

# DRONE



# STEAM

## DRONES@STEAM

Fostering digital Transformation in VET schools  
and creating new job prospects in the labour market

**Project Result No: 2**

**Activity 3: EDUCATIONAL PACK: TEACHING MATERIAL AND  
ASSESSMENT**

UNIT 3, Chapter 3.1

**Lead partner(s): Politeknika Txorierrri**



Co-funded by  
the European Union



This project has been funded with support from the European Commission. This communication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein. Project number: 2021-1-EL01-KA220-VET-000034686

## CONTEXT

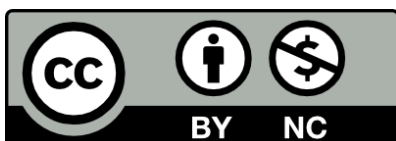
Grant agreement	2021-1-EL01-KA220-VET-000034686
Programme	Erasmus+
Key action	Cooperation for innovation and the exchange of good practices
Action	Strategic Partnerships
Project acronym	DRONES@STEAM
Project title	DRONES@STEAM: Fostering digital Transformation in VET schools and creating new job prospects in the labour market
Project starting date	28/02/2022
Project duration	28 months
Project end date	27/06/2024

## WEBSITE:

<https://dronesteam.eu/>

## CONSORTIUM: PARTNER LIST

- University of Crete (UoC) - Greece
- ECAM-EPMI (ECAM) - France
- Cyprus Computer Society (CCS) - Cyprus
- Politeknika Ikastegia Txorierrri S. Coop (PIT) – Spain
- National Center for Scientific Research “Demokritos” (NCSR) - Greece
- A & A Emphasys Interactive Solutions Ltd (EMP) – Cyprus
- Regional Directorate of Primary and Secondary Education of Attica (RDPSEA) – Greece



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## UNIT 3: Lesson Plan 3.1

UNIT 3	
<b>Chapter 3.1</b>	<b>Drone operation and maintenance</b>
Equipment, Software, Consumables (if needed)	Air:bit 2 (Drone + Remote Control) PC with access to the internet Pliers Philips Screwdriver Socket wrench Tester Spare parts kit
Duration	2 teaching hours
<b>Short description</b>	In this worksheet, students will learn <b>how to collect technical information about the drone and its operating conditions</b> . They will also <b>learn to identify the most common failures and the necessary corrective actions</b> for the drone to operate correctly
<b>Learning Outcomes</b>	Knowledge of how to identify potential issues before piloting the drone
	Familiarity with common repairs and maintenance tasks required for drones
	Problem-solving, Critical Thinking, Initiative, Teamwork, Attention to detail
<b>Activities</b>	
Activity 1	Activity 3.1.1.1
Aim of the activity	The objective of this activity is to help students identify the technical characteristics that define a drone and to prepare a pre-flight checklist of the different parameters that affect the piloting of a drone
Duration	40 mins
Type of Activity	Worksheet
Teaching Objectives	By the end of this exercise, students will develop an understanding of the importance of technical documentation in the drone industry and the role it plays in ensuring safe and efficient drone operations
Resources	Worksheet 3.1.1 / Exercise 3.1.1.1
Activity 2	Activity 3.1.1.2
Aim of the activity	This activity is designed to help students detect drone faults or problems and how to solve them
Duration	40 mins
Type of Activity	Worksheet
Teaching Objectives	By the end of this exercise, students will acquire technical knowledge related to drone maintenance and repair tasks. This will involve learning about the various components and subsystems of drones, understanding how they work, and identifying common issues that may arise during drone operations
Resources	Worksheet 3.1.1 / Exercise 3.1.1.2
Activity 3	Activity 3.1.1.3
Aim of the activity	In this activity, students will learn to identify the critical components of the drone in order to propose a list of spare parts and make repairs.
Duration	40 mins
Type of Activity	Discussion

Teaching Objectives	By the end of this exercise, students will learn about spare parts, replacement procedures, how to install extensions or additional components, and how to optimize resources by prioritizing critical components. This requires an understanding of various spare parts and extensions available for drones, and how they can be used to enhance drone performance or replace damaged or worn-out components
Resources	Worksheet 3.1.1 / Discussion 3.1.1
<b>Further Reading</b>	
Resources/Links	<a href="https://tech.microbit.org/hardware/2-0-revision/radio-microbit-runtime-lancaster-university-github-io">https://tech.microbit.org/hardware/2-0-revision/radio - micro:bit runtime (lancaster-university.github.io)</a>  <a href="https://www.youtube.com/watch?v=yVA6-5ork1E">https://www.youtube.com/watch?v=yVA6-5ork1E</a>

## Activity worksheet 3.1.1 (teacher version)

### Chapter 3.1: Drone operation and maintenance

**Level:** Intermediate

In this activity worksheet, we will address knowledge related to the inspection, maintenance, and spare parts management of a drone. More specifically we are going to learn:

- How to prepare a pre-flight checklist as a tool for inspection
- How to identify the necessary maintenance tasks depending on the problem detected in the drone
- How to create a spare parts list

#### Exercise 3.1.1.1: Pre-flight inspection. Checklist

A checklist is an essential tool to perform a pre-flight inspection and it helps ensure safe and efficient drone operation. By checking critical parameters before each flight, the operator reduces the risk of accidents and ensures that the drone is operating within its limitations. Additionally, a pre-flight checklist can help operators identify any issues that may require repairs or maintenance, prolonging the lifespan of the drone and ensuring that it operates effectively for a long time.

Work in groups to draft a pre-flight checklist for your drone kits. You can start from the following categories: Operating Conditions, Drone, Remote Control, Calibration & Test and Safety. Afterward, all proposals will be combined and a final version of the pre-flight checklist will be prepared.

**NOTE:** A suggested checklist is shown below.

PRE-FLIGHT CHECKLIST				
AIRCRAFT:	LOCATION:		DATE:	
	ITEM	OK	ITEM	OK
<b>OPERATING CONDITIONS</b>	<b>Weather.</b> Wind speed and direction		<b>Flight Area.</b> Non-participants	
	<b>Weather.</b> Visibility: fog, precipitations		<b>Flight Area.</b> Take-off and landing space	
	<b>Weather.</b> Temperature, humidity		<b>Flight Area.</b> Altitude Limits	
			<b>Flight Area.</b> Local Restrictions	
<b>DRONE</b>	<b>Battery.</b> Fully charged		<b>Flight Area.</b> Visual Inspection	
	<b>Battery.</b> Properly installed and securely fastened		<b>Motors.</b> Securely attached	
	<b>Frame.</b> No visible damage or loose parts		<b>Motors.</b> Cable connectors plugged	
	<b>Frame.</b> Landing legs		<b>Controller.</b> Control board and micro:bit nuts tightened	
	<b>Propellers.</b> Securely attached		<b>Connection.</b> Radio Channel	
<b>REMOTE CONTROL</b>	<b>Battery.</b> Charged		<b>Camera.</b> Connected and securely fastened	
	<b>Battery.</b> Properly installed and securely fastened		<b>Connection .</b> Radio Channel	
	<b>Controller.</b> Calibration. GMC		<b>Connection .</b> Operating Range	
<b>CALIBRATION &amp; TEST</b>	<b>Drone Startup.</b> GMC (Gyroscope, Motor Drive, Calibration)		<b>Remote control – Drone communicated</b>	
	<b>Drone visualization</b> (operating modes, battery...)		<b>Propellers armed</b> from the remote control	
	<b>Motor test</b>		<b>Test.</b> Take off - Hovering - Landing	
	<b>Remote-control visualization</b> (Pitch, Roll, Yaw, Arm)			

<b>SAFETY &amp; REGULATIONS</b>	Safety Gear	Pilot License	
	First Aid Kit	Drone Registration	
	Safety Perimeter	NAA Special Authorization*	

### Exercise 3.1.1.2: Post-Flight Inspection. Maintenance and Troubleshooting

The drone can suffer various types of damage during flight:

- Crashes: this is the most common type of damage. It can be caused by collisions, battery failure, loss of control or mechanical failure.
- Electrical damage: components such as batteries, control boards or motors can be damaged due to power surges, overheating, overloading, and short circuits.
- Flyaway: the drone flies out of control due to a loss of connection to the remote control.



Performing a post-flight inspection will help us detect damages and then carry out the necessary maintenance work to repair the drone and restore its operability. You can repeat the pre-flight checklist checks as a guide or create a specific post-flight checklist.

If no damage has occurred, it is also important to perform regular maintenance to minimise the risk of future failures.

#### What is corrective maintenance?

Repairing equipment after a problem has occurred is reactive maintenance because it is performed in response to a failure or malfunction. The goal of corrective maintenance is to restore equipment to its original operating condition as quickly as possible to minimize downtime and avoid further damage. Corrective maintenance is often more costly and time-consuming than preventive maintenance, as it may require more extensive repairs or replacement of parts.

#### What is preventive maintenance?

It involves regular inspection, cleaning, and replacement of parts to prevent potential breakdowns and extend the life of equipment. Its goal is to identify and fix problems before they cause significant damage or disrupt operations. This type of maintenance is typically scheduled and performed regularly, such as daily, weekly, or monthly, depending on the type of equipment and the manufacturer's recommendations.

Suppose we are a small business involved in the distribution and repair of educational drones. One of our customers has asked us to carry out maintenance on their drones. They have been out of use for a long time and they want to tune them up.


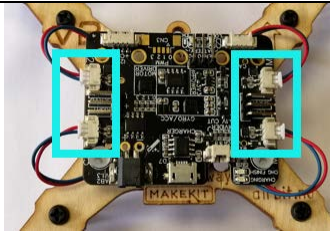
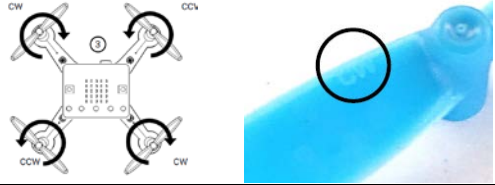
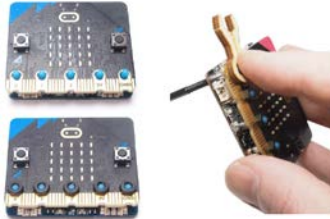

Refer to the Troubleshooting Quick Guide below to help you identify the type of problem and carry out the corresponding corrective actions to repair all the drones.

**\*NOTE:** In order to familiarise the students with different types of malfunctions, it is proposed to handle the drones before the students inspect them. Possible manipulations:

1. Loosen the drone's battery connector.
2. Discharge a battery below the minimum flight level
3. Move the protectors so that they collide with one of the propellers.
4. Loosen the connector drone's battery connector.
5. Switch a CW propeller for a CCW propeller.
6. Loosen the barrel nuts at the micro:bit to the control board.
7. Remove one of the aluminium spacer rings at the control board.
8. Change the radio channel on one of the micro:bit.
9. Loosen the landing legs
10. Cover the camera lens with some material



## TROUBLESHOOTING QUICK GUIDE

COMMON PROBLEMS	INDICATORS	INSPECTION	CORRECTIVE ACTION	
<b>BATTERY</b>	<ul style="list-style-type: none"> <li>• Drone is not holding the charge</li> <li>• Battery is not charging</li> <li>• Battery life is shorter than usual</li> </ul>	<ul style="list-style-type: none"> <li>• Battery connector properly plugged?</li> <li>• Battery cable damaged?</li> <li>• Battery's charging cable damaged?</li> <li>• Check the battery status led at the control board (Charging/Charged/Low/Ok)</li> </ul>	<ul style="list-style-type: none"> <li>• Plug tightly the battery cable to the control board connector</li> <li>• Repair/Replace the charging cable if damaged</li> <li>• Replace the battery if damaged</li> </ul>	 <p style="font-size: small; text-align: center;">Normal                      Low battery</p>
	<ul style="list-style-type: none"> <li>• Drone is unable to take off. Propellers spinning</li> </ul>	<ul style="list-style-type: none"> <li>• Check the battery level. Red light at the control board if not enough battery to fly</li> </ul>	<ul style="list-style-type: none"> <li>• Charge fully the battery</li> </ul>	
<b>MOTORS</b>	<ul style="list-style-type: none"> <li>• All motors are working and spinning but the drone doesn't lift off</li> </ul>	<ul style="list-style-type: none"> <li>• Check Throttle &gt; 50 %</li> </ul>	<ul style="list-style-type: none"> <li>• Raise Throttle to the minimum flying value</li> </ul>	
	<ul style="list-style-type: none"> <li>• Drone spinning out of control</li> <li>• Drone is unable to hover</li> </ul>	<ul style="list-style-type: none"> <li>• Remote and drone micro:bit looking forwards?</li> <li>• All motors correctly fixed in their positions</li> <li>• Are motor cables damaged?</li> <li>• All motor connectors tightly plugged?</li> </ul>	<ul style="list-style-type: none"> <li>• Plug tightly the motor cable into the control board connector</li> <li>• Repair/fix the motor cable/connector if damaged</li> <li>• Replace the motor if damaged</li> </ul>	
<b>PROPELLERS</b>	<ul style="list-style-type: none"> <li>• Not all the propellers are spinning</li> </ul>	<ul style="list-style-type: none"> <li>• Propellers touching the protectors?</li> </ul>	<ul style="list-style-type: none"> <li>• Reposition the protectors</li> </ul>	
	<ul style="list-style-type: none"> <li>• Propellers spin but the drone doesn't fly</li> </ul>	<ul style="list-style-type: none"> <li>• Proper propellers (CW/CCW) are set in the correct motors?</li> </ul>	<ul style="list-style-type: none"> <li>• Remove the propellers gently with pliers. Identify the 2 CW and 2 CCW propellers (by eye or by blowing) and reinsert them in the correct position</li> </ul>	
	<ul style="list-style-type: none"> <li>• Stability issues</li> </ul>	<ul style="list-style-type: none"> <li>• Check the propellers are securely attached</li> </ul>	<ul style="list-style-type: none"> <li>• Firmly attach the propellers by pressing in from the core</li> </ul>	
<b>CONTROL BOARD</b>	<ul style="list-style-type: none"> <li>• Control board is working but the micro:bit is not switching on</li> </ul>	<ul style="list-style-type: none"> <li>• Any corroded or broken electronic components?</li> <li>• Any missing or loose barrel nuts?</li> <li>• Any missing or loose aluminium spacer ring?</li> </ul>	<ul style="list-style-type: none"> <li>• Remove the drone's micro:bit,</li> <li>• Replace the missing parts</li> <li>• Replace the controller if damaged</li> </ul>	
<b>CONNECTION</b>	<ul style="list-style-type: none"> <li>• Drone is not receiving the signal from the remote control</li> </ul>	<ul style="list-style-type: none"> <li>• Both transmitter and receiver have the same radio channel? Reset the micro:bit to check the channel numbers</li> <li>• Signal is not blocked by other devices or obstacles?</li> <li>• Remote control is within range of the drone?</li> </ul>	<ul style="list-style-type: none"> <li>• Modify the radio channel numbers in Make-Code and re-upload the code the micro:bit</li> <li>• Label each micro:bit with its name and radio channel to avoid future errors</li> </ul>	

<b>FRAME</b>	<ul style="list-style-type: none"> <li>• Drone's stability and flying performance affected</li> </ul>	<ul style="list-style-type: none"> <li>• Missing silicone rings or rubber bands?</li> <li>• Check for damages in the frame (arms and protectors)</li> </ul>	<ul style="list-style-type: none"> <li>• Replace missing parts</li> <li>• Repair by gluing if possible or replace</li> </ul>	
<b>CALIBRATION &amp; GYROSCOPE</b>	<ul style="list-style-type: none"> <li>• Drone is not flying straight or hovering correctly</li> <li>• Not possible to arm the motors due to Tilted/Disarm warning</li> </ul>	<ul style="list-style-type: none"> <li>• Tilted/Disarm message</li> </ul>	<ul style="list-style-type: none"> <li>• Place the drone on a flat surface and press Reset for recalibration. Check the GMC message is displayed after resetting</li> </ul>	
<b>OVERHEATING</b>	<ul style="list-style-type: none"> <li>• Drone's components are overheating</li> </ul>	<ul style="list-style-type: none"> <li>• Motors overheated?</li> <li>• Control board overheated?</li> </ul>	<ul style="list-style-type: none"> <li>• Let the drone cool down before flying again</li> <li>• Avoid flying in extreme temperatures or direct sunlight for extended periods</li> </ul>	
<b>LANDING LEGS</b>	<ul style="list-style-type: none"> <li>• Drone is not able to land safely</li> </ul>	<ul style="list-style-type: none"> <li>• Any missing, loose, or damaged landing leg?</li> </ul>	<ul style="list-style-type: none"> <li>• Tighten the nuts</li> <li>• Replace the landing leg if broken/missing</li> </ul>	
<b>CAMERA</b>	<ul style="list-style-type: none"> <li>• Camera is not working</li> </ul>	<ul style="list-style-type: none"> <li>• Make sure connectors are properly plugged and the cables are not damaged</li> <li>• Check connectivity with the app</li> </ul>	<ul style="list-style-type: none"> <li>• Make sure connectors are properly plugged and the cables are not damaged</li> <li>• Check connectivity with the app</li> </ul>	
	<ul style="list-style-type: none"> <li>• Camera produces poor quality images</li> </ul>	<ul style="list-style-type: none"> <li>• Bracket securely attached to the frame?</li> <li>• Check the camera settings and focus</li> <li>• Make sure the lens is clean</li> <li>• Check it is not obstructed by any debris or protective cover</li> </ul>	<ul style="list-style-type: none"> <li>• Tighten the camera bracket screw</li> <li>• Check the camera settings and focus</li> <li>• Make sure the lens is clean</li> <li>• Check it is not obstructed by any debris or protective cover</li> </ul>	
<b>SOFTWARE HARDWARE FIRMWARE</b>	<ul style="list-style-type: none"> <li>• Not possible to download new code to the micro:bit</li> </ul>	<ul style="list-style-type: none"> <li>• Have you paired the micro:bit?</li> </ul>	<ul style="list-style-type: none"> <li>• Check for any available firmware updates</li> </ul>	
	<ul style="list-style-type: none"> <li>• Drone control is not stable</li> </ul>	<ul style="list-style-type: none"> <li>• Compatible micro:bit and controller version with the code?</li> </ul>	<ul style="list-style-type: none"> <li>• Check the drone's hardware and software versions are compatible</li> </ul>	

### Discussion 3.1.1.1: Spare parts and extensions

Continuing with our small drone business, we have just received a new request from one of our customers: they want to know what spare parts they would need for six (6) new Air:bit kits they are planning to buy for their school.

They are wary of the robustness of the wooden parts. They would like as many of the parts as possible to be 3D printed for durability. They would also be interested in expanding the functionality/usage of their kits.

Working in groups, draft a list of spare parts and extensions that you would recommend to your client. Then, discuss the different proposals together to decide which is the best option, assessing its pros and cons.

You should keep the following in mind:

- Most common repairs
- Components most susceptible to wear and/or damage
- Critical spare parts
- Possible extensions and add-ons
- Budget
- Potential of the customer's school students to:
  - o design and manufacture spare parts
  - o develop and install extensions

