ECOSYSTEM

Methodical material/guidelines

School's name (country)	Escola Secundária Campos Melo – Covilhã, Portugal
Intro part: 5-10 sentences about the topic we are going to work on (some sentences about ecosystems, why this particular object was chosen, etc.)	The developing of ecosystem model device will allow students to better understand the relations between its different components and how changes of environmental factors, such as temperature, humidity, soil moisture, light affect the growth of an ecosystem. Therefore, to measure and control the environmental conditions, a small scale model, sufficiently closed from the exterior, equipped with several sensors and a water irrigation system was designed. The automating of the ecosystem device will be done by a microcontroller. It will collect the information from the sensors, action the water irrigation and the cooling fans systems and also send data to the computer. The water irrigation system will allow changes in the soil moisture and humidity, while the cooling fans will provide air circulation, in and out the device, thus changing temperature and also humidity By building such a device we expect to have a basic control of parameters which have impact on the functioning of the ecosystem.
Subjects most relevant to both formal and non-formal education	Biology, information technology, electronics, learning from experience and critical thinking
Recommended target group (age/class of students)	16-17 year old students (11-12th grade)

Equipment (what kind of equipment is needed to produce this device?)	– Arduino Uno Microcontroller – Power supply adapter for Arduino (7-12V) – Transparent plastic box – Water reservoir – Small water pump (e.g., aquarium water pump, windshield washer pump) – Motor controller (e.g., DFRobot DC motor shield for Arduino Uno) – Computer cooling fans – Soft and hard plastic tubes – Water aspersers – Temperature-humidity sensor (e.g., DHT22) – Soil moisture sensor – Temperature soil sensor (e.g., Gravity Waterproof DS18B20 Sensor Kit) – Servo motor (e.g., Hitec HS-422) – Jumpers wires – Computer using a data streamer (e.g. PLX-DAQ)
Step by step instruction (might be also photo story): What steps have to be taken to produce this device?	1. Open the holes on the ecosystem box lid for the two cooling fans. 2. Mount the cooling fans on the ecosystem box lid. 3. Build the irrigation arm with the water aspersers on the hard plastic tube 4. Assemble the water irrigation system by attaching the irrigation arm to the servo motor. 5. Mount the water irrigation system ecosystem box. 6. Connect with soft plastic tubes the irrigation arm to the water pump and this last one to the water reservoir. 7. Mount the Arduino microcontroller with the DC motor controller shield on the ecosystem box lid. 8. Connect the all the sensors (temperature-humidity sensor, soil moisture sensor and soil temperature sensor) and servo motor

	to microcontroller and the water pump to the to the DC motor controller. 9. Connect the power supply to the Arduino microcontroller and water pump and configure all the sensors, servo motor and water pump to work as pretended. 10. Build an ecosystem with organic materials in the device box and place the soil moisture and temperature in the ecosystem. 11. Fill the water reservoir. 12. Connect the Arduino microcontroller to the computer Excel to collect data. 13. Start de ecosystem device.
What students will learn? What is the outcome of this task?	Students will learn how program a microcontroller, to analyse data, to understand the relation between variables and how to control them to optimizing a system. Students will understand changing environmental factors will impact the growth of an ecosystem and therefore be more environmental conscious. In the end, students should improve their skills associated with find solutions and critical thinking.
Attractive photos which characterise the process (at least some parts of it)	 Fig.1 – Preparing da ecosystem box lid before mounting the cooling fans.

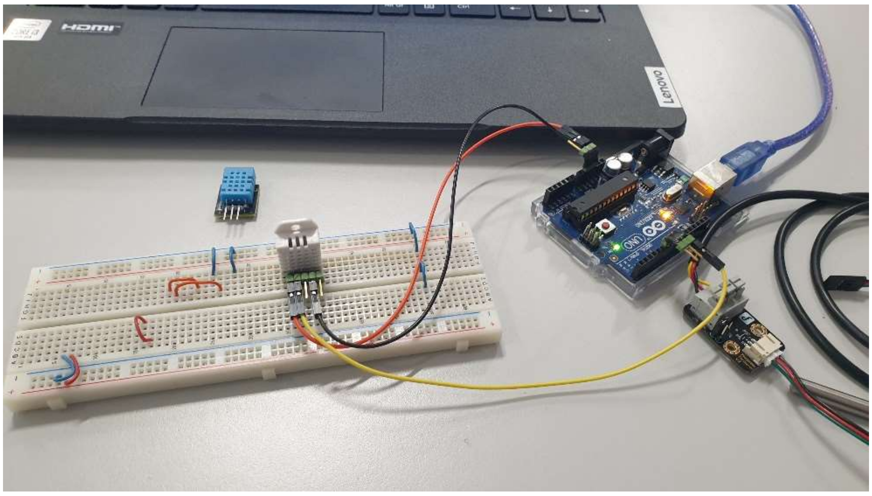
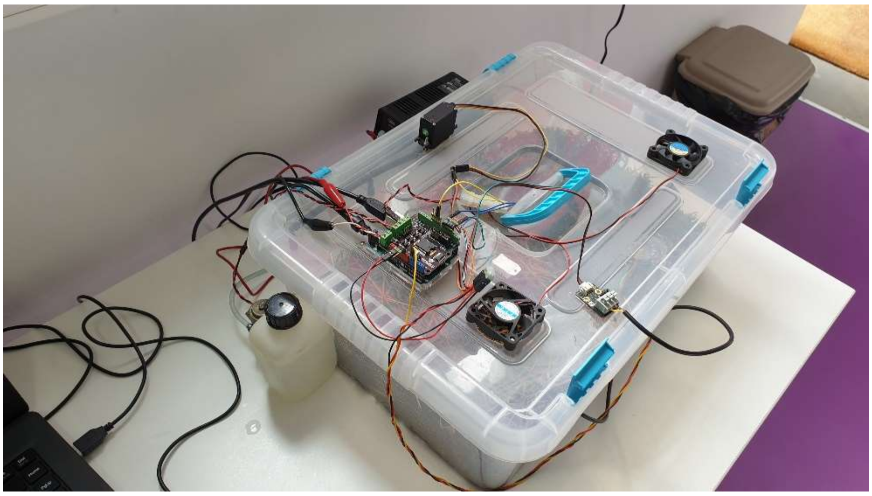
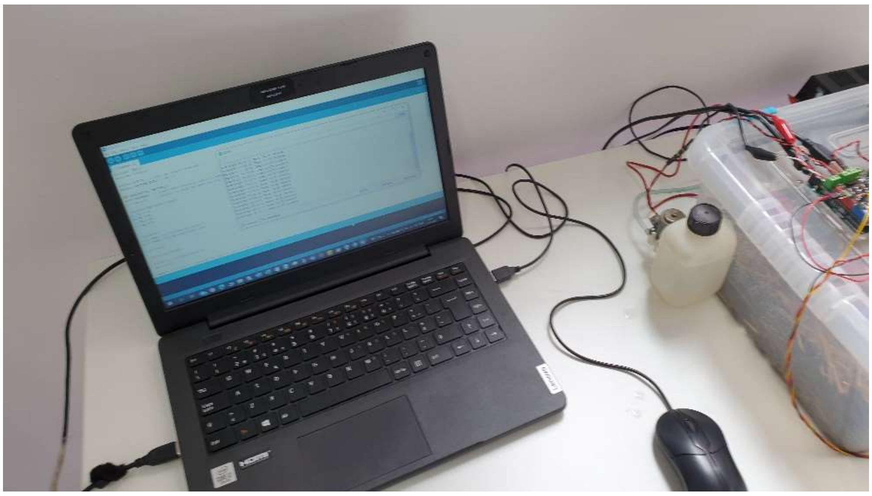


Fig.2 – Testing the temperature-humidity sensors.

Fig.3 – Adding the first layer of soil with some earthworms.

Fig.4 – Ecosystem finished.

	 Fig.5 – Ecosystem device – wiring all components.  Fig.6 – Reading sensor data.
Photos and links where the process of producing or functioning could be observed	Video of the ecosystem device – Building process: Ecosystem device.mp4 Video – Testing functioning – Testing water irrigation system.mp4