D.E.L.T.A.

Drones:

Experiential Learning and new Training Assets

Intellectual Output 2

ICT 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	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 **OUTPUT LEADER**	**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

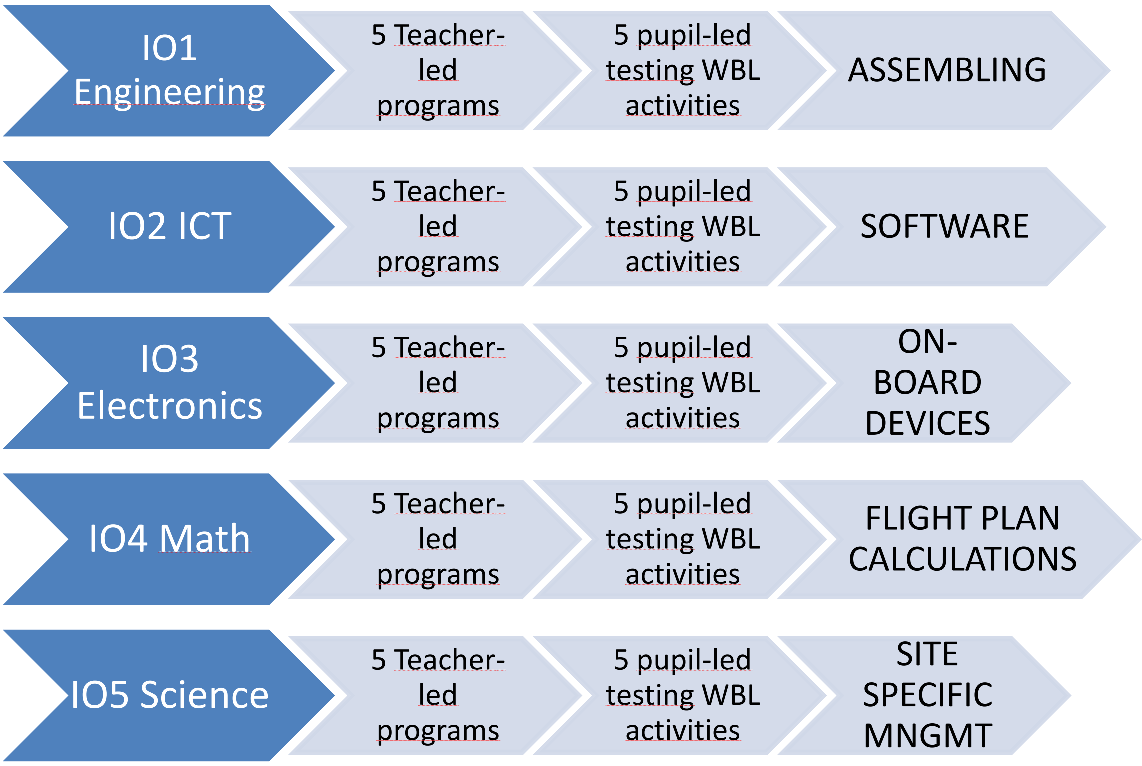


Figure 1 - D.E.L.T.A. project general structure

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.

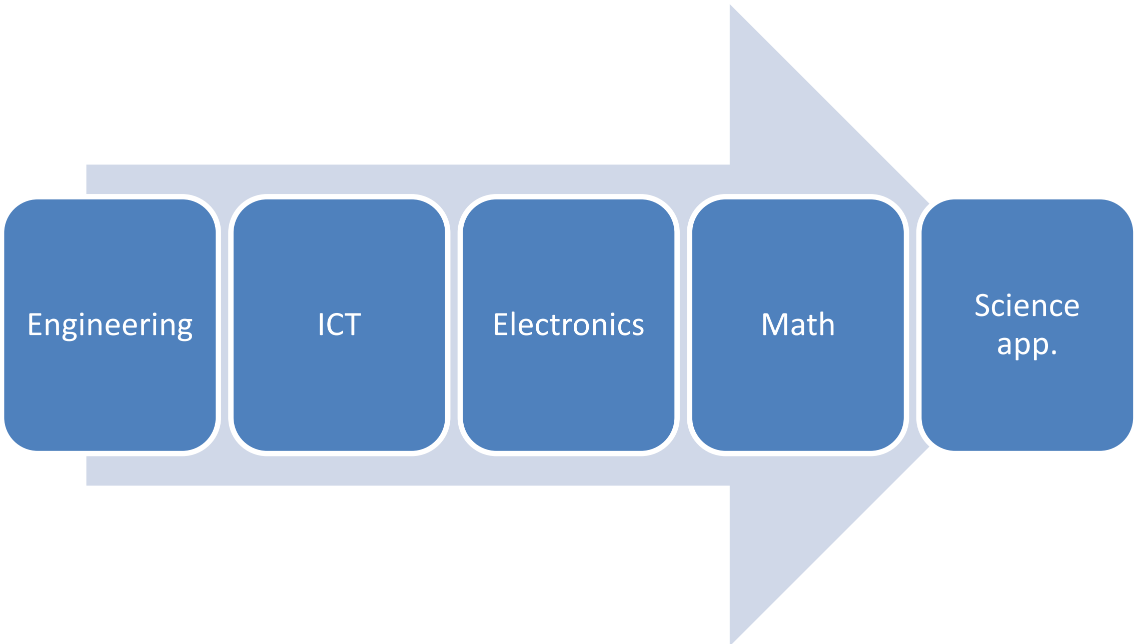


Figure 2 – The industrialization process of an inoffensive drone

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.

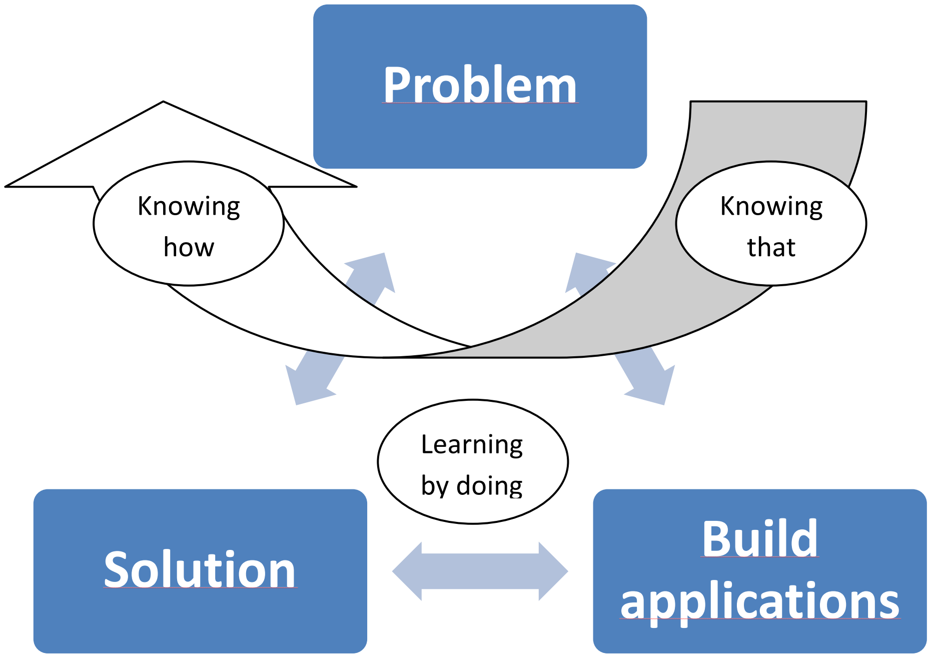


Figure 3 –Application scheme of the Work Based Learning didactic methodology

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).

The Output consists of a set available for reuse, released in OER (Open Educational Resource) mode, of educational experiments related to the drone flight software programming operations, or alternatively, applications for ground data management collected by a 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 computer science, programming and 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.

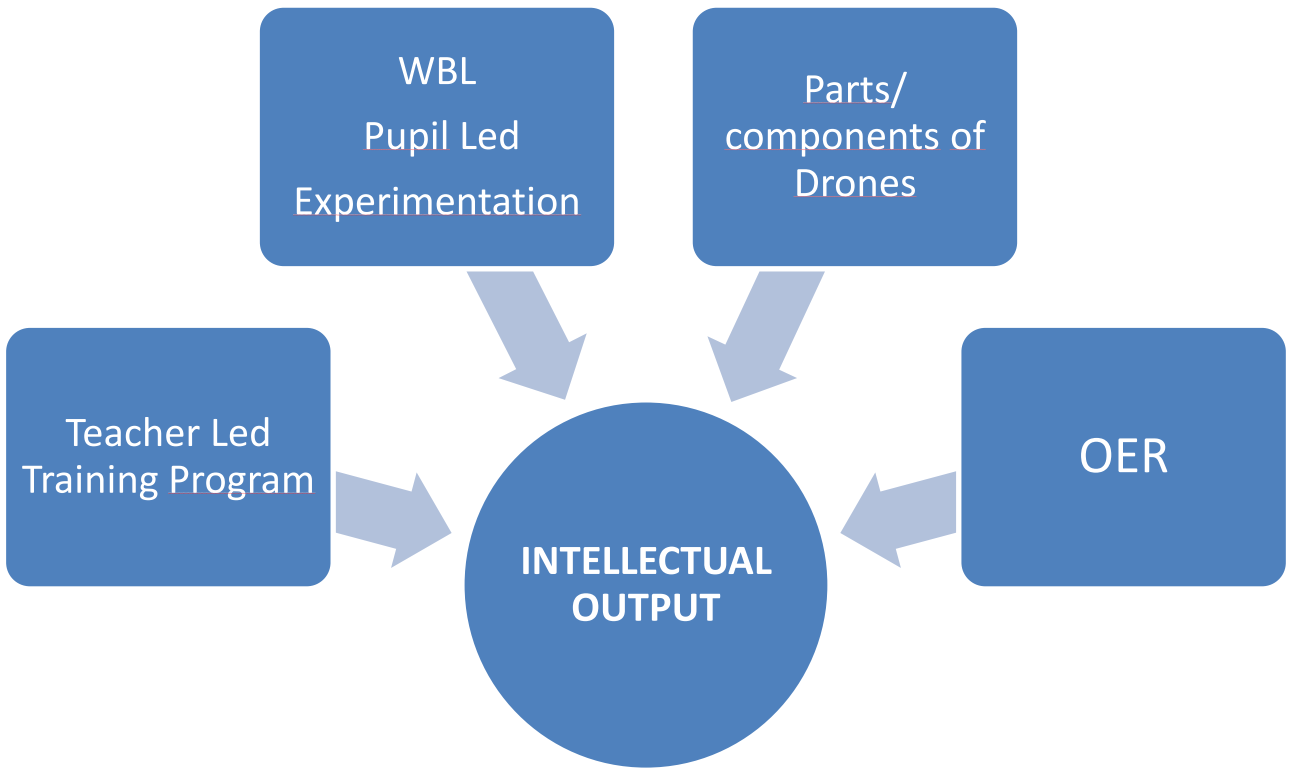


Figura 4 – Structure of the Intellectual Output

Intellectual Output 2 consists of three distinct operational phases: Design - Test - Release, each identified on the basis of the key target groups, the organized educational and pedagogical environments, the technologies adopted and the activities actually performed. Leader of Output 2 is identified in P8 LIIS - Liceul Teoretic de Informatica "Grigore Moisil" of Iasi, Romania, an institute of excellence in the field of programming, computer science, computer, digital and system applications.

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.

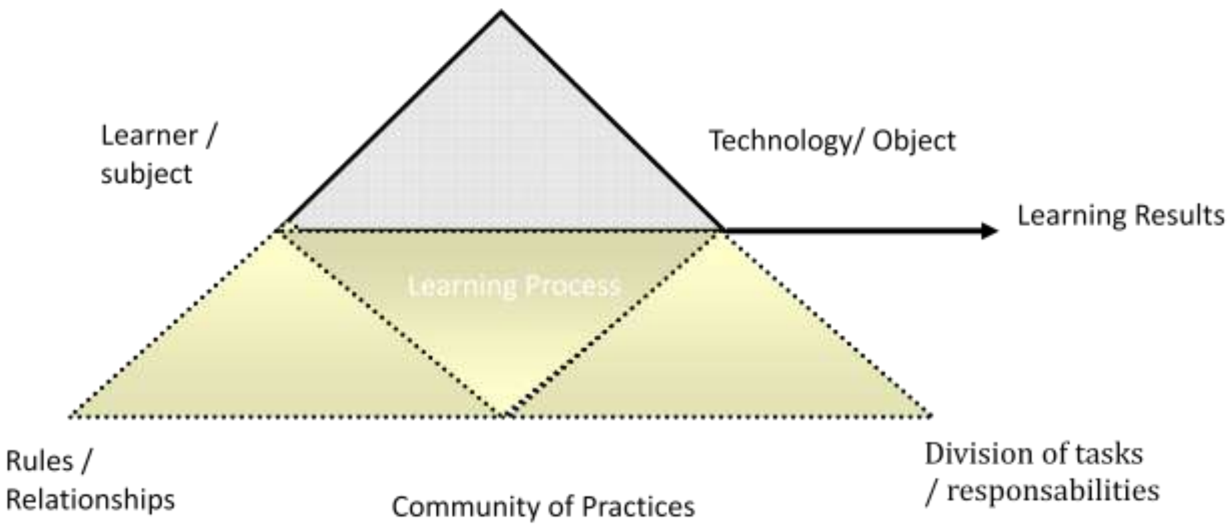


Figure 5 – Grafic representation of the activity theory by Y. Engestrom

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 ICT programme 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

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.

Because of its role as Output Leader, as well as the specific IT and system skills of the teaching staff, and the high specialization of curriculum programs, the P8 LIIS team designed and shared its own approach to IO2, proposing to address the issue application of ICT disciplines to drones by developing an image and data processing application. For example, the scenario was hypothesized in which a camera or video camera mounted on a drone in flight would photograph or film the image of a school wall in which there is a crack, perhaps at a high height or dimensions not easily detectable by the naked eye.

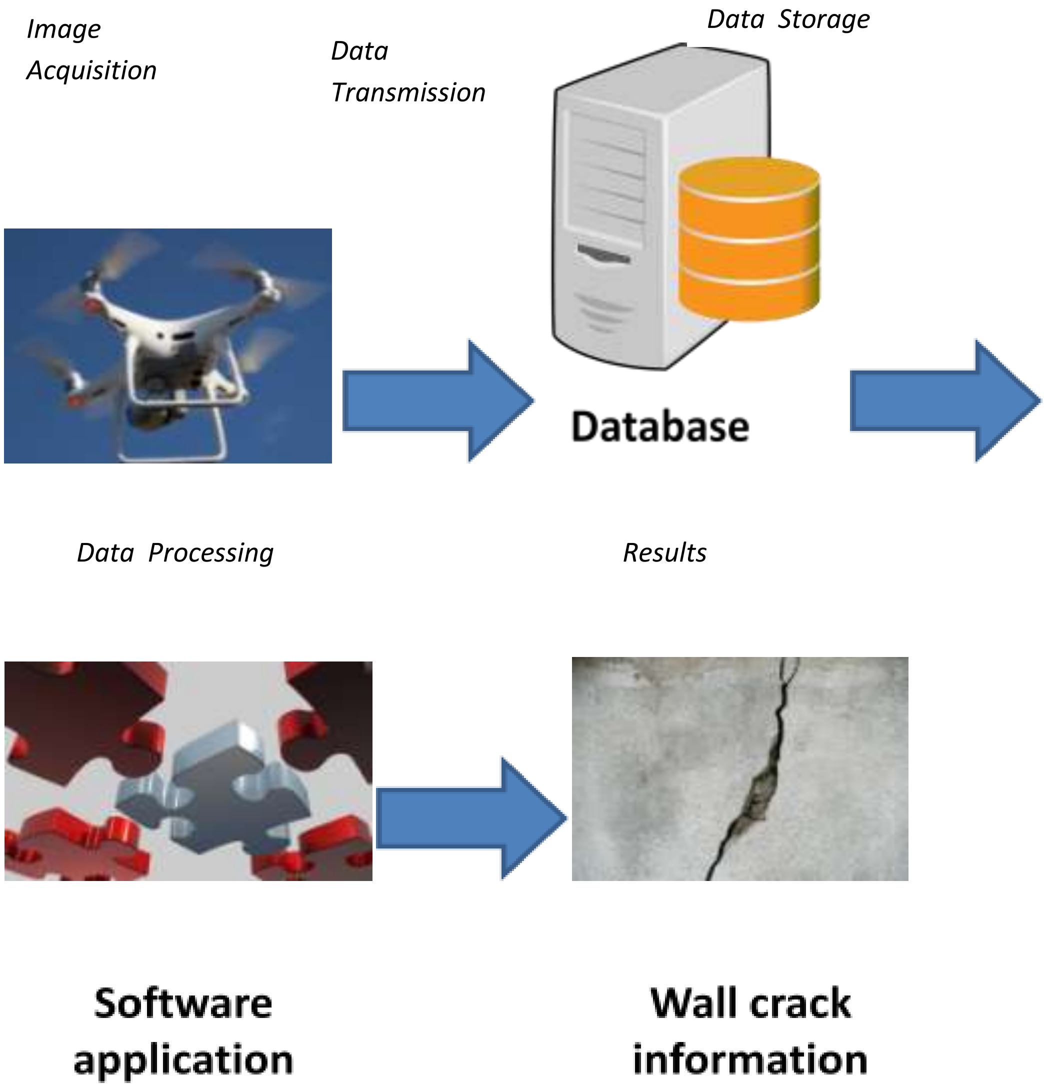
P8 LIIS has made itself available to all partner schools by offering its technical teaching support as well as two different ways of approaching the problem:

#Approach 1:

High level of theoretical input skills

High level of work based learning

High level of complexity



#Approach 2:

Lower level of theoretical input skills

Work based learning accessible at low threshold

Lower level of complexity

Database with sets of visual data

Software application developed by LIIS

Wall crack information

#Tools and Equipment

Drone with camera and US sensor

Open Source Software

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=akEPUeB7uSc

Students involved:

About 30 students attending the upper three-year course in programming and 3D modeling

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

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

Learning objectives

a.Didactic learning ojectives related to curricular STEM subjects:

Computer Science	Drone programming (settings, initialization, identification of referencing points, geolocation, balance of the drone) Process images in real time on the server Processing / querying and interpreting large databases Program the server-drone communication interface
Systems & data networks	Image storage on server Using efficiently the memory Creating a database (search ID)
Maths	Creation of algorithms for the software 3D identification of the drone flight path

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

Computer Science	Software LIBRE PILOT GCS, PHP 7.1 , Laravel 5.5, HTML5 Javascript CSS3, Bootstrap 3.4, MySQL
Systems & data networks	Image storage on server Processing images Applications Software of mathematical concepts (different types of spatial coordinates.
Mathematics	Cartesian and3D polar coordinates e 3Dpolari applied to points cloud GIS (geographic informational system)
Special needs students	Analysis of the server who hosts the images (open source

	program)
English	Drone related terminology

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

Class	**Lab**	**WBL @ P9 Ludor Engineering University of IASI, Faculty of Mechanical Engineering Continental Corporation, IASI**
Theoretical lessons of Computer Science, Systems & Data Networks, Mathematics. Drone technology (PHP, Arduino, CSS, MySQL): theoretical notions	Laboratory activities: data preparation. LIBRE PILOT GCS processing software: - Setting parameters / usage / control of the drone - driving and manipulating the drone - Theoretical and practical notions: Raspberry PI - Introduction to Laravel 5.5, HTML5 CSS3, Javascript, PHP - Introduction to Bootstrap 3.4, MySQL	- P8 Ludor Engineering, owner: lesson on drone technology, national and European laws and regulations, induced by the sector industry - University of Iasi, Faculty of Mechanical Engineering: supply of workshops for students on programming and driving a drone, also through demonstration flights - Continental Corp. has created an ARDUINO / Raspberry PI plate platform and guided students in processing images to identify structural defects on school walls (cracks)
English (non-STEM extension)	Drone related terminology	

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, a multi-nation automotive company based in IASI: 1 company tutor

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

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 team chose to carry out the program by focusing on the configuration and basic programming of the drone, setting and adjusting the parameters of flight, stabilization and connection of the brushless motors, as well as the setting of the video channel. Arduino technology was used on open source software to try to write an engine management program (engine management program). The parameters have been tested in a first time connect the drone to the ignition program installed on the PC. Subsequently, the team of students attempted to launch the drone but the experiment ended in failure (the drone overturned). Problems in the management of the rotor have therefore been found, highlighting the need for further refinement of the programming and configuration system.

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 to the following address https://www.youtube.com/watch?v=XokBToVEhAc

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

Knowing the basic concepts of statics; Knowing how to apply the theoretical principles in the study of simple motor machines; Knowing the main operating characteristics of electronic components; Knowing in principle the command and control methods of the various converters; Knowing the different interface conditions; Knowing the main operating characteristics of the various types of sensors; Knowing in principle the command and control methods of the various sensors; Knowing the different methods of information transmission; Knowing the main operating characteristics of the transmission; Knowing the difference between unidirectional and bidirectional signals; Knowing the difference between digital and analog signals.

Capacity

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

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; Drones and Safety; ENAC regulation; Air spaces and airspace classes; Responsible flying: areas where flight is not allowed.

Capacity

Electronic programming of a microcontroller using the Arduino platform;
Forced flight termination system; Balance the propellers; 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

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 chosen to introduce its students to the basics of scratch programming using Tynker, a free visual coding language for educational purposes, which allows you to set the drone's parameters and flight path. For the experimentation the MiniParrot drone Mambo was used, particularly light and manageable and of reduced complexity in terms of mechanics and electronic components. Flight programming and management operations can be performed directly from the Tynker control panel without using a remote controller. 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=17mQQLCLN-M

Students involved:

n 20/25 students of the Technical Electronic and Automation (class IV)

Duration of the design phase: approximately 10 hours

Duration of the testing phase: about 20 hours

Learning objectives:

Curricular learning objectives:

Computer Science & Computer Science	Basics of scratch programming Basics of visual programming Use of software and programming languages for automation
Electronics	Robotics bases Bases of automation circuits
Teaching for special needs	Visual programming and for minimum objectives Insertion of the learner in a collaborative and experiential work group

Extracurricular learning objectives

IT and Electronics	Configuration and installation of additional components of the Drone: Low resolution camera Bluetooth functionality Ultrasonic sensor for remote sensing Ultrasonic sensor for automatic height detection Cannon installation, mechanical arm

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

The activity was entirely set according to the logic of Work Based Learning. There were no classroom phases, given that the delivery entrusted to the group of learners concerned:

- the familiarization of learners with the development environment in scratch
- familiarization with the Tynker software interface
- collaborative learning and experimentation organization
- programming of the flight path of the 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

P5 IISS "C.E. Gadda", Fornovo T. – Langhirano (Parma), Italia

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.

1) Headquartes of Fornovo T., project manager Prof. Luciano Amadasi

Reconstruction of a 3D model from photographs taken by a camera on board a drone. An ancient mansion located in Fornovo Taro, Parma, called "Villa Carona", was used as a model.

Through the digital processing of the image set by means of 3D processing software, such as 3D Zephyr which also releases a free version for educational purposes, it is possible to reconstruct both the flight path of the drone through the point cloud, and to elaborate a model three-dimensional of Villa Carona, observable through Oculus Rift technology. As a complement to the activities, the physical model of Villa Carona was manufactured using 3D printing.

The three-dimensional model of reconstruction of Villa Carona obtained through the revision of the 3D Zephyr software 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=Z4n4ri_i41s

2) Extraction of drone flight data (altitude, flight speed, flight distance, flight time ...) by processing and querying the system LOG FILE. Through the use of basic programming skills in C, and thanks to the adoption of an open source IDE (integrated development environment) such as Code Blocks, the students have obtained useful information for the data handling of the drone.

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=jblqOojILUk

Students involved:

Fornovo site: 20 students of the IT technical course (IT and Telecommunications)

Langhirano site: 20 students of the IT technical course (IT and Telecommunications)

Duration of the design phase: approximately 30 hours

Duration of the testing phase: about 60 hours

Learning objectives:

Curricular learning objectives:

ICT	Processing extended databases Programming skills in C language
Systems and Networks	Sizing of a core memory Rendering of a virtual model 3D printing
Mathematics	3D space
Special needs didactics	3D printing Oculus Rift

Extracurricular learning objectives:

ICT	Software 3DF-ZEPHYR. Points cloud and processing large databases.
Systems & networks	Fitting a core memory with particular reference to 3DF-ZEPHYR. Software applications to represent mathematical concepts (different types of spatial coordinates). Modeling and 3D printing of a three-dimensional sample obtained from images processed with the 3D Zephyr software
Mathematics	Cartesian and polar three-dimensional co-ordinates applied to the point cloud.
Special needs didactics	Observation of the 3D representation of Villa Carona through the Oculus Rift tool. The observer moves along a virtual trajectory acquired through the 3D Zephyr software
English (non STEM extension)	Drones related terminology
History (non STEM extension)	Brief mention of historical events related to Villa Carona

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

1. <u>Reconstruction of a 3D model of Villa Carona</u>

In Class	In Lab WBL	WBL Further details
Theoretical computer science lessons, Networks and systems, Data processing, Mathematics.	Laboratory activity on data preparation. Process data with 3D Zephyr: extract a dense point cloud, a mesh, generate the texture and the animator panel of the key points of the mesh. Use of the CURA software for 3D modeling and printing of the Villa Carona physical model. Using the Oculus Rift for display operations.	P2 Aerodron instructs students on drone technology, legislative and regulatory aspects. The pilots of P2 Aerodron conduct a demonstration flight with different types of drones (quadricottero, esacottero, e-bee). The pilots of P2 Aerodron also taking some pictures by flying the drone over the roof of Villa Carona.
History (non STEM extension) Short mention of historical events related to the events of	Search for historical documents in municipal archives	

Villa Carona	

2. <u>Data Extraction from the drone's LOG File</u>

WBL setting: Computer lab equipped with Laptop with C compiler + APM with log data

Initial explanation of the concept and type of LOG files

Tutorials on small files

Explanation on the structure of the LOG file

Capture flight log file from APM

Choice of data to be analyzed

Data analysis

Programming: coding blocks to extract and summarize the data from the LOG file

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

- A professional from 3D ArcheoLab in Parma, organization that deals with digital technologies (surveys, modeling and 3D printing) for the reconstruction of the artistic and cultural, architectural and museum heritage.

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

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 by connecting to the software installed on a local PC.

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: 40 hours

Duration of the testing phase: 60 hours

Learning objectives

Professional modules	**Didactic learning objectives**	**Output (skills)**	**Output skills (extracurricular)**
System integration	Supervision or execution of the commissioning of the plants, adjustment of the parameters and execution of the necessary tests and verifications, both functional and regulatory	*[Practical module delivered in WBL mode]* 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 the resources and learning opportunities related to the scientific, technological and organizational evolution of the sector and to information and communication technologies, to maintain the spirit of updating and adapting to new work and personal situations
Configuring Mechatronic Systems	Obtain the data needed to plan the assembly and maintenance of mechatronic systems	*[Integrated theory / WBL module]* Determination of the characteristics of mechatronic	*[Modulo pratico erogato in modalità WBL]* Configurazione di sistemi meccatronici industriali,

		systems or of modifications to be made, analysis of requirements and design conditions	selezionando l'attrezzatura e i componenti che li costituiscono
	Programming of automatic systems, verification of operating parameters and system safety, following the procedures established in each case	*[Integrated theory / WBL module]* Setting up system budgets or changes, using computer applications and database prices	*[Integrated theory / WBL module]* Application of communication strategies and techniques, adaptation to the contents to be transmitted, to the purpose and characteristics of the recipients, to ensure efficiency in the communication processes

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

II. 2 Physical products of the experimentation

IO2 consists of 3 distinct and complementary partes:

1) this document, which aims at providing 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 IO2. The materials are publicly available at the shared link https://drive.google.com/open?id=1XeLrlmzIxC2uzl7vclCn77cr3jhwkqVo

In the folder named IO2 - ICT it is possible to find:

to. The proposal of P9 Ludor Engineering for the implementation of the ICT program applied to drones, as developed by P8 LIIS

b. P2 Aerodron guidelines for drone hardware and software configuration

c. P6 CPIFP's approach to drone programming

d. P4 Berenini's approach to drone programming

is. The drone LOG files and the C ++ programming files according to the P5 Gadda approach

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

Final note

The Intellectual Outputs and the results of the project are released according to the international license Creative Commons Share Alike 4.0. The products are available for reuse, transfer and modification through adaptation, in the form of an Open Teaching Resource (OER - Open Educational Resources): any user interested in OER can download, modify and disseminate the Intellectual Output for non-commercial purposes, provided that credit is given to the author Cisita Parma scarl and provided that the new OER is shared according to the same license terms.

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/