D.E.L.T.A.

Drones:

Experiential Learning and new Training Assets

Intellectual Output 3

ELECTRONIC PROGRAMME

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Partners' List

NO.	PARTNER	SHORT NAME	COUNTRY
P1 - COORDINATOR	**CISITA PARMA Scarl**	CISITA	Italy
P2	Aerodron Srl	Aerodron	Italy
P3	IIS "A. Ferrari"	Ferrari	Italy
P4 OUTPUT LEADER	**IISS "A. Berenini"**	Berenini	Italy
P5	IISS "C.E. Gadda"	Gadda	Italy
P6	Centro Público Integrado de Formación Profesional Corona de Aragón	Corona de Aragon	Spain
P7	Fundación AITIIP	AITIIP	Spain
P8	Liceul Teoretic de Informatica "Grigore Moisil"	LIIS	Romania
P9	SC Ludor Engineering Srl	LUDOR	Romania
P10	Universidade Portucalense Infante D. Henrique – Cooperativa de Ensino Superior Crl	UPT	Portugal

Introduction: why Drones

At the threshold of 2020, the EU scenario in terms of education and vocational training shows a gap: on the one hand, the strong pressure of the labor market which is the constant and growing search for profiles with strong STEM skills (mathematics, science, techniques and engineering); on the other hand, there is an inadequate level of STEM skills in the secondary cycle student population, in which about 22% is below the average of skills and knowledge with respect to their European peers, with peaks of 36% in the case of a partner disadvantage -cheap. A gap that widens further if we consider the gender gap, due to the fact that a still insufficient number of girls approach the technical-scientific culture.
As a result, while 90% of jobs in the next 10 years will require STEM skills, with over 7 million jobs available or being created in this area, it is estimated that the disalignment between education and the labor market costs to the EU the lack of 825,000 skilled workers.[1]

To tackle these critical issues, the EU 2020 strategy, already expressed in the "Joint Report of the Council of the ET 2020 - New priorities for European Cooperation in Education and Training (2015) focuses on a innovative concept of education and training:

- hoping for an educational process more focused on the learner and personalized, also with a view to overcoming the gender disparity in access to the fields of knowledge STEM
- betting on technology as a tool able to connect theory and practice, STEM subjects and concrete objects in the physical space, as well as the training path and the career path
- rehabilitating and enhance non-formal and informal learning paths, to complement traditional theoretical and frontal learning
- Work-based learning is promoted in the form of self-managed project work by learners, as a tool to recover and reinforce the motivation of disadvantaged students or students with low academic performance
- A new role is proposed for VET teachers, who become facilitators and mediators of the learning process, rather than knowledge providers, also thanks to the updating of teaching and pedagogical methods

[1] Sources: Eurydice report “Sviluppo delle competenze chiave a scuola e in Europa: sfide e opportunità delle politiche educative”; Eurydice Europe Report “Structural Indicators for monitoring education and training systems in Europe – 2016”, cft Eurostat, section “Education & Training”, “Europe 2020 indicators”.

From these assumptions the idea of the DELTA project was born, which aims to make an innovation contribution to technical and professional training courses at European level, promoting the learning of the STEM curricular disciplines through the work based learning methodology, through the use of harmless drones as a technology in use.

It should be pointed out right away that drones are not the end of learning, but the means that allows secondary school students to deal with mathematical-scientific disciplines, often perceived as difficult and discouraging, through a technology applicable to concrete aspects of everyday life , transferable to a context of participatory and collaborative learning, in which students are placed in a community of practices in which they take personal responsibility for and personalize their study path.

According to MIT Technology Review of 2014 (10 Breakthrough technologies) the drones would have become one of the 10 technological innovations with the greatest impact on the world economy, and the forecasts were not slow to come true. Drones are proving to be strategic for many harmless and civil purposes: rescue missions after catastrophic events, such as earthquakes and the transport of life-saving drugs; mapping of buildings to identify risks related to asbestos; environmental monitoring to avoid deforestation and hydrogeological risks; security control in high-traffic public places such as stations, airports, events; border control; urban and interurban traffic monitoring; video footage for film and documentary activities; precision agriculture; transport and delivery of light goods.

The idea behind the project is the adoption of inoffensive drone technology as a means to improve STEM skills in VET students and to develop technical and professional skills that prepare them to enter the labor market more easily by strengthening their employability. The technology of drones is combined with many aspects present in the European STEM curriculum, easily exploitable and transferable in terms of construction of teacher-led educational programs, invested with a new role of facilitator of learning, bringing theory to laboratory practice. The application of STEM theory to a real object will help teachers to involve and motivate students, especially those with low profit and / or special needs and learning difficulties. In fact, it is believed that VET students are more inclined to learn theoretical concepts through practical activities than through traditional teaching methods in which the teacher only explains concepts and assigns tasks and exercises.

On the basis of STEM educational programs developed by the teaching staff in a teacher-led perspective, the students cooperated in a community of practices inserted in a situated learning context that simulates the work-place, to study, disassemble and build inoffensive drones or parts of they, according to a logic of work-based learning.

This was possible thanks to the strategic cooperation implemented within the partnership, established on the basis of the following criteria:

a) By type of partner

Education side

- Coordinator Cisita Parma, training institution with skills in planning training and learning paths

-5 VET schools selected from 3 EU countries (Italy, Romania, Spain), equipped with technical, professional IT, electronic, mechanical-engineering, scientific curriculum

-1 University (Universidade Portucalense, Portugal) equipped with Department of Computer Science and researchers in the field of digital technologies for situated learning

Business side

-1 company expert in the development of digital applications for the use of drones in civil and industrial (Italy)

- 1 engineering firm expert in automotive solutions, as well as development of engineering applications for learning purposes (Romania)

- 1 research center expert in technological applications on plastics, engineering and automotive, also in aeronautics (Spain)

b) By combination on a territorial basis and by logic of "industrial chain":

working groups have been set up at national level to facilitate collaboration thanks to regional and linguistic continuity.

In particular, the following nerve centers have been identified:

Italy

1 training institution with skills in planning training and learning (Coordinator Cisita Parma)

3 VET schools located in the Emilia Romagna region specialized in engineering and electronic disciplines

1 company expert in applications for the drone industry

Romania

1 VET school specializing in computer science and programming

1 company expert in technological, engineering and digital applications

Spain

1 VET school specializing in industrial chemistry, engineering and automotive disciplines

1 research center expert in technological applications on plastics, engineering and automotive, also in aeronautics

Chapter I. D.E.L.T.A. project: aim and structure

Based on the discussion, D.E.L.T.A. following fundamental objectives have been set:

- Tackling phenomena of school dropout and student motivation, implementing teaching strategies that favor the acquisition of STEM disciplines according to an experiential and practical approach more suited to the learning style of VET students

- Familiarize VET students with inoffensive drone technology, as a pretext for the practical application of formal mathematical-scientific languages traditionally taught with a theoretical approach

- Create learning environments in situation, thanks to the co-planning, by educational institutions and companies, of a work-based learning setting, organized according to the production / industrialization logic of a drone

- Strengthen the professional skills and employability of VET students

- Updating and strengthening the teaching skills and methods of VET teachers and trainers, through the full integration of technological tools, digital applications and their potential

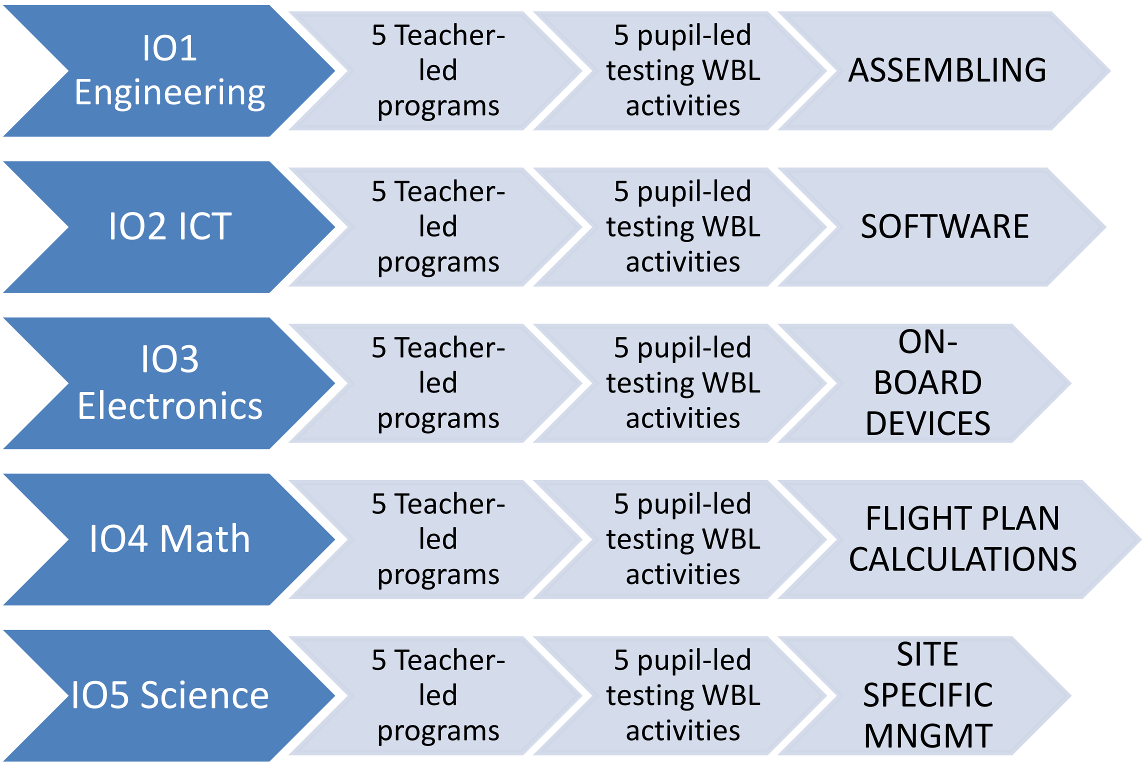


Figure 1 - D.E.L.T.A. project general structure

The general structure of the D.E.L.T.A. project has planned to proceed according to the logic of the industrialization of a harmless drone, identified in the phase of operational co-planning thanks to the synergy between educational and training institutions on the one hand (P1 Coordinator + P10 University of Porto), and on the other the business oriented partner with special reference to P2 Aerodron by virtue of the specific skills of the sector.

In production, in fact, a harmless drone must be:

1) Designed, manufactured and assembled

2) Configured from the point of view of the software, determining the conditions for the study and processing of data on the ground

3) Configured from an electronic point of view, identifying and implementing the devices to be installed on board

4) Scheduled to follow the correct flight plan trajectory

5) Planned to carry out a mission identified according to a useful application for civil and / or industrial purposes.

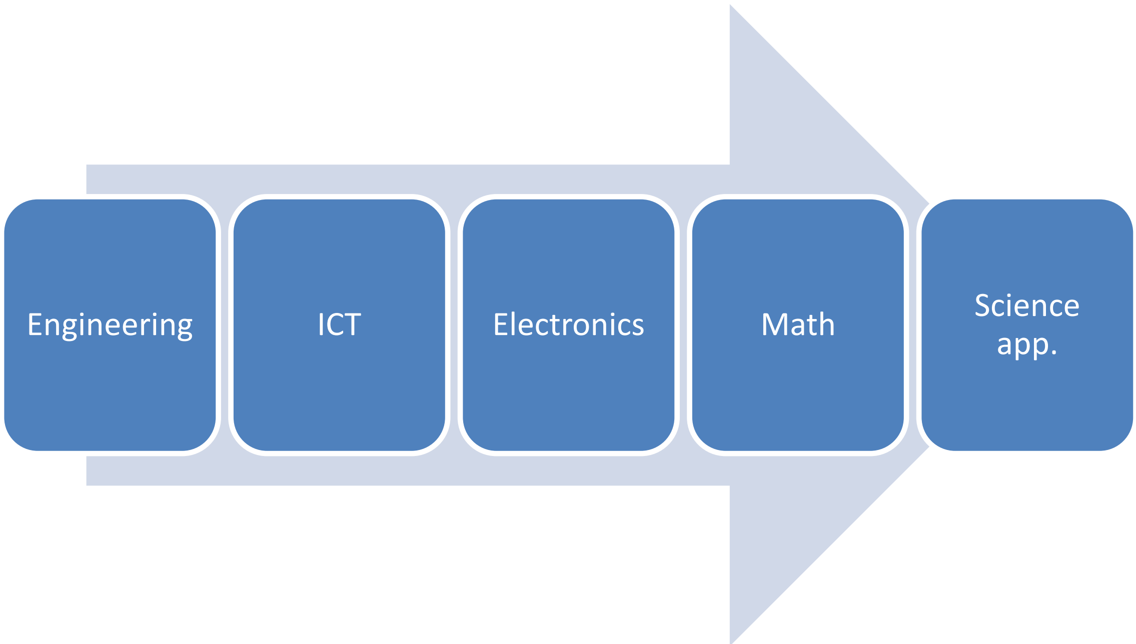


Figure 2 – The industrialization process of an inoffensive drone

Each of these phases can be easily implemented in a context-based learning context, organized through the teaching methodology of work-based learning from a pupil-led project work perspective, based on the collective and laboratory resolution of a concrete problem.

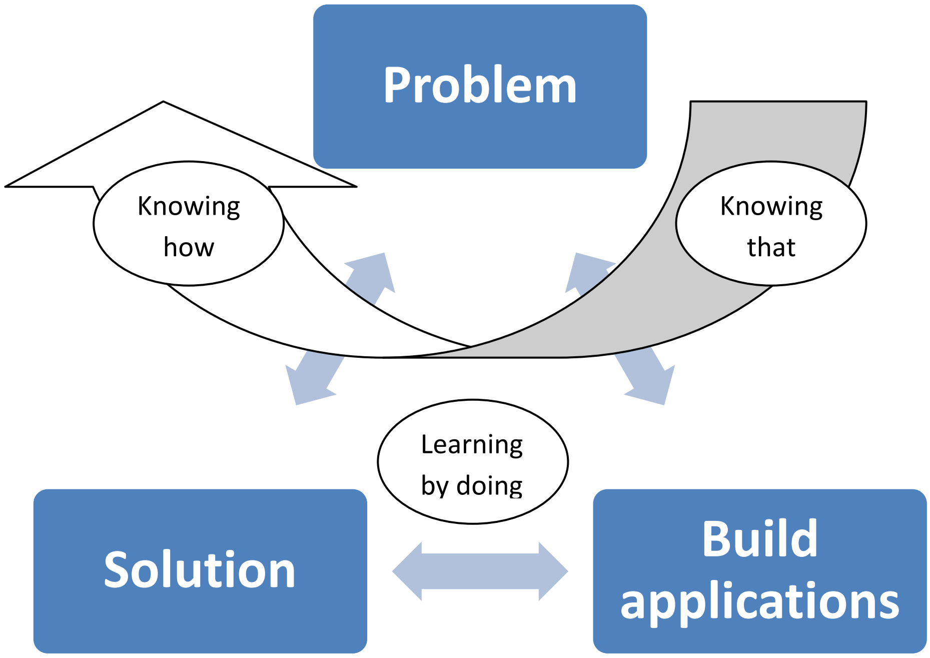


Figure 3 –Application scheme of the Work Based Learning didactic methodology

The students, organized in work groups that identify a emerging community of cognitive apprenticeship practices, are confronted with a concrete problem to be solved, linked to the construction or study of a harmless drone or its components. Immediately they must activate prior knowledge related to their informal or non-formal knowledge, as well as to formal languages learned in the institutional educational context, cooperating to identify applications, strategies and techniques to obtain the solution to the problem faced. In this way they pass from "knowing what / to" to "knowing how" a phenomenon occurs or manifests itself.

Each phase of the drone industrialization process lends itself to multiple modes of use within the VET educational curriculum, since it requires the study and mastery of formal mathematical-scientific languages, both the predisposition of a learning environment that simulates the organization socio-technical work-place.

Through the phases of the D.E.L.T.A. project, thanks to the interdisciplinary approach, the VET students were able to develop:

a) Professional skills relating to key technologies of the digital age, such as information technology for on-shore processing of data collected by the in-flight drone (IO2) and electronics for the assembly on board of aircraft of cameras, components of sensors (multi-spectrum, thermal, "sense & avoid" vision for in-flight interaction) and geolocation (IO3);

b) STEM curricular competences: engineering for the design, production and maintenance of inoffensive drones (IO1); mathematics, through trigonometry for setting the flight plan, and 3D modeling through the point cloud for volumetric calculations and remote sensing (IO4); physical and natural sciences to contextualise the problems that can be faced thanks to the technology in use - such as precision agriculture, environmental and hydrological monitoring (IO5).

Chapter II. Intellectual Output 3 – Electronics Programme

The Output consists of a set available for reuse, released in OER (Open Educational Resource) mode, of educational experiments related to the operations of design, installation and sizing of the components for vision, detection and geolocation present on board the drone, organized according to the logic of work-based learning in a simulation context of the corporate production department.

The activities of the Intellectual Output are substantiated in a teacher-led educational program, relating to the subjects of the electronic area and industrial automatic systems, for the performance of the disciplinary school curriculum in work-based mode. The program prefigures the conditions for the repeatability of the experimentation and for the pedagogical organization of the work-based learning setting, so that it is as self-managed as possible by the students in project work pupil led mode. An integral part of the Output are the physical objects and the products of experimentation, documented through videos and photos of the situated learning environment.

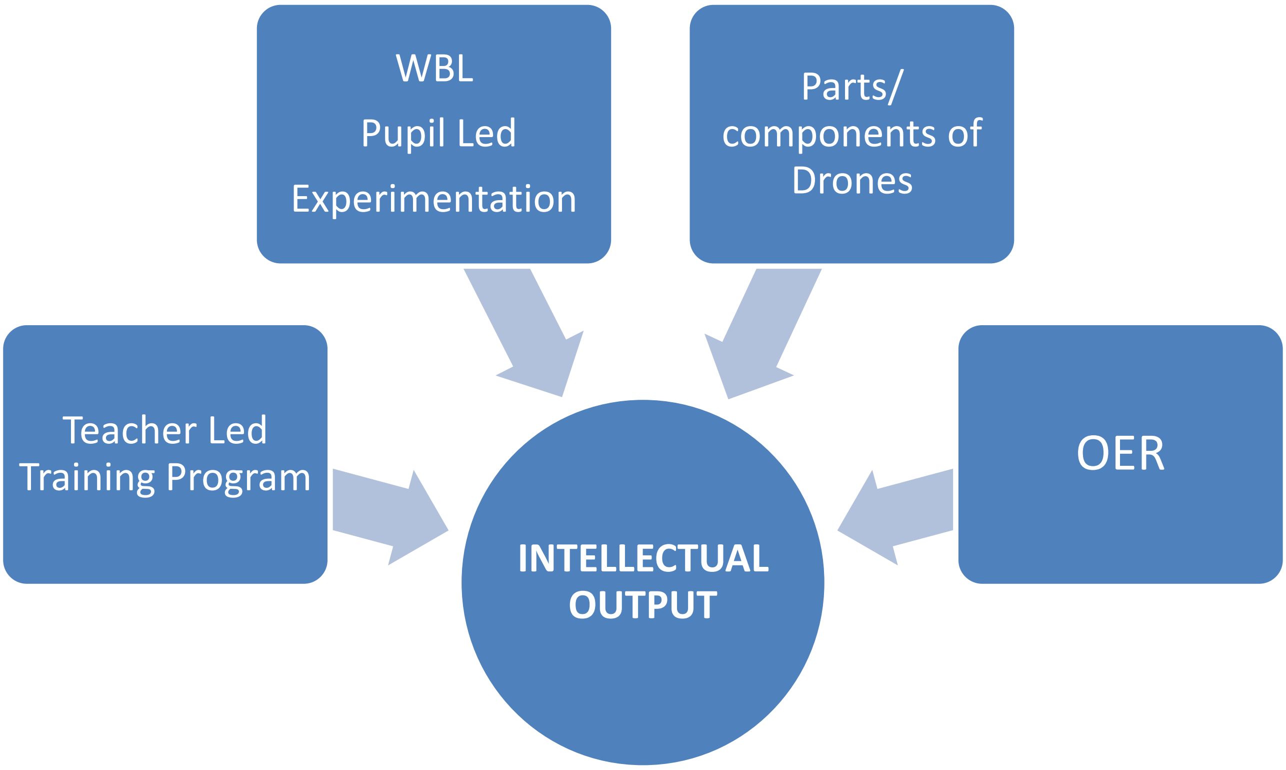


Figure 4 – Structure of the Intellectual Output

Intellectual Output 3 consists of three distinct operational phases: Design - Test - Release, each identified on the basis of key target groups, organized educational and pedagogical environments, the technologies adopted and the activities actually performed. Leader of Output 3 is identified in P4 IISS A. Berenini di Fidenza (PR), by virtue of the specialization in the industrial curriculum and in the development of electronic applications and plant engineering solutions for automation.

Phase	What	Who
Phase 1. DESIGN	1.1 Definition of the Learning Objectives 1.2 Design of the Training Programme 1.3 Didactic design of the experimentation	Leading Partner P8 together with P1 defines the guidelines for the identification of the learning objectives All schools identify Learning Objectives and plan the experimentations Business Partners support schools in the Design and creation of the work-based learning setting
Phase 2. TESTING	2.1 Testing 2.2 Monitoring & feedback	All schools with the support of business partners
Phase 3. RELEASE	3.1 Fine tuning of the Training programme for validation and replicability 3.2 Release in form of OER	All schools

The theoretical approach and the methodological framework that supports the educational experimentation of the Intellectual Output finds its scientific model in the theory of the Activity Sector of Yrjö Engeström (1987). According to this model, the learner in his learning path is confronted with physical objects (the drone in this case) and technologies (mechanical and engineering for IO1) that represent the tools for solving a practical problem that the field of activity proposes. The solution, the new object or the new technology in outcome represents the result of the activity itself. However in this learning process the learner is never alone, but in the field of activity he finds himself inserted in a community of practices, in which other learners live together at the same level, with which he can exchange knowledge and skills according to a peer-relationship. to-peer, as well as trainers and teachers who perform a scaffolding function supporting and facilitating the process of acquiring skills. In this community of practices there are explicit rules and tacit conventions of behavior, hierarchically or more fluidly structured relationships, based on the sharing of responsibilities, tasks and supervision of the same or different technologies. For this reason it can be stated that in the upper part of the framework of the field of activity, which represents the tangible and visible part of the practice, the so-called "hard skills" or technical skills emerge, while in the lower part, submerged and less visible but from the strong influence on all the actors involved, there are the so-called "soft skills" or relational skills.

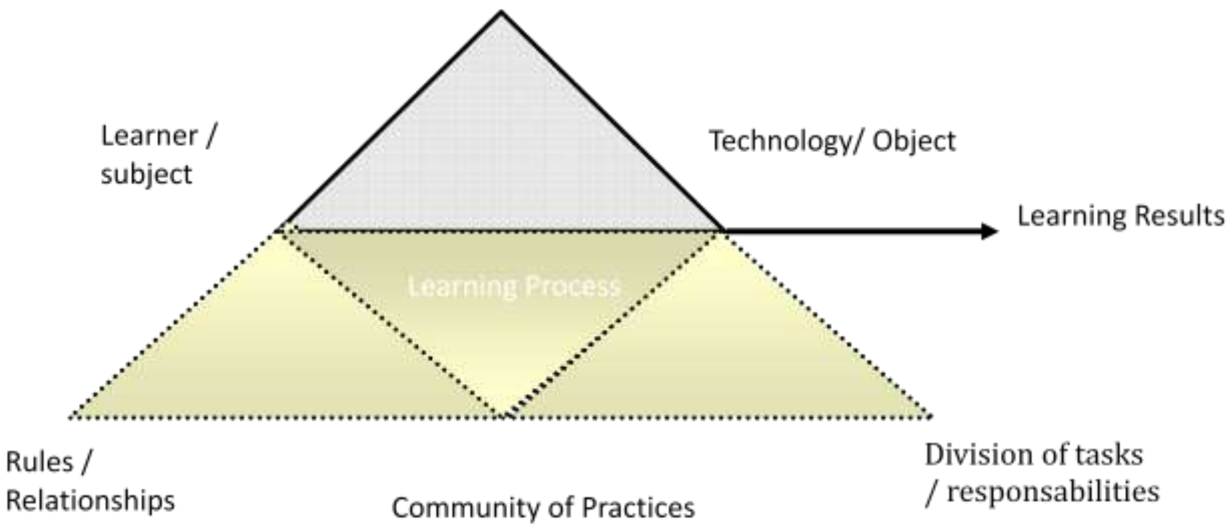


Figure 5 – Grafic representation of the activity theory by Y. Engestrom

The target groups involved in the field of activity exceed the traditional boundaries of the school class, because they involve multiple actors at various levels of responsibility and effectiveness:

- Target group 1: VET students, normally attending the upper three-year course of the secondary cycle, enrolled in mechanics, maintenance and technical assistance, electronics and automation, IT and programming courses. The involvement of an entire class group was planned for each school (around 20/30 students) or an interdisciplinary learning group was established from different

classes. A significant part of the learner group was selected based on the condition of greater socio-economic disadvantage and risk of school exclusion due to low performance or motivation.
- Target group 2: VET teachers and trainers with teaching assignments for technologies and mechanical design and electronic plant engineering. Teachers responsible for planning the school curriculum were also involved, as well as those responsible for work-placement activities and curricular internships in local companies. At each VET partner school, a working group specifically dedicated to overseeing the activities of the D.E.L.T.A. project was set up within the teaching staff.
- Target group 3: entrepreneurs and technicians of partner companies, in which a working group composed of experts in applications related to drones, engineering and automotive solutions, as well as business tutors responsible for welcoming students in training during curricular internships, or those responsible for recruiting new workforce.

II.1 Implementation of the ELECTRONICS applied to drones

The activities of each of the 5 participating VET schools will be summarized below, illustrating the objectives, contents and structure of the experiments. Information will be provided on the pedagogical organization of the work-based learning environment, the target group of students involved, the duration and some indications on the curricular objectives achieved or not achieved.

OUTPUT LEADER

P4 IISS "A. Berenini", Fidenza (Parma), Italy

https://www.istitutoberenini.gov.it

It is an institute with both VET study courses (Mechanical Technician, Electronic Technician / Automation, Chemical Technician) and high school (Scientific Applied Sciences option).
The project team decided to involve in the experimentation about 20/25 students of the VET address in Electronics / Automation, which also combines mechanical design skills with the knowledge of electronic circuits and systems and Arduino boards.

P4 Berenini has decided to focus on the Reverse Engineering approach with regards to the drone electronics. The choice has matured from the awareness that automated tools such as drones are already natively equipped with tested electrical and electronic circuits ready for use, as well as accompanied by exhaustive documentation both online and offline to investigate all aspects. The P4 Berenini team has therefore chosen to follow the approach according to which the electronics of the drone is ready, and that it was therefore more useful and meaningful from an educational point of view to dismantle it and study it.

A low-cost drone (DJI Spark) was then purchased, which the students disassembled to take measurements on the microcontrollers, responsible for adjusting the flight speed of the drone, marking PWM (pulse-width-modulation), and testing the presence , the frequency and intensity of the motor signal. Specific tools were used such as the oscilloscope and the multimeter to study the characteristics of direct and alternating current.

The learning setting of work based learning is documented with a self-produced video, publicly available on the official YouTube channel of the D.E.L.T.A. Project at the following address https://www.youtube.com/watch?v=_x1jG5tP7Ag

Students involved:

n 30 students of the Technical Electronic and Automation (class IV - V)

Duration of the design phase: approximately 10 hours

Duration of the testing phase: about 30 hours

Obiettivi di apprendimento curriculari:

Module 1: measurement of electrical signals elettrici (4 hrs)	Use of electronic equipment (oscilloscope, multimeter, function generator)
Module 2: microcontrollers (16 hrs)	Knowing and using the Atmel Atmega16 microcontroller (setting, I / O port configuration, use of memory and timers, signal generation)
Module 3: PWM generators piloted by microcontrollers (10 hrs)	Ability to design and build electronic circuits with microcontroller.

Organization of the learning environment according to the work-based-learning approach

Didactic methodology % **Tools**	**Work – based learning setting**
Frontal lessons 10% Individual study 10% Study in groups 10% (students alone and in groups have studied the issues introduced at a general level)	Introduction to the functioning of electric motors and electronic circuits. It was decided to provide only a limited area of knowledge that would allow students to orientate themselves in self-employment and group work.
Guided laboratory activities 20% (operational skills are introduced through simple guided programming experiences) Group work (pupil led) 50% Technologies and tools used: - instrumentation of the electronics laboratory - direct current motor - microcontroller development environment	The activity is carried out in the electronics laboratory Students are divided into working groups with leaders supported by the teacher Students work essentially independently among peers. The teacher intervenes only in cases of necessity (malfunctioning or non-functioning of equipment, measuring instruments and drone)

The scaffolding roles of situated learning:

a.Scaffolding figures identified within the school staff and their professionalism:

2 professors of Electronics and Industrial Plant Engineering

- 1 electronic engineer

- 1 doctor in physics

With teaching skills in: Electronic and electrotechnical systems, automatic systems and industrial plant engineering

b. Scaffolding figures identified outside the school context:

business professionals from partner P2 Aerodron di Parma, because of the following professionalities and technical competences

Founder & CEO of AERODRON. Electronical engineer, pilot	Sales manager and manager of public administration projects. Expert in technological innovation.	2 experienced UAV pilots, with a qualification recognized by ENAC. 1 pilot is also a geologist and an expert in photogrammetry and digital applications

P3 IIS "A. Ferrari", Maranello (Modena), Italia

https://www.ipsiaferrari.mo.it/

This is the VET institute originally founded by Enzo Ferrari as a training center for the technicians of the renowned car manufacturer, and subsequently transformed into the State Professional Institute. Currently it includes 3 professional addresses for the five-year diploma (Car-repair, Maintenance of Transportation, Maintenance and Technical Assistance) and 1 address for the technical diploma (Transport and Logistics, Articulation of Construction of the Means of transport).

The P3 Ferrari team has chosen to extend the program already started during the Intellectual Ouptput 2 project, dedicated to the IT infrastructure aspects of the drone, where the basic drone configuration and programming was carried out. Starting from the basic parameters set during IO2, during IO3 the students disassembled, identified and tested all the components of the electric motor and the electronic circuit. Once the electronic system is ready, an electric motor test is carried out to verify the correct system configuration.

A check-list of aspects to verify and the procedure to follow to work on the electronic circuit of the drone was developed by the students:

- Choice of drone body and its ideal weight (180 grams)

The choice of materials fell on carbon fiber in terms of lightness and performance, but it would also have been possible to focus on fiberglass, aluminum or plastic polymers.

- Choice of brushless motor type
- Choice of command board, usually Arduino, but also other Open Source options can be admitted

-Choose the type of software for managing the command board, which can be connected in WiFi, Bluetooth or infrared.

- Carry out scratching: program the command card

- Mounting the card and its components

Video camera for remote management

Brushless motors

Propellers

Battery

- Create APP for drone remote control

The learning setting of work based learning is documented with a self-produced video, publicly available on the official YouTube channel of the D.E.L.T.A. Project at the following address https://www.youtube.com/watch?v=i5RM3RI1sFw

Students involved:

About 30 students who have set up an interclass work group as part of the alternating school work activities, coming both from the professional addresses in "Maintenance and Technical Assistance" and "Maintenance of Transportation" and from the technical address in "Transport and Logistics - Articulation Construction of the means of transport ".

Duration of the design phase: about 10 hours

Duration of the testing phase: about 20 hours

Learning objectives

The primary learning objectives were defined based on the outgoing skills profile that graduates from the "IIS A. Ferrari" institute mature: at the end of the five-year course the students must achieve learning outcomes related to the educational, cultural and professional. Specifically, I am able to master the use of technological tools with particular attention to safety in the places of life and work, to the protection of the person, the environment and the territory; they must use result-oriented strategies, work by objectives and the need to assume responsibility in respect of ethics and professional ethics. Students are able to master the fundamental elements of the problem by making observations relevant to what is proposed using an appropriate technical language. Students must also cooperate in group work and engage constructively with teachers, the group of parties and the actors who share in the learning community, while organizing their work, managing the material and making judgments about their work.

Curricular learning objectives:

Knowledge:

Know the basic concepts of statics; Knowing how to read dimensional drawings with indications of tolerances and roughness; Know the application fields of electronics; Know the main operating characteristics of electronic components; Know in principle the command and control methods of the various converters; Know the different interface conditions; Know the main operating characteristics of the various types of sensors; Know in principle the command and control methods of the various sensors; Know the different methods of information transmission; Know the main operating characteristics of the transmission; Know the difference between unidirectional and bidirectional signals; Know the difference between digital and analog signals; Know the sinusoidal signals; Know the various types of current; Identify the elements that make up an electrical circuit; Know, classifications and methods of recognition of electric cables; Know the problems related to the use of adapters; Know the unit of measurement of the capacity; Know the methods that regulate the charge and discharge of a capacitor; Know the main types of batteries; Know the battery charging techniques; Know the parts of an electric motor; Know the magnetic forces that induce rotation in an electric motor; Know the wiring diagram of a starting system; Know the specifications of the measuring instruments.

Skills

Knowing how to associate the various typical uses with the various components; Knowing how to associate each sensor with its use methods, in terms of limits and performance; Knowing how to read technical manuals and find documentation from alternative sources to school ones; Knowing how to distinguish transmission methods and their use; Knowing how to read technical manuals and find documentation from alternative sources to school ones; Knowing how to represent the current and the alternating voltage through the vectors; Know what is meant by sampling a signal; Knowing how to explain the functioning of an electric generator; Know what the three fundamental electrical quantities are: symbols and units of measurement; Knowing how to carry out the insertion of instruments for measuring the voltage of the current and the electrical resistance; Knowing how to calculate the capacitance of a capacitor according to its physical and geometric characteristics; Knowing how to choose the most appropriate measurement method; Knowing how to find the fault in a device using the diagnostic tools; Understand the possible failure from the diagnosis and remedy it

Extracurricular learning objectives:

The general objective is to train students ready to take advantage of the skills acquired during the course in a professional way. The course is aimed at the acquisition of practical skills immediately applicable in the field.

Knowledge

Introduction to multirotors: Commercial uses of multi rotors; Elements of electronics, Volts, Amps, Watts; Main components of multi rotors; LiPo batteries, use, Safety; Commercial flight control units, technical analysis;

Capacity

Assembly, Maintenance, Aerial Shooting and Photogrammetry with Civil Drones

Radio Systems; Forced flight termination system; Balance the propellers; Make the welds; Use the tester; LiPo battery charger settings; Theoretical multirotor sizing calculations with dedicated software

From the point of view of behavioral skills:

Adapting the communication style to that of the other party; Listening and understanding the other's point of view; Increasing awareness of the structure of communication processes and manage their contents; Communicating within the group: managing conflicts and building consensus; Developing synthesis skills: communicate in a concise way; Knowing how to communicate and listen in an active and engaging way, relate effectively, a personal and professional competitive advantage.

Organization of the learning environment according to the work-based-learning approach

In class	Work-based learning At school
Frontal and theoretical lessons in the classroom -mechanical elements: machinery - mechanical systems - mechanical design	Premises: Laboratory of Electronics, Mechanics, assisted design (CAD) Equipment: PC, Logic, Multimeter and what can be found in the electronics and mechanical laboratories and how much to buy for the specific realization of the project; Materials: Arduino electronic boards; open source software for programming and basic configuration of the drone Conditions of logistical accessibility to the equipment: access to the specific equipment and materials for the project the teachers participating in the project and the students selected from the 3rd and 4th grade classes of the work group. All users have attended training courses on work safety

Scaffolding roles in the situated learning environment:

a.Scaffolding roles inside the shool staff and relevant professionalities:

In vocational education, scaffolding has always been an important teaching technique, reinforced by the role of ITPs (Technical Practical Teachers), support teachers and educators. In particular with respect to the D.E.L.T.A. project the scaffolding figures have had the purpose of:

- enhance pupils' experience and knowledge
- implement adequate interventions with regard to diversity
- to encourage exploration and discovery
- encourage collaborative learning

- promote awareness of one's own way of learning
- carry out educational activities in the form of a laboratory.

The teacher does not determine the learning mechanically. The teacher and the materials he proposes become resources within a process in which learning takes place in many complex ways. The pedagogy of the project has turned out to be an educational practice able to involve students in working around a shared task that has its relevance, not only within the school activity, but also outside it. Working for projects leads to the knowledge of a very important work methodology on the level of action, the sensitivity towards it and the ability to use it in various contexts. The D.E.L.T.A. project, in fact, has been and can be a motivating factor, since what is learned in this context immediately takes, in the eyes of the students, the figure of tools for understanding reality and acting on it.

b. Scaffolding roles outside the school context:

Professionals of the P2 business partner Aerodron of Parma, by virtue of the following professionalism and technical skills

Founder & CEO of AERODRON. Electronical engineer, pilot.	Sales manager also responsible for public administration projects. Expert in technological innovation.	2 experienced UAV pilots, with a qualification recognized by ENAC. 1 pilot is also a geologist and an expert in photogrammetry and digital applications

<u>P5 IISS “C.E. Gadda”, Fornovo T. – Langhirano (Parma), Italia</u>

http://www.itsosgadda.it/

It is a school with two branches, with both VET (Computer Technician, Economic Technician and professional diploma in Maintenance and Technical Assistance) study addresses and high school students (Scientific Applied Sciences option, both four-year and five-year).
Both branches worked on the project, with two different approaches complementary to each other.

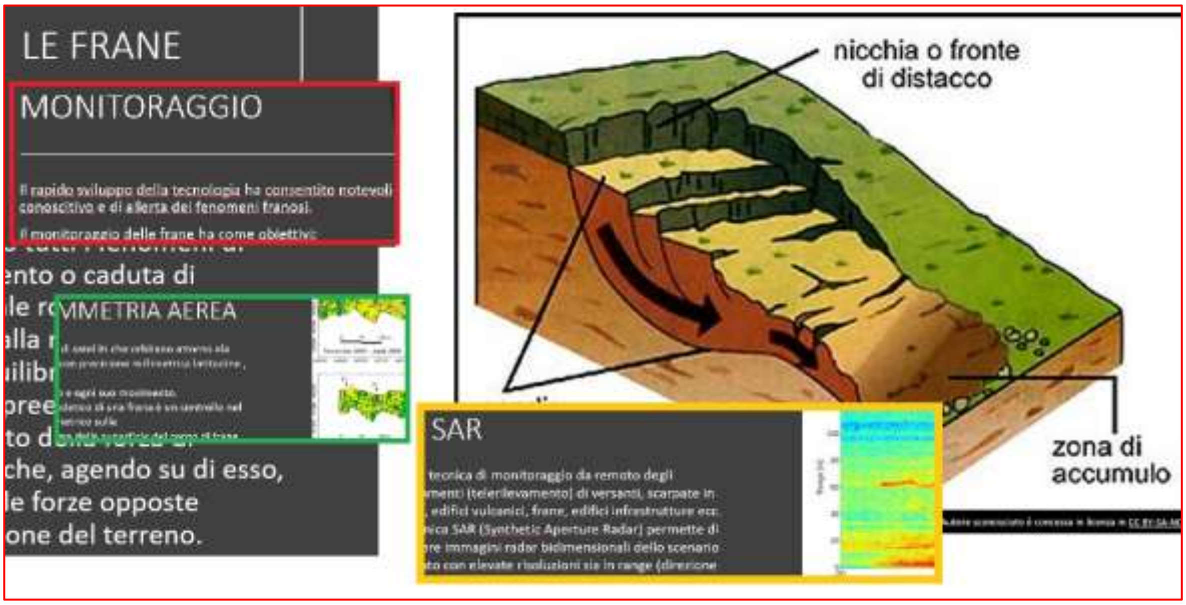
he starting point for the experimentation was the drone previously assembled in reverse engineering mode (see IO1 and IO2) to be improved through identification, configuration and installation of the system electronics (Pixhawk, remote control, sensors, ...), which was possible install on board thanks to a cover (containment box) printed in PLA via 3D printer.

The team at the Langhirano site (project manager Prof. Francesco Bolzoni), through the involvement of about 15 students in the Professional Maintenance and Technical Assistance address, implemented the preconditions to make the drone perform electronically and complete: the installation of an AutoPilot system (Pixhawk) on the wing of the drone, to provide it with a system of sensors suitable for measuring environmental parameters (barometer, gyroscope, accelerometer).

The learning setting of the work based learning (Langhirano site) is documented with a self-produced video, publicly available on the official YouTube channel of the D.E.L.T.A. Project at the following address https://www.youtube.com/watch?v=FptqTzpEClM

The Fornovo team (project manager Prof. Luciano Amadasi) involved students in laboratory activities close to the Physics discipline for the design and sizing of the casing to be printed in 3D, intended to house the electronic circuits (materials used in the laboratory of Physics: resistors, inductances, capacitors, matrix board, electric cables, tin, PLA for the printing of the casing). Subsequently, he prepared an introduction program, intended for the students of the Applied Science Option High School, for the applications of the drone in the field of remote sensing and photogrammetry, achievable thanks to the sensors of the electronic circuit supplied.
Open source software tools such as ArduPilot and Mission Planner were then presented and used to set up drone flight and parameters for detecting environmental phenomena. The learning setting of the work based learning (Fornovo site) is documented with a self-produced video, publicly available on the official YouTube channel of the D.E.L.T.A. Project. at the following address https://www.youtube.com/watch?v=1LvT0BnAkFY

The details below related to learning objectives report extra curricular disciplinary extensions that have been proposed to Liceo students: remote sensing technologies thanks to the drone sensors have allowed us to deepen geological and earth science (water on Mars) issues thanks at a seminar organized by the Department of Mathematical, Physical and Natural Sciences of the University of Parma.



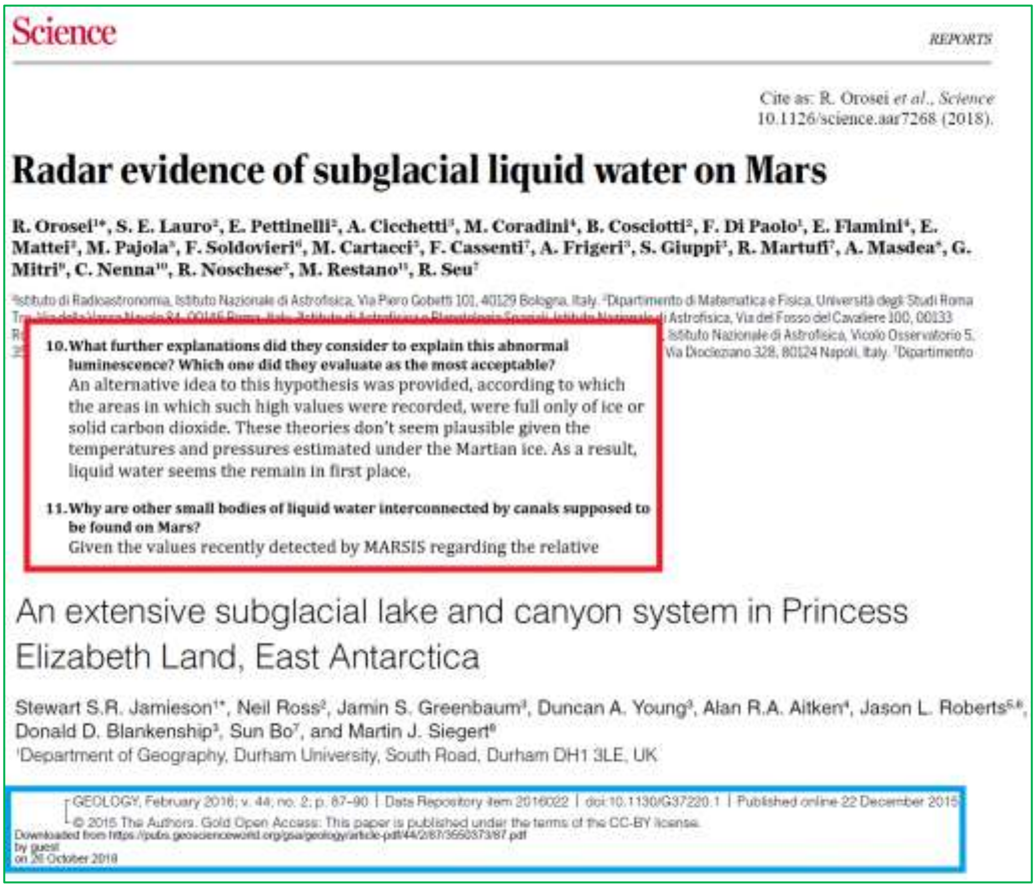
Students involved:

Fornovo headquarters: n 15 students of the Liceo Scientifico Forensic Sciences Option

Langhirano headquarters: n 15 students of the professional address in Maintenance and Technical Assistance

Duration of the design phase: approximately 30 hours

Duration of the testing phase: about 60 hours



Science REPORTS

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Radar evidence of subglacial liquid water on Mars

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10. What further explanations did they consider to explain this abnormal luminescence? Which one did they evaluate as the most acceptable?
An alternative idea to this hypothesis was provided, according to which the areas in which such high values were recorded, were full only of ice or solid carbon dioxide. These theories don't seem plausible given the temperatures and pressures estimated under the Martian ice. As a result, liquid water seems the remain in first place.

11. Why are other small bodies of liquid water interconnected by canals supposed to be found on Mars?
Given the values recently detected by MARSIS regarding the relative

An extensive subglacial lake and canyon system in Princess Elizabeth Land, East Antarctica

Stewart S.R. Jamieson[1*], Neil Ross[2], Jamin S. Greenbaum[3], Duncan A. Young[3], Alan R.A. Aitken[4], Jason L. Roberts[5,6], Donald D. Blankenship[3], Sun Bo[7], and Martin J. Siegert[8]
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Learning objectives:

The learning objectives were chosen within the curriculum programs of the STEM and non-STEM disciplines (English, law) relating to the Scientific High School Option Applied Sciences and Professional Maintenance and Technical Assistance Institute. For each subject, information is provided on the teaching methods (frontal lesson, laboratory, WBL).

Physics	Improve the functionality of the drone already implemented in IO1 by another class. Preservation of angular momentum and number of thrusters. The pixhawk. Pulse Width Modulation and Pulse Position Modulation signals. Install the electronic equipment for flight having only the knowledge of the properties of the components (WBL method).

	Radio connections, remote control setup. Install necessary sensors on the fly: gyroscopes, accelerometers, altimeters, gimbal ... Design and test a DOWSER sensor: it is a water or metal detector, useful for the systematic scanning of large portions of territory by flying over a drone.
Science	Apply the theoretical knowledge of the Gauss-Boaga reference system to flight programming. GPS systems (America), GLONASS (Russia), GALILEO (Europe). The problem of the detection of aquifers in the territory. Dowsing.
Mathematics	Representing functions applied to drone technology on the Cartesian level. Coordinate systems. Related calculations.
Techniques of graphic representation	Design and implement a 3D carter to be applied to the drone.
ICT	Open source programs. ARDUPILOT: tuning of propellers and flight instruments. MISSION PLANNER: flight scheduling. Examples of imperative programming in code C.
English	Lettura e rielaborazione di un testo sull’etica dell’uso del drone.
Law	Normativa italiana ed europea sull’uso del drone.

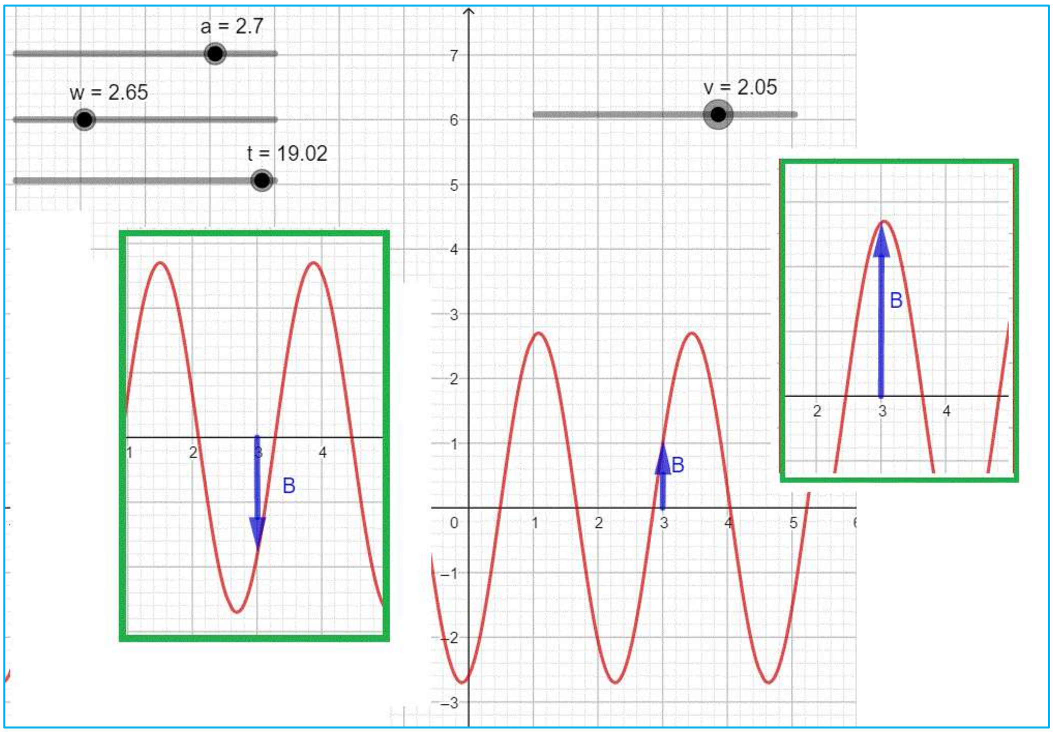

Figure 6 - Sinusoidal electromagnetic wave

Organization of the learning environment according to the work-based-learning approach

Subject	***Hours & objectives***	***Methodology***	***Contents***
Electronics	18 hrs Finalization of the drone, piloting.	*Frontal lessons 10%* *Individual Study 10%* *Teamwork 80%*	Brushless motors, dynamics connected to the flight of the drone (conservation of angular momentum, stability of the drone ...). Pulse Width Modulation and Pulse Position Modulation signals, basic circuits. Radio connection, remote control piloting. PIXHAWK, CPU, serial ports, RGB code, GIMBAL stabilizer, height sensors. Geolocation GLONASS, GALILEO, GPS; trajectory programming with Ardupilot / Planner. Digital control of system efficiency. Testing in an external environment.
Graphics	3 hrs Design and 3D printing of the case for the allocation of on-board instruments.	*Team work*	The case was designed with CAD and then printed in PLA with the 3D printer.

Natural Science	8 hrs Groundwater and the problem of landslides	*Frontal lessons 20%* *Individual study 10%* *Team work (research) 70%*	Phenomenology, state of activity, tools for monitoring, causes, remedies. The pupils studied the topic and produced two PPT presentations
Mathematics	2 hrs Goniometry and the electromagnetic waves.	*Frontal lessons 100%*	The mathematics teacher used GEOGEBRA to show the behavior of a plane wave. This is a prerequisite for the discussion of the physics colleague.

English	5 hrs Reading and comprehension of a text in English	*Frontal Lessons 10%* *Individual study 30%* *Teamwork 60%*	This is a normative document of the European Community on the use of SAPRs and the right of citizens to privacy.
English Chemistry Natural Sciences	10 hrs	*Teamwork 80%* *Frontal Lessons 20%*	The students, assisted by the professors, have been waiting for the reading, understanding and study of two scientific articles in English related to the

			remote sensing of liquid water in the terrestrial and Martian polar subsoil. An interdisciplinary verification test was then administered in English
Physics	10 hrs Realization in the laboratory of radar antenna for the detection of aquifers.	*Work of a small group followed by a lesson on how the mechanism works.* *Teamwork 80%* *Frontal lessons 20%*	The working group created a large solenoid with a high frequency alternating current. In solenoid it behaved as an emitter and receiver of electromagnetic waves. The presence of water was measured by measuring the amplitude variation and the phase shift between the signal source and the signal detected at the ends of the solenoid, by means of a demodulator. The effective frequency was experimentally found within the limits of the poverty of the laboratory means. The physics teacher then explained to the students the functioning of the apparatus

WBL	3 hrs Visit to the department of Earth Sciences at the University of Parma.		*Frontal Lessons 100%*	The students attended an exhaustive lesson on the mechanisms of remote sensing of liquid water. The lecturer has covered technical aspects of the Martian probe with hints of geolocation and has provided interesting news concerning the three-dimensional digitalization of the terrestrial, lunar and Martian soils.

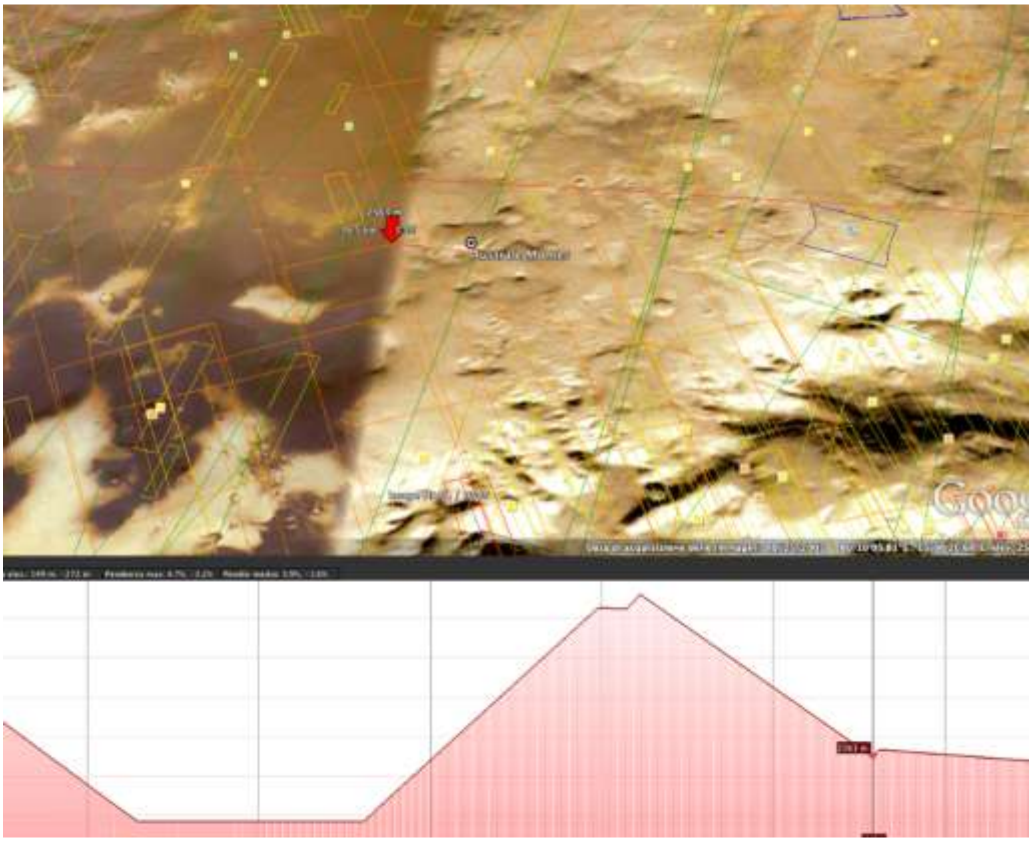

Figure 6 – Orography of the martian ground

The scaffolding roles of situated learning:

a.Scaffolding figures identified within the school staff and their professionalism:

Electronics teacher *Engineer, STEM teacher for the class involved in the experimentation.*	Electronics lab teacher *STEM teacher for the class involved in the experimentation.*	Mechanical technologies teacher *Engineer, STEM teacher for the class involved in the experimentation.*
Maintenance and technical assistance teacher. *Engineer, STEM teacher for the class involved in the experimentation.*	Technlogical lab teacher *STEM teacher for the class involved in the experimentation.*	Law teacher *Dealing with law and regulation about UAV's flight*
CAD Design teacher *Graphics teacher expert in CAD and 3D printing*	Maths teacher *STEM teacher for the class involved in the experimentation. Project manager*	ICT and systems & networks applications teacher *STEM teacher for the class involved in the experimentation.*

b. Scaffolding figures identified outside the school context:

- professionals of the P2 business partner Aerodron of Parma, by virtue of the following professionalism and technical skills

Founder & CEO of AERODRON. Electronical engineer, pilot	Sales manager and manager of public administration projects. Expert in technological innovation.	2 experienced UAV pilots, with a qualification recognized by ENAC. 1 pilot is also a geologist and an expert in photogrammetry and digital applications

P6 Centro Público Integrado de Formación Professional "Corona de Aragon", Zaragoza, Spain

https://www.cpicorona.es/web/

This is a VET institute that offers a professional two-year course as the last cycle of secondary education, accessible to secondary school graduates (aged 16 and over). The institute also welcomes workers who wish to retrain professionally or add / update their technical skills, in day or evening mode. CPIFP offers, among others, the following study addresses:

- Industrial Mechatronics
- Production planning in mechanical manufacturing
- Electrotechnical and automated systems
- Civil Construction
- Environmental Chemistry
-Industrial chemistry

The students of the Industrial Mechatronics course carried out configuration and programming of the static and flight parameters of the DJI drone through the NAZA M-V2 software. The correct functioning of the configured parameters was tested indoors through connection to the software installed on local laptops.

The learning setting of work based learning is documented with a self-produced video, publicly available on the official YouTube channel of the D.E.L.T.A. Project at the following address https://www.youtube.com/watch?v=CU93RgGyP38

Students involved:

About 20 students from the Course in Industrial Mechatronics and Mechanical Design

Duration of the design phase: 10 hours

Duration of the testing phase: 20 hours

Learning objectives

Professional Modules	**Didactic learning objectives**	**Output skills**	**Output skills (extracurricular)**
Electrical and electronic systems	- Identification of electronic-electrical elements in a machine, industrial equipment or automated line, describing the function they perform and their relationship with the other elements -Keep the power supply systems and the associated electronic automations, replacing the elements and verifying the operation of the installation	*[Practical form delivered in WBL mode]* System adjustment and commissioning. Operating parameters. Adjustment techniques. Adjustment of position and proximity sensors. Configuration of electronic automatisms in a machine or automated installation, adopting the most appropriate solution and respecting the established operating conditions	[Theoretical module] Analyze and use resources, such as installation and set-up of electronic devices on board; learning opportunities linked to the scientific, technological and organizational evolution of the sector and to information and communication technologies, to keep the spirit of updating and adapting to new work and personal situations

Organization of the learning environment according to the work-based-learning approach

Didactic methodologies % **Tools**	**Work – based learning setting**
Theoretical lessons 50% Laboratory 50% Technology & tools used: Different components of a drone and other equipment such as a voltmeter, an oscilloscope.	The experimentation took place within the study course module dedicated to the production and assembly of industrial components, in which students must develop mechanical maintenance skills. - Scaffolding: school systems are based on different industrial modules provided by teachers with heterogeneous skills. CPIFP to coordinate all the training organizes a weekly meeting with a teacher in charge of general coordination. - Relationships: students learn and need to work in groups. Teachers support and monitor the development of skills

The scaffolding roles of situated learning:

a.Scaffolding figures identified within the school staff and their professionalism:

A professor of mechanical and industrial engineering, expert coordinator of innovation projects and organization of work based learning sets, both in the upper secondary cycle and at the University of Zaragoza

CAD design expert teachers

Expert lecturer in 3D printing

Certified UAV pilot for vehicles up to 5 kg

b. Scaffolding figures identified outside the school context:

1 professional of the P7 business partner AITIIP of Zaragoza, with experience in co-designing learning environments that simulate industrial design in the automotive and aeronautical fields

1 tutor of the University of Zaragoza, expert in mechanical engineering projects and industrial applications, with experience in designing learning environments according to the work-based learning de approach by virtue of the following professionalism and technical skills

P8 Liceul Teoretic de Informatica "Grigore Moisil", Iasi, Romania

http://www.liis.ro/

It is a school of excellence in the field of technical studies in the field of information technology, systems engineering and programming. It is CISCO Academy's certified headquarters and every school year around a hundred graduates immediately enter the labor market of the Romanian Moldavian region, a constantly growing technological and IT hub.

Learning objectives

Being an institution that is highly specialized in computer science, LIIS does not offer within its educational program the disciplines related to electronics or automation systems. However, an afternoon club called "Eurodrone" was designed by the project team, which was configured as an optional extra-curricular activity, optional for interested students on a voluntary basis, to which around 30 students joined (with a fairly balanced proportion). between males and females).

LIIS is a theoretical high school and students present the following critical issues / areas of development:

Practical learning opportunities for building electronic circuits and devices.

get used to devices and technological tools to know how to use them

learn to read an electrical / electronic scheme

increase motivation in learning physics.

The extracurricular activity aims to promote students' intuition about electronics, starting from simple schemes to the more complex ones, such as those related to drone technology, in order to develop the following skills:

-Read an electrical / electronic scheme, use a measuring device, create a simple circuit, adapt electronic circuits to drone technology.
-Use simple measurement tools, skills developed during the Physics lessons. Identification of passive circuit elements (resistors, generators, connectors). Identification of active levels of circuits such as transistors, diodes, integrated circuits (elementary level).

The learning setting of work based learning is documented with a self-produced video, publicly available on the official YouTube channel of the D.E.L.T.A. Project at the following address https://www.youtube.com/watch?v=OMKNFCGOc7A

Students involved:
Approximately 30 students on a voluntary basis, generally selected among those most interested in exploring issues of industrial application, engineering and automotive, as well as 3D modeling

Duration of the design phase: 30h (6 weeks x 5h)
Duration of the testing phase: 30h (6 weeks x 5h)

b. Extra curricular knowledge and skills that contribute to the outgoing professional skills of students:

Subject	**Contents**	**Learning Objectives**
General electronics 15 hrs	- Elementary concepts of electronics - The tinning technique - Passive electronic components and components: applications - Electronic components and components: applications - Conventional signage used in electronics - Electronic scheme and its components - Auxiliary operations - Optoelectronic devices: applications - Integrated circuits: applications	Recognizing the parts used in electronic assemblies; Reproduction and definition of the characteristics of the pieces used; Classifying the pieces used according to the established criteria; Recognizing the characteristics of electronic circuits; Application of family relationships to perform simple calculations; Recognizing the devices, tools and materials used and how to use them
Drone's electronics	Practical realization of electronic	Identification of the electronic

10 hrs	drone assemblies Verification of assembly operation Repair of simple defects in electrical and electronic circuits Software products for educational purposes for the representation of electrical and electronic circuits	components necessary for electronic assembly; Control of the parameters of the parts using the measuring devices; Execution of the technological operations necessary to realize a connection according to the safety regulations at work; Identification and repair of simple failures of the assembled assemblies Verification of the performance of devices made with measuring and control devices Promote the image of the assemblies made and identify opportunities to capitalize on them
Software electronics 5 hrs	Software products for educational purposes for the representation of electrical and electronic circuits	Cooperate to conduct analysis of electronic schemes and selection of the parts needed for the drone circuit Working together for the efficient use of tools and materials Organize group work and perform tasks within the group

Organization of the learning environment according to the work-based-learning approach

Class	**Lab**	**WBL - support**
Theoretical lessons about physics and electronics (30%)	Physics Laba 30% Team work (pupil led)20 % Individual study 20% Technologies and tools used: Measurement and control tools Tools and devices used in drone assemblies	PhD Ing. Doru Cantemir, owner of P8 Ludor Engineering, expert in technological applications for educational and industrial purposes, 3D modeling, rapid prototyping and additive manufacturing

The scaffolding roles of situated learning:

a. scaffolding figures identified within the school staff and their professionalism:

1 teacher of English language, coordinator of the project and responsible for the pedagogical organization of the experimentation, implementation and verification of the learning objectives, as well as management of relations with the Coordinator P1 Cisita Parma for the monitoring of the project phases;

2 professors of Computer Science

1 IT lab technician

1 mathematics teacher

1 physics teacher

1 teacher of network and system engineering, CISCO / ORACLE instructor

1 professor of economics

b. Scaffolding figures identified outside the school context:

PhD Ing. Doru Cantemir, owner of P9 Ludor Engineering, expert in technological applications for educational and industrial purposes, 3D modeling, rapid prototyping and additive manufacturing.

Continental Corporation, multinational company with a plant in IASI: 1 company tutor

II.2 Physical products of the experimentation

IO3 consists of 3 distinct and complementary parts:

1)this document, which aims to provide guidelines for the replicability and transferability of the experimentation to another educational and training context, of any level, order and level

2) 6 videos documenting the work-based setting of the experimentation (2 videos for P5 Gadda and 1 video for each of the 4 VET school P3 Ferrari, P4 Berenini, P6 CPIFP and P8 LIIS), publicly available on the YouTube channel of the D.E.L.T.A. Project https://www.youtube.com/channel/UCoLeV-LZzAYRj7pr1wckprA

3) teaching materials useful for the replicability of experimentation such as presentations with technical specifications relating to the technologies adopted in IO3. The materials are publicly available at the shared link https://drive.google.com/open?id=1XeLrlmzIxC2uzl7vclCn77cr3jhwkqVo

In the folder called IO3 - Electronics you can find:

a. P4 Berenini's proposal for the implementation of the electronics program applied to drones

b. The proposal of P6 CPIFP for the implementation of the electronics program applied to drones

c. The proposal of P3 Ferrari for the implementation of the electronics program applied to drones

d. The .stl files for 3D design of the box and cover of the housing to be printed in 3D according to the approach of P5 Gadda

e. Source codes, .php files and .sql files for drone programming according to approach a)

Final note

The project resources can be consulted and downloaded free of charge at the following channels:

Official multilingual website of D.E.L.T.A. project:
www.deltaproject.net
(Resources available in Italian, English, Spanish, Romanian and Portuguese)

Official YouTube Channel of Delta Project, where it is possible to view 30 videos dedicated to the work-based learning setting: each of the 5 partner schools has self-produced a video documenting the laboratory and experiential environment in which the students have materially produced or designed and studied drone components , for each of the 5 Intellectual Outputs envisaged (P5 Gadda produced 2 videos * Output, for each of its two Fornovo and Langhirano locations.

Shared folder on su Google Drive belonging to D.E.L.T.A. project account deltaeuproject@gmail.com , from which it is possible to download the didactic materials for each Intellectual Output, designed for replicability and transferability, at the address https://drive.google.com/open?id=1XeLrlmzIxC2uzl7vclCn77cr3jhwkqVo

Institutional website of Cisita Parma scarl, Coordinator of D.E.L.T.A. project
https://www.cisita.parma.it/cisita/progetti-internazionali/progetto-eramus-ka2-delta/
(Resources available in Italian, English, Spanish, Romanian and Portuguese)

National and international public repositories for OER – Open Educational Resources sharing:

OER Commons, digital library in English dedicated specifically to Open Educational Resources https://www.oercommons.org/

TES, British portal for free sharing of multidisciplinary teaching material, https://www.tes.com/

Alexandrianet, italiano portal for free sharing of multidisciplinary teaching material, http://www.alexandrianet.it/htdocs/

Further social updates are published onto:

Official D.E.L.T.A. project Facebook page @deltaeuproject https://www.facebook.com/deltaeuproject/

Institutional digital channels of the Coordinatore Cisita Parma scarl:

Facebook https://www.facebook.com/CisitaPr/

Twitter https://twitter.com/CisitaPr

LinkedIn https://www.linkedin.com/company/cisita-parma-srl/