D.E.L.T.A.

Drones:

Experiential Learning and new Training Assets

Intellectual Output 4

DELTA DRONES

Experiential Learning and new Training Assets

MATHEMATICAL PROGRAMME

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Partners' List

NO.	PARTNER	SHORT NAME	COUNTRY
P1 - COORDINATORE	**CISITA PARMA Scarl**	CISITA	Italy
P2	Aerodron Srl	Aerodron	Italy
P3	IIS "A. Ferrari"	Ferrari	Italy
P4 LEADER DI OUTPUT	IISS "A. Berenini"	Berenini	Italy
P5 OUTPUT LEADER	**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

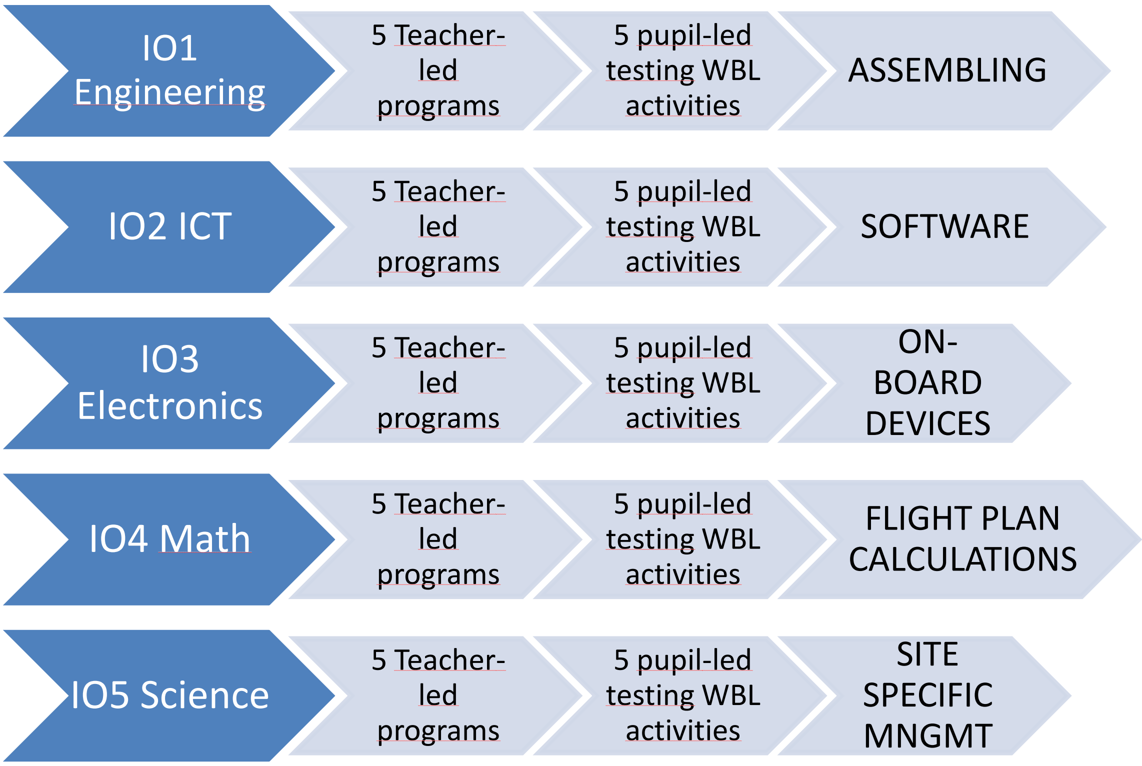


Figure 1 – General structure of D.E.L.T.A. project

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.

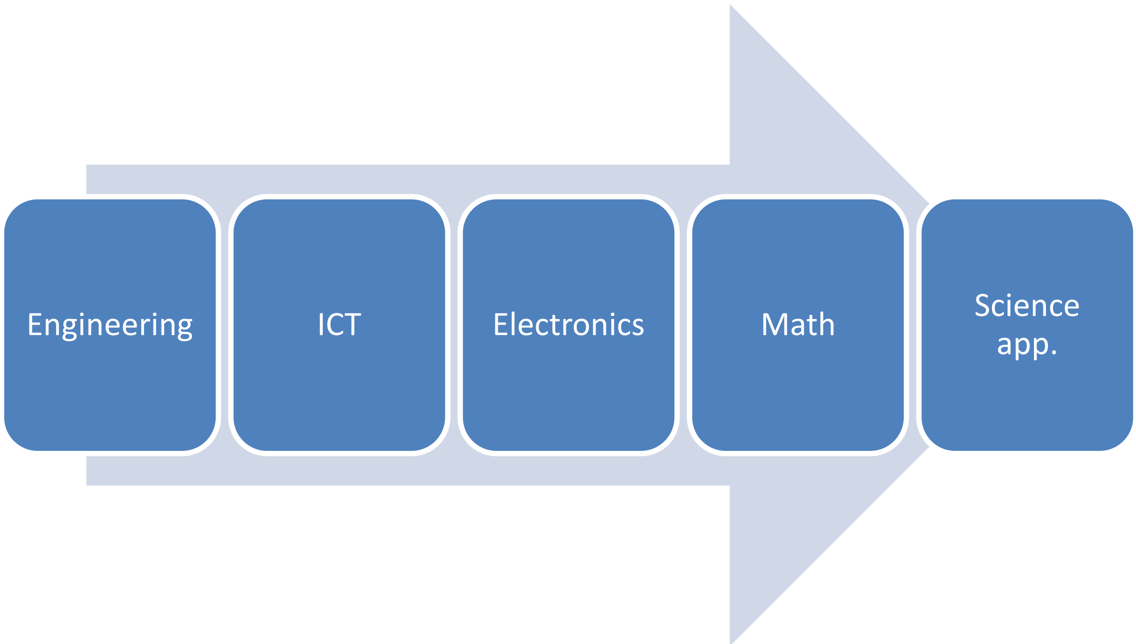


Figure 2 – The process of industrialization of an inoffensive drone

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.

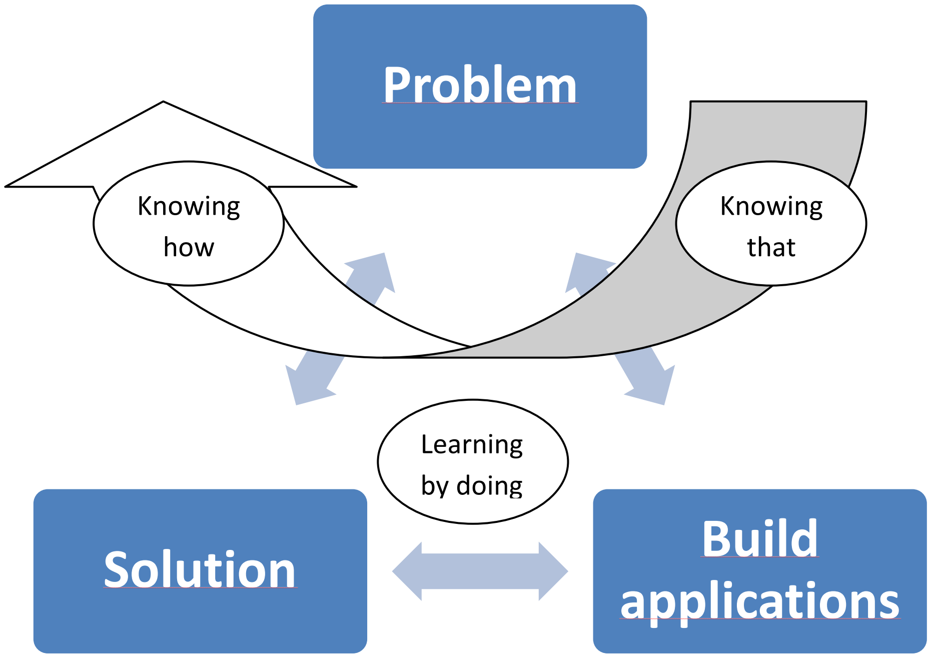


Figure 3 –Application scheme of Work Based Learning didactic methodology

The students, organized in work groups that identify an 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), educational experiments related to the preparation of the flight plan and systems for managing the landing phases of a drone, including also calculation activities for take-off, remote driving, route control, organized according to the logic of work-based learning in a simulation context of the company production department.

The activities of the Intellectual Output are substantiated in a teacher-led educational program, related to the subjects of theoretical and applied mathematical area, 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.

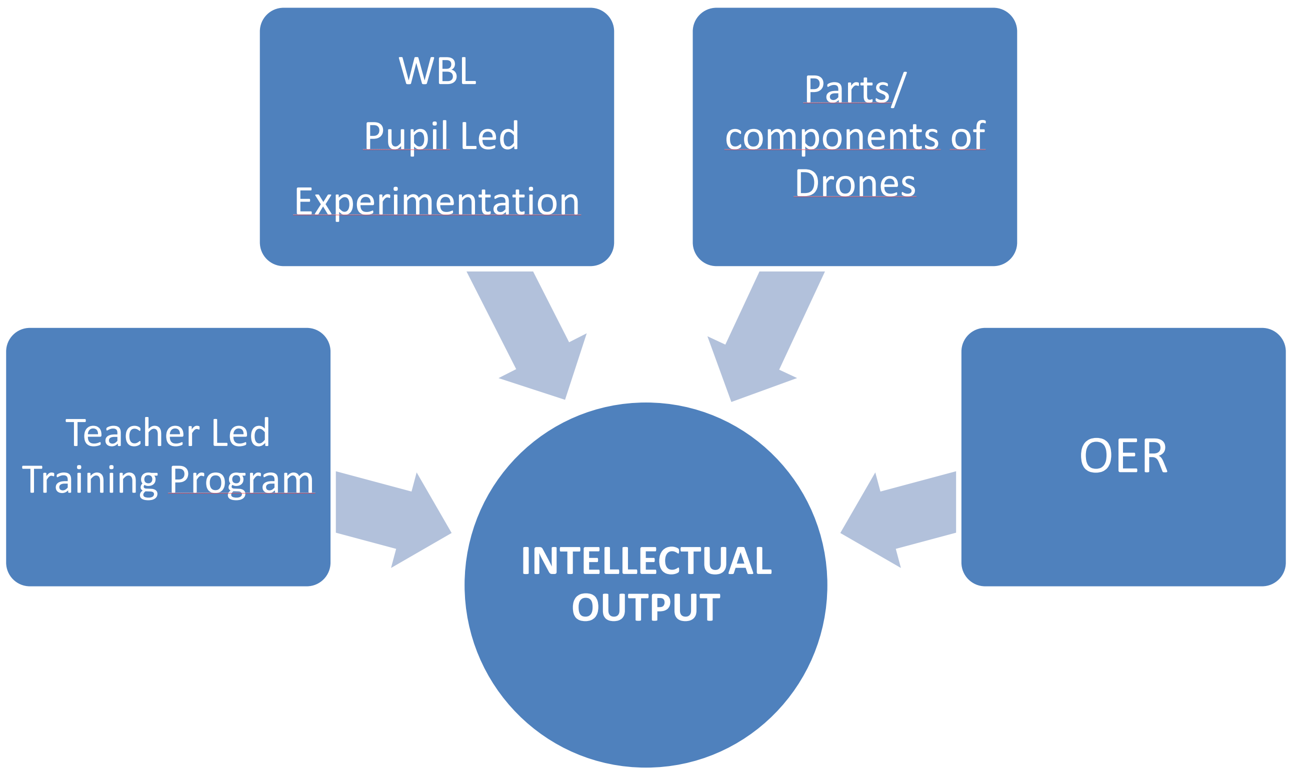


Figura 4 – Structure of the Intellectual Output

Intellectual Output 4 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. Output Leader 4 is identified in P5 IISS C.E. Gadda di Fornovo-Langhirano (PR), thanks to the specialization of the team leader Prof. Luciano Amadasi, holder of the chair of Mathematics, graduated in Physics, with 30 years of teaching and teaching experience.

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.

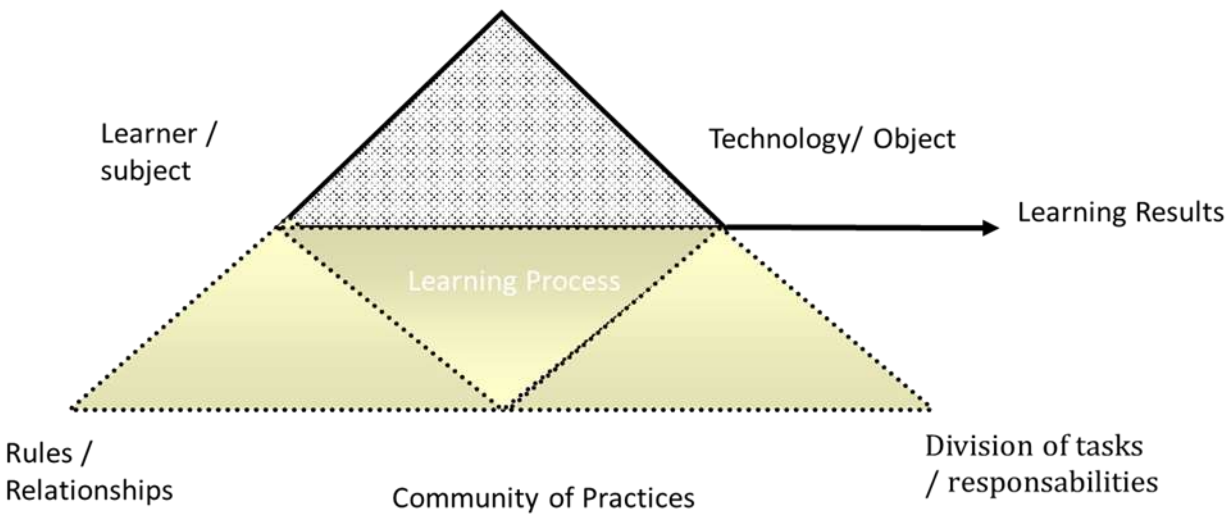


Figure 5 – Grafic representation of the activity theory by Y. Engestrom

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 MATHEMATICAL 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

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

http://www.itsosgadda.it/

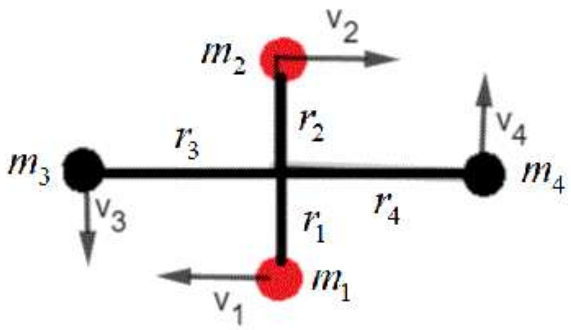
It is a school with two branches, with both VET (Computer Technician, Economic Technician and professional diploma in Maintenance and Technical Assistance) study addresses and high school students (Scientific Applied Sciences option, both four-year and five-year).

Both branches worked on the project, with two different approaches complementary to each other.

Output Leader 4 is identified in P5 IISS C.E. Gadda di Fornovo-Langhirano (PR), thanks to the specialization of the team leader Prof. Luciano Amadasi, holder of the chair of Mathematics, graduated in Physics, with 30 years of teaching and teaching experience.

P5 Gadda, suggested to the other partner schools a series of different approaches for the treatment of the curricular subject of mathematics applied to drones. Each approach has been designed to be integrated and exploited with the logic of work-based learning, with different degrees of difficulty, complexity of theoretical aspects or practical technologies according to the target students that each Institute intends to involve.

#Approach 1

Topic: drone technology and angular momentum conservation level of WBL: ↔	Starting from the theorem of conservation of classical physics, it is possible to introduce a rather simple mathematical argument: the first degree equation or a more complex treatment of the vector-related problem. Consider the following model: a single helix connected to a symmetrical frame; $m_{1,2}$ are the masses of each blade placed in the corresponding center of gravity; $v_{1,2}$ the speed vectors of the blades; in the same way $m_{3,4}$ and $v_{3,4}$ are the masses and velocity vectors of the ends of the frame.  Simpler Handling: $P_{\text{starting}} = 0$ $P_{\text{final}} = -m_1 v_1 r_1 - m_2 v_2 r_2 + m_3 v_3 r_3 + m_4 v_4 r_4$ Vector Handling:

	$$\vec{P}_{\text{starting}} = 0$$ $$\vec{P}_{\text{final}} = \sum m_i \vec{r}_i \times \vec{v}_i$$ From the conservation law: $P_{\text{final}} = P_{\text{starting}}$ ... From this simple calculation it is possible to calculate $v_{3,4}$ and understand why most drones have a number of pairs of propellers. The impossibility of a single helix drone occurs naturally. An interesting, though not easy, argument is the operation of a drone with an odd number of propellers.

#Approach 2:

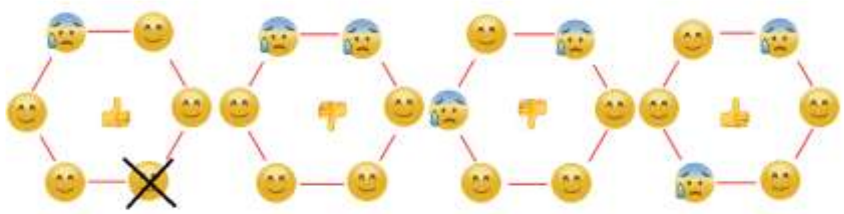
Topic: Diagnostics related to drone's technology Theoretical topic	The probability of obtaining the perfect functioning of a single component of a system as a function of time is called Reliability. According to the Poisson distribution law: $R(t) = e^{-\lambda\tau}$ where *t* is the time of functioning and λ id the failure probability. The failure probability of a component of a *t* function is: $P(t) = 1 - R(t)$ (complementary events). The reliability of the complete set of propellers of an n-copter provided that the failure of only one of them causes the breakdown of the entire system (non-redundant system) is: $R(t) = e^{-n\lambda\tau}$ or, in the case of different essential components: $R(t) = e^{-\Sigma\lambda i\tau}$

	A system in which the error of one component does not cause its complete failure is defined as redundant. The reliability of a redundant system (in which the break occurs only when each component does not work) is: $R(t) = 1 - \Pi(1- e^{-\lambda i \tau})$

Approach 3

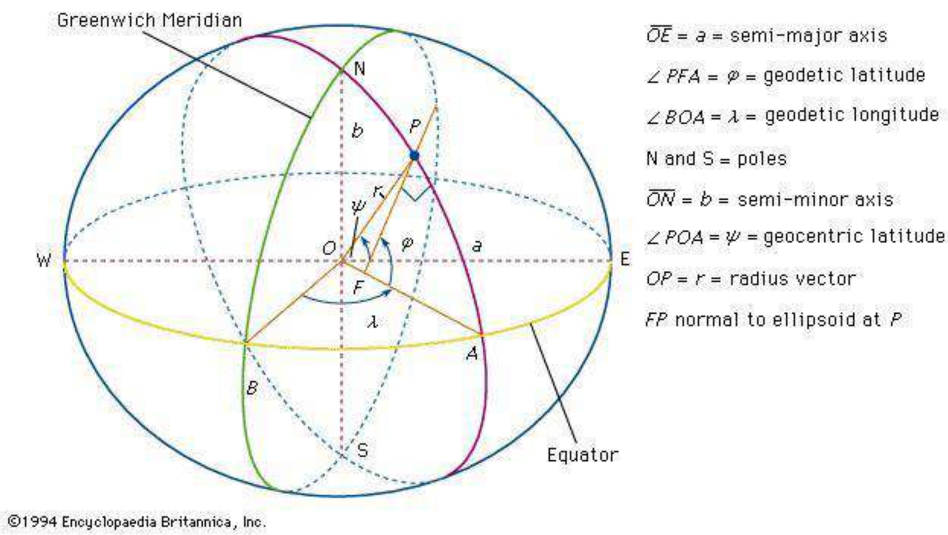
Topic	DIRECT COMPUTATION OF THE FAILURE PROBABILITY OF A BRUSHLESS ENGINE
Diagnostics related to drones technology	- Prepare a series of propellers with an automatic continuous on / off system. - Identify the operating time of each motor.
Example n 1	- Computation of the probability of failure λ
Level of WBL: ↑	Documentation https://sciencing.com/calculate-failure-rates-6403358.html 

Approccio #4

Topic	THE ESPONENTIAL FUNCTION
Diagnostics related to drones technology	Starting from the fundamental law R (t) = and –λτ it is possible: - Investigate the exponential function (plot function, monotony, R (0), lim R (t), concrete meaning of each point). - Compute the reliability and probability of failure of the set of propellers of an n-cottero. - Compute the operating time of the set of helices of an n-cotter in which the law R (t)> = α (exponential equations and inequalities) exists. Another interesting problem, although not easy, can be the following: Calculate the reliability function of the set of helices of an hexacopter on condition that the failure of the system occurs with the failure of two helices as shown below or with the failure of more than two helices (probability theory, combinational calculus ...) 
Example n 2 Level of WBL: ↓	

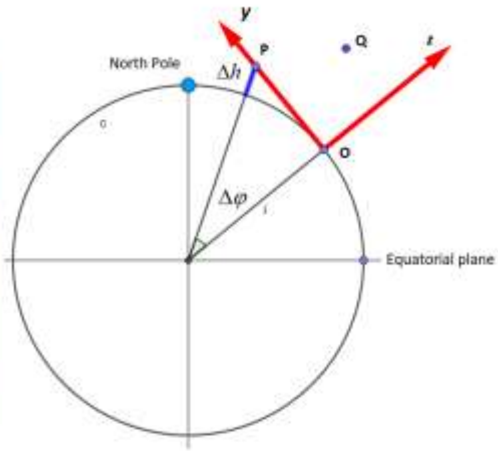
Approach # 5

Topic:	GEOLOCALIZATION
GPS & WGS84	Prerequisites: 3D cartesian coordinates. Theory of conic sections

Theoretic topic	Trigonometry Meaning of the acronyms: GPS ↔ Global Positioning System, WGS84 ↔ World Geodetic System. 

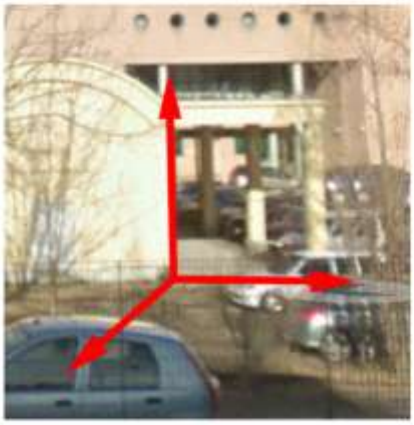
Approach #6

Topic: GPS and WGS84 Example 1 Level of WBL: ↑	CONVERTING LOCAL COORDINATES IN GPS COORDINATES - Approximation • Establishing a three-dimensional XYZ structure in the school yard or gym according to the following criteria: x : East, y: North, z: local direction "up" • Approximation of the ellipsoid to a sphere identified in the local space - Select a set of points in the surrounding space - Convert the local coordinates of the points into GPS coordinates

	-Check the correctness of the calculations by means of a smartphone  

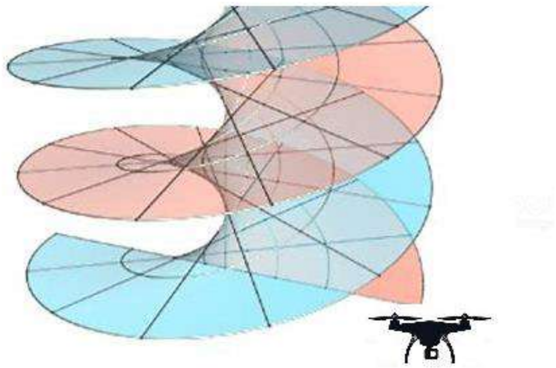
Approach #7

Topic:	CONVERTING LOCAL COORDINATES IN GPS COORDINATES - Exact method
GPS & WGS84	• Establish a three-dimensional XYZ structure in the school yard or gym according to the following criteria:
Example 2	x : East, y : North, z : local direction "up"
Level of WBL: ↑	
	• Approximation of the ellipsoid to a sphere identified in the local space - Select a set of points in the surrounding space - Convert the local coordinates of the points into GPS coordinates -Check the correctness of the calculations by means of a smartphone

	$\begin{bmatrix} e \\ n \\ h \end{bmatrix} = \mathbf{R}(\varphi,\omega) \begin{bmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{bmatrix}$ $X = X_0 + \Delta X$ $Y = Y_0 + \Delta Y$ $Z = Z_0 + \Delta Z$ $\begin{bmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{bmatrix} = \mathbf{R}^{-1}(\varphi,\omega) \begin{bmatrix} e \\ n \\ h \end{bmatrix}$ $\mathbf{R}^{-1}(\varphi, \omega) = \mathbf{R}^{T}(\varphi, \omega)$ $\mathbf{R}^{T}(\varphi, \omega) = \begin{bmatrix} -sen\omega & -sen\varphi\cos\omega & \cos\varphi\cos\omega \\ \cos\omega & -sen\varphi sen\omega & \cos\varphi sen\omega \\ 0 & \cos\varphi & sen\varphi \end{bmatrix}$ 

Approach #8

Topic:	TRAJECTORIES & FUNCTIONS
	preconditions:
GPS and WGS84	- Convert the coordinates (see previous example).
	- Theory of functions
Example 3	Fly the drone along some specific mathematical trajectories.
WBL content: ↑	Example:
	x(t) = t (straight line)
	y(t) = 0
	z(t) = t + 1
	x(t) = 0 (sinusoid)
	y(t) = t
	z(t) = 2+ sin(t)
	x(t) = t+q (on a plane surface)
	y(t) = t-q

	$z(t) = 2t + 3$ $x(t) = r\cos t$ $y(t) = r\sin t$ (helicoid) $z(t) = \alpha t$ 

Starting from these possibilities, the Fornovo team chose to work on the 5-6-7 approach, applying a degree of theoretical complexity and work-based integration gradually increasing the familiarization of the students involved with the technology. of drones. The theme chosen by the Fornovo headquarters team was the planning of a drone's orbit according to curves in three-dimensional space, accompanied by GPS geolocation operations.

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=TA8XUf1SOL4

The team at the Langhirano site instead focused on approach 3, calculating the failure probability rate of one of the n-cottero brushless motors thanks to activities with a high component of work-based learning.

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=9MWA61weoYg

Students involved:

Fornovo headquarters: 15 students from the Bachelor Study course in Applied Sciences

Langhirano headquarters: 15 students of the VET course in Maintenance and Technical Assistance

Duration of the design phase: approximately 20 hours

Duration of the testing phase: about 30 hours

Learning objectives:

The learning objectives were chosen within the curriculum programs of the STEM disciplines related to the addresses of the Liceo Scientifico Option Applied Sciences and the Professional Institute of Maintenance and Technical Assistance. For each subject, information is provided on the teaching methods (frontal lesson, laboratory, WBL).

Main critical issues in learning: - curricular mathematics - applied mathematics - other STEM disciplines (Sciences, Computer Science)	Mathematics Applying theoretical knowledge to real situations.
	Sciences: Getting used to using the potential that modern technology offers for study and the terrestrial environment.
	ICT: Getting used to using programs that have a directly verifiable application value.
Entry prerequisites	Mathematics: algebraic calculus, goniometry, analytic geometry of the plane, conics.
	Sciences: basic concepts related to the earth's surface
	ICT: basics of imperative programming in C language
Curricular learning objectives	Mathematics

	Studying the GPS geolocation system (WPS84); Applying the knowledge of analytical geometry and trigonometry to the concrete case of the spatial coordinates of points on our planet; Transforming the coordinates of a local reference system into GPS coordinates; Planning the flight of the drone so that the trajectory follows a given equation curve.
	Science: Google Earth exercise about geolocalization
	ICT: Transforming the coordinates from a local reference system to the WPS84 system. Generating a .doc (wp) file with the coordinates of the points of a given curve. Verifying that the drone flies at least one predetermined curve.
Extracurricular learning objectives	Mathematics: Elements of analytical geometry of three-dimensional space, quadrics, curves in R3, matrix calculation. ICT: setting up a matrix calculation, trajectory programming.

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

Subject & duration	***Methodology***	***Contents***	***Work – based learning setting***
Mathematics 20 hrs	Frontal Lesson 30% Laboratory organized according to the Work based learning approach (70%)	Study of the GPS geolocation system (WPS84). Analysis of analytical geometry in three-dimensional space aimed at planning the trajectory of a drone.	The project was carried out by supplying the students with a set of worksheets in each of which a problem was posed of which essential indications were provided, with simulations using

		Application of the knowledge of analytical geometry and trigonometry to the concrete case of the spatial coordinates of points of the terrestrial three-dimensional space. Parametric curves in three-dimensional space and trajectories.	the free application for the study of GEOGEBRA mathematics. Each card was created by working in groups or sometimes individually. The final verification was carried out individually, each student was allowed to consult only their own work cards.
ICT 10 hrs	Team work 100% according to the Work based learning approach	C++ language programming	In the computer lab, some students have created a C ++ program consisting of the planning of the flight of a drone according to a broken line with vertices on a helicoid. Focus on the drone flight mechanism

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

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 Ferrari team has chosen to extend the program already started during the Intellectual Ouptput 2 and 3 project, dedicated to the IT infrastructure and electronic aspects of the drone, in which the basic configuration and programming of the drone was carried out. Starting from the basic parameters set during IO2, and of the electronic motor circuit tested in IO3, during IO4 the team chose to provide VET students with skills in mastering formal mathematical languages that would allow them to perform theoretical calculations for sizing multi-rotors . The module was entitled "The Mathematics I Like", in order to motivate the students of the Professional Institute, generally not inclined to the theoretical study of abstract concepts, to the understanding of the practical use of mathematical knowledge. In order to create more engaging teaching methods, students were invited to download the free Matematica f (x) app on their mobile devices, which allows them to draw graphics from the equation of a straight line.

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=1PumGwos1pc

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 12 hours

Duration of the testing phase: about 36 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

Connectives and calculation of statements. Hypothesis and thesis. The induction principle. Set of real numbers. Imaginary units and complex numbers. Structures of numerical sets. The number π.

Sine and cosine theorems. Nth power of a binomial. Polynomial functions; rational and irrational functions; function module; exponential and logarithmic functions; periodic functions. Conics: definitions as geometric places and their representation in the Cartesian plane. Functions of two variables. Continuity and limit of a function.

Skills

Prove a sentence from others. Find and apply the formulas for the sum of the first n terms of an arithmetic or geometric progression. Apply trigonometry to solving problems concerning triangles. Calculate limits of sequences and functions. Calculate derivatives of functions. Analyze examples of discontinuous or non-derivable functions at some point. Represent in a Cartesian plane and study the functions f (x) = a / x, f (x) = ax, f (x) = log x. Describe the qualitative properties of a function and construct its graph.

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

Theoretical multirotor sizing calculations with dedicated software and mobile applications

Capacity

Assembly, Maintenance, Aerial Shooting and Photogrammetry with Civil Drones; Forced flight termination system; Balance the propellers.

From the point of view of behavioral skills:

Adapt your communication style to that of the other party; Listening and understanding the other's point of view; Increase awareness of the structure of communication processes and manage their contents; Communicate within the group: managing conflicts and building consensus; Develop 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

School subjects	**Training programme**	**Learning objectives for each module**	**Didactic methodologies %** **Tools**	**Organization of the Work – based learning setting**
Mathematics	Module 1 (12 hours): - Hypothesis and thesis - Groups of real numbers; - The number π; - Sine theorems e cosine; - Periodic functions - Conics: definitions geometric and representation of Cartesian diagram Module 2 (12 hours) - Polynomial functions; - Rational functions e irrational; - Function of the module; - Exponential functions e logarithmic; Module 3 (12 hours) Functions of two variables; Continuity and limits of a function	Being able to apply the formulas; Being able to recognize graphics	*Frontal lessons 40 %* *Activity of laboratory 20%* *Group work (pupil led) 20%* *Individual study 20%* *Laptop;* *Mobile phone with app for the study of mathematics*	Multimedia classroom equipped with computer equipment

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 decided to focus on the mathematical calculations to be performed for the determination of the position in the three-dimensional space of an object (people or the drone itself) starting from the analysis of 2D images, taken thanks to the drone.

The mathematical skills trained thanks to this program are:

- Equation of a straight line
- the systems of equations
- computational skills thanks to the use of a spreadsheet

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=7a9Wn4KtnmU

Students involved:

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

Duration of the design phase: approximately 8 hours

Duration of the testing phase: about 20 hours

Learning objectives

The learning unit was divided into 3 distinct phases:

1) Stimulation. Involvement of the students in the use of a drone (DJI Spark) equipped with sensors for human detection and commands given with simple hand and body gestures, a technology that makes it possible to control and manage flight without a flight controller

2) Practical application: Telemetry. Thanks to the use of the PIX4D Software it is possible to plan the flight of a drone, taking photographs that, processed, can return 3D images and thermal maps.

3) Mathematical study on how to calculate the coordinates of an object in three-dimensional space starting from two different two-dimensional coordinate images, by calculating the equations of two lines that converge at a point.

Critical issues in mathematics education, entry prerequisites and learning objectives:

Main critical issues in the learning of curricular mathematics	Lack of capacity for abstraction; Difficulties in solving equations; Difficulties in dealing with problems of analytical and trigonometric geometry
Entry requirements	Basic knowledge of Euclidean geometry
Curricular learning objectives	Analytical geometry (study of the straight line); Trigonometry (use of triangulation for calculating distances); Ability to deal with problems of analytical geometry including the lines
Extracurricular learning objectives	Use trigonometry for practical applications; Understanding of linear relationships between physical quantities; Fundamentals of optics
Interdisciplinary Links	Linear relationships: mechanics, physics, electronics, systems

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

School subjects	Didactic programme	Learning objectives	Didactic methodology % Tools	Work – based learning setting
Technologies and Design Maths	Module 1: introduction to analytical geometry (4 hours) Module 2: the lines in analytic geometry (8 hours) Module 3: trigonometry (8 hours)	Module 1: use of the Cartesian plane, concept of coordinates, drawing of lines Module 2: calculation of the angular coefficients, distance between a point and a straight line, distance between two points, clergy of the point of intersection between two lines Module 3: calculation of distances with the trigonometry methods	Lectures 20% Individual study 10% Study in groups 10% (students alone and in groups have studied the issues introduced at a general level) Guided laboratory activities 20% (operational skills are introduced through simple guided experiences) Group work (pupil led) 40% Technologies and tools used: - personal computer - a DJI Spark Drone - spreadsheet	The activity is carried out in the computer lab Students are divided into working groups with leaders supported by the teacher Students work essentially independently among peers. The teacher intervenes only in case of need.

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

<u>P6 Centro Público Integrado de Formación Professional "Corona de Aragon", Zaragoza, Spain</u>

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

In the previous phases of the DELTA project, 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, within the computer and electronic programs carried out during IO2 and IO3. The correct functioning of the configured parameters was tested indoors through connection to the software installed on local laptops.

During IO4, dedicated to the study of Mathematics through the use of drone technology, about 20 students were involved in the course dedicated to Civil Construction. The P6 team has therefore decided to exploit the aspects linked to photogrammetry and the processing of images taken by a drone, to which it is possible to apply mathematical calculations to deduce geographical coordinates, flight height, distances traveled by the drone and respective distances between points, and other information useful for geolocation.

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=e2c5B2gjCrU

Students involved:

About 20 students from the Civil Construction Course

Duration of the design phase: 10 hours

Duration of the testing phase: 20 hours

Learning objectives

School subjects	**Didactic programme**	**Learning objectives**
Topographic measurement	- Analyze the technical documentation, including all the necessary data, making calculations to be able to obtain a flight plan, to obtain correct photographs	- Obtain and analyze the information provided to be able to perform topographical work. - Obtain parameters to represent

Photogrammetry	- Represent an area using specific software and images obtained from a flight of drones Compare topographic activity and standard photogrammetry with respect to the activity carried out with a drone, which saves time at work.	an area, process the collected data and calculate coordinates, heights, distances

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

Didactic methodology % **Tools**	**Work – based learning setting**
Theoretical lessons 20% 80% laboratory Technology & tools used: Computers equipped with specific software programs for photogrammetry and topographic surveys such as PhotoScan	The experimentation took place within the study course module dedicated to construction and civil engineering works, in which students must develop skills related to photogrammetric techniques and topographic surveys. - 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

An expert in photogrammetry and topographic surveys

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.

Being an institution that is highly specialized in computer science, LIIS offers a solid mathematics program within its educational program, which is however addressed from a theoretical and formal point of view. To address the most practical, laboratory and work-based aspects of the DELTA project, the project team designed an afternoon club called "Eurodrone", which was configured as an optional extra curricular activity, which can be chosen by interested students on a voluntary basis. , to which around 30 students have joined (with a fairly balanced proportion of males and females).

Thanks to the D.E.L.T.A. project about 30 students attending the regular high school course were able to benefit from a mathematics education applied to drone technology.

The main critical points that P8 students present in the study of mathematics are the following:

The non-homogeneous level of knowledge and skills with which the students dealt with the analytical implementation of a trajectory (applied mathematics in physics - the study of the trajectory)

Difficulty applying the instructions - documentation in English, not always well structured.
Difficulties in group work, group work, students with different levels of progress and skills
Difficulties in multidisciplinary tasking (computer science, physics, mathematics, sciences)
The variety of open source programs used created difficulties: java applet Bootstrap 3.4 matcad (all programs that were not studied based on the national curriculum) and the fact that students have various concerns and a different level of mastery in STEM subjects in time.

Learning objectives

The activity continues the program started during IO2 and IO3, related to the construction of an app able to process and process images acquired by the drone, allowing the acquisition of environmental information (for example, a possible crack in the painting of the gym wall of the school).
During IO2 the students of P8 LIIS worked especially on the drone programming and on the construction of the database able to host images and information; in the course of IO3, on the other hand, the learners configured the drone circuit electronically.
The goal of IO4 lies in the study of the mathematics aimed at calculating and establishing the trajectory of the drone to optimize the acquisition of data (points in the space related to the collection of data regarding the flight path; acquisition of images in flight).
Further objectives, related to the entire experimentation of the project D.E.L.T.A. as a whole they are:
Creation of a series of photos of the interior of a building (gym), images to be stored on the server, analyzed and introduced in a database to be observed in terms of possible defects

or cracks in the walls.

Creation of a follow-up program and identification of the object according to a main color / characteristic.

Phases of study / implementation of the program

1. Equation of a trajectory in a gravitational field
2. Programming of the drone following the trajectory parameters

to. Introduction of variables and setting of start / stop points in LIBRE PILOT

b. Flight controls, understanding of technical software using open source: terminology / position

3. Correct errors in the trajectory equation due to external disturbance factors

to. The students worked on mathematical simulations for the drone trajectory in UNITY, to follow the tasks imposed on the drone (reaching the data acquisition points where the photos will be taken)

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=qNr0uwGCeWc

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)

Duration of the testing phase: 60h (8 weeks)

Curricular learning objectives

Mathematics	Process large databases Analytical expressions that define the flight path of the drone Program the drone (setting / initialization / instructions to avoid crashing against walls)

	Three-dimensional space
Physics	Movement in the gravitational field
Geolocalization	Acquisition of GPS data necessary for mathematical equations relating to the flight path of the drone
Vectorial Geometry	Use the vectors related to the drone position to elaborate analytical equations related to the trajectory
English *(non-STEM extension)*	Terminology related to drone technology Complex level documentation in a non-synthetic and non-aggregated form

Extracurricular learning objectives that contribute to the vocational skills coming out of students:

Computer Science	Software LIBRE PILOT GCS Applet java Bootstrap 3.4 matcadJavascriptsi CSS3 Bootstrap 3.4, MySQL
Systems & network systems	Image storage on server Image processing Application and display of mathematical concepts on software (different types of spatial coordinates)
Mathematics	Cartesian coordinates and three-dimensional polar coordinates applied to the point cloud
Special needs didactics	Server use with set of stored images Use of open source programs for visualization
English *(non-STEM extension)*	Terminology related to drone technology. Complex level documentation in a non-synthetic and non- aggregated form

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

School subject	Didactic programme	Learning objectives	Didactic methodologies % Tools	Work – based learning setting
Mathematics	Movement in the gravitational space. Flight path. Trajectory equation. Coordinates. Bemoulli's principle and the Venturi effect 15hrs	Identification of the variables that influence the trajectory. Use of the correct mathematical tools	*Theoretical lessons 70%* *Lab 30%* *Team work : (pupil led)50 %* *Individual study 50%* *Technologies & tools used:* *Computer, drone, Raspberry PI*	Physics Lab ICT Lab
Applied Mathematics	Definition of static and dynamic stability Longitudinal stability Influence of the position of the center of gravity on longitudinal stability control Lateral and directional stability 15h	Translating the work programs imposed by the drone into the mathematical equations Establishing relationships between data sensors for correct navigation	*Theoretical lessons 70%* *Lab 30%* *Team work : (pupil led) 50 %* *Individual study 50%*	Physics Lab ICT Lab
Aerodynamics (Physics)	Drone load and resistance to advancement Angular momentum and its balance	Developing a model to lower and land the drones through a laminar flow (without wind) and in a turbulent environment (with wind)	*Theoretical lessons 30%* *Lab 30%* *Team work : (pupil led) 20 %*	Physics Lab ICT Lab

	Weight, weight traction and resistance Drone balancing methods Drilling and rotation of the drone 5hrs		*Individual study 20%*	

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

IO4 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 IO4. The materials are publicly available at the shared link https://drive.google.com/open?id=1XeLrlmzIxC2uzl7vclCn77cr3jhwkqVo

In the folder called IO4 - Mathematics it is possible to find:

a. P4 Gadda's proposal for the implementation of the mathematics program applied to drones

b. The proposal of P8 LIIS for the implementation of the mathematics program applied to drones

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/