and meteorology or communication satellites — can help these people in the fields of agriculture, pasture, fishing, forest preservation, regional and urban planning, catastrophe mitigation, environmental impact prevention, health, education, etc.

In contrast to developed countries, until now, no major South American space institution has come up with an educational division or a research team that is primarily dedicated and concerned with the development of space education material in all space areas using the regional language, regional examples and data about the regional space programs. This situation extends even in the remote sensing and meteo-
rology areas, although both are very concerned with outreach space educational programs. And it is the estimate of the author that in other developing countries like those in Africa, Asia and Eastern Europe, the situation is generally the same.

Why is there so little interest on more advanced educational resources in South America? It is actually not a lack of interest, but a problem caused by the following reasons.

- Lack of good infrastructure to generate educational material, in general.
- Lack of institutional support towards making educational material.
- Lack of financial support to develop this kind of material. It is very difficult to get financial support to develop educational material in space sciences because there is no diffusion of the educational space program at the financing organisations in such a way that motivates them to finance such activities. There is a very good financial support for research development but very little for educational material development.
- The desire of developing material with the same high standard as in the developed countries having better resources. The material developed by these countries has excellent quality and outstanding educational resources, but most of the time, these are beyond the financial and infrastructure capabilities of their counterparts in South America.
- Besides, in developing countries, there is no tradition in the development of educational material for space sciences, because most of them do not have educational space activities, or even space programs. Usually, they are just satellite data users.
- The existing educational material, in general, comprises of isolated personal efforts and of the teachers’ personal annotations that give the courses. Often, there is no institutional educational commitment for the development of such material (Sausen et al., 1997).

5. Educational material in South America — examples

Let us see some very good examples of educational material using computing resources in South America. As it will be seen from the examples below, the majority of education material that makes use of computer resources is basically dedicated to the remote sensing and GIS or meteorology areas.

5.1. Brazil

- INPE and the Latin American Remote Sensing Society (SELPER)/Chapter Brazil have developed a CD-ROM for high school students on remote sensing and GIS teaching. In this CD-ROM, there are 27 LANDSAT images, corresponding to the capitals of the Brazilian states and the Brazilian capital, a text about all the regions, all the states and capitals. There is also the geoprocessing software SPRING-View, developed by INPE, and a database about Brasilia. This CD-ROM can be also used as an educational resource for geography.
- INPE and SELPER/Chapter Brazil have developed two tutorials about the LANDSAT Program and the Remote Sensing History, both in Portuguese and Spanish, which are available at the SELPER and INPE Homepages (http://www.ltid.inpe.br/selper/frame.html and http://www.ltid.inpe.br/educacao.html).
- INPE and SELPER/Chapter Brazil are developing, in partnership with 11 countries in South America, and using satellite images, an Atlas about South American and Antarctic Ecosystems dedicated to high school students. INPE, National Commission on Space Activities of Argentina (CONAE), Center for Remote Sensing of Natural Resources, Ecuador (CLIRSEN) and ESA are delivering images for this atlas. The atlas will be published in hardcopy and in CD-ROM (Sausen, 1999a).
- A researcher from the Weather Forecast Centre and Climate Studies (CPTEC) INPE, has developed a CD-ROM dedicated to Meteorology Education. This CD-ROM, which is designed for high school students, uses several multimedia resources and uses narration. It presents a large number of illustrations and multimedia resources (loyolla@cptec.inpe.br).
- The Aerospace Technical Centre (CTA), through the space activities Area — NAEE and Aeronautic and Space Institute (IAE) has developed a CD-ROM on space education, launchers and astronomy. This
CD-ROM was developed to support the space education activities at CTA (nae@iconet.com.br).

5.2. Argentina

- CONAE is developing the Space Education Mission, a program of activities for elementary school students (age 11), at the Teofilo Tabanera Space Centre, Córdoba. This is an opportunity for children to visit a space centre, learn what a satellite is and simulate a series of operations with the Argentine satellite SAC-A, such as those performed by real operators, but using a didactic software specially developed for the students. The program was used by nearly 80 schools of the Province of Córdoba (over 300 students and nearly 100 teachers), who attended an introductory lecture on satellites and visited the Córdoba Ground Station, where they observed the reception of remote sensing data and their use.

- CONAE has submitted the IMSAES Project within the frame of the Announcement of Opportunities for the use of images from the Multispectral Medium Resolution Scanner (MMRS) instrument of the SAC-C satellite, to be launched in April 2000 from the Vandenberg Air Force Base (USA). The goal of this project is to use MMRS images for teaching social sciences (history and geography) and thus making satellite images a common tool for teachers and students at high school level (ages 14–18).

- The Program for the use of satellite images at the educational level. The University of San Juan (Institute for Mining Research of the Engineering Faculty) is developing this project with the aim of making available to high school teachers and students (age 12–18) concepts, methods and techniques related to the use of satellite images, applied to the generation of geoscientific charts and environmental studies. CONAE contributes to the project by providing Landsat images and technical and scientific advice on the subjects of interest to the students.

- Pilot project: delivery of satellite image receivers at schools. CONAE is implementing this project, which consists of the use of low resolution images of NOAA at high school level (age 12–18), in order to familiarise the students with satellite images and enable them to receive the images by using information technology resources and their own antennae. The goal of the project is that these schools generate satellite information and distribute it to other schools. At present, nine receivers for low resolution NOAA images have been delivered to high schools — technical and non-technical — of the Provinces of Córdoba, Santa Fe and in the Federal Capital and the Gran Buenos Aires.

5.3. Chile

- The Remote Sensing and GIS Program at the Catholic University-PUC, Santiago, has developed a tutorial about remote sensing and GIS, available at the PUC-Remote Sensing and GIS Program Home-page. This tutorial is geared for university students and is also used for training of professionals active in the natural resources (http://www.cprsig.puc.cl).

6. Conclusions

In South America, the large space centres have training courses dedicated to professionals. All of them are offered very frequently, but none of these qualification programs are dedicated to the development of educational material using computer resources. And one of the basic priorities of establishing and continuing an educational program is the development of educational material.

In Brazil, there is a blooming space industry and about 24 industries involved in space sciences, which provide professional training courses. In Argentina, there are about three industries involved in the space program, especially IPAV, but none of them has created regular qualification programs or even an developed educational material.

Actually, most of the space qualification programs in the space area use computers, but these are confined to text editing, creation of databases for administrative purposes, administration, Internet and WEB access, or sometimes to access tutorials developed in other countries, which are invariably offered in English and not regional languages.

It is known that English is used as a universal language. Nevertheless, the lack of an educational material in regional languages limits the achieve-
ments and reduces the number of users, in contrast to the new vision of bringing space education to the general population. It makes it difficult for elementary and high school students to have contact, even a little, with the qualification programs in the space area, although they will eventually form the new generation of professionals. Those students or professionals, knowing English and making use of the tutorials available on the WEB, can acquire much more information about the space programs of Europe, Canada, Russia, USA, Japan and India, than from the space programs developed in their own countries.

Developing countries should start thinking on how to create programs dedicated to the development of educational material on space sciences. These programs have to be an institutional commitment, not an occasional and limited unilateral effort. Furthermore, consideration should be given to adapt the use of computer resources in a way that is suited to the local setting of each country.

The author has frequently heard teachers or space researchers in Brazil, Argentina, Chile, Bolivia and Venezuela, saying that they cannot formulate educational material because they do not have enough money or hundreds of satellite images to develop it. Most of them do not even try to find a creative solution, such as to cooperate or get support from private companies involved in space activities or multinational companies (Telefonica, Coca-Cola, IBM, etc.), space agencies, universities, foundations, etc., or what is even worse, they consider settling for the development of an educational material that is simple, boring and time-consuming. Basically, in developing countries it is not teachers but rather the space researchers — who are concerned about education and indirectly become teachers — that are involved in educational activities.

Our community is already perfectly aware about the importance of space science education on all formal and informal education levels. We should now go ahead and find easy, creative and more economical solutions for the development of educational material using computing and multimedia resources. It may not be possible to produce a tutorial fully with images, figures, graphics, maps, photos or live scenes. Perhaps, the use of videoconferences can be used 3 years from now. That is fine, but even now there is no obstacle to take a common video camera and register a traditional course given in a classroom or a seminar, as was done recently in Argentina during a radar course, and in Brazil during a seminar about space activities for journalists. This material can be easily edited, without high costs, copied several times and then distributed to universities for distance education programs making use of TV, e.g., as it is used in poorer regions of developing countries.

And we may also consider the important and precious help provided by students from communication, computing, physics, geography, education courses, etc. They can work as trainees in projects, with cooperation among the universities, private companies and space research institutions, for the development of educational material. The author has experienced this with a computer science student who is working as trainee for the Latin American and Antarctica Ecosystems Atlas. She is completely happy because she can work on a project like that and, this work increases her knowledge in the use of multimedia in computing. At the same time, she is learning about remote sensing, and moreover, at the end of the training she will have an excellent resumé.

The UN is creating the Centres for Space Science and Technology Education in developing countries. At the moment, there are three centres — one in India, one in Morocco and one in Nigeria. The Latin American and Caribbean Region Centre is under implementation in Brazil and Mexico and two more centres, one in Eastern Europe and another in Jordan, are under study. These centres could help the development of educational material in developing countries.

We have to take more risks in the computing area, which is a powerful resource in the classroom; it may transform any class in a constant information source. Computer resources make the students use their creativity, prod their curiosity, make the classes more interesting and, most importantly with elementary and high school students, we can bring the space activities to the next century professionals.

It is also necessary that the education authorities in South America, and elsewhere, invest in better schools, particularly those located in rural areas, by providing good infrastructure and computing resources or distance education, because these students
also want to land at the moon or become astronauts one day or even be excellent professionals active in the space area.

We need to think about creating regular professional qualification programs and educate new university students, such that they have at least some knowledge in the space area. This will be a relevant contribution for the future of the region and certainly for a better quality of life.

But, in order to do all these things we have:

- to develop educational material in our own language;
- to have institutional commitment for the development of educational material;
- to motivate education authorities, at national and regional levels, to support the publication and distribution of educational materials in space sciences;
- to motivate and to give means to educators and researchers to prepare materials to support space science teaching;
- to motivate the universities with publishing facilities to generate educational material and distribute it widely through scientific societies;
- to favour actions with the private sector that encourage the generation and distribution of educational material.

References


