KA201: Strategic Partnerships
for school education

RoboPisces

"innovative educational ROBOtics

strategies for PrImary SChool ExperienceS"

WP2: Curricula and tool development
D2.3.1: "Report on version v0.1 of the basic kits used during C1"

Responsible Organization: Università Politecnica delle Marche

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Preface

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01/03/2021	0.1	Initial version of the deliverable

1   Introduction

1.1   Scope and objectives of the deliverable

This deliverable is related to WP2 "Curricula and tool development" T2.3.3 "Report on version v0.1 of the basic kits used during C1" of the Work Plan (Annex I of the Monitoring and Evaluation Plan).

The scope of the deliverable is to report the development of v0.1 of the basic toolkit, which is the teacher's kit sent in August to the teachers who were going to take part in the training online.

Objectives of the deliverable are: to report the genesis of the toolkit as it is, to describe the toolkit in this phase, to briefly report its functioning, to describe teachers' acceptance of the toolkit, to highlight next steps in the development of the basic toolkit, which will be the v2 (student's kit).

1.2   Introduction to the basic toolkit v0.1

At the kick-off meeting the RoboPisces partners agreed that instead of using the SAM Labs, as stated originally in the proposal, UNIVPM would have searched the market for other tools more economic and compliant to the project's needs.

UNIVPM identified the basic topics of Robotics, IoT, and Marine Robotics that would have laid the technological foundation of the RoboPisces curriculum (IO3). The RoboPisces curriculum (IO3), whose leader is LU, is closely related to the IO2 since the toolkit will be part of the curriculum and the activities. The IO3 will develop a large and comprehensive set of activities based on the toolkit; IO3 will provide useful educational tips, lesson plans, and assessments.

UNIVPM searched the market and retrieved a better solution to answer the project needs: an ESP32-based device with a lot of possible applications, ranging from the development of traditional terrestrial robots to the development of environmental activities (in particular, it also allows the realization of activities about the marine environment) and IoT. Moreover, this device could be integrated into the RoboFISH advanced kit to allow students and teachers to focus on the new topics once they learned the basics of the device. Notably, this new technology could bring the possibility to provide schools with more kits since it is less expensive than the ones envisaged in the first place during the proposal submission. Another advantage of the kit is the shape factor: it is big enough to be handled by primary school students, and it is small enough to be included in a more portable RoboFISH advanced kit.

Before the COVID-19 pandemic, it was envisaged that teachers could benefit from the live course on the fundamentals of Robotics, Marine robotics, and IoT. During the virtual meeting (held online on the 18th May 2020) UNIVPM presented the toolkit and the plan for the release of the kits. During the same meeting, partners agreed to be trained online on the use of the toolkit to be prepared to start the activities in the second year of the project.

In August 2020 the basic toolkits v0.1 were shipped to partners and the online course was opened on the UNIVPM e-learning platform (https://learn.univpm.it/course/view.php?id=10571). Each topic identified as fundamental for the curriculum was turned into a key lesson for teachers.

1.3   Structure of the deliverable

Chapter 1: description of the scopes, objectives and structure of the deliverable.

Chapter 2: report of the RoboFISH curriculum, a collection of topics that covers the fundamental aspect of Robotics.

Chapter 3: description of the RoboFISH basic toolkit v0.1

Chapter 4: report of the relevant comments from teachers

Chapter 5: report of the planned next steps in the development of IO2

2   The RoboFISH topics

UNIVPM identified 3 groups of required technological topics to be faced with the RoboFISH toolkit, divided into basic and advanced: Fundamentals of robotics, IoT and Marine Robotics.

The basic topics are:
1. Robot Design Jobs
2. Robotics Disciplines
3. HW & SW tools for Robot Design
4. My first machine
5. The Robot brain: Action-Reaction
6. Senses and Sensors
7. Muscles and Actuators
8. My first robot
9. Listening and Communicating
10. My first p2p communication

The advanced topics are:

- The IoT group:
    1. The robotics things
    2. Robots and sensors network
    3. Distributed actuation
- The Marine robotics group:
    1. Peculiarities of the environment we are moving into
    2. The right actuators for the environment
    3. The right sensors for the environment

These topics are the basis for the RoboPisces curriculum, which is thus mirrored in the picture below. The first year of implementation corresponds to the group of basic topics, whereas the second year of the curriculum corresponds to the advanced topics.

At the end of each year students will be able to assemble and program their robot. At the end of the first scholastic year of implementation of the curriculum, students will be able to assemble and program a robot that can move on the ground. At the end of the second year of the implementation students will be able to realize the "smart things" they invented and to program and customize the RoboFISH advanced toolkit that will move underwater.

As already mentioned, the RoboPisces educational curriculum (IO3) will be an inventory of activities that will build upon the RoboFish kit (IO2). UNIVPM provided the presentation of the topics that can be developed throughout the curriculum with the RoboFish kit to partners. The figure below graphically represents a two-year educational path that can be developed following a linear route made by several educational spots.
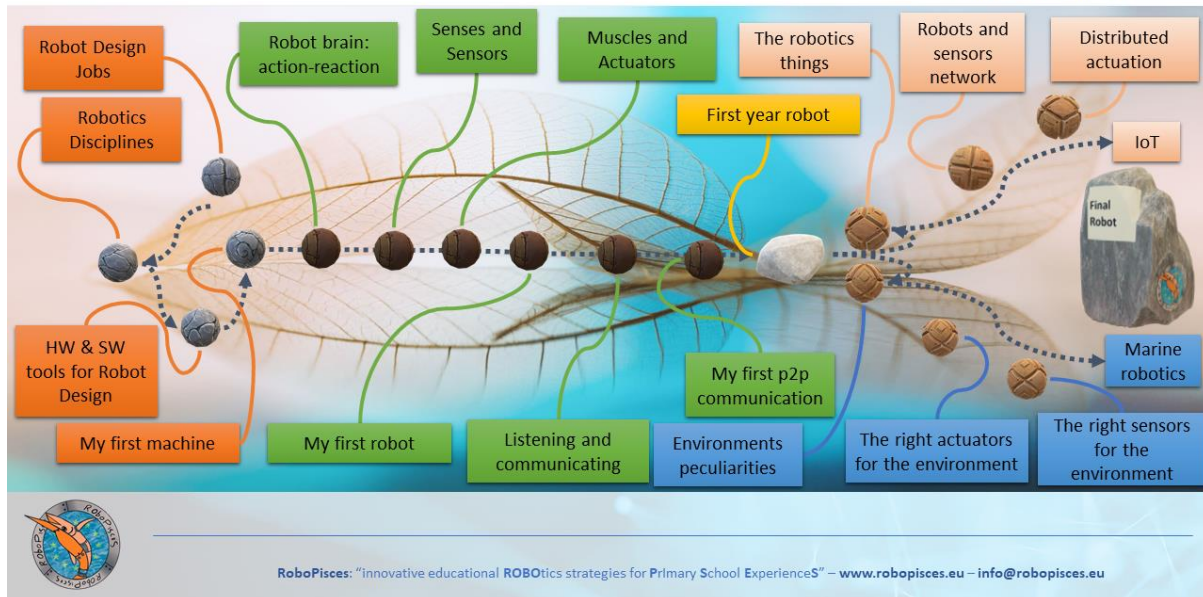
A first plan was to have:

- two quarters (year 2020/21) dedicated to the basic curriculum which will provide students with the basic notions of Robotics;
- then, two quarters (the last year of the project 2021/22) dedicated to the advanced curriculum (IoT and distributed control strategies, the marine environment and marine robotics).

Each spot in the two-school-year educational path represents a topic (namely key-lesson). UNIVPM delivered each topic through a tutorial for teachers. Each tutorial guides teachers on how to use the toolkit elements to explore that topic with his/her classrooms. Through these tutorials, teachers can build their technical skills and competences. Upon this core knowledge, teachers can also easily integrate other elements of their teaching mastery to enrich their lesson plan and target the lesson to the needs of their students (adding theoretically other small spots on the fishbone). It is essential on this point to have at the end of the term a detailed report of the lessons to produce the final outputs of the project in two directions: for IO3 (educational curriculum) and IO4 (Teacher training manual).

The online teachers' training course's structure was organized around these topics. Each topic became a key lesson for teachers. Each topic became a set of lessons (one or more) developed by the universities of the project and adapted to the special situation by teachers.

3   The RoboFISH basic toolkit (v0.1)

3.1   List of parts

The teacher's kit includes:

Component	Q.ty	Purchase link
Access Point	1	https://www.amazon.it/gp/product/B07S7T6WTT/ref=ppx_yo_dt_b_asin_title_o02_s00?ie=UTF8&psc=1
USB C cable	1	https://www.amazon.it/AUKEY-Intrecciato-Ricarica-Trasmissione-Samsung/dp/B07X5L6NFL/ref=psdc_1486835031_t1_B01CFI3QDC?th=1
Central Unit+ ENV sensor + SPK	1	https://m5stack.com/collections/m5-core/products/m5stickc-development-kit-with-hat
I2C Extender cable (1m)	1	https://m5stack.com/products/4pin-buckled-grove-cable
I2C Extender cable (2m)	1	https://m5stack.com/products/4pin-buckled-grove-cable
I2C Grove-T Connector	5	https://m5stack.com/collections/m5-accessory/products/grove-t-connector-5pcs-a-pack
Sensor Button	1	https://m5stack.com/collections/m5-unit/products/mini-dual-button-unit
Sensor Joy Unit	1	https://m5stack.com/collections/m5-hat/products/m5stickc-joystick-hat
Sensor Moisture	1	https://m5stack.com/collections/m5-unit/products/earth-sensor-unit?variant=16804783882330
Sensor Angle	1	https://m5stack.com/collections/m5-unit/products/angle-unit
Actuator MiniFan	1	https://m5stack.com/collections/m5-unit/products/mini-fan-unit
Actuator Servo	1	https://m5stack.com/products/m5stickc-servo-hat?_pos=5&_sid=308ffde4f&_ss=r
Actuator BugC	1	https://m5stack.com/collections/m5-hat/products/bugc-w-o-m5stickc
Actuator PuppyC	1	https://m5stack.com/products/puppyc-w-o-m5stickc?_pos=8&_sid=308ffde4f&_ss=r
Loudness sensor	1	https://www.seeedstudio.com/Grove-Loudness-Sensor.html
box		https://www.ikea.com/it/it/p/samla-contenitore-trasparente-70102972/

| box lid | | https://www.ikea.com/it/it/p/samla-coperchio-per-contenitore-l-5-trasparente-10110300/ |

3.2 Basic Functioning

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. Current Firmware version is 1.4.5
ENV sensor		It is an environment sensor which can sense **temperature**, **humidity** and **atmospheric pressure**. It is built with SHT30, BMP280 and BMM150 sensors, it is programmed over I2C. SHT30 is a digital temperature and humidity sensor with high precision and low power consumption. BMP280 is an absolute barometric pressure sensor which is especially

		designed for mobile applications. BMM150 is a magnetometer, which can be used to monitor the change and the direction of magnetic field. It offers the highest flexibility to optimize the device regarding power consumption, resolution and filter performance.
SPK		SPK HAT is an M5StickC compatible **speaker**, integrated PAM8303 amplifier (3w single channel type D power amplifier), High PSRR and differential inputs eliminate noise and rf interference, thus it has the characteristics of simple functions and high audio reproduction.
I2C Extender cable (1m)		This **GROVE cable**, compatible with the GROVE port on M5StickC, 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. It comes in 2 sizes (1m and 2m) to allow units to be placed near or far from the M5StickC.
I2C Extender cable (2m)		This **GROVE cable**, compatible with the GROVE port on M5StickC, 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. It comes in 2 sizes (1m and 2m) to allow units to be placed near or far from the M5StickC.
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 with 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. A STM32F030F4 microprocessor inside this block implements the I2C communication (address: 0x38) 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, in the most streamlined way, which allows to get more HMI experience.
Sensor Moisture		EARTH unit is a **Soil Moisture Sensor** for measuring the moisture in soil and similar materials. The soil moisture sensor usage is pretty straightforward: the two large exposed pads function as probes for the sensor, together acting as a variable resistor. The higher moisture that is in the soil means the better the conductivity between the two so that 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. Inside this Unit an extra potentiometer allows to change the measurement range (Adjustable threshold, including 10K adjustable resistor). 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 signal rotatory control for applications such as volume, brightness, 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 portB. In M5Stack product system, Normally the Grove color indicates the type of communications: • Black: Single BUS (AD ,DA ,GPIO) • Red: I2C • Blue：Uart • White： Others(depends) Output voltage range: 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 N20 Motor (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 with the new and upgraded "ES9251II" digital servo. This 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 the STM32F030F4 microcontroller, 4 SG90 micro servos (Servo angle range：0-180°), a battery holder and an independent switch. PuppyC base needs to be used with the M5StickC controller. After the StickC is programmed, it communicates with PuppyC through the I2C protocol (0x38) to control the steering motion. It walks slowly and is easy to control. Due to the small contact area, the movement is slow and the frictional force is as large as possible

		even on a soft surface. It can be programmed using the UIFlow IDE and it can be connected to the M5StickC as a hat.
Loudness sensor		The Grove - 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		This 5-liters box can collect 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.

The picture below shows the **UIFlow IDE** version 1.4.5 and the corresponding M5StickC that is about to be connected (little rectangle on the bottom right side of the picture):
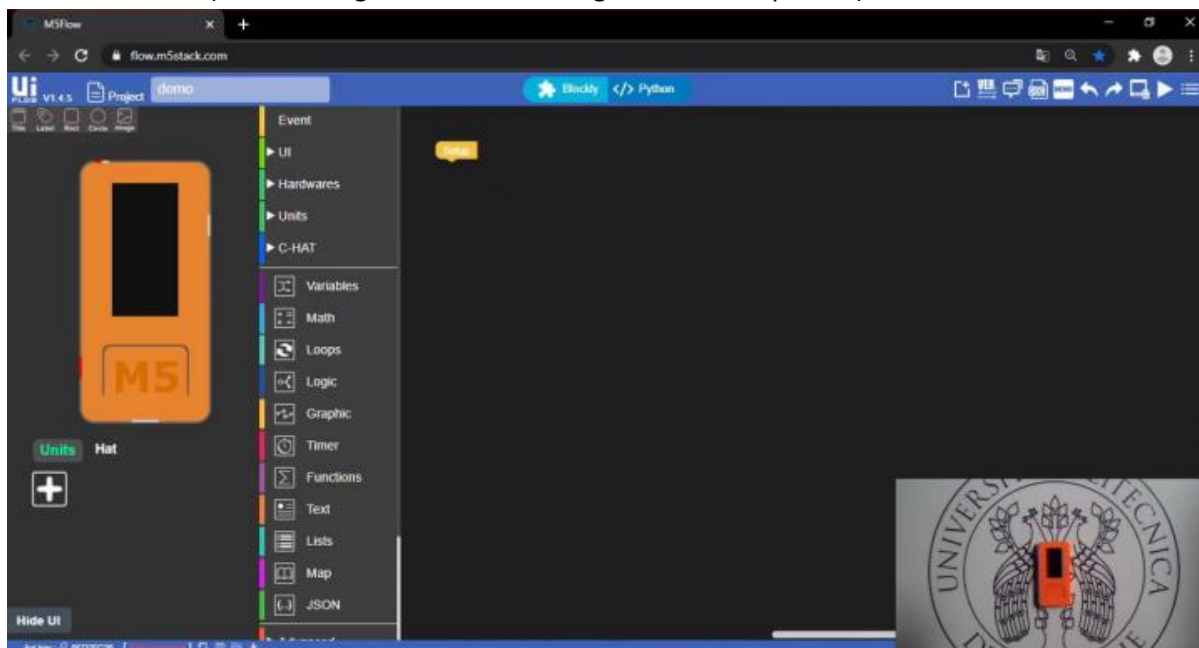
On the IDE students can find the blocks that help them program their device. They can use the blocks for doing math and logic ("Math" and "Logic" from the vertical menu of the available blocks) or they can use blocks for changing the light color of the screen ("Hardwares"). They can select the blocks that will drive the functioning of units and hats after selecting "Units" or "Hats" and then the "+" white sign under the virtual M5StickC on the left of the screen; a menu of all hats or units will appear and students will have to select the unit or hat that they want to insert in the project. Each M5StickC can communicate with other M5StickC by means of a specific protocol, which is called "EspNow". Blocks for communication via EspNow can be found under the Advanced menu on the central column of the screen.

4 Feedback on the RoboFISH basic toolkit

4.1 Delivering the toolkit

The kits were shipped by UNIVPM using the DHL courier (all but IC Solari which received the kits by hand from the coordinator) to the schools originally involved in the project:

RP school country	No. Of kits sent	shipped
Croatia	2	26/08/2020
Malta	2	05/08/2020
Italy	2	28/08/2020
Greece – Rafina	1	05/08/2020
Greece - Rhodes	1	05/08/2020

The kits were also shipped to other project's partners and stakeholders to further commit and engage in the project activities:

Country	Name	position	No. Of kits sent
Ireland	Eleni Mangina	RP partner and AR/VR expert	1
Greece	George Sarrigeorgeou	RP partner and teacher at a vocational school	1
Latvia	Linda Daniela	RP partner and expert in smart pedagogy	1
Italy	Mariantonietta Valzano	primary school teacher	1
Italy	Paola Pazzaglia	primary school teacher	1
Italy	Antonella Puccetti	primary school teacher	1

4.2   Feedback from teachers after the Online training course

Questions were:

1. The course structure was clear to me
2. The course contents were simple
3. The course contents were explained very well
4. It was hard to understand how to navigate through the course
5. I already knew the contents of the course
6. I need more information to understand the topics
7. Topic 1 and 2 were unnecessary
8. Topics are too difficult for teachers.
9. Topics are too difficult for students
10. I really struggled with the activities on the kit
11. I didn't grasp the meaning of the introductory (theoretical) part of the topics

	1	2	3	4	5	6	7	8	9	10	11
	%	%	%	%	%	%	%	%	%	%	%
Strongly disagree	0,00	3,23	0,00	16,13	12,90	0,00	32,26	9,68	3,23	0,00	12,90
Disagree	3,23	16,13	0,00	48,39	38,71	16,13	45,16	29,03	22,58	12,90	41,94
Neutral	9,68	45,16	32,26	6,45	29,03	32,26	6,45	32,26	25,81	45,16	32,26
Agree	61,29	22,58	54,84	16,13	9,68	35,48	3,23	9,68	19,35	29,03	3,23
Strongly agree	19,35	6,45	6,45	6,45	3,23	9,68	6,45	12,90	22,58	6,45	3,23

The answers were strongly influenced by the presence of the category "neutral". Bearing that in mind, about the 61% of the teachers found the course explained very well (Q3), and the 30% of the teachers found it simple (Q2) and only about the 22% found it too difficult for teachers. Only about the 14% of teachers were already familiar with the contents of the course (Q5). Theoretical introduction to the topics were easily understood by 55% of the respondents (Q11) and topics 1 and 2 (introductory activities to Robotics) were much appreciated (Q7, 77%). Activities with the kit were the ones that most challenged the teachers (Q10, 35%). When asked during meetings, teachers emphasized the fact that most of them were absolute beginners to robotics; moreover, they added that their learning was slowed down due to the several duties they were charged as an extra to face the COVID19 restrictions and guidelines. They had to adapt to distance learning abruptly when the coronavirus spread the first time; then, they had to adapt the classroom environment to restore the learning activity in the school obliging to the national rules for the containment of the spread of the disease. Notwithstanding the difficulties, they reached the end of the course with success. As a note, they found that if they could have more time to spend on practical activities with the kit and to be in the same room with the experts guiding their exploration they would progress much faster and in a more engaging way. They do hope that the next training activity C2 could take place as a on site activity and not remotely.

Teachers also asked to provide a glossary of difficult technical terms. It was agreed with the leader of IO4 (UAegean) that such glossary would have been added to the Teacher Training Manual to improve its efficacy, enhancing the clarity of the training.

5   Next steps

Next steps include to develop and ship the student's kit (the RoboFISH basic toolkit v2) before the start of the implementation.

Unfortunately, due to the spread of the coronavirus, the completion of the online course took longer than expected. So, first results from the teachers' evaluation, which was planned to let UNIVPM receive feedback on the kits at C1 completion, arrived at the end of January. The v2.0 kits could be assembled following the feedback reported by teachers during the online meetings and during TPM2. Partners decided that the basic kits v2.0 would be shipped to schools anyway in order to make the teachers ready to start activities as soon as the situation could allow it, to let teachers familiarise further with the kit and to present it to other colleagues