Acta Astronautica 98 (2014) 147–154

Contents lists available at ScienceDirect

Acta Astronautica

journal homepage: www.elsevier.com/locate/actaastro

Utilization of the International Space Station for education and popularization of space research ☆

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ARTICLE INFO

Article history:
Received 14 December 2013
Received in revised form
24 January 2014
Accepted 31 January 2014
Available online 8 February 2014

Keywords:
International Space Station
Space education
Experiment
Bauman
Workforce

ABSTRACT

Providing aerospace industry with highly qualified workforce is an international problem. There are multiple science and educational programs which are currently being developed aimed at training specialists capable of solving tasks related to the development, creation, testing and utilization of complicated technical systems. Some portion of these programs is being conducted with the support of national space agencies.

Currently, the task of using International Space Station as modern innovative element in the system of aerospace education of students is pending. Recently the YouTube and Lenovo manufacturer of laptop computers have offered to students to develop scientific experiments, the best of which are to be conducted on board of International Space Station. The project was supported by various space agencies – USA (NASA), Europe (ESA) and Japan (JAXA) – and by Space Adventures company, which specializes in space tourism.

Actual start of implementing educational technologies from space platform took place during the flight of orbital complex "Mir" (1987–2001). Russian cosmonauts, headed by flight engineer Alexander Serebrov, conducted a series of lessons from space, demonstrating various experiments in the condition of weightlessness and illustrating the laws of nature by unique tests. As a result of such lessons, several educational videos – in Russian and in English – have been created with the topics in physics, hydrodynamics, mechanics, liquids in space, and others.

Currently, in order to utilize the educational capabilities of Russian segment of International Space Station, a scientific-educational program of space experiments has been developed as part of Russia's Federal Space Agency program of space experiments. The program creates conditions for attracting the youth to independent scientific-research activity under the supervision of leading experts from space companies. The main advantage of the program is possibility to conduct dialog by high-school and university students with the crews of International Space Station using amateur radio channels. Some of such lessons may be viewed at WWW.RS0ISS.RU. Use of amateur radio frequencies allows communication with the station and experiments at schools and universities in live mode.

This article demonstrates the results of Russian and International space experiments – "RadioScaf", "MAI-75", "About Gagarin from Space", "Shadow-beacon", "Great Beginning" – and outlines the plans for new projects, such as experiment to study the deployment of frame-less thin-film structure from the extra-small-size spacecraft "Sail-BMSTU" and others.

☆ This paper was presented during the 64th IAC in Beijing.

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http://dx.doi.org/10.1016/j.actaastro.2014.01.031

Utilization of International Space Station as modern innovative element in the system of space education of youth allows popularizing the achievements of space exploration, improving the quality of education and increasing the popularity of space activity.

1. Introduction

International Space Station (ISS) is a unique space platform used for research in such fields as life science, biology, biotechnology, natural science and materials technology, research of human body and Earth & Space science. The space station demonstrates efficiency of several technologies, including robotic fueling in space and several-bodies maneuvers in orbit, and is a platform for various scientific and technological experiments and for educational events for new generations [1].

Fifteen nations participating in creation and operation of this multi-functional research facility are paying great attention to extracting the maximum value from usage of the ISS. The space station is used today as a modern educational aid in the system of aerospace education of high-school and university students, post-graduates, and young experts. During the 14 years of operation a big number of educational experiments were conducted on board of the station. Here are several examples:

- Scientific-educational event of NASA called "Butterflies, Spiders and Plants in Space", which has demonstrated the efficiency of utilizing ISS as a platform for conducting experiments aimed at students, and for teaching natural science, technology, and mathematics.
- "AuroraMAX" project by the Canadian Space Agency, the first project of monitoring aurora borealis from Earth and ISS.
- Modular didactic materials developed by European Space Agency, including ISS educational kits, issued in 12 languages, and videos, covering fundamental space science, education in medicine, diet and space robotics; lessons from board of ISS in real time for junior and middle high-school in 13 languages, and also educational courses for university students and teachers.
- For the decade (1999–2009) the European Space Agency was running the SUCCESS student contest. The SUCCESS stands for Space station Utilisation Contest Calling for European Student initiatives. The SUCCESS students contest was a competition for University students from ESA member states from all disciplines. The objective of the Contest was to propose experiment that could fly on the International Space Station. The first prize was a paid one-year internship at the ESA European Space Research and Technology Centre (ESTEC) in the Netherlands to prepare his/her experiment to fly onboard the International Space Station. In the last decade around a dozen SUCCESS experiments were flown onboard the International Space Station. For example: GraPhoBox during the Delta mission in 2004, followed by Bone Photeomics during the Eneide mission in 2005, UTBI and CASPER during the Astrolab mission in 2006. In 1999–2009 the contest has attracted more than 1000 students [2].
- "Uchu Renshi" – a cycle of space poems in Japanese language, organized by JAXA Japan Aerospace Exploration Agency, with the goal to unite people, including board members at ISS, allowing them to jointly think about Universe, Earth, and life itself – all of that leads to creating of related poems. JAXA is also conducting a contest of experiments in weightlessness, which allows students from Japan and countries of Asia to conduct parabolic flights and conduct experiments with plant seeds within the framework of international cooperation.

Quite recently even YouTube video hosting together with Lenovo notebook manufacturer have offered to high-school and university students to develop scientific experiments, the best of which would be implemented on board of International Space Station [3]. The main task is to stimulate the students to study the scientific world on Earth and beyond. This project was supported by space agencies from USA (NASA), Europe (ESA) and Japan (JAXA), and also by Space Adventures a space tourism company.

At United Nations Experts Meeting on the International Space Station Humanitarian Benefits, which took place in Vienna on June 11–12, 2012 United Nations Office for Outer Space Affairs (UNOOSA) has offered a concept entitled "Educational Material Distribution; Microgravity Experiments of Education", which has a goal to translate microgravity and space flight technology educational materials into official UN languages and distribute such materials using its network all over the world [1]. UNESCO offered several concepts related to information/public outreach and educational activity. The concept entitled "Educational activities with schools" has offered to use UNESCO network of high-schools in order to distribute the educational materials which were developed for ISS and space flights. The concept entitled "Educational activities with universities" has offered to use the network of universities in order to develop the sets of customer-oriented educational materials and distribute it all over the world. UNESCO also offered to support student's projects in which the readily-available remote sensing data from ISS is used, e.g. monitoring of selected areas or changes in environment of climate.

Russian segment of the International Space Station (RS ISS) is also a unique laboratory, which is subject to effects of space. Russian Federal Space Agency has approved in December 2012 at Long-Range Program of Applied Scientific Research and Experiments, planned on Russian segment of ISS [4]. The segment of this program entitled "Education and Popularization of Space Research" describes the conduction