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How to Incorporate Astrobiology into University Education Curricula for Space Science and Technology? The Regional Centres for Space Science and Technology Education, affiliated to the United Nations

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Abstract

Based on resolutions of the United Nations General Assembly, Regional Centres for Space Science and Technology Education were established in India, Morocco, Nigeria, Brazil/Mexico, and Jordan. Simultaneously, education curricula were developed for the core disciplines of remote sensing, satellite communications, satellite meteorology, space and atmospheric science, and global navigation satellite systems. This paper provides a brief summary on the status of the operation of the regional centres with a view to continue utilizing them as information centres of the International Committee on Global Navigation Satellite Systems (ICG). Space Weather and Astrobiology are specific fields that can be incorporated into the already existing education curricula.

Keywords: Satellite communications; Sensing and geographic information systems; Satellite meteorology and global climate

Introduction

Since 1988, the United Nations, through its Programme on Space Applications, supported the establishment and operation of regional Centres for Space Science and Technology Education in Africa, Asia and the Pacific, Latin America and the Caribbean, and Western Asia [1-6]. Simultaneously, detailed education curricula at the university level were developed and published for remote sensing and geographic information systems, satellite communications, satellite meteorology and global climate, space and atmospheric science, and global navigation satellite systems (positioning, navigation, timing) [7,8]. These five disciplines also constituted the priority thematic areas of the United Nations Programme on Space Applications, established in 1971. In the following we briefly review these developments and highlight the most recent updated education curricula in the five disciplines that are available in official languages of the United Nations, for implementation at the regional centres and beyond.

Space science and technology education can be pursued at the elementary, secondary and university levels. In space faring nations, national education standards for space science and technology are applied to curricula at these levels. Such an innovation has not yet fully taken place in developing nations, partly because the benefits of space science and technology have not been sufficiently appreciated and partly because the facilities and resources for teaching science and technology at educational institutions are not yet fully developed [9,10]. Education in space science and technology in industrialized nations has become highly interactive; the world-wide web and other information technologies are particular useful tools in education programmes at all levels [11].

The incorporation of elements of space science and technology into university-level science curricula serves a dual purpose for industrialized and developing nations. It can enable nations to take advantage of the benefits inherent in the new technologies, which, in many cases, are spin-offs from space science and technology. It can also revitalize the educational system, introduce the concepts of high technology in a non-esoteric fashion and help to create national capacities in science and technology in general. Already in 1999, in that regard, Pyenson and Sheets-Pyenson, in their in-depth research work, Servants of Nature, emphasized that:

"Both geographical decentralization and interdisciplinary innovation have become watchwords in academic science. Electronic information processing to some extent obviates the necessity for a scientist or scholar to reside at an ancient college of learning. Universities everywhere have adapted to new socioeconomic conditions by expanding curricula. They have always responded in this way, although never as quickly as their critics would like. Measured and deliberate innovation is one of academia's heavy burdens. It is also a great strength. Emerging fields of knowledge become new scientific disciplines only after they have found a secure place in universities. We look to universities for an authoritative word about the latest innovations. New scientific ideas emerge in a variety of settings, but they become the common heritage of humanity only when processed by an institution for advanced instruction like the modern university" [12].

Currently these words are specific advice for addressing space weather and astrobiology in existing education curricula for space science and technology. In general, there are many challenges in the teaching of science at university level, both in developing and industrialized nations. The general problem confronting science education is the difficulty for students to see or experience the phenomena being taught, which often leads to an inability to learn basic principles and to see the relationship between two or more concepts

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and their practical relevance to problems in real life, particularly when they are derived from space science and technology. Added to those problems is a lack of skills in the relevant aspects of mathematics and physics and in problem-solving strategies. There are also language problems in nations in which science is not taught in the national language(s). Over the years, industrialized nations have overcome most of the basic problems, except perhaps a psychological problem, namely that students may consider science to be a difficult subject [13-16].

In its resolution 45/72 of 11 December 1990 the General Assembly of the United Nations endorsed the recommendation of the Working Group of the Whole of the Scientific and Technical Subcommittee, as endorsed by the Committee on the Peaceful Uses of Outer Space (COPUOS), that the UN should lead, with the active support of its specialized agencies and other international organizations, an international effort to establish regional centres for space science and technology education in existing national/regional educational institutions in the developing nations [17].

In its resolution 50/27 of 6 December 1995 the UN General Assembly also endorsed the recommendation of the COPUOS that these centres be established on the basis of affiliation to the United Nations as early as possible and that such affiliation would provide the centres with the necessary recognition, strengthening the possibilities of attracting donors and of establishing academic relationships with national and international space-related institutions [18,19].

Regional centres were established in India for Asia and the Pacific, in Morocco and Nigeria for Africa, in Brazil and Mexico for Latin America and the Caribbean, and in Jordan for Western Asia, under the auspices of the Programme on Space Applications, implemented by the Office for Outer Space Affairs [1,15] (Figure 1). The objective of the centres is to enhance the capabilities of Member States, at the regional and international levels, in various disciplines of space science and technology which can advance their scientific, economic, and social development. Each of the centres provides postgraduate education, research, and application programmes with emphasis on (i) remote sensing and geographic information systems; (ii) satellite communications; (iii) satellite meteorology and global climate; (iv) space and atmospheric science, and (v) global navigation satellite systems (positioning, navigation, and timing) for university educators and research and application scientists (Figure 2). Since 1996 centres implement 9-month postgraduate courses in the five areas based on model curricula that emanated from the UN Meeting of Experts on the Development of Education Curricula for the Regional Centres for Space Science and Technology Education, held in Granada, Spain, in 1995. Since 1995 the curricula have been reviewed, revised, and updated at regional and international educational meetings [20], and, more recently, in the meetings of the International Committee on Global Navigation Satellite Systems (ICG) [21, 19].

The Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III, 1999) recommended that collaboration should be established between the regional centres and other national, regional, and international organizations to strengthen components of their education curricula [22]. In its resolution 54/68 of 6 December 1999, the General Assembly endorsed the resolution of UNISPACE III entitled 'The Space Millennium: Vienna Declaration on Space and Human Development', in which action was recommended to ensure sustainable funding mechanisms for the regional centres [23].

The Office for Outer Space Affairs of the Secretariat of the UN, in cooperation with the European Space Agency, organized a second UN Expert Meeting on the regional Centres for Space Science and Technology Education: Status and Future Development in Frascati, Italy, back in 2001 [24]. The meeting reviewed the status of establishment and operation of the regional centres with a view to enhancing cooperation between them. However, the main objective of

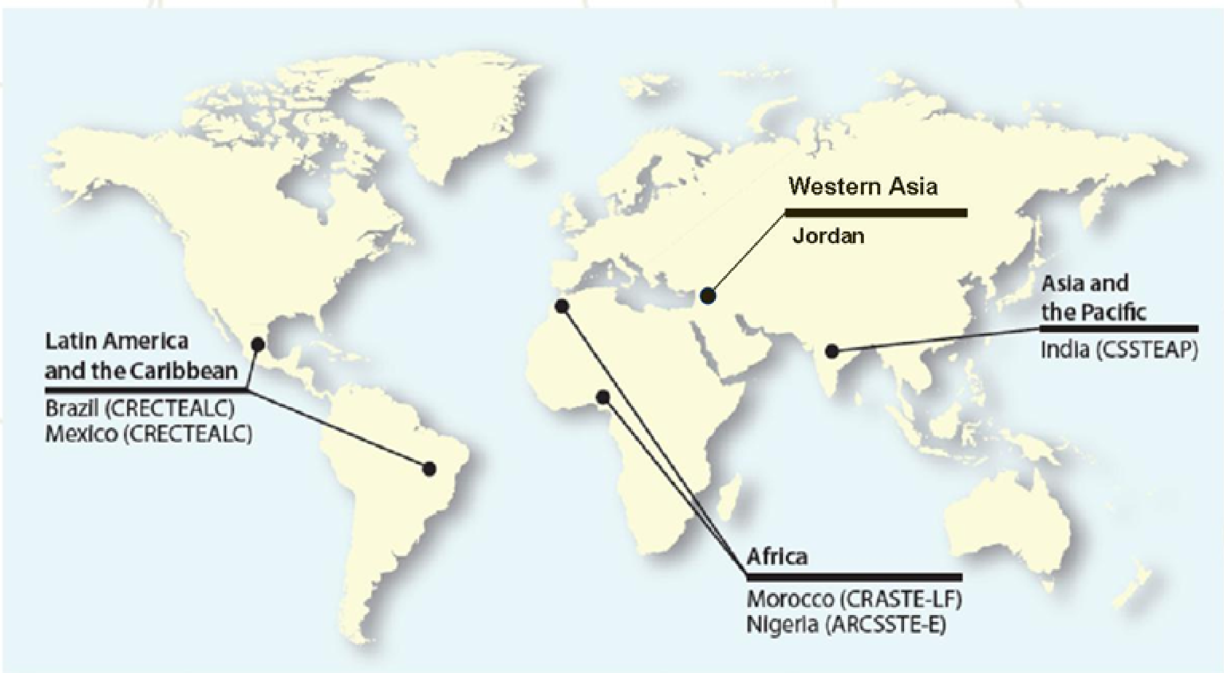

Figure 1: World map showing the geographical location of the regional Centres for Space Science and Technology Education in the four economic regions on Earth.

Figure 2: Cover pages of the five education curricula available in print and on the world-wide web as utilized by the regional Centres for Space Science and Technology Education.

the meeting was to review and update the curricula at the university level. The meeting considered that education still varied significantly between nations and even between institutions within the same country, which led to differences in space science and technology education curricula in terms of course content and modes of presentation. The meeting noted that the model curricula [5] had contributed to resolving such problems.

The meeting thoroughly updated the education curricula and drew up course syllabuses that differ from most of those available in the literature and on the worldwide web. They are based on physics, mathematics, and engineering as taught in many universities around the world. They are not tailored to any specific space-related project or mission that may have been or will be executed by any specific institution. The curricula are available, in official languages (Arabic, Chinese, English, French, Russian, Spanish) of the United Nations as United Nations documents [25].

Pursuant to holding the UNISPACE III Conference in 1999, within the framework of the International Committee on Global Navigation Satellite Systems (ICG) [15,19], which was established as a forum for the purpose of promoting the use and application of Global Navigation Satellite Systems (GNSS) on a global basis, negotiations with the regional centres were concluded, to utilize them as a "hubs" for training and information dissemination on global applications of GNSS and their benefits for humanity. The ICG Information Centres aim to foster a more structured approach to information exchange in order to fulfill the reciprocal expectations of a network between ICG and regional centres. By using the already existing structures and outreach of the regional centres, ICG and, specifically GNSS service providers, save efforts and financial resources while gaining the support of already operating centres for information dissemination. On the other side the regional centres expanded their range of knowledge and service and thus opened new opportunities to connect to other GNSS interested actors in their regions. Implementation of such a concept deepened the cooperation of the members of ICG and thus contributed to a common approach on matters of mutual interest related to civil satellite-based positioning, navigation, timing, and value-added services, as well as compatibility and interoperability among the GNSSs, while increasing their use to support sustainable development, particularly in the developing nations.

The ICG Executive Secretariat and ICG working groups co-Chairs indicated two areas where they assist the process of the development and progress towards the ICG Information Centres: technical level, which will include various GNSS technologies, with possible collaboration with industry leaders; and linkages with current and planned GNSS and augmentation system providers. Linkages have been established through collaboration with the ICG working groups (seminars/trainings and supportive material), as well as communication and outreach to the wider community through the ICG information portal, mailing lists, brochure, and newsletter [25].

Additional to the above regional education centres and ICG, specialized centres, particularly focusing on selected programmes as implemented by the International Center for Space Weather Science and Education at Kyushu University, Fukuoka, Japan (http://www.serc.kyushu-u.ac.jp/index_e.html), the education and research Centre in Basic Space Science at the University of Nigeria in Nigeria (http://www.cbssonline.com/aboutus.html), and the Centre for Mathematical Sciences in India (http://www.cmsintl.org), started offering courses on a regular basis.

Space weather and astrobiology are two fields of currently increasing interest for possible incorporation into the existing education curricula in space science and technology.

At the fiftieth session of the Scientific and Technical Subcommittee of COPUOS, Vienna, 11-22 February 2013, China proposed the establishment of a Regional Centre for Space Science and Technology Education in Asia and the Pacific at Beihang University, China [26,27].

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