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Abstract

"Spazio allo Spazio", active since 2010, involves students aged 5 to 20. This educational project was launched by a group of Italian teachers from the *Lower Secondary School Fermi* in Villasanta who believed Space exploration could be an efficient way to convey the idea that the extraordinary experience of the astronaut, who on the International Space Station must acquire new skills and be able to dominate a challenging and unpredictable context, similar to a disabled person's routine in daily life. This was a winning choice because gradually international institutions promoted similar initiatives. The central theme of space exploration is used to promote values of sustainability, equity and diversity, allowing students to become acquainted with the world of astronauts while facing subjects related to integration and disability. Several national and international universities and institutions, at the forefront of scientific research, have contributed to this project. The main topics of the project are: 1) Space exploration: the astronaut's experience is the starting point for lessons, cultural exchanges, lectures and interdisciplinary strategies to raise awareness about humans in space, the international cooperation for the International Space Station, physical training, technical, scientific and cultural preparation. 2) Career orientation: meetings with experts in different fields, from Science, Technology, Engineering, Mathematics to Arts and Physical Education, help students achieve better knowledge of themselves, their potential and limits acquiring skills in scientific research methodology in a multilingual environment. 3) Inclusion: as astronauts experience the limits of gravity and disability in Space, students can face their limits, through experiences of adapted physical activity, addressing issues related to the integration and insertion of people with different skills in school and society. 4) Team building: starting from the example of collaboration which takes place in space missions and scientific research, students are encouraged to experience teamwork. This is true for the teachers too, thanks to the strengthening of cooperative teaching, in the sharing of resources and good practices as well as in the implementation of innovative forms of communication and multimedia documentation. The project aims at making students able to face new and more advanced educational challenges and cognitive objectives, developing work strategies by transferring already tested approaches and processes to new situations. This is noticeable in the more self-conscious choices that former students have made about their future. An example is illustrated by an ex-student who directed his training path in the Science and Engineering field.

Keywords

Astronaut, Career orientation, Inclusion, Team building

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Acronyms/Abbreviations

OAVdA	Osservatorio Astronomico della Regione autonoma Valle d'Aosta
CNES	Centre National d'Études Spatiales
ESA	European Space Agency
EAC	European Astronaut Centre
DLR	Deutsches Zentrum für Luft und Raumfahrt
ASI	Agenzia Spaziale Italiana
ITU	International Telecommunication Union, Geneva
UNOG	United Nations Office in Geneva
ISP	Istituto Scienze Polari
CERN	European Organization for Nuclear Research
CNR	Consiglio Nazionale Delle Ricerche
ISMAR	Istituto di Scienze Marine
YOPP	Year of Polar Prediction
ENEA	Ente Nazionale per le nuove tecnologie, l'Energia e l'Ambiente
PNRA	Programma Nazionale di Ricerche in Antartide
ARISS	Amateur Radio on the International Space Station
STEAM	Science Technology Engineering Art Mathematics
STEM	Science Technology Engineering Mathematics
ESOC	European Space Operations Centre
DDI	Disabled Divers International

1. Introduction

Spazio allo Spazio is an educational project launched in 2010 by a group of Italian teachers from *Lower Secondary School Fermi* in Villasanta, a small town near Milan. It stems from an attentive school that wants to experience innovative teaching that enables the crossing of boundaries of individual subjects promoting transdisciplinary learning in a laboratorial way, oriented towards inclusion. These teachers believe Space exploration to be an efficient way to convey the idea that the extraordinary physical and psychological abilities of the astronaut have a surprising, unexpected similarity to the ones disabled people use in their daily life. [1] In fact, the astronaut, an excellence in the field of science and technology, while experiencing microgravity and weightlessness, must acquire new skills and be able to adapt to a challenging and unpredictable context, just like a disabled person does every day. Students learn through different experiences simulating theoretical and practical tasks on topics from the national curricula. They are required to handle various tests, to take responsibility, to face up to their

own limits, including physical ones, and to assess their capabilities. Using the astronaut as an example in teaching, means setting challenging objectives, providing specific training, creating a synthesis of skills and knowledge to achieve abilities that can be used in any field in the present and the future.

2. Didactic aims

The aim of this project is to focus students' attention on topics connected with space exploration, inclusion, and career orientation through teamwork. The project pursues educational goals aimed at improving self-awareness and students' potential. It proposes the achievement of cognitive aims related to STEAM topics and to the other subjects through an interdisciplinary approach. In strengthening the skills and competences of each student, including those with special needs and disabilities, entrepreneurship is promoted as a proactive and creative attitude in order to be the protagonists of one's learning and not mere spectators of the teaching efforts of others.



Figure 1. CNR Arctic Station Dirigibile Italia 2021

3. Didactic approach

The different activities carried out within the project use different methodologies and tools, with the aim of making students the protagonists of their learning, stimulating their curiosity for knowledge and their desire to open new horizons on the world. Lessons, in presence or remotely, periodic video contacts with some international realities broadcast via streaming from the project's YouTube channel, allow the involvement of several classes at the same time and the participation of families in the educational activities proposed by the school for their children. Particularly significant for the development of students' oral skills, are the events dedicated to issues linked to the project, which see the direct involvement of students in the roles of presenters and in the exhibition of works which recount the different experiences they have lived. The use of their mother tongue and the foreign languages studied (English and French) makes it possible to communicate

beyond the confines of school, to reach international realities of great educational importance. Over the years, these ties with foreign realities have made it possible to create a twinning collaboration with the *collège* "Pierre de Fermat" in Toulouse and to participate in numerous educational trips in Europe and in Italy (EAC in Cologne, CERN and ITU in Geneva, *Scuola Normale Superiore di Pisa* and others). Each experience of this kind is always preceded by a series of in-depth activities, conducted by the teachers in class. The scope of communication is relevant for the type of work linked to the project itself. The constant updating of the dedicated blog and the availability of videos on the YouTube channel allows for continuous use of the content covered and gives visibility to the work carried out by the students. Their involvement is also required in the graphic elaboration and design of the posters of the various events as also in the participation in creative competitions, during particular events such as, the European Day of Languages (competitions "Space for Words" and "The Lottery of Words") and the launch of weather balloons in Antarctica, with logos made by primary and secondary school pupils. More recent experiences such as "The Science Festival" have shown how the proposal of "contest" constitutes a highly challenging element for students and gives them the opportunity to express themselves, putting their personal skills and abilities into play. The personal re-elaboration of the contents dealt with takes place through the creation of "logbooks" that reflect and summarize the meaning of the activities carried out and collect the impressions and students' point of view.

4. Learning activities

4.1. Space exploration

Space and the astronaut's experience represent the common thread linking the different school subjects, becoming the starting point for lessons, cultural exchanges, lectures, and interdisciplinary strategies to raise awareness about humans in space, their physical training, technical, scientific, and cultural preparation.

Students learn Space topics by attending workshops and virtual planetarium shows, they observe the Sun in a Heliophysics laboratory and the sky with the naked eye using special telescopes in the Italian Starlight Stellar Park OAVdA. [2]

They visit European space centres (CNES, ESA, DLR), international agencies and organizations (ITU, CERN), a space theme park

(Cité de l'Espace), and museums about the history of space exploration (ISMAR, the Science and Technology Museum in Milan).

They experience virtual reality space in a Cave Automatic Virtual Environment 3D (Virtual Immersions in Science - *Scuola Normale Superiore Pisa*). They improve their knowledge of the Earth's climate and become aware of the ongoing climate change, by taking part in school projects (#Volare#Beyond#YOPP, The Climate Detective School Project - ESA), visiting the marine research centre CNR-ISMAR in Bologna, having video conferences with the researchers of the CNR Arctic Station *Dirigibile Italia* and the Concordia Base in Antarctica (AUSDA - Adopt a School from Antarctica – ENEA/PNRA). These activities promote the development of STEM competences and skills, including scientific methodology, data collection, visualisation and analysis of the weather balloons data dedicated to our school, subsidised by Bicocca University and launched from different sites (Linate airport- Milan, Mario Zucchelli and Concordia Base in Antarctica).

Students are involved in lessons given by astronaut trainers in order to study the consequences of microgravity aboard the International Space Station. They train by simulating the experience of an astronaut in space through a practical lesson at the swimming pool, with the use of specific equipment provided by a highly specialised staff (Disabled Divers International - Italy) and on one occasion, they also flew in the indoor skydiving facility, Aero Gravity of Milan. They take part in nutrition workshops where they are taught healthy eating, correct food lifestyles, and wellness in general. They learn about what space food is and how it has changed in time (ARGOTEC, *COOP-Lombardy Italy*). Students meet, have videoconferences and lectures on scientific and technological topics with qualified space experts like university professors of astrophysics, astronomy, physics and engineering. In collaboration with the Amateurs Radio (ARISS), students had the opportunity of a radio contact with the astronauts Paolo Nespoli and Luca Parmitano while on the Space Station and in person on their return from their missions. They also met and spoke to astronauts Samantha Cristoforetti, Thomas Pesquet, Maurizio Cheli, Tim Peake, Walter Villadei, Franco Malerba, Scott Douglas Altman, Joe Acaba, Alexander Misurkin, Mark Vande Hei, Sergey Ryazansky, Randy Bresnik. These

meetings heighten their awareness of the space programs and of their importance for modern society. All these space educational activities are meant to develop and reinforce the students' literacy and competence in STEAM-related subjects helping to stimulate their creativity, critical thinking and resourcefulness.



Figure 2. Samantha Cristoforetti, EAC 2012, Cologne Germany

4.2. Career orientation

At the heart of this project, there is the contribution to career orientation. Lower Secondary School, among its various missions, helps and guides students in their choice of high school, encouraging them to recognize personal aptitudes and to think about their future. Throughout the project experiences, students have the opportunity to learn about the different aspects of the experts' jobs. They gather valuable information on the personal experiences and training paths of the experts that have led them to their current jobs. A significant opportunity is represented by the meeting with renowned experts not only from the field of science and technology, but also from the fields of art, sport, literature, languages and music as well as representatives of the institutional world and international diplomacy. These interactions favour the acquisition of skills in the context of scientific research methodology and encourage the adoption of significant role models, leading to more conscious and responsible choices. Among significant experiences for career orientation, it is worth mentioning:

- the annual European Day of Languages event, which emphasizes the importance of multilingual learning as a tool for better intercultural understanding;
- the STEM International Day of Women and Girls in Science, which contributes to the reflection on science and gender equality, a

goal included in the UN 2030 Agenda for Sustainable Development. [3] The testimonies of women protagonists in scientific fields, still perceived as male-dominated, are an inspiration to many girls in our school;

- the lectures given by leading figures from the world of academia and national and international research;
- meetings with experts during school trips to national and international study and research institutes, aerospace training centres (DLR, ESA, ASI, ISMAR, ISP, CNES, CERN, ITU, UNOG, INAF Centres, *Scuola Normale Superiore of Pisa*, Astronomical observatories, planetariums, museums, Cité de l'Espac);
- meetings at school and video conferences with illustrious personalities and representatives of the scientific, cultural and sports world (astrophysicists, astronomers, physicists, engineers, meteorologists, doctors, researchers, journalists, writers, interpreters and translators, Paralympic and Special Olympic athletes);
- collaboration offered by ex-students, who contribute to the preparation, implementation and running of initiatives linked to the project, for example organizing and presenting events, proposing lessons and peer-to-peer tutoring.



Figure 3. Andrea Accomazzo, ESA/ESOC 2018, Darmstadt Germany

4.3. Inclusion

Just as the astronaut, who needs special psychophysical requirements in microgravity conditions, to face new difficulties which require the ability to adapt to a different environment, so the students experience their own and other people's sensory, movement and language limitations. Trying to understand, help and include those who live them daily they also learn to activate functional compensatory strategies. The workshop methodological approach leads pupils with disabilities to work in more stimulating contexts, in which they are called upon to develop new processes of autonomy in the management of schoolwork and to collaborate with their peers in order to establish

positive emotional relationships. Thus reducing the gap in the results obtained in the different activities as well as achieving all the educational and relational objectives set out in the Individual Education Plans of pupils with disabilities. Students experience real situations of disability through the various activities proposed; where they witness the impressive inner strength and willpower that is needed to face and deal with everyday hardships allowing them to enhance their strengths, reinforce their skills and develop human sensitivity capable of translating into concrete attitudes of help and support, which is pro-social behaviour. Examples of the activities are reported below.

At the Institute for the Blind of Milan, students have the possibility to experience “Dialogue in the dark” where they share a sensory enhancement workshop path by entering specifically designed darkened rooms that reproduce an environment from daily life and gain a completely new emotional point of view. Helped by a visually impaired guide, in a completely new perspective, they can’t see with their eyes, but must use their other senses. Thanks to this experience, a reversal of roles is created where the sighted become blind and the blind become sighted. They attend lessons in the Italian Sign Language, they do several adapted physical activities to allow them to develop cooperation and an attitude of acceptance of differences. They play sports related to the Blind Sports Federation (baseball, tennis, climbing, torball, showdown) and other adapted sports (wheelchair basketball, sitting volleyball, adapted swimming activities) in collaboration with the Italian Paralympic Committee, Disabled Divers International Italy, We Fly Team, Italian Alpine Club, other sports associations such as Vero Volley Monza, Aero Gravity Milan, Air Force sport centre and many others. They meet Paralympic and Special Olympic athletes who prove their worth both nationally and at the highest international level.



**Figure 4. DDI Italy – Swimming Pool
Vimercate Italy**

4.4. Team building

Starting from the example of cooperation which takes place in space missions and scientific research, students are encouraged to experience teamwork, respecting their own and others’ diversity through collaborative practices. By accomplishing group tasks, students learn to get along with peers, to listen, trust and support each other, while developing life skills such as communication and collaboration. This is true for the teachers too, thanks to the strengthening of cooperative teaching, in the sharing of resources and good practices. The workshop activities that students undertake implicate teamwork, encouraging entrepreneurship, focusing on the value of cooperation and negotiation together with a communicative exchange in languages other than their mother tongue. Teachers propose many group activities using curricular learning units on orienteering, coding, robotics, physical resistance, nutrition and current relevant world issues.

As part of the *Spazio allo Spazio* project for example a learning unit on robotics and coding is held during Technology classes, allowing students to create simple computer programs that can control the actions of robotic devices. It is divided in theoretical lessons and practical lessons both in English, held by the teachers and external experts. The former students of the project, contribute to the lesson and coordinate the intervention of the guests and the questions of the younger learners. The students are divided into teams with different tasks but with the necessity of communication between the various groups, to be able to reach a positive outcome of the mission. In the end, the individual groups join and test the mission.



Figure 5. Robotic Lessons

5. Results

The results can be summarized in the enhancement of cooperative teaching, in the strengthening of curricular topics, in raising awareness on the issue of inclusion, in the experimentation of multi-lingual teaching, in the implementation of innovative forms of communication and in the sharing of multimedia documentation. Students have been able to grasp the importance of skills such as the ability to cooperate, to be enterprising, flexible and adaptable; they have recognized the strength of willpower and commitment, supported by passion, which has led them to carry out every work activity with competence and enthusiasm. Finally, they have come to understand the interdisciplinary, international and multicultural dimension in which they live as "Citizens of the World".

The use of innovative communication technologies (interactive whiteboards, video conferences, dedicated platforms, blogs and the project website), well before the pandemic, compelled students and teachers to face the challenges of on-line teaching and learning with major confidence. This constituted an unexpected outcome, as if everyone was on a space mission directly in contact with the Control Centre on Earth.

Ludovico, one of the co-authors of this article, is a former student who has been participating in the project since the beginning of Lower Secondary School until today. Now he is enrolled in Aerospace Engineering at the *Politecnico di Milano*. His studies and life path are one of many examples of how the project has been able to pursue and achieve its educational and teaching goals. School orientation activities, especially the meetings

with professionals enthusiastic about their work, have helped him recognize his aptitudes and have underlined the need to cultivate passions with commitment and dedication to transform them into talents. He has remained in contact with teachers and classmates learning the importance of friendship and inclusion.

6. Conclusions

The project is the expression of a school open to the world around it, in contact with other realities and contexts, which gives stimulating opportunities, that cares about the individuality of each person and values Science as the link to improve human relationships and commitment.

Acknowledgements

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Figure 6. Project Activities