A story about how the novel ROSPIN Academy programme is bringing space education to the Romanian youth in the pandemic context

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Abstract
Continuous education is the foundation of a sustainable society and ecosystem, and this paper relates the story of one of the most ambitious educational programmes for University students from Romania. The country acceded to the European Space Agency's Convention in 2011, but does not have a dedicated undergraduate programme for space education, although the local space industry is growing and is demanding more skilled professionals. In this context, the Romanian Space Initiative has been organizing the ROSPIN Academy educational programme since the spring of 2021. Currently, each Edition of the Academy has 3 Levels, coordinated with the least busy University periods: Level 1 is an introduction to the space sector (autumn 2021), Level 2 consists of a technical overview of the lifecycle of space missions (spring 2022), and Level 3 offers hands-on experience with industry (summer 2022). Although the curriculum's core is spacecraft engineering, it aims to reflect the sector's interdisciplinarity, so topics such as astronomy, space sustainability and policy are also covered. The Lessons are delivered in English by national and international speakers from industry and academia, ranging from young graduates to experienced professionals. Participants can interact directly with them, in a context that promotes the idea that space is not only for rocket scientists. The participants' interpersonal skills are also trained through exercises and games about space topics, which require them to work together in teams. The accepted participants of the Academy are selected based on their motivation and thinking, relevant knowledge and compatibility with the Academy learning concept. Currently, more than 400 applicants have been accepted in the past or current Editions of ROSPIN Academy. Last but not least, the national outreach achieved through this programme is a key defining value. ROSPIN Academy is present at national level, across industries, and mixes undergraduates and graduates, with focus on the former. This is demonstrated by the evolution of the distribution of the accepted participants, in terms of city, year and field of studies. Due to the organisation's efforts to promote the second Edition nationwide with the support of professors from the biggest STEM Universities, this distribution has clearly evolved. Edition 2 shows a more diversified pool of participants compared to Edition 1, which mostly had active participants with aerospace background from Bucharest. As a result, ROSPIN Academy is uniting the local space communities while educating the next generation of space engineers.

Keywords
Community, Interdisciplinarity, Modern Space Education, Technical and Interpersonal Skills

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Acronyms/Abbreviations

CV	*Curriculum Vitae*
EO	*Earth Observations*
ESA	*European Space Agency*
ESPI	*European Space Policy Institute*
EU	*European Union*
NASA	*National Aeronautics and Space Administration*
NGO	*Non-Governmental Organization*
ROSPIN	*Romanian Space Initiative*
SSEA	*Symposium on Space Educational Activities*
STEM	*Science, Technology, Engineering, and Mathematics*
UPB	*University Politehnica of Bucharest*

1. Introduction

The global space economy is steadily growing, reaching a total of $371 billion in 2020, with the satellite industry having a $271 billion share. At the same time, the commercial and non-profit communications satellite market share has grown from 28% of the satellite industry in 2018 to 48% in 2020, demonstrating a tendency towards a commercially led space industry. In line with the industry growth, the number of spacecraft launched per year has increased from around 500 in 2019 to over 1800 in 2021 [1]. This has been fuelled by the 200 kg class satellite constellations becoming the norm in the industry (SpaceX and OneWeb) [2]. Moreover, there is a sustained effort towards nanosat to microsat scale constellations (like Planet and Spire Global), which is leading to a range of current and future platforms in the 3U-12U size scale for Earth Observation, Internet of Things and Communication [3].

The global space economy growth and the commercialisation of the space market is also reflected at European level, increasing the need of qualified professionals to work in the industry. The EU budget allocated to space activities has increased from €5 billion for the 2007-2013 period to €14.8 billion for the 2021-2027 period. The European space industry is the second largest in the world with 231.000 professionals for an industry worth between €53 - €62 billion. A third of the world's satellites are manufactured in Europe and the EU companies have increased their turnover from €90 billion in 2011 to €161 Billion in 2018. The upstream sector, focused on launchers, generates €8.8 billion and accounts for 6% of the global space industry in terms of job creation (around 43.000 jobs). The downstream market is also increasing as the number of employees has risen by 17% in the past year to 11.600 [4-5]. Overall, ESA estimates that for every Euro spent on space there has been 6 Euros benefit to society as well as job creation [6]. Having high quality and easily accessible space education in Europe is essential to supplying this growing market with a trained workforce as is also highlighted in the ESA Agenda 2025 [7].

A study done by the European Space Policy Institute (ESPI) indicates that all EU, ESA and European Associated Member States have at least one educational programme that has a space-related focus [8]. However, the majority of these programmes are focused in Western Europe (e.g. UK, France, Spain, Italy, Germany and the Netherlands) and they are usually specializations at a Masters or PhD level. As a result, Bachelors programmes represent only 16% of the courses at European level [8], making early access to space education difficult across the continent. This is where a programme like ROSPIN Academy can help deliver space knowledge to Bachelors level audiences, thus leading to an earlier specialization in relevant areas for this industry.

At a national level, Romania has less than 10 space-related programmes, with the main body of courses being offered by the Aerospace Engineering Faculty of the University Politehnica of Bucharest (UPB). However, none of the Bachelors specializations are related to space sciences, with the focus being on aeronautics [9]. At Masters there is a single relevant course on Systems Engineering, taught in Romanian, while at European Level 93% of the Masters level space courses are in English. Overall, the space education currently offered in Romania is limited and lacks diversity due to the limitations of the native language. On the other hand, the local space industry has been growing steadily, especially since Romania joined ESA in 2011. There are now several multinational companies in Romania, producing space software (e.g. Thales, GMV, Deimos) and hardware (e.g. High Performance Structures, Saab), as well as several research institutes (e.g. COMOTI, INCAS) involved in ESA funded projects. However, the vast majority of the graduates joining the national space industry are not formally educated in this field, due to a lack of access to relevant programmes. This is the gap that the Romanian Space Initiative (ROSPIN) is trying to bridge with the educational programme discussed in this paper, namely ROSPIN Academy.

2. The Romanian Space Initiative

The Romanian Space Initiative is a young Non-Governmental Organization (NGO) that came to life thanks to passionate people that converged towards one goal – bringing space closer to the Romanian youth. As such, the ROSPIN vision is to create a united community of individuals with similar aspirations regarding the space sector. To achieve this, ROSPIN is very active in its mission to develop the Romanian Space Ecosystem through various activities, in line with the organization's 3 pillars:

- Pillar #1 – educational programmes
- Pillar #2 – hands-on technical projects
- Pillar #3 – community events

Overall, the ROSPIN team presently counts ~ 70 students and professionals, who are either organizing or participating in ROSPIN projects and activities. In order to succeed in creating a powerful community within a technologically complex and internationally collaborative environment such as the space sector, the ROSPIN culture is strongly rooted in core values such as teamwork, diversity and inclusiveness. Individual fulfilment is another core value, since the volunteer team members need to feel empowered to achieve their personal goals, while also learning and growing within the organization. Ethical behaviour is also central, as well as transparent communication to foster trust in leadership, trust in teams and trust in individuals. Also, pro-actively seeking innovation, adaptability and creativity are other core values. Last but not least, sustainability also has an important role to develop the organization and to ensure the community is educated to venture out in the space sector with an approach that does not jeopardising the future with today's actions.

3. The ROSPIN Academy concept

3.1. Origin and proof of concept

The concept for the educational programme known as ROSPIN Academy (under pillar #1) was born at the end of 2020, in the COVID-19 pandemic. In fact, this emerged as a response to a clearly identified need within ROSPIN's first project (chronologically speaking) – a technical team that aims to develop the first educational CubeSat in Romania (under pillar #2). When endeavouring to expand this team, a significant number of candidates showed substantial interest for such a space project, but lacked the knowledge required to meaningfully contribute.

To address this need, the ROSPIN leadership developed ROSPIN Academy, to make space attractive to Romanian University students, to offer them a context to understand the sector's complexity, depth and level of international collaboration, as well as to prepare them to join this sector. The Academy is based on a series of online Lessons that focus on spacecraft engineering, but some of them also cover higher-level, interdisciplinary topics. Through this, the participants understand the motivations and concerns of the various stakeholders in this growing sector, while also developing their knowledge and professional skills.

The first Academy Edition was delivered in the spring of 2021 with Lessons taking place twice a week, over a 3 months period. It served as a testing ground to see how such a novel programme is received by undergraduate and postgraduate students from Romania. Edition 1 enabled the ROSPIN team to learn valuable lessons, related to the optimum duration and timing of the Academy, the selection process of the participants, the communication and sharing of materials with them, the development of their interpersonal and networking skills, and the communication with the volunteer Speakers.

3.2. Current architecture and curriculum

After Edition 1, the comprehensive curriculum was restructured in 3 Levels of increasing difficulty and technical depth. These Levels are coordinated with the least busy University periods and allow for an annual recurrence, as shown below for the past and current year:

- Edition 1 (spring of 2021)
- Edition 2, Level 1: An introduction to the space sector (autumn of 2021)
- Edition 2, Level 2: Lifecycle of a space mission (spring of 2022)
- Edition 2, Level 3: Practical experience with industry (summer of 2022)
- Edition 3, Level 1 (autumn of 2022)

Level 1 serves as an introduction to various perspectives, covering higher-level topics such as astronomy, the evolution of the space sector (past, present and future), space education and careers, space policy and law, space sustainability, and human spaceflight.

Level 2 continues with specialised spacecraft engineering topics (the core of the Academy), following the lifecycle of space missions: feasibility studies, mission design and systems engineering, orbital mechanics and mission analysis, the various spacecraft subsystems and their design, manufacture, assembly, integration and testing, launch, and operations.

The Lessons within the first two Levels are delivered entirely online and they are based on the restructuring of the original curriculum.

Then Level 3 (proof of concept in 2022) will be designed for the most astute participants and it will take place in person as a 1-week intensive workshop. It will be organised in partnership with relevant stakeholders from the national sector, giving the participating teams the challenge to design, present and defend a space mission in front of a professional jury, hence putting in practice the knowledge and skills acquired in the previous Levels.

3.2.1. Interpersonal skills

In addition to acquiring knowledge by attending the Lessons, the participants also get to interact with each other and practice their interpersonal skills in the process, e.g. communication, critical thinking, debating, networking, etc. This is achieved through various exercises and games (i.e. Energisers) that are based on space topics or scenarios, for example a survival exercise in a scenario of a crew being stranded on the Moon, and having limited resources and tools. The participants are split into smaller groups (usually 5 – 6 per group) and have to work in teams for these Energisers, which are included in the Level 1 and 2 Lessons. The benefits of participating in these Energisers are expected to be reflected through productive teamwork in Level 3. Furthermore, it is likely that Level 3 will include dedicated training to further develop their relevant interpersonal skills, in addition to improving their technical expertise through this practical, hands-on experience.

3.2.2. Diversity of Speakers

A main contribution to the value of ROSPIN Academy is the network of national and international Speakers, ranging from young graduates to world-renowned experts in their fields, reflecting the internationally collaborative and diverse character of the space sector itself. Participants can interact directly with them, in a context that promotes the idea that space is not only for rocket scientists. All the Lessons are delivered in English, training them directly in a necessary language for joining this sector. Table 1 presents the number and diversity of volunteer Speakers who delivered Lessons within the Academy, for each Edition and Level that has been organised. It is also noted that the total number of Speakers from Edition 1 is comparable to that from the 2 Levels of Edition 2, highlighting the effect of restructuring the curriculum, without changing the content that is covered from one Edition to the next.

Table 1. Diversity of ROSPIN Academy Speakers, from one Edition to the next [1]

	National Speakers working in Romania	National Speakers working abroad	International Speakers working abroad
Edition 1	16	7	8
Edition 2, Level 1	11	2	4
Edition 2, Level 2	3	9	3

The Speakers come in a volunteer capacity, not as direct representatives of their current or past employers. However, it is worth noting these have been professionals from GMV, Thales, ROMSPACE (i.e. national industry), ESA, Deimos, GMV, CGI, Airbus, ClearSpace, Blue Origin (i.e. international industry), and the Universities of Southampton, Stuttgart, Delft and Washington (i.e. academia).

A similar diversity is also envisioned for Level 3, which will aim at gathering professionals from both industry and academia.

3.2.3. Complementary ROSPIN activities

ROSPIN Academy acts as a launch pad for its target group, since the Alumni can then also get involved in other projects and activities of the organization, e.g. technical projects such as the CubeSat team or the Earth Observation (EO) Data team (under pillar #2). Under pillar #3, a notable opportunity will be the Romanian Space Forum (proof of concept in 2022), which will provide an end-to-end experience for the participants, putting them in direct contact with Romanian space stakeholders. Community events are also taking place monthly, fostering networking opportunities. Last but not least, the national effort of ROSPIN is enabled by its Ambassadors, who are Academy Alumni. Their long term goal is to allow ROSPIN to migrate from a single organization model to a group of local space communities with their own dedicated projects and events.

4. Results & discussion

4.1. Target group and eligibility

The direct ROSPIN Academy beneficiaries are the accepted participants, so the programme's success is evaluated from this perspective. The target group are undergraduate University students, although some postgraduate and PhD students are also accepted, as long as the majority of accepted participants is represented by undergraduates. This target has the aim of reaching an audience at an early development stage in their careers, to inspire them to consider building a career in space.

Accepted participants from Edition 1 have not been considered for Levels 1 and 2 of Edition 2, since the curriculum's content has remained substantially the same, and so the availability of slots is maximised for those who have not had this opportunity before. However, those with Certificates of Participation from Edition 1 will be considered for Level 3 of Edition 2, as this will occur for the first time in 2022.

Furthermore, students from both STEM and non-STEM Universities have been accepted to the introductory Level 1, whereas only students from STEM Universities have been considered for Levels 2 and 3. Also, candidates do not need to have participated in Level 1 to be considered for Level 2, but this is advisable. Similarly as before, Edition 2 participants will require a Certificate of Participation at least from Level 2, to be considered for Level 3.

4.2. Selection process and earning Certificates of Participation

Based on the lessons learned in Edition 1, the ROSPIN team has refined the application and selection process of the participants. Currently, an applicant does not need to provide a CV or a cover letter, but instead has to submit a comprehensive application form. The selection is based on evaluating 3 strengths of the application: their motivation & thinking, their relevant knowledge, and their compatibility with the Academy learning concept.

Until now, more than 400 applicants have been accepted in the past or current Editions and Levels, and hence have been given an opportunity to learn more about the space sector and spacecraft engineering.

Currently, Certificates of Participation are awarded to the most dedicated participants, solely based on their attendance. These Certificates are provided only to participants who attended at least half of the Lessons for a given Edition or Level.

4.3. Increasing national outreach

Another defining value for ROSPIN Academy is the national outreach achieved through the accepted participants, which directly contributes to ROSPIN's overall mission and vision. After dedicated efforts to promote Edition 2 nationwide, with the support of professors from the biggest STEM Universities across the country, the national distribution of accepted participants has seen a clear growth in Edition 2 compared to Edition 1. This is also reflected through the associated acceptance rate of participants:

- ~ 95% for Edition 1, by accepting 144 participants
- 50% for Level 1 (Edition 2), accepting 175 participants from 340+ individual applications
- 75% for Level 2 (Edition 2), accepting 135 participants from 175+ individual applications

Overall statistics are shown in Figures 1a, 1b and 1c, about the distribution of more than 400 accepted participants in ROSPIN Academy.

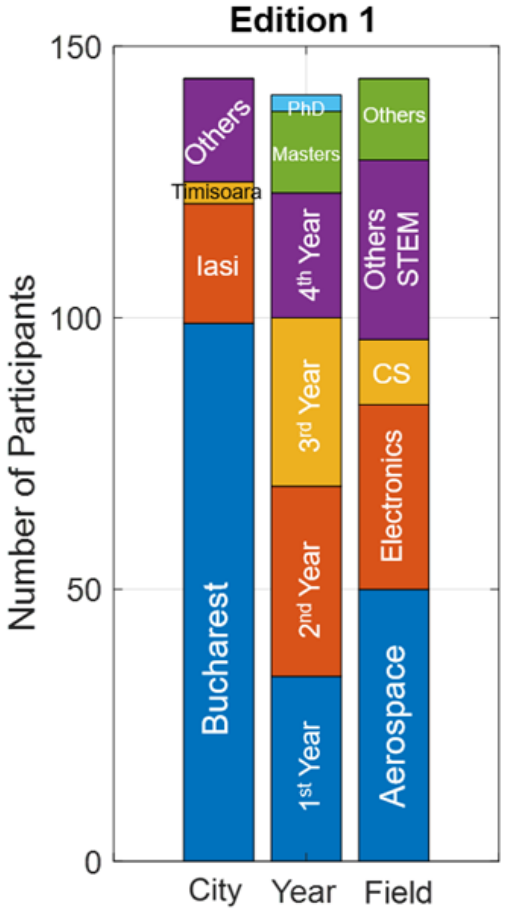

Figure 1a. Distribution of accepted participants in Edition 1

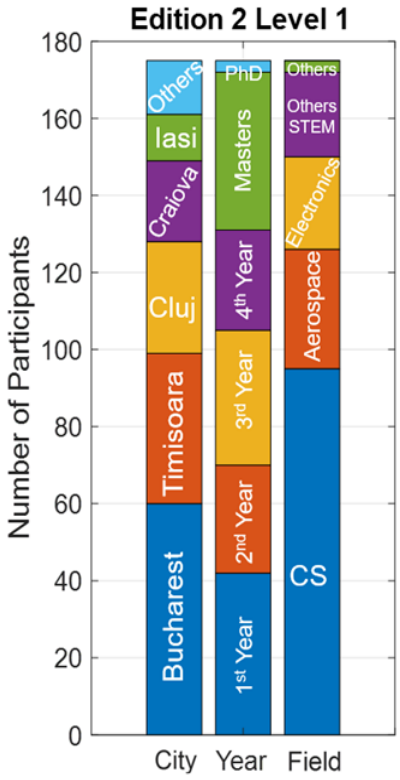

Figure 1b. Distribution of accepted participants in Edition 2 – Level 1

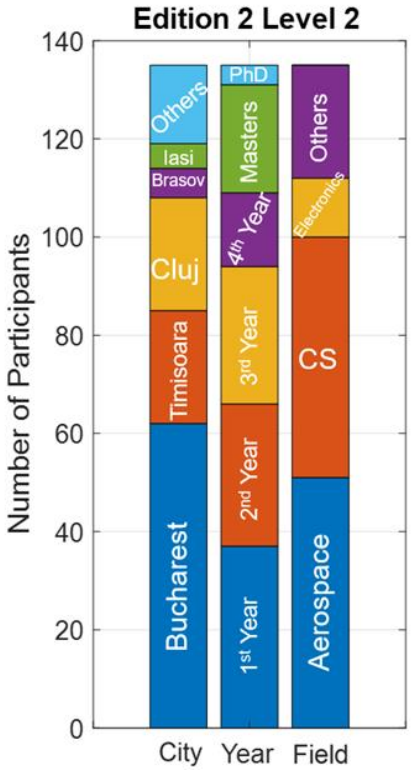

Figure 1c. Distribution of accepted participants in Edition 2 – Level 2

5. Conclusions

Continuous education is the foundation of any sustainable society, and this paper described one of the most ambitious educational programmes in Romania. ROSPIN Academy has been offering high quality space education since early 2021, and the accepted participants have an end-to-end educational journey. The ROSPIN team has grown alongside them, and the programme has grown substantially in record time. In the future, the Academy will continue to take place recurrently. It will also keep fostering relationships with stakeholders, improve the participants' engagement, enable even more national outreach, and improve the knowledge checking of its participants. Also, in 2022 a novel workshop will be integrated in the Academy concept through Level 3, continuing to prove the value of this programme in the context of a growing space sector. The continuation of ROSPIN Academy will also keep raising space awareness in Romania and continue to expand opportunities, in line with ROSPIN's mission and vision.

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