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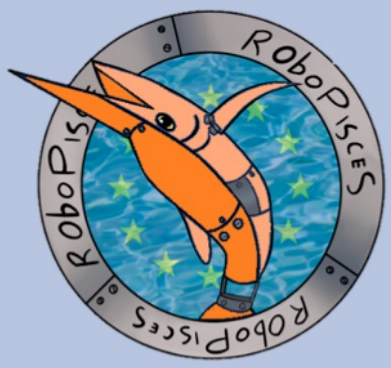
innovative educational ROBOtics strategies for PrImary SChool ExperienceS



RoboFISH toolkit

Notes

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To acknowledge this material the following information must be reported:

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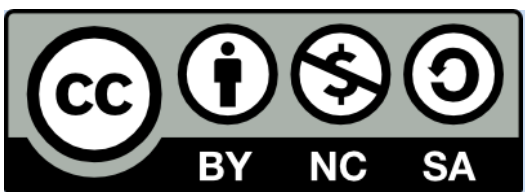

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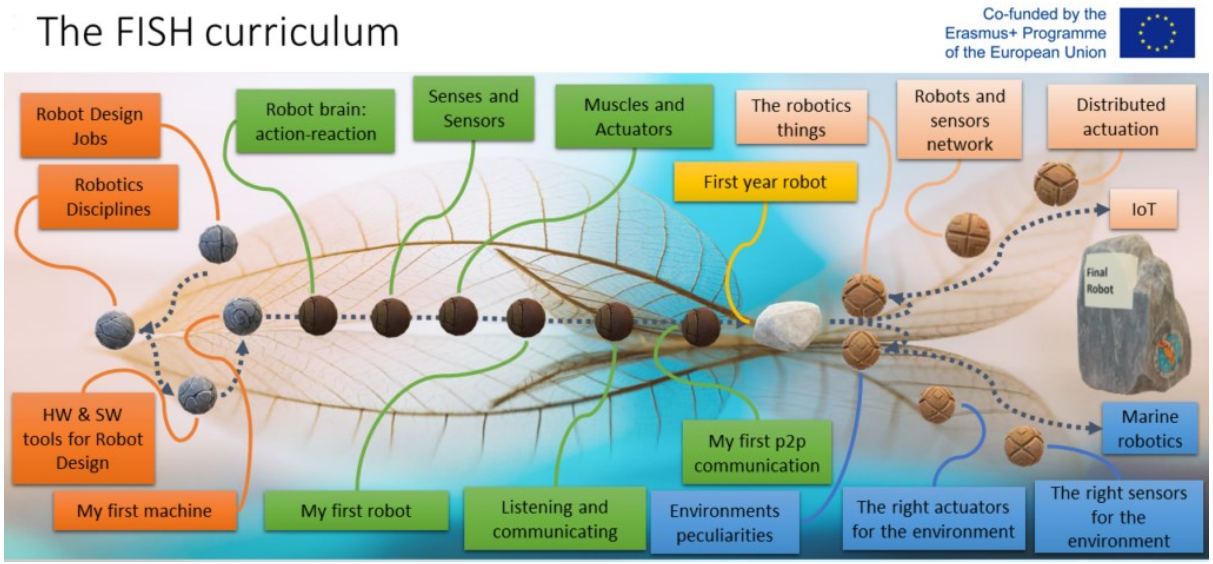
1 Introduction

The RoboPisces project aims at introducing educational robotics into primary school curricula by proposing a full set of outputs which enable every teacher and educator to bring robotics in STEAM activities within the curriculum of primary school. The three project's outputs are the RoboPisces curriculum, the RoboFISH toolkit and the RoboPisces teacher training manual.

The **RoboPisces curriculum** is an inventory of activities about robotics as a discipline. By means of robotics other learning objectives of other school subjects and competences can be developed and boosted. The RoboPisces curriculum follows the proposed path of key topics called the FISH curriculum, which identifies two sets of essential topics that allows students and teachers to master robotics: the fundamentals of robotics and the advanced topics, namely the Internet of Thing (IoT) branch and the Marine environment branch. The RoboPisces curriculum organizes the educational activities developed within the project and carried out in the classroom. A topic in the FISH curriculum may correspond to many activities or even to a set of scenarios in the RoboPisces curriculum.



This inventory of activities has proven its effectiveness in raising interest towards STEAM (Science, Technology, Engineering, Arts and Maths) subjects within the primary school students of four European countries during a very hard period such as covid pandemic. Despite the difficulties, students were eager to get to know the subject involved with the activities and to get their hands on the toolkit to build their ideas.

A key point for success was **training teachers** about robotics and about the methodology to bring robotics into the classroom. Teachers learnt the ropes about educational robotics thanks to the online course, which was delivered as an asynchronous self-paced training course which is still available as a MOOC for all interested teachers and educators. During the training, teachers learnt the basic educational ideas underpinning educational robotics and also the fundamentals of

robotics, namely what is a sensor, an actuator, how to build a robot using the project's toolkit and many other concepts and practical skills.

To bring this comprehensive approach to educational robotics in the curricula of primary school, the project developed a special toolkit, which is composed by a set of components that can be used to support the integration of the FISH curriculum into the classroom and also to support teachers' training on the proposed topics. The **RoboFISH toolkit** is unique in the edtech scenario because it allows both the construction and deconstruction of an artefact and also allows students to manage a real marine robot that resembles a fish.

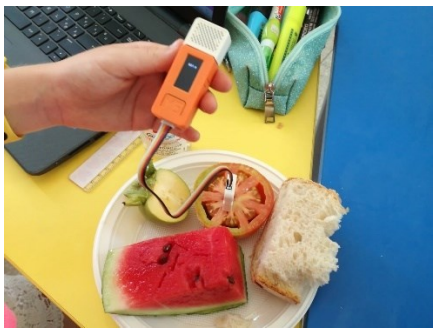
The RoboFISH toolkit allows teachers to face themes like measurements in science, the differences among the different Earth's environment, Ocean Literacy, communication among a network of robots and much more.

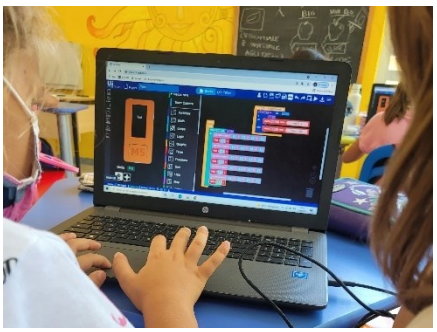
The toolkit which is described in this report is the RoboFISH toolkit that teachers used in the classroom and that was used for the RoboPisces contest in Rhodes (Greece).

2 The RoboFISH toolkit

The RoboFISH toolkit is a set of mechatronic components specifically developed for carrying out the activities in the classrooms since primary school.

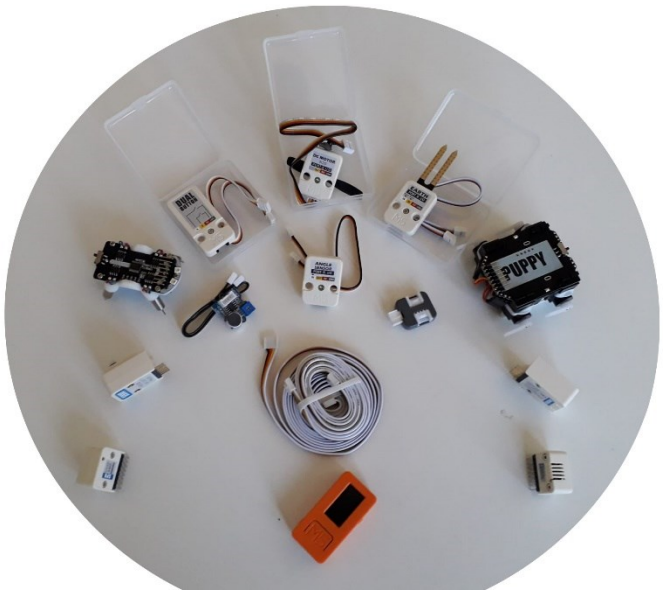
Its components are grouped in two sets: the components of the basic toolkit and the components of the advanced toolkit. The words “basic” and “advanced” are used to establish a clear connection with the two main sections of the FISH curriculum: “basic” refers to the introduction of the fundamental topics of robotics, and “advanced” refers to the more advanced activities, namely Internet of things and Marine robotics.





More information on the RoboFISH basic toolkit and RoboFISH advanced toolkit can be found at the RoboPisces website. To learn to use the RoboFISH follow the RoboPisces MOOC.

2.1 Basic toolkit



The basic toolkit has several components that contribute to the implementation of the RoboPisces curriculum. Each of these components are described in the table below.

Component		**Function**
Access Point (WD03 Wireless router by RAVPower))		Ravpower WD03 is a small battery powered router with a SD Card reader and an ethernet port. It can be used to read SD card from a phone and copy files (eg: pictures) to a hard drive for backup. Moreover, it has a 6000mah battery that can recharge a USB plugged device. Finally, it can act as a router to share a ethernet or wifi connection. It provides a secure **WiFi connection**. It's a wireless router that will work as access point for the module; thus, the module will be connected to the internet and this will let us program it through the UIFlow web application.

USB C cable		it connects the M5StickC to the power plug. It can be used to connect the M5StickC to the PC, if needed.
Central Unit “M5StickC”		It is the **programmable unit** that receives data from sensors and sends data to actuators. It can be programmed with the UIFlow IDE using a Scratch-like programming environment or using Python.
ENV sensor		It is an environment sensor which can sense **temperature**, **humidity** and **atmospheric pressure**. It is built with a digital temperature and humidity sensor with high precision and low power consumption, an absolute barometric pressure sensor and a magnetometer, which can be used to monitor the change and the direction of magnetic field. It is programmed over I2C thanks to the UIFLOW IDE.
SPK		SPK HAT is an M5StickC compatible **speaker.** It has the characteristics of simple functions and high audio reproduction.
I2C Extender cable (1m)		This **GROVE cable** is dedicated to the I2C protocol and is made of 4 wires: two for data SCL e SDA (yellow and white), one for power (red), and one for Ground (black). It is useful to connect the units to the M5StickC at the Grove port.
I2C Extender cable (2m)		This **GROVE cable** is dedicated to the I2C protocol and is made of 4 wires: two for data SCL e SDA (yellow and white), one for power (red), and one for Ground (black). It is useful to connect the units to the M5StickC at the Grove port.

I2C Grove-T Connector		It is a **T-shaped hub** for connecting more than one unit at the same time to the M5StickC.
Sensor Button		This item is the "**Dual Button**": it has two buttons of different color. They share the exact same mechanism: button status can be detected by the input pin status by simply capturing the high/low electrical level. It has a GROVE interface to be connected to the M5StickC and has dedicated blocks in the UIFlow IDE. It can also be mounted on the Lego blocks, thanks to two Lego-compatible holes.
Sensor Joystick Hat		**Joystick** HAT is one of the HAT modules that is specifically designed for M5StickC. It implements the I2C communication with M5StickC. This mini-volume joystick module supports full angular movement and center press, and **outputs angular data** as well as **button digital signals**. With the 'HAT' unified plug-in design it can provide reliable connection.
Sensor Moisture		EARTH unit is a **Soil Moisture Sensor** for measuring the moisture in soil and similar materials. The soil moisture sensor has two large, exposed pads that function as probes for the sensor. They act together as a variable resistor: the higher moisture that is in the soil means the better the conductivity between the two, so the sensor will result in a lower resistance, and a higher SIG out. It supports both Analog and Digital output. The ADC interface can be used to read the moisture in soil. It has a GROVE interface and is supported by the UIFlow IDE. It also has two Lego-compatible holes.

Sensor Angle		**ANGLE** is a rotary switch Unit which simply includes a 10K Ohm potentiometer inside. This unit can be used for Continuous signals control in applications such as volume control, brightness adjustment or motor speed. A potentiometer is a manually adjustable variable resistor with three terminals: two terminals are connected to a resistive element; the third terminal is connected to an adjustable wiper. The position of the wiper determines the output voltage. The out voltage is captured and converted by AD on ESP32 on port B. The Output voltage range is: 0 ~ 2500mV It has a GROVE interface and is supported by the UIFlow IDE. It also has two Lego-compatible holes.
Actuator MiniFan		It is a small, simple **DC motor** with no gear connected to a small fan piece (60 mm mini fan paddle). This N20 motor has a 5V DC supply voltage. The output shaft has a rotational speed of 8800 RPM, single-direction rotation. It has a GROVE interface and is supported by the UIFlow IDE. It also has two Lego-compatible holes.
Actuator Servo		**SERVO HAT** as the name suggests, is a **servo motor** module. It comes with 145°±10° range of motion and can be controlled by PWM signals. The signal pin of the hat is connected to G26 on M5StickC. **Features**: • Servo Type: Digital • Spinning speed: 0.09sec/60° • Gear material: Plastic • Weight: 2.5g • Torque: 0.25Kgf.cm(at 4.8v) • Voltage: 5.0V±0.2V

Actuator BugC		It is a little **robot** resembling a **Bug**. It has: 4 Geared motors (1 each leg), 2 RGB LEDs onboard, equipped with a battery holder. It allows flexible movement in all directions. More specifically, the motors specifications are: • Rated voltage: 3.7V DC • Rated speed: 15000-2000rpm • Rated current: 50mA • Stall current: 70mA • Insulation resistance: 10MΩ It can be programmed using the UIFlow IDE and it can be connected to the M5StickC as a hat.
Actuator PuppyC		**PuppyC** is a programmable four-legged robot base compatible with M5StickC. It contains a microcontroller, 4 micro servos (Servo angle range : 0-180°), a battery holder and an independent switch. PuppyC base is an HAT to the M5StickC controller. After the M5StickC is programmed, it communicates with PuppyC through the I2C protocol to control the steering motion. It walks slowly and is easy to control. It can be programmed using the UIFlow IDE and it can be connected to the M5StickC as a hat.
Loudness sensor		The Loudness Sensor is designed to detect the loudness of environmental sound. Based on amplifier LM2904 and a built-in microphone, it amplifies and filters the high-frequency signal that is received from the microphone, and outputs a positive envelope. The output value depends on the level of the sound input. In order to avoid unnecessary signal disturbances, the input signal will go through two times filtering inside the module. Lastly, there is a screw potentiometer that enables manual adjustments to the output gain. It can be programmed using the UIFlow IDE and it can be connected to the M5StickC grove port.

box and box lid		The basic toolkit is shipped in a 5-liters box that collects all the components of the kits and also some additional material that teachers would like to store. It is tailored to the project's needs by means of stickers reporting the logos of the RoboPisces partners, the RoboPisces logo and website, and the version of the kit.

To know more about the robotics concepts behind this technology visit our online course at the RoboPisces MOOC . To get an overview of the toolkit visit https://www.robopisces.eu/robofish-basic-toolkit/.

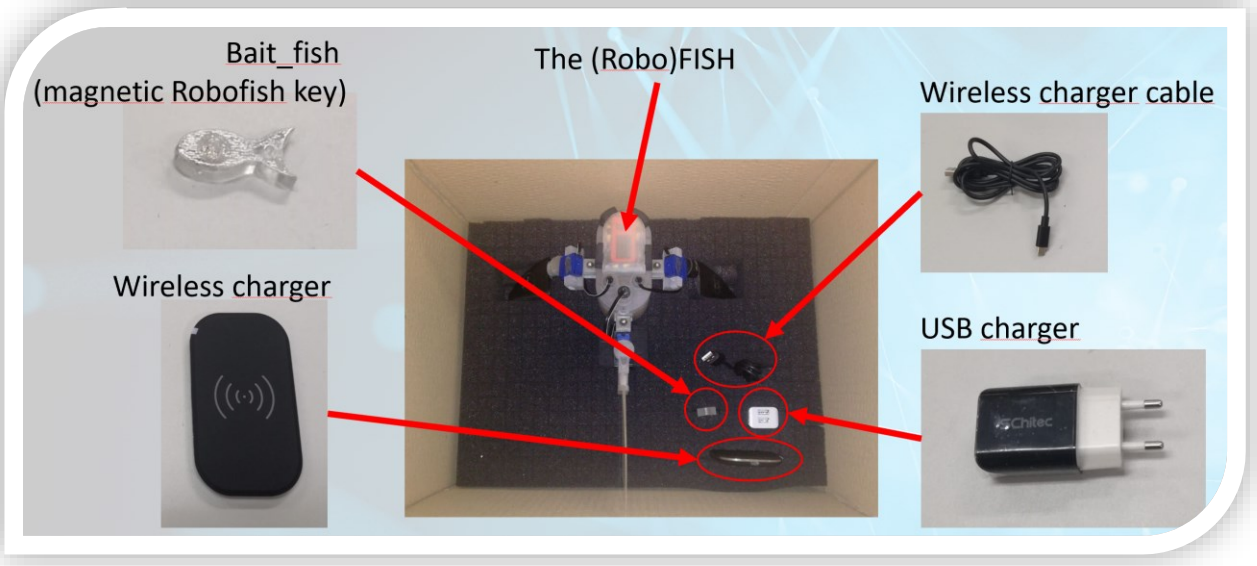
2.2 Advanced toolkit

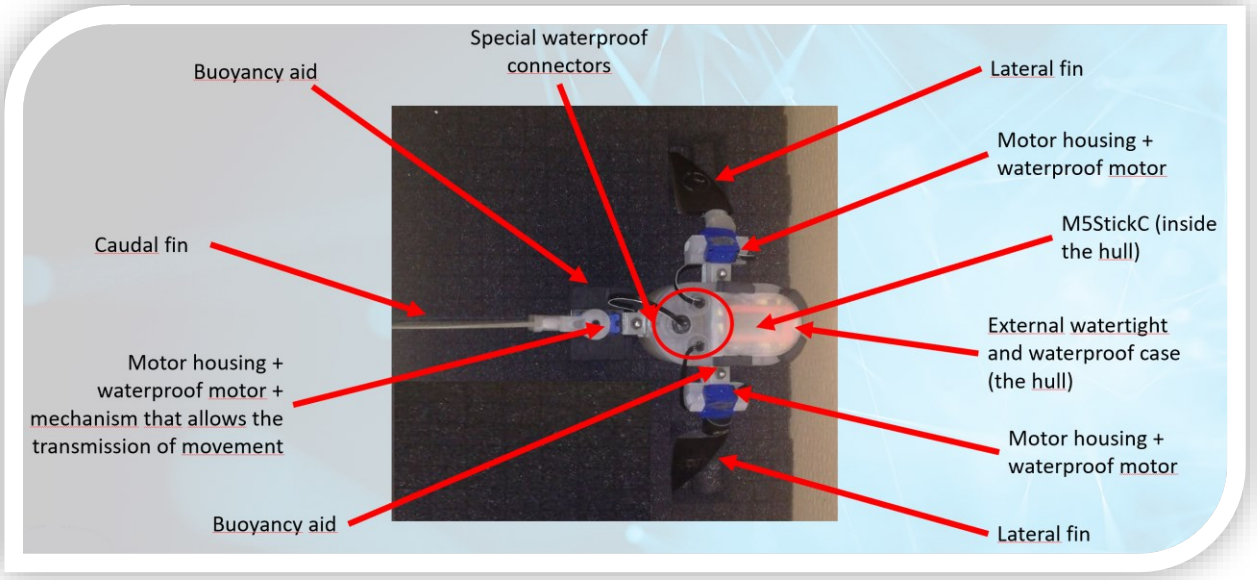
The advanced RoboFISH toolkit is designed to bring educational marine robotics into the classroom. It is a fully assembled waterproof and watertight robot that let students safely explore concepts about marine environment. In addition, it comes in the shape of a little marine fish.

It is based on the same ESP32 technology of the basic toolkit, so that teachers and students can concentrate only on the educational activity, not on learning another programming language or knowing from scratch another device.

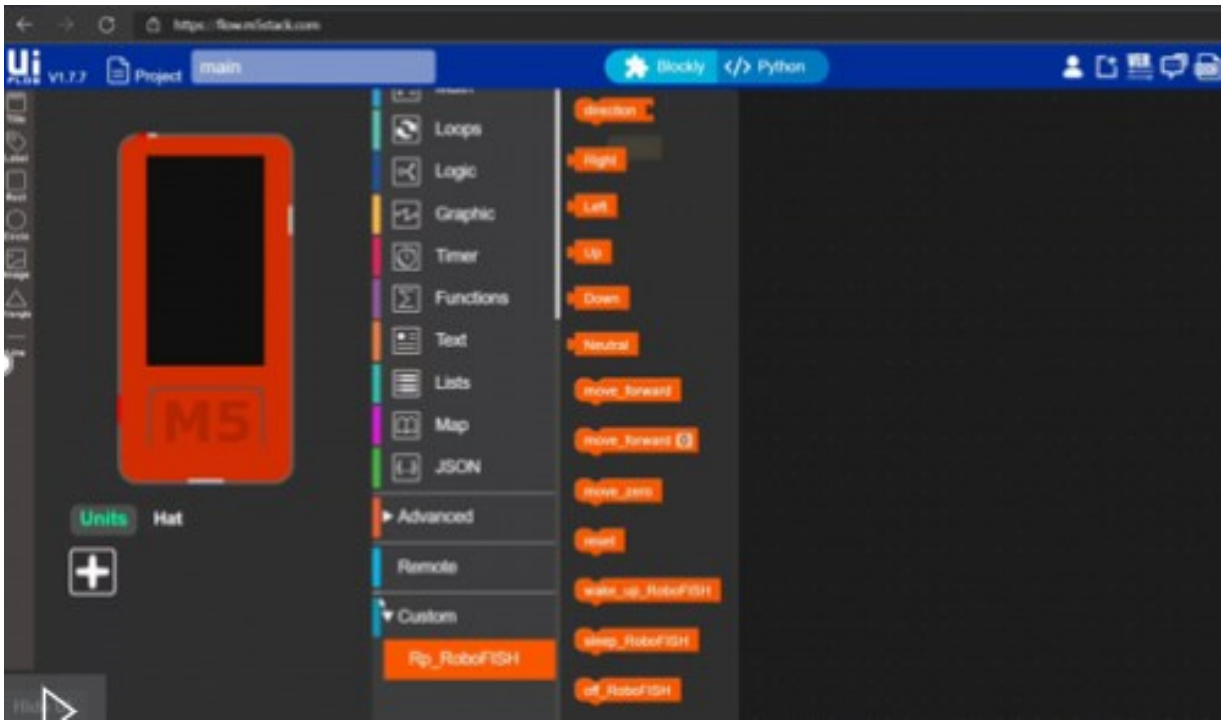
It can be charged thanks to a Wi-Fi charging system. There's no need to open the sealed hull because every button can be pressed thanks to a magnetic key that operates the command. Moreover, the LCD screen, a functionality that is much appreciated by students is visible from the hull thanks to its transparency.

The RoboFISH is shipped in a box containing every single useful element to operate it.





A dedicated software add-on was developed within the project to program the RoboFISH advanced kit. It can be downloaded from the RoboPisces MOOC learning platform and it allows students to intuitively program the robot. The add on integrates perfectly with the UIFlow IDE based on Blockly programming language.



To know more about the robotics concepts behind this technology visit our online course at . To get an overview of the toolkit visit https://www.robopisces.eu/robofish-advanced-toolkit/.

3 Educational activities with the RoboFISH toolkit

3.1 Online Teacher Training course

To learn the ropes about robotics, marine environment, IoT and educational tips and tricks about the integration of robotics into the school curricula, teachers can follow the self-paced online course available at the RoboPisces MOOC. Here, teachers can watch videos about the theory, download demo software to operate the toolkit, read the full description of the activities, discuss ideas in the forum section and also ask for help or additional information about the course contents, if needed.

All the materials are OERs under the CC BY-NC-SA 4.0 license.

3.2 RoboPisces Teacher Training Manual (IO4)

A very interesting and important result of our project is the Teacher Training manual, which can lead teachers through the discovery of the fundamentals of educational robotics. It can be easily downloaded from https://www.robopisces.eu/io4/ and from the RoboPisces MOOC.

3.3 RoboPisces Curriculum (IO3)

Smart learning relies on both technology and pedagogy to meet the needs of the students who will work and live in the 21st century and beyond. The Robopisces curriculum is an inventory of activities that exploits the potential of the RoboFISH toolkit. It is vailable at https://www.robopisces.eu/io3/ and at the RoboPisces MOOC.

More information about the project at…

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