The ESA Academy's Training and Learning Programme

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***Abstract*— The ESA Academy Programme is the overarching framework of activities provided by the ESA Education Office for university students from ESA Member States, Canada and Slovenia. The purpose of this programme is to complement and enrich the students' traditional university education through a suite of hands-on and training activities, enabling direct transfer of knowledge from agency, academic and industry professionals as well as access to world-class facilities.**

The ESA Academy aims to improve students' skills and to boost their motivation, enabling them to pursue careers and join opportunities within the Space sector and/or within other Science, Technology, Engineering or Mathematics (STEM) subjects and to bridge the gap between studies and professional life.

The Training and Learning Programme is one of the two core pillars of the ESA Academy. This programme offers a portfolio of training sessions covering different areas of ESA expertise.

Attendance at the training sessions is by competitive application. Selected university students are sponsored for travel and accommodation and get documents allowing them to claim ECTS credit to their Universities. More than 50 training sessions have been delivered since March 2016. Existing training sessions are periodically redelivered and new training sessions are under development to enrich the existing portfolio.

This paper presents the ESA Academy's Training and Learning Programme, gives an overview of its portfolio of training sessions, and provides some statistics and feedback from participants. Training session development and related challenges as well as possible e-learning opportunities are also discussed.

Keywords*— *ESA, ESA Academy, Tertiary Education, Hands-on activities, Training and Learning

I. The Training and Learning Programme within the ESA Academy

The ESA Academy Programme [1] is the overarching framework of activities provided by the ESA Education Office for university students from ESA Member States, Canada and Slovenia. The Training and Learning Programme is one of the two pillars of the ESA Academy, it has been operational since 2016 and aims at complementing the typical academic education in space-related disciplines offered in universities. Two of its main objectives consist in attracting, to the space sector, students that will constitute the next generation of professionals, and create opportunities to improve their competence and skills, by transferring knowledge, know-how, and familiarity with professional standard practice in all fields of ESA expertise. ESA Academy has the ambition to contribute to better prepare the future workforce for the space community of the ESA Member States, and to help university students to get acquainted with the opportunities offered by the space sector. Further information can also be found in the 3rd SSEA conference paper "The ESA Education Programme and its ESA Academy", Marée et al.

The Training and Learning Programme (TLP) offers a portfolio of 4-5 day long training sessions, addressing many different fields of the ESA expertise. These training sessions are developed and delivered by experts in specific domains. These trainers are usually ESA employees or retirees but may also be specialists from other space organisations, agencies, academic institutions, universities or the space industry. Up to 20 training sessions are organised every year at the ESA Academy's Training and Learning Facility (TLF), located in the ESA Education Training Centre, ESEC-Galaxia, Belgium [2].

In addition, the Training and Learning Programme further supports and promotes interaction with space professional by offering university students:

- sponsorship to participate in international conferences and to present their space related projects,
- support to other space-related learning opportunities coordinated with, or by, ESA partners.

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II. Development of the ESA Academy's Training and Learning Programme

The TLP development began in the second half of 2015, with the aim of complementing the portfolio opportunities offered by the ESA Academy's Hands-on Programme for university students.

In the first six months after the creation of the Training and Learning Programme (TLP), in parallel to designing the overall TLP concept, a first facility called the ESA Academy's Training and Learning Centre (TLC) was developed in ESEC-Redu, Belgium.

In March 2016, the first training session was delivered at the TLC, and it was followed by five other pilot sessions before the end of year. The following years, the portfolio was expanded to allow for the delivery of 13 training session in 2017, 20 in 2018, and 19 sessions are planned for 2019.

In 2018, a new training facility called the ESA Academy's Training and Learning Facility (TLF) was developed in ESEC-Galaxia, Belgium, allowing the participation of more students in each training session (increasing from 24 to 30 students per session) and offering improved livestream and recording functionalities.

Six training sessions have already been livestreamed, allowing additional students to benefit from ESA Academy training sessions.

The portfolio of ESA Academy training sessions is currently composed of over 20 different training sessions listed below in *Table I*:

Table I: List of ESA Academy Training Sessions

TRAINING SESSION	FIRST DELIVERED	FURTHER DELIVERIES
Gravity-Related Experiments Training Week [b]	Mar-'16	Jan-'17 Jan-'18 Jan-'19 Jan-'20[a]
ESA/ELGRA Gravity-Related Research Summer School	Jun-'16	Jun-'17 Jun-'18 Jun-'19 Jun-'20 [a]
Fly Your Satellite Lessons Learned Workshop [f]	Jul-'16	
Concurrent Engineering Workshop	Sep-'16	Mar-'17 May-'17 Feb-'18 May-'18 Mar-'19 May-'19 Jan-'20[a] May-'20[a]
Post-Alpbach Summer School Event	Nov-'16	Nov-'17 Nov-'18 Nov-'19 Nov-'20[a]
Human Space Physiology Training Course	Jan-'17	Mar-'18 Mar-'19 Oct-'20[a]
Ladybird Guide to Spacecraft Operations Training Course	Oct-'16	Sep-'17 [g] May-'18[c] Sep-'18 [g] Sep-'19 [g] Sep-'20[a]
Ladybird Guide to Spacecraft Communications Training Course	Feb-'17	Mar-'18 [g] Jul-'18[d] Feb-'19 [g] Feb-'20[a]
Introduction to Space Law Training Course	May-'17	Jun-'19
Standardisation Training Course	Jun-'17	Jun-'18 May-'19 Sep-'20[a]
Product Assurance Awareness Training Course	Jun-'17	May-'18 June-'19
Concurrent Engineering Challenge	Sep-'17	Oct-'18 Nov-'19
Rosetta Science Operations Scheduling Legacy Workshop	Oct-'17	Apr.'19
CubeSats Concurrent Engineering Workshop	Jan-'18	Jan-'19 Mar-'20 [a]
CubeSats Hands-on Training Week	Feb-'18	Sep-'19
Space Debris Training Course	Apr-'18	May-'19 [g] Jun-'20[a]
Earth Observation Satellite Design Training Course	Oct-'18	Apr-'20[a]
Space System Engineering Training Course	Nov-'18	Mar-'20[a]
Technology Transfer and Innovation Training Course	Nov-'18	Mar-'20[a]
Earth Observation Remote Sensing Workshop	Dec-'18	May-'20[a]
Fly Your Satellite! Phase D Workshop [e]	Apr-'19 [g]	
ESEO In-Flight Experience Workshop [e]	Aug-'19	
Clean Space Training Course	Feb-'20 [a]	

[a] Planned but TBC
[b] First edition known as 'ESA Experiments Hands-on Projects Training Week'; FYT (Fly Your Thesis!), DYT (Drop Your Thesis!), SYT (Spin Your Thesis!) and OYT (Orbit Your Thesis!) students only
[c] Organized for ESEO (European Student Earth Orbiter) students
[d] Organized for ESEO and FYS (Fly Your Satellite!) students
[e] ESEO (European Student Earth Orbiter) students only
[f] FYS (Fly Your Satellite!) students only
[g] With students in livestream

Additional training sessions are constantly under development. For instance, at the time of writing, the Clean Space Training Course is being developed, and it is planned for first delivery in February 2020. Training sessions are usually then repeated annually or biannually.

III. ESA Academy Training Sessions

ESA Academy training sessions last 4 to 5 days and can have different formats, which mainly are:

- **Training courses**: a series of lectures complemented by exercises or a group project.
- **Workshop**: a mix of lectures and hands-on activities.
- **Training week**: a mix of lectures, workshops and/or hands-on activities to provide information and guidance to successfully go through the different phases of an ESA Academy hands-on programme.

Some training sessions are organised in collaboration with other entities. For example: since 2016 the ESA/ELGRA Gravity-Related Research Summer School is organized annually with the European Low Gravity Research Association (ELGRA)

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[[3],[4]] and since 2017 the Human Space Physiology Training Course is conducted with colleagues from the European Astronaut Centre (EAC) [5] and the Concurrent Engineering Challenge with three different universities each year.

A. Training session development

Each ESA Academy training session is developed through a collaboration between the ESA Education Office and ESA technical experts and/or external experts in the field. The development process comprises four Work Packages (Fig. 1):

Design:

Based on the input from the different experts, an overall approach for the training session is defined in this first phase. This is done through the:

- generation of training objectives,
- definition of target student audience,
- definition of training structure,
- definition of training format and delivery method,
- definition of evaluation methodology,
- definition of internal effort, initial planning and trainers.

Development:

This phase translates design decisions into actual training material through the:

- development of lecture plans,
- development of lectures, exercises, group projects, and assessment protocol (if applicable),
- development of the training evaluation form,
- review of the effort required and initial planning,
- a dry-run (1 day) with the objective to verify training objectives, format and sequence of the session, overall content and key messages.

Delivery:

In this phase, the training session is actually delivered. The following sub-tasks are:

- liaison with students and trainers for logistics,
- preparation of final training material,
- conducting the training session.

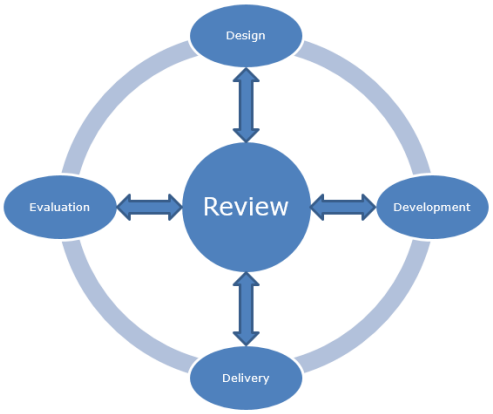

Fig. 1: Overall development process of an ESA Academy training session

Evaluation:

The purpose of this final phase is to verify that the training session has achieved its objectives and identification of strengths and weaknesses and lessons learned. This final phase is done through the:

- analysis of the students, trainers and ESA Education Office feedback,
- update of training format and material as needed.

B. Student application and selection process

In order to participate in an ESA Academy training session, students must fulfil the following criteria at the time of application:

- be aged between 18 and 32 years,
- be a citizen of an ESA Member State, Canada or Slovenia,
- be enrolled as a full-time student in a university (and not graduating before the training session),
- be studying for an engineering or science degree.

For each training session, the profile of the students in terms of level and field of study is tailored to the training content.

Interested students apply via the ESA Education website by filling-in an application form, providing a motivation letter, a CV, a recommendation letter from a university professor or academic supervisor and an official copy of their academic records. Selected students are informed around one month before the training session starts. Their participation is free of charge and ESA provides them with a sponsorship to cover their travel, accommodation and meals.

Most training sessions have open applications, however some specific sessions are offered to students already participating in ESA Academy's hands-on programmes or who are interested in one of these opportunities (see *TABLE I*). In this way the ESA Education Office makes the link between the two pillars of the ESA Academy programme (i.e. the Hands-on Programme and the Training and Learning Programme) and uses its resources and facilities in a synergetic manner.

C. Training session delivery

The training sessions are delivered in the ESA Academy's Training and Learning Facility (TLF) located in the ESA Education Training Centre, ESEC-Galaxia, Belgium. The TLF can accommodate up to 30 students and up to 8 trainers and is both a training room and an educational Concurrent Design Facility (CDF) [6]. The facility contains smart boards, large displays, individual workstations and an audio-video system, which the trainers can control to share their training content and/or to allow students to share their work. In addition, the facility offers recording and livestream functionalities. The general layout of the facility can be seen in Fig. 2.

The training sessions usually last between 4 days (32 hours) and 5 days (40 hours) allowing students to claim ECTS credit(s) from their Universities for their participation.

The number of trainers per training session and their respective contribution depends on the format and topic of the

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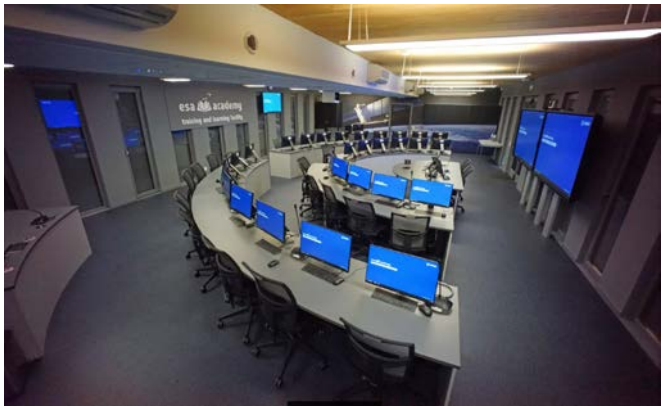

Fig. 2: The ESA Academy's Training and Learning Facility

training session. On average, a training session is delivered by 9 trainers coming from ESA, other space agencies, academic institutions, universities or space industry.

Most of the trainers travel to the ESA Education Training Centre to deliver their content face to face in the TLF, but some lectures are also delivered by videoconference.

For the students following the ESA Academy training sessions via livestream, the lectures are streamed in real time from the TLF. Students are requested to follow most of the sessions live and have a few days to watch the recordings of the other sessions.

For most of the training sessions, the students are evaluated at the end of the week by the trainers through a group exercise or project, or an individual online evaluation questionnaire.

At the end of the training sessions, students go home with a copy of the training content, a certificate of participation and (when applicable) a course transcript, and are asked to fill-in an anonymous online feedback questionnaire.

D. Benefits for the Students

The Training and Learning Programme offers students the chance to complement their university lead education with additional training in subjects that they often are not covered in the normal university curricula.

Furthermore, the TLP offers students the chance to learn from competent space professionals and to benefit from their experience, gaining a transfer of knowledge and experience from the current to the future generation of space professionals.

In addition to the formal benefits of the training sessions, the students also get the chance to network with the trainers, and their peers, forming relationships which may be quite beneficial for them also in their future professional careers. This aspect in particular has proven to be a fundamental part of the programme, and it is often mentioned in the student feedback, as illustrated in the following student quote: "In less than a week, I learnt a lot of new things from many different fields and I had the unique opportunity not only to discuss scientific matters with experts but also to hear their stories and fragments of their lives thanks to their sincere will to transmit to us students their passion and enthusiasm for their work, in which they completely succeeded. Furthermore, I met a lot of students from all over Europe: just in a few days, they passed from being strangers to esteemed colleagues and, more than all, good friends. I am happy to have gained so much from that week, not only in terms of knowledge but also in terms of personal growth, special connections and friendships."

E. Challenges

Throughout the development and growth of the TLP, a number of challenges were met, including the following, which may be of interest to others developing training sessions:

- identification of relevant topics to create a portfolio of training opportunities to complement what is taught at university,
- defining standard and corporate formats for the training sessions including specific procedures, documents, templates, vocabulary, …
- finding experts (and backups) interested in sharing their knowledge and know-how with the students, and who are available to develop and deliver training content (both in terms of time and skill)
- adapting the content of the training session to the level and background of the students and/or ensuring the correct study level of students is identified for the training session,
- ensuring a coherent and consistent training content to offer a complete overview of the topic to the participating students,
- efficiently promoting the programme and training sessions opportunities to reach students in all ESA Member States, Canada and Slovenia,
- managing high or low number of applications,
- selecting, with a fair and consistent selection process, a balanced group of students taking into account nationality, gender, level and field of study, …
- developing livestream activities and explore possible e-learning opportunities to increase the number of students benefitting from the existing programme,
- scheduling an annual programme to ensure a minimum number of training sessions and repeatability of the different topics,
- implementing intellectual properties rules and data protection policies,
- dealing with logistics and administrative tasks related to the organisation of about 2 training sessions per month involving a large number of participants coming from worldwide locations,
- maintaining and upgrading the training facility to ensure smooth training delivery,
- …

Last but not least, it is interesting to recall that the Training and Learning Programme is a "living" entity, built upon a dynamical approach, which constantly evolves to adapt to internal factors (from trainers and participating students) and external (new technologies, new topics identified to be brought to the attention of the students): as it developed, key improvements were made, taking also into account students' and trainers' feedback, and profiting from the progressively more and more enriched experience of the ESA Education staff involved.

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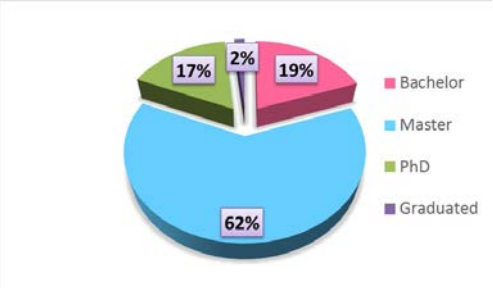

Fig. 4: Level of study of participating students

IV. Feedback and Statistics

1287 Bachelor, Master, PhD students and young graduates (the latter mostly from the Post-Alpbach Summer School Events), of which around 30% were female, have participated in the 52 ESA Academy training sessions delivered between March 2016 and June 2019 (Fig. 3).

The students came from 27 different countries (students from non ESA Member States only accepted for Post-Alpbach Summer School Events) and 290 different universities from around the world (Fig. 4), with a wide variety of backgrounds in science and engineering including aerospace, mechanical, electrical and telecommunications engineering, physics and astrophysics, space science, and medicine.

Through the livestreamed sessions, 81 additional students were able to follow some ESA Academy training sessions online.

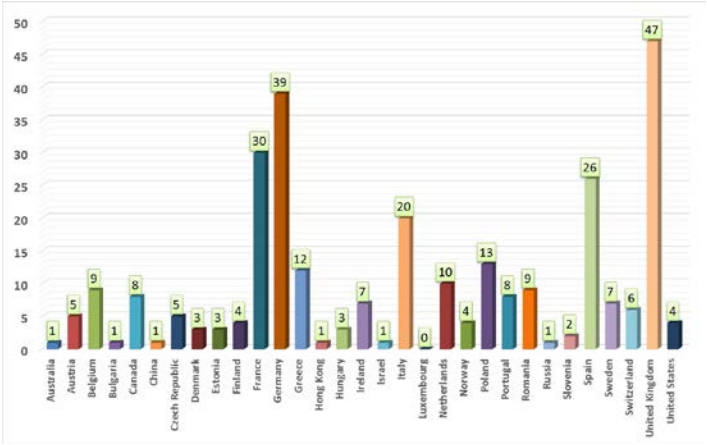

Fig. 3: Number of universities of participating students per country

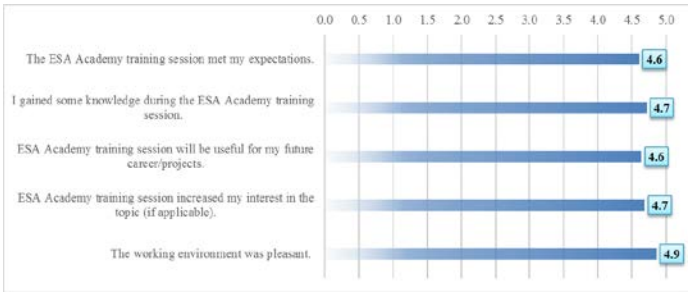

Fig. 5: Students feedback after their participation in an ESA Academy training session (1 = totally disagree, 5 = totally agree).

To continually improve the ESA Academy's Training and Learning Programme, the students are asked to provide anonymous feedback and impressions after each training session. As shown in Fig. 5, displaying the average answer given by the participating students over 52 training sessions, the training sessions are clearly perceived as beneficial for the students' education and future career.

V. Further Development and Challenges

In the coming years, more ESA Academy training sessions will be developed to complement the TLP portfolio and to cover additional fields of the ESA expertise.

Existing training sessions will continue to be updated after each edition, to ensure the quality and accuracy of the content and to ensure that it is delivered in the most effective manner to the students. As the job market is changing and students have to develop their "21st century skills" to stay competitive, ESA Education Office needs to identify new "space" skills and take them into account when developing new opportunities.

To increase the number of opportunities for the University students, the number of training sessions offered annually in the TLF will probably be increased in the coming years, as well as the number of livestreamed sessions. In addition, ESA Education Office is considering to develop a few online courses based on the content of existing ESA Academy training sessions and to offer them on a dedicated e-learning platform.

Acknowledgments

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Furthermore, the authors would like to thank all their colleagues of the ESA Education team, because their competence and dedication are key to ensure University students can get the best possible benefit from their participation in the ESA Academy's Training and Learning Programme.

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