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Resources to introduce Inquire Based Scientific Education in Secondary and High School

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Abstract

The global Hands-on Universe association is producing and distributing free resources world-wide to implement Inquire Based Scientific Education (IBSE) at secondary and high school levels. The materials are inspired in astronomical research and space exploration. The association is implementing the Galileo Teacher Training Program world-wide. In this contribution, a summary on the most recent resources being implemented by HOU-España and developed with Spanish participation is presented.

1 Introduction

In recent years, many studies have highlighted an alarming decline in young peoples interest for key science subjects, including natural sciences and mathematics. Although the number of students is increasing in most European countries, too few students choose scientific study fields, which are crucial to sustainable socio-economic development. In some countries even the absolute number of students in these fields is decreasing. In addition, among lower and upper secondary school students there is a well documented trend of diminishing attitudes towards science study as age progresses, especially in the range $14-17$ years old. From a gender perspective, the problem is also acute: persistent gender gaps exist in the choice to study some science subjects and in the relative advancement of the two sexes up the career ladder in science-related professions. At the same time, international assessment initiatives such as PISA and TIMSS have repeatedly shown that the quality of student learning outcomes

in science and mathematics falls far below the levels of coherent understanding that are typically specified in curriculum and benchmark documents. Furthermore, the acquisition of competencies that are essential in all ways of life, in a society increasingly dependent on the production and use of scientific knowledge, is also under increasing threat. More than ever in the history of humanity, it is a vital need for democratic society to provide all citizens with scientific literacy (including numeracy), critical thinking, reasoning strategies and a positive attitude towards scientific inquiry. Based on these trends, Europe's long term economic and scientific and innovation capacities will decline. Reversing them is a major educational, technological and policy challenge.

For many years different institutions (research or industrial laboratories, science teacher education groups) have undertaken initiatives in collaboration with schools at the local level, with sometimes impressive results that tend to be short lasting depending on funding availability and the extent of commitment by individuals involved. Based on existing evidence, there is a very clear case that the role of schools in nurturing childrens and future citizens interest as well as peoples awareness of the role of science in society, needs to be enhanced. In many educational systems, science teaching begins at the end of primary school, well after attitudes towards science have been formed and are sometimes deeply ingrained. Despite longstanding efforts, teaching methods remain very resistant to change and are too often prone to be seen as attempts to indoctrinate rather than inspire students into science. Innovation in science curricula has also been slow in many countries. As a result, science in schools still remains distant from issues of contemporary interest, from social expectations, including the needs of industry and other employers, and from the way science is done, in authentic contexts, as a process of inquiry aimed at the development of problem solving and predictive capabilities. In fact, the EC also recognizes this problem, stating that there is a need to rethink how science is taught in schools. Making science more appealing to the young requires a serious rethinking of the way science is conveyed. Young people attribute their lack of interest in science and technology to the way science is taught in schools, the complexity of these subjects, and an apparent shortage of attractive career prospects.

For more than 15 years now, the Hands-on Universe (HOU) association has been a key driver to implement Inquire Base Scientific Education (IBSE) at schools world-wide. The association has provided tools and exercises, courses for teachers and students, contests and world-wide interaction scenarios. At national level, HOU-España sited at the Universidad Complutense de Madrid (http://www.houspain.com), at European level, European Union-HOU sited at the Université Pierre et Marie Curie in Paris (http://www.euhou.net), at global level the Global HOU associated cited in Lisbon, Portugal ((http://www.globalhou.net) have been collaborating world wide to enhance and motivate science education. In this contribution, two of the most recent activities released by the HOU consortium to the educational community are presented. The project "EU-HOU connecting classrooms to the Milky Way" is described and presented in Sect. 2. The project "Discover the Cosmos" is described in Sect. 3. A brief summary is provided at the end.

2 EU-HOU connecting classrooms to the Milky Way: a network of small radiotelescopes for education

This project has developed the first European network of radiotelescopes for education, enabling schools to explore the Milky Way through Internet, and IBSE pedagogical resources to be used in the classrooms. This will provide the opportunity to explain European research in schools at the time of ALMA first light. The MWG project provides pedagogical tools to secondary school teachers, enabling them to propose interactive activities to their pupils. Multilingual exhibitions, accompanied by booklets, have been prepared to disseminate basic knowledge about radio-astronomy in schools and outreach sites. The development of the first radiotelescopes network for education and the promotion of its pedagogical use enables pupils to perform by themselves observations of the Milky Way in real-time, to acquire data and observe the remote control of the radio-telescope with a Webcam. To achieve this objective, a multilingual Web interface in java has been developed to control each radio-telescope. To avoid possible apprehension of teachers to use remotely control instruments in classrooms, a simulator of observations has been released based on an existing and publicly available all-sky survey. Exercises based on radio-astronomical data and tested by pilot teachers and their pupils have been prepared, translated and adapted in each partner country. A pupil-friendly plugin adapted to radio-astronomy has been developed for the data analysis software SalsaJ (developed in previous EU-HOU projects). The project aims at reaching several thousands of pupils in European schools, through the active involvement of their teachers, and public at large. A multilingual CDrom gathering pedagogical materials ready to use in classrooms has been prepared and will be disseminated through the national school system and informal structures receiving schools.

HOU-España is participating in this project through the collaboration between the Complutense and Politechnic Universities. One of the small radiotelescopes in the network has been installed on the roof of the building of the Telecommunication Engineering School at UPM (see Fig. 1).

3 Discover the COSMOS

The Discover the COSMOS (http://www.discoverthecosmos.eu) coordination action aims to demonstrate innovative ways to involve teachers and students in e-Science through the use of existing e-infrastructures in order to spark young peoples interest in science and in following scientific careers. It aims to support policy development by:

- demonstrating effective community building between researchers, teachers and students and empowering the latter to use, share and exploit the collective power of unique scientific resources (research facilities, scientific instruments, advanced ICT tools, simulation and visualisation applications and scientific databases) in meaningful educational activities, that promote inquiry-based learning and appreciation of how science works
- demonstrating effective integration of science education with e-infrastructures through

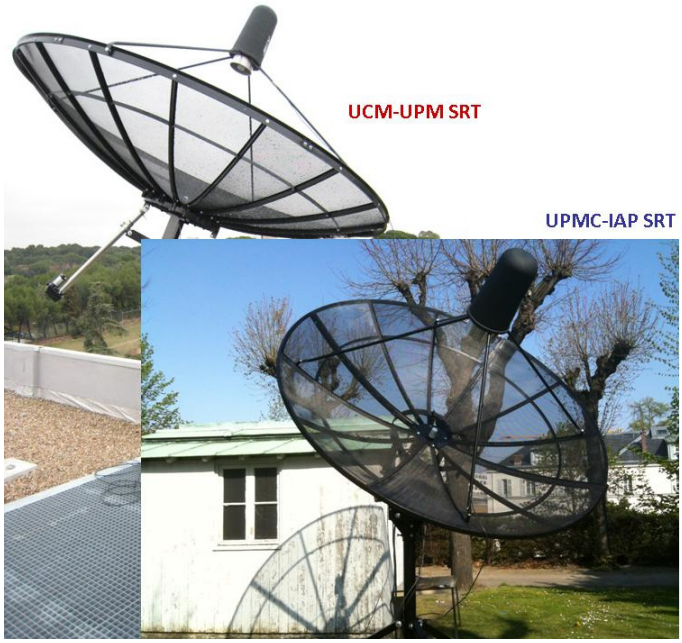

Figure 1: Two of the EU-HOU Small RadioTelescopes. *Left:* the SRT at the UCM-UPM campus in Spain, *Right:* the SRT at the Institute d'Astrophysique de Paris in France

a monitored-for-impact use of eScience activities, which will provide feedback for the take-up of such interventions at large scale in Europe and

- documenting the whole process through the development of a roadmap that will include guidelines for the design and implementation of effective educational and outreach activities that could act as a reference to be adapted for stakeholders in both scientific research outreach and science education policy.

The project is providing educational scenarios ready to be implemented by the teachers in the classroom associated with the European Research Space.

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