The ISS Education Programme for Students: A New Outreach Initiative

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Today's students are tomorrow's work force, and thus students should participate in the global space programme so that they will feel motivated to follow space careers, work in the space domain, and create a generation that is literate in science and educated in space matters. This will lead to a continuously regenerated workforce that will profit from the injection of new ideas and initiatives.

Introduction

Getting students involved in today's space programmes is important not only for the space industry in terms of providing a talented work force for the future, but also for the public in general who are the voters and potential political supporters of European space exploration. In addition, present statistics show an overall decline in the numbers of science and technology students. For these reasons, ESA has committed, with a unanimous decision at the Manned Space Programme Board, to allocate 1% of the European utilisation resources on the International Space Station (ISS) to the youth.

Although, as the main tool for future research in microgravity, the ISS will only be routinely available to European researchers from 2005, there are already several possibilities for valuable education programmes for research in this domain. They include simulations in the

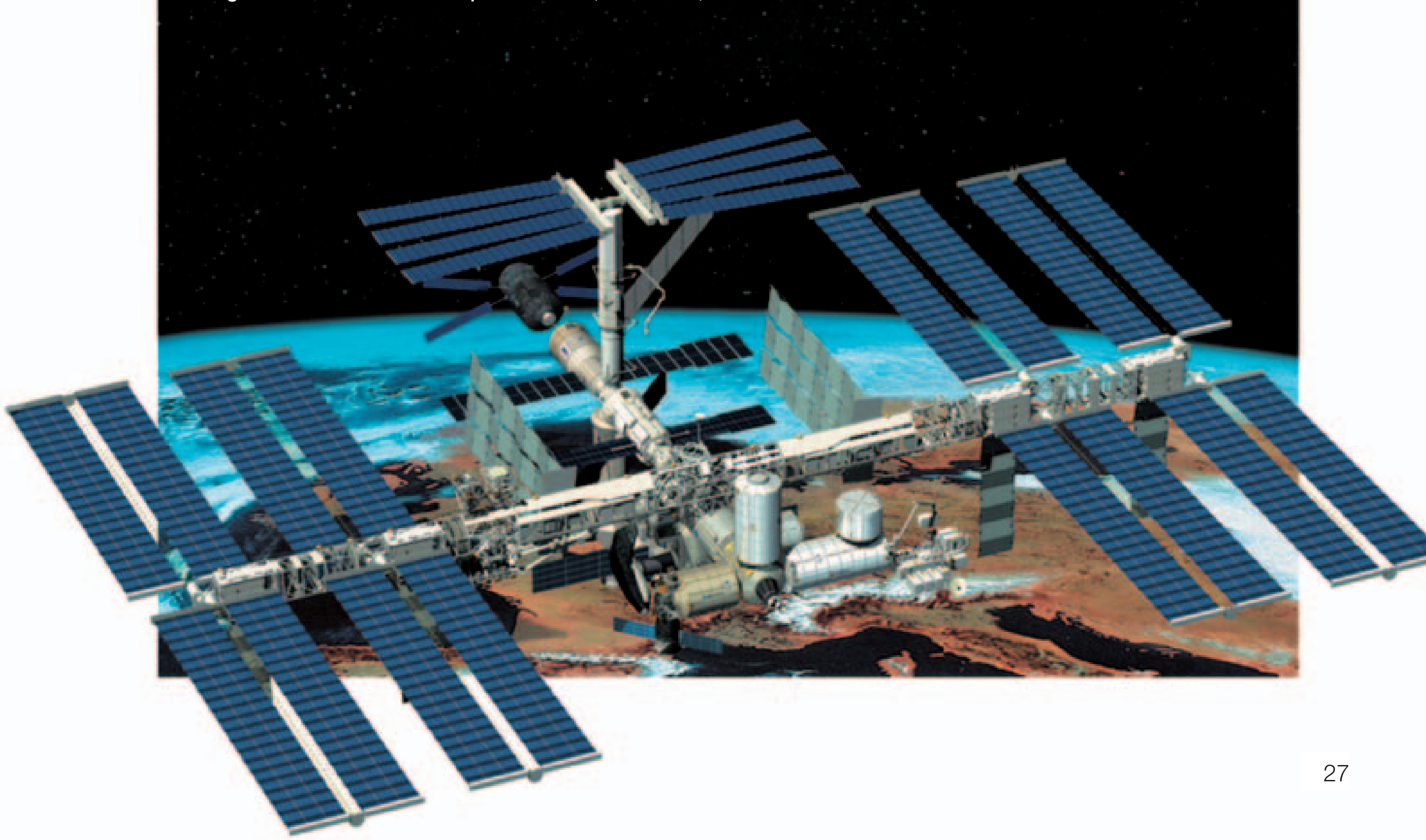

Figure 1. The International Space Station (ESA/D. Ducros)

Columbus module mock-up in the Space Station User Centre at ESTEC, student places on ESA parabolic-flight campaigns, and other opportunities such as those provided by the Russian Foton spacecraft. It is within this framework that ESA's Education Programme for Research on the International Space Station has been defined.

Objectives and scope of the Programme

The Education Programme for Research on the ISS has two distinct but linked objectives: to create opportunities for students to take part in microgravity research on a continuing basis, and to reach as many students and young people as possible during the process. The Programme addresses European students between 8 and 27 years of age. It makes use of the ground facilities and services provided as part of the European investment in the ISS, as well as of a portion of the accommodation and operational resources – 1% per year, equivalent to 13 kg of experiments annually – provided by the European Columbus laboratory.

The Education Programme is the result of a collaboration between ESA's Directorate of Manned Spaceflight and Microgravity and its Office for Education, who have together initiated the 'Pyramid to Space' programme. The latter is designed to dovetail with the Agency's existing outreach activities as a complementary and inter-linked entity. The activities proposed within it will work together with and respect existing policies and initiatives in order to create a continuous, flexible outreach programme.

The programme can be represented as a pyramid structure whereby the activities initially address tens of thousands of students, a few of whom are eventually awarded access to the ISS experimentation facilities. The numbers of young people targeted for involvement in each activity are indicated on the right-hand side of the pyramid.

In order to stimulate young people to get involved not only in the research but also in the outreach activities, the concept of 'Space Miles' has been created: by conducting outreach for ESA activities, students earn 'space miles'. Enough 'space miles' enable them to take part in space-related activities organised by the Agency, which can allow them to move up one level in the pyramid. For those with enough 'space miles', near the top of the pyramid, there might even be future employment opportunities with the Agency.

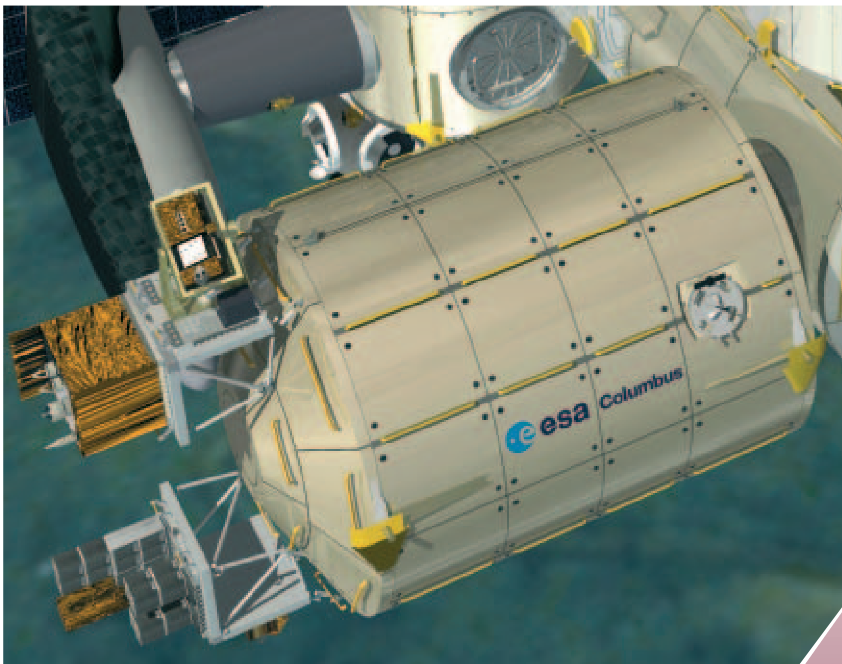

Figure 2. The Columbus module on the ISS

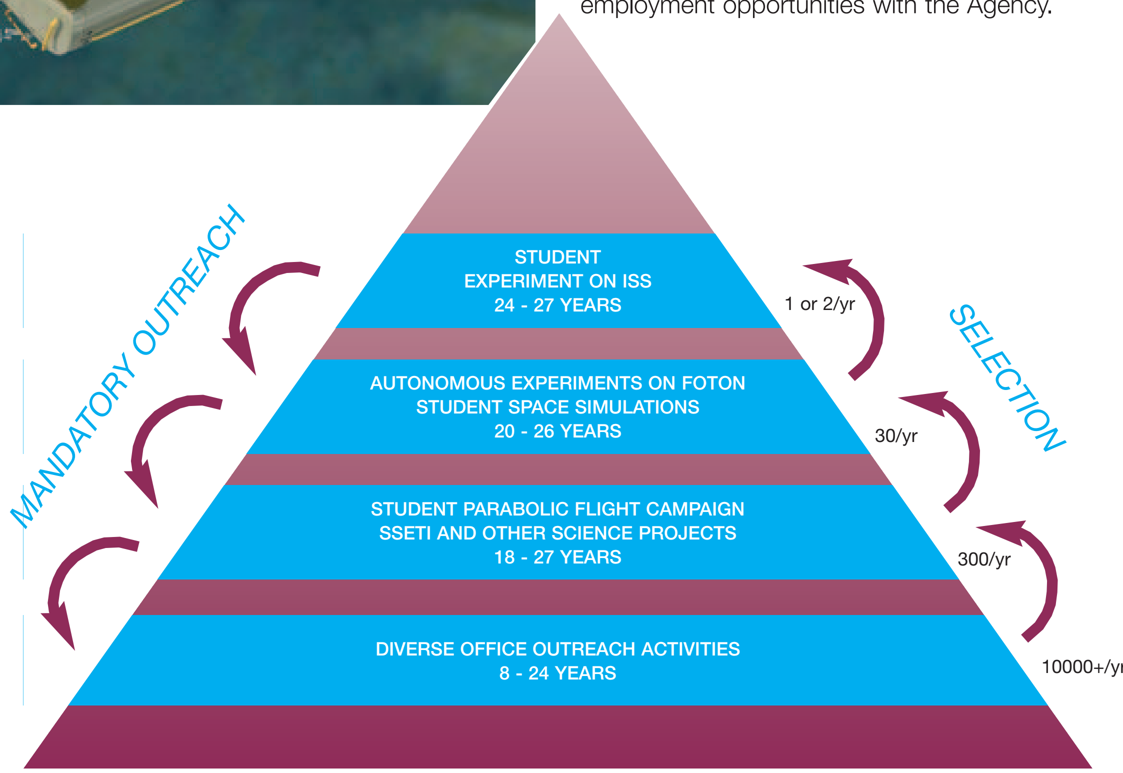

Figure 3. The 'Pyramid to Space'

The different activities in the Programme

Basic outreach

Basic outreach activities are aimed at involving a significant number of young Europeans and at increasing their literacy in science and technology in general, and in the space domain in particular. Examples are space games – both Internet-based ones and those sold in shops – teachers' programmes, congresses like the IAF and initiatives such as SSETI (Student Space Exploration and Technology Initiative), in which a large number of European students design a satellite using distributed development techniques.

Figure 4. Participants in the fourth ESA Student Parabolic-Flight Campaign, Bordeaux, July 2001 (ESA/Anneke van der Geest)

Student parabolic-flight campaign

The second layer in the 'Pyramid to Space' is the student parabolic flight campaign. This campaign takes place on an annual basis, with around 120 students and 30 microgravity experiments being flown during each campaign. The selection criteria take into account the originality of the idea, the technical complexity of the experiment, the demonstration of zero gravity, and the outreach activities conducted by the team. The latter can include video and web-site creation, television and newspaper coverage, and presentations to participating schools and universities. The students' outreach proposals will increase their 'space mileage' and be weighted in the selection procedure. From the student campaign, one or two of the best experiments will then be selected to be flown on an ESA professional parabolic-flight campaign.

Figure 5. The Columbus module mock-up at ESTEC in Noordwijk (NL)

Simulations in the Space Station User Centre

Student simulations will be a part of the User Centre's wider familiarisation and training sessions, which are aimed at both committed and potential ISS users. Facilities that are currently available and suitable for student simulations in the Columbus mock-up are:

- the Microgravity Glove Box
- the Drawer Racks, containing the Protein Crystal Growth Experiment, the Microgravity Applications Furnace, and the Electrophoretic Orientation Experiment.

The first student simulation activities are due to take place in 2001 with the arrival of seven students from the 12th European Union's Young Scientist competition. They are the winners of the special award presented by ESA's Director of Manned Spaceflight and Microgravity at a Ceremony in Amsterdam in September 2000.

Student experiments on professional parabolic-flight campaigns

The presence of student experiments on professional parabolic flights is important because it represents the acceptance and recognition of their research by the scientific community. The distinct classification difference between the student and professional flights will give them the feeling that they have progressed and 'moved up the pyramid'. An average of one student experiment will be flown per professional parabolic flight. It also represents a vital test of ISS experiment suitability and is therefore positioned just before the ISS payload in the student 'Pyramid to Space' (Fig. 3). The selection criteria take into account the originality of the idea, the technical complexity of the experiment, the degree of scientific interest, and the practicality of actually performing the experiment during the student parabolic-flight campaign.

Experiments on the ISS

The ultimate reward for students offered by the 'Pyramid to Space' programme is to have their payload flown on the ISS. The students selected must have successfully completed the preceding 'steps' involving other microgravity research activities and also have carried out sufficient outreach activities along the way. They will therefore be those individuals who are the most motivated, who propose the most exciting and scientifically valuable experiments, and who have involved the most people through their outreach efforts.

From the start of utilisation activities in the Columbus laboratory (currently scheduled for 2005), approximately 13 kg of student experiments will be sent up each year to the ISS and accommodated in the European Columbus module or on the Columbus external attachment points. The experiments will then be carried out by the ISS crew members and the results or samples sent back to Earth.

One of the major problems with student experiments on ISS are the long turn-around times for typical ISS experiments. In order to reduce access time, and hence the cost, students could follow a 'piggyback' approach, fitting their experiment into any spare hardware/allocation space available.

The facilities available in the Columbus module and their respective launch dates are as follows:

Biolab	2004
Fluid Science Laboratory (FSL)	2004
Material Science Laboratory (MSL)	TBD
European Drawer Rack (EDR)	2004
External Attachment Points	2004

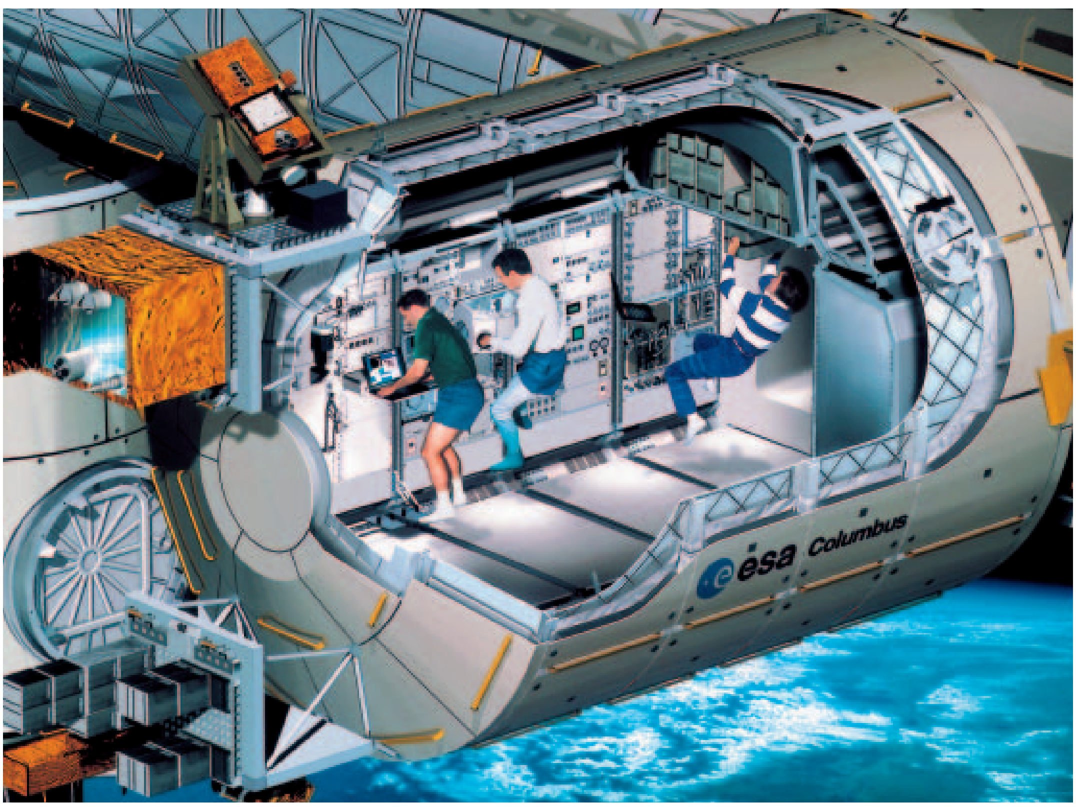

Figure 6. The interior of ESA's Columbus module (ESA/D. Ducros)

Biolab

The Biolab is designed for the study of small invertebrates, micro-organisms, cell cultures, etc.

Experiment costs	~ 50 kEuro (hardware only)
Turn-around time	2 years
Size limitation	60 x 60 x 100 mm^3 (the container)
Average weight per container	1.5 kg

Biolab is suitable for student experiments. It has been suggested that the student experiments should weigh less than 5 kg to minimise the number of containers needed, and hence also costs.

Biolab facility (ESA/D. Ducros)

European Modular Cultivation System (EMCS)

The EMCS is designed for early usage of the ISS before the other biological facilities such as Biolab become available. It will be located in an Express rack in the US Laboratory. Although it is provided as part of a barter agreement with the United States, European access is also possible. Its principal use will be for botanical experiments, but it will also be possible to accommodate experiments involving small invertebrates.

Experiment costs	< 50 kEuro (hardware only)
Turn-around time	Several years
Size limitation	60 x 60 x 160 mm^3 (the container)

Although the EMCS will fly for the first time only in 2003, experiment-proposal and peer reviews have already been taking place for two years. As a result, it is already fully booked for its first two years of operation, making its early use for student experiments highly unlikely.

Fluid Science Laboratory (FSL)

Experiment costs	2 – 4 MEuro
Turn-around time	3 years
Size limitation	400 x 270 x 280 mm^3 (the container)

Although theoretically the FSL is suitable, in practice it would be difficult to accommodate student/educative experiments, as there is only one large experiment container, which by its uniqueness and sheer size implies large, complex and hence expensive experiments and a very long waiting list of users. Any proposed sharing of the container would probably not be popular with those scientists. Therefore, the suggestion is to use the European Drawer Rack for student fluid-science payloads.

Fluid Science Laboratory (ESA/D. Ducros)

Material Science Laboratory (MSL)

Experiment costs	50 – 100 kEuro
Turn-around time	3 years
Size limitations	20 – 30 mm, 120 mm and 250 mm

As for the FSL, the MSL is considered theoretically suitable for educative use and student experiments. In particular, several past student material-science parabolic-flight experiments would be suitable for the MSL, as well as some of the combustion experiments.

Each experiment cartridge is estimated to weigh between 1 and 2 kg, and the weight of experiments that can be conducted per year in the MSL is predicted to be between 10 and 50 kg. The 13 kg currently proposed for one student experiment therefore appears to be far too ambitious and the suggestion is therefore to use the European Drawer Rack, or TEMPUS, for student material-science experimentation.

European Drawer Rack
(ESA/D. Ducros)

European Drawer Rack (EDR)

The EDR provides four Mid-Deck Lockers (MDLs) and four Standard European Drawers (SED). The main differences between the two are that the lockers are powered during transport and the drawers are not, and the drawers are slightly bigger.

Experiment costs	Depends on instrumentation
Turn-around time	6 months
Size limitations	44 x 25.3 x 56.6 cm^3 (MDLs)
	59 x 40 x 30.5 cm^3 (EDRs)

The EDR is considered suitable for student experiments because it is dedicated to smaller payloads with a quick return and delivery of mission products, estimated at around six months. In addition, it is recognised as the most flexible experiment carrier on board the Columbus laboratory, which would indeed seem to favour its use for student payloads. On the negative side, the EDRs are empty and would require all instrumentation to be added, which could greatly increase costs, depending on the experiment chosen.

Selection

The selection process will follow a two-step approach, with one step dedicated to satisfying the mandatory outreach requirement, and the other to evaluation of the proposed experiment itself. The outreach selection will consider motivation, excitement and the number of people involved, whereas the experiment itself will be scrutinised by the Directorate of Manned Spaceflight and Microgravity for scientific value, viability, feasibility and suitability for possible accommodation both in the parabolic-flight (zero-g) aircraft and on the ISS.

Schedule

Today it is expected that the first student payloads will be flown on the ISS in 2005, with the overall schedule being along the following lines:

November 2002	AO for student parabolic flight
July 2003	Student flight campaign
October 2003/May 04	Professional parabolic flight
Summer 2004	Simulations at ESTEC
Early 2004	AO Student ISS payloads
Late 2005	ISS payload flown

This would mean that the whole process, from student parabolic flight to ISS payload, could take less than three years, which is a suitable timeline for students.

The ISS Education Foundation

In order to provide comprehensive support to the Education Programme outlined above, in addition to the effort and funds invested by ESA, a foundation is being promoted called the 'ISS Education Foundation'. This foundation will be supported by industry, academia and governmental organisations, which will provide financial as well as 'in kind' contributions (e.g. technical expertise, access to facilities). The foundation will also include high-profile individuals (Honorary Members), who will make in-kind contributions to selected Education Programme activities that the Foundation is supporting (such as the awarding of prizes, etc.).

Conclusion

The ISS Education Programme is a comprehensive outreach/education initiative born through the combined efforts and collaboration of ESA's Manned Spaceflight and Microgravity and its Administration Directorates. The unanimous support for the initiative from the ESA Delegations is a concrete sign that European decision makers are very aware of the importance of education in today's society, particularly for the space sector. The long-term success of the initiative depends not only on the ESA commitment, but also on the support of those entities – industrial, academic and governmental – that will match ESA's effort and join the ISS Foundation.