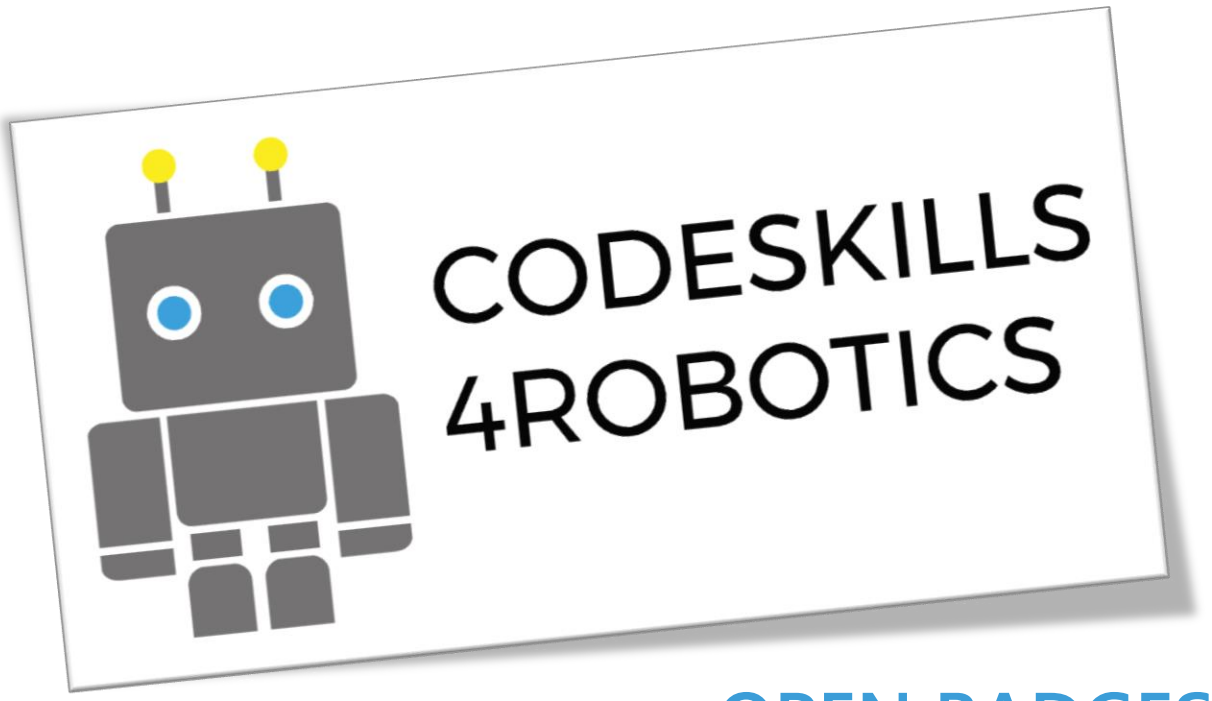

OPEN BADGES ECO-SYSTEM GUIDE

CODESKILLS4ROBOTICS: Promoting Coding & STEM Skills through Robotics: Supporting Primary Schools to Develop Inclusive Digital Strategies for All

IO3: The Eco-System of the CODESKILLS4ROBOTICS Assessment & Validation Methodology Through the Open Badges

Partners: Emphasys Center, Cyprus, N.C.S.R. "Demokritos", Greece

Grant Agreement No: 2018-1-EL01-KA201-047823

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ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ ΙΚΥ

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CODESKILLS 4ROBOTICS

Table of Contents

1. Introduction

Based on IO1 (CODESKILLS4ROBOTICS Competence Framework) and IO2 (Dual Educational Back Pack), IO3 develops the Open Badges eco-system for the validation of the skills to be acquired by both primary school teachers and students as well as the structure and description for issuers: primary school teachers.

This reports aggregates the work done in the framework of IO3 (The Eco-System of the CODESKILLS4ROBOTICS Assessment and Validation Methodology Through the Open Badges) and specifically all three activities specified in the proposal:

IO3-A1: Design the eco-system for the implementation and use of the Open Badges

IO3-A2: The CODESKILLS4ROBOTICS Guide

IO3-A3: Preparation for the development of the Assessment Tool

The Open Badges (OB) system aims to introduce Quality standards for Coding and Robotics skills in primary schools, both in relation to the strengthening of Teachers profiles and in relation to the introduction of evidence-based data for Quality Assurance.

Acquiring Open Badges is a motivating procedure, which provides incentives for primary school students to continue their training. It is linked to the coding and robotics skills, as Open Badges are created online through the use of an open-platform and can be shown on various personal pages. In addition, at a later step, primary school teachers and later students can use this method in their own work environment to motivate their colleagues/employees/volunteers.

Open Badges were originally developed by the Mozilla Foundation with funding from the MacArthur Foundation (Surman M., 2011). The Open Badges Standard describes a method for packaging information about accomplishments, embedding it into portable image files as a digital badge, and establishing an infrastructure for badge validation.

2. CODESKILLS4ROBOTICS Project Consortium

The CODESKILLS4ROBOTICS Consortium consists of six (6) Organizations from four (4) European countries:

P1	GR	National Center for Scientific Research "Demokritos"
P2	BE	Lifelong Learning Platform
P3	GR	Regional Directorate of Primary and Secondary School Education of Crete
P4	CY	Emphasys Centre
P5	GR	Hellenic Mediterranean University
P6	SE	Halsingland Education Association

3. Aims of IO3

Based on the development of the benchmark research to map out the current scene in each country, the development of the Digital Competence Framework (IO1) and the Educational Back Pack accompanied with the campaign (IO2), the main aims of IO3 are to:

- Develop the theoretical background of the methodology used
- Identify within the Competence Framework design in IO1 the benchmarks and indicators which are crucial and can be linked to specific levels of the Open Badges i.e. levels that need to be achieved in order for a student to receive an Open Badge.
- Create the structure (levels, hierarchy connections between single badges or group of badges)
- Allocate a task/test/challenge that needs to be accomplished to be awarded with each Open Badge and make the necessary links in relation to the assessment process and the tool to be used.
- Develop graphic design (png images) of badge system
- Take all technological actions to link the Open Badges eco-system to the developed e-platform in terms of taking the quests - challenges, issuing Open Badges and exhibiting Open Badges on students and teachers' profiles.
- Investigate possible ways that Open Badges can be endorsed by external organizations and stakeholders – synergies.

The introduction of this recognition and validation process through the use of the Open Badges is an added value to the project, as it enables both teachers and students to have a valid proof of the acquisition of basic coding and robotics skills, which can be added to their CV/digital profile. The Open Badges is a motivating procedure which encourages and provides incentives for active participation.

4. The Theory of the Open Badges Eco-System

4.1 Open Badges

Open Badges are a digital representation of skills, learning outcomes, achievements or experience such as:

- Hard skills: knowledge, competences, etc.
- Soft skills: collaboration, communication, etc.
- Participation and community involvement
- Official certification
- Authorization

Open Badges are verifiable, portable digital badges with embedded metadata about skills, achievements and experience, and they are shareable across the web. Each Open Badge is associated with an image and information about the badge, its recipient, the issuer, and supporting evidence. Badges can be used to set goals, to motivate behavior or convey success. They can be particularly useful for recognizing new forms of learning beyond the traditional classroom environment. Learning happens everywhere, and badges provide a way to validate the outcome.

4.2 Benefits

The benefits of using Open Badges are:

- Badges can demonstrate a wider range of skills and achievements of a learner acquired through formal, non-formal and informal learning methods and activities.
- Badges are portable and verifiable digital objects. All this information may be packaged within a badge image file that can be displayed via online CVs and social networks.
- Each Badge includes the description of the achievement: i.e., it describes the particular path a learner undertook for his or her achievement, accompanied by the evidence to support the badge award.
- Each Badge includes information about the earner's identity, a link to information about the issuer and a link to a description of what a badge represents.
- Badges can be used to unlock learning and career pathways. They can be used to support individuals to achieve learning goals, to provide routes into employment; and to nurture and progress talent within organizations.

- Badges can represent personal attributes that matter to employers (such as soft skills)
- Badges can be used in professional context. Thousands of organizations, including non-profit organizations, major employers or educational institutions, issue badges in accordance with the Open Badges Specification.

Figure 1: Understanding Open Badges

4.3 Key Elements

4.3.1 The Issuer

The issuer defines a competence that could be acquired by a user, designs the learning material for it and assesses the users with regards to the acquisition of the competence. The issuer then creates a relevant badge and makes it available for earning by any user. For each badge, the issuer should make available details of the criteria that an earner must meet in order to be awarded the specific badge. The reviewer of an assessment compares the evidence provided by the earner against the specific badge criteria.

Any individual or organization can create an Issuer profile and begin defining and issuing Open Badges. This is being done by a diverse range of organizations and communities, including:

- Schools and universities

- Employers
- Community and nonprofit organizations
- Government agencies (including NASA)
- Libraries and museums.
- Event organizers and science fairs (Including Intel)
- Companies and groups focused on professional development (such as the CODESKILLS4ROBOTICS consortium)

An entity that can be described with a name, a description, an URL, an image, and an email address is a possible candidate to become an issuer. It furthermore needs a technology platform that supports the Open Badges Specification in order to issue Open Badges.

4.3.2 The Platform

Many companies have been creating badge issuing platforms compliant with the Open Badges Specification. They provide a wide range of services which allow non-technical users to issue Open Badges credentials. The platforms used for issuing Open Badges offer a variety of custom services including online badge designers, badge discovery, issuing, assessment workflow, display, user profiles, social sharing and tools to integrate with existing learning systems. All Open Badges issuing platforms allow recipients to export their badges to other online options. This allows users to stack and share their badges earned on different platforms and to choose their own spaces to establish their identity on the web.

4.3.3 The Earner (Recipient)

Open Badges help to recognize skills gained through a variety of experiences, regardless of the age or background of the learner. They allow earners to get awards for following their interests and passions, and to unlock opportunities in life and work by standing out from the crowd. Earners have to register on the organization's platform and can claim a badge when the pre-defined criteria have been met during the evaluation phase.

4.3.4 Evaluation

There are different options for the assessment process:

- Asynchronous assessment: learners seek out the assessment when it is convenient for them instead of being required to take an exam at a pre-determined time.

- Stealth assessment: assessment and awarding badges can happen automatically and provide immediate feedback.
- Portfolio assessment: work samples, projects and other artifacts the learner has produced can be used as evidences for claiming a badge.
- Multiple assessors or group assessment: multiple contexts of assessment such as course organizers, peers or learners themselves.

4.3.5 The Displayer

Open Badges are designed to be shared. By sharing them, individuals exhibit their achievements to others and turn them into a valuable currency to unlock new opportunities.

Badges also can be shared:

- On blogs, websites, e-Portfolios, and professional networks
- In job applications
- On social media sites - Twitter, Instagram, Facebook, LinkedIn
- In our email signature

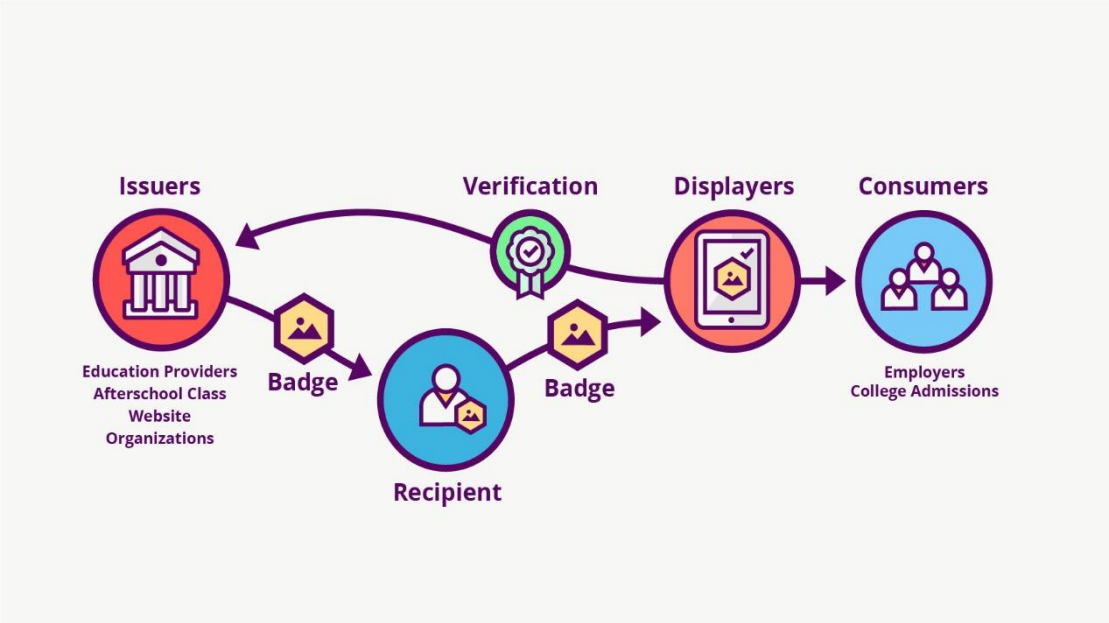


Figure 2: The Open Badges Eco-System

The above image, depicts the Open Badge eco-system. Issuers deliver a Recipient baked Open Badge images, which he/she stores in a Backpack or other displayer, which verifies the content and display verified metadata to many Consumers who are interested in his/her accomplishments.

4.4 Technical Aspects

4.4.1 Badge Class and Assertion

An earnable badge is defined as a badge class, using a variety of data items including descriptions, criteria and information about the issuing organization. When an issuer decides to award that badge to a specific earner, he or she creates a badge assertion. A badge assertion describes the data for an awarded badge.

In particular, it includes:

- the earner's identity
- a link to the generic badge class linked to
- information about the badge issuer.

All the data for the badge is defined using JSON structures. To award a badge to an earner the issuer creates a badge assertion in JSON.

4.4.2 Badge Image Properties

The image for a badge should be a square PNG (or SVG). The file size should be a maximum of 256KB and should not be smaller than 90 PX square.

Things you can verify and explore in a badge:

- Details about the organization issuing the badge
- What the individual has done to earn the badge
- The criteria that the badge has been assessed against
- That the badge was issued to the expected recipient
- The badge earner's unique evidence (optionally included)
- When the badge was issued and whether it expires

4.5 Institutional Endorsements

Badges are like commercial products that have to be endorsed by a certain celebrity or institution in order to be promoted it in a wider sphere and to gain the support of the consumer. In this section, institutions from public and private sectors, which are endorsing open badges as a recognition tool, will be highlighted. Furthermore, the importance of endorsing a badge within the ecosystem will be highlighted.

4.5.1 Governmental Institutions

The Council of the European Union is one of the intergovernmental institutions which have expressed its support to the open badge as one of the nonconventional

approaches to recognize someone's work. In a conclusion made by the Council and Representatives of the Government of the Member States released in November 23, 2016, it was stated that "To appeal to young people and to ensure greater impact on their lives, new settings where young people spend their time, such as modern city infrastructure and virtual space, as well as new approaches using innovative online and offline tools (such as gamification, GPS based activities, learning badges or design thinking), should be reflected upon and taken into account in the further development of education and training of youth workers." (Council of the European Union, 2016). This statement affirms that learning badges such as open badges are one of today's trends in recognizing learners' skills and knowledge acquired by training.

Within the EU, the Lithuanian National Commission for UNESCO together with the Lithuanian Association of Non-Formal Education recommend the use of open badges to other UNESCO affiliated schools in the country (Lithuanian National Commission for UNESCO, 2016).

Aside from these EU bodies, in 2013 the U.S. Department of Education's Office of Vocational and Adult Education (OVAE), funded a study which "explores the feasibility of developing and implementing a system of digital badges for adult learners and the implications for policy, practice, and the adult education delivery system" (Finkelstein, Knight, & Manning, 2013). In the US, the following institutions have a long tradition implementing the open badge system as a recognition tool:

- EDUCAUSE - a leading association in the field of information technology focusing in higher education.
- The Society for Science and the Public administers the Intel International Science and Engineering Fair (Intel ISEF), - the largest precollege science completion in the world.
- The American Association for State and Local History
- The Yale Center for Emotional Intelligence

These institutional endorsements from various governmental bodies show that open badges are a legitimate tool to be considered and one of the trends in the 21st century which should be further explored in the field of formal and non-formal education.

4.5.2 Private Sector Endorsement

Aside from Mozilla Foundation which started with the idea of open badges, various entities in the private sector have been using open badges. For instance, the American company Microsoft "developed a badge system for the Partners in Learning Network (PiLN) of educators and school leaders to promote technological competencies and relevant skills in today's digital age." (Chow, 2014). On its official website, the company explains why they are offering badges: "Your digital badge allows you to easily share the details of your skills in a way that is trusted and verifiable" (Microsoft, 2016). One

of the well-known institutions which is using open badge is the National Aeronautics and Space Administration (NASA). In 2012, NASA together with Project Whitecard and the Wheeling Jesuit University collaborated to convince the California Academy of Science to implement Mozilla's open badge system in "recognizing life's achievements" (NASA, 2016). Aside from companies, formal education institutions have been also using open badges as a recognition tool. In Europe, some of these institutions include Beuth University of Applied Sciences Berlin in Germany, Newcastle University in the United Kingdom and Universitat de les Illes Balears in Spain (Mozilla Foundation, 2016c).

5. Open Badges for CODESKILLS4ROBOTICS

Open Badges provide portable and verifiable information about skills and achievements. Primary school teachers can give to their students the opportunity to earn Open Badges representing desired skill sets in a dynamic, evidence-based way. Open Badges represent legitimate, authenticated achievements described within the badge and linked to the CODESKILLS4ROBOTICS project.

5.1 CODESKILLS4ROBOTICS Open Badges Eco-system

The CODESKILLS4ROBOTICS consortium has designed the framework and teaching – learning material for Coding and Robotics skills which are presented in IO1 and IO2.

The e-courses that have been developed are:

Module 1: Develop Basic STEM and Programming Skills

Module 2: Building and Programming Small Robots & 4 Creative Scenarios

- Scenario 1: History Scenario - Talos: From the Legend to Modern Robots
- Scenario 2: Space Scenario - Robot from Earth to Space
- Scenario 3: Environment Scenario - The Environmental Facility
- Scenario 4: Culture Scenario - Form your own Robot Guitar Band!

The CODESKILLS4ROBOTICS consortium has designed and developed the following nine (9) Open Badges:

- One (1) Open Badge for the Teacher/Mentor
- Three (3) Open Badges for Module 1: One per level (Basic, Intermediate, Advanced)
- Four (4) Open Badges for Module 2: One per Cross-Curricular Scenario
- One (1) Overall Open Badge for the successful completion of the CODESKILLS4ROBOTICS training programme i.e., upon earning all seven (7) available Open Badges of Modules 1 & 2.

Thus, one (1) Open Badge is available to be earned by Teachers/Mentors and eight (8) Open Badges are available to Teachers/Mentors who wish to use them in their teaching courses for validating the newly acquired skills of their students through the integrated e-learning and e-assessment platform, which has been designed and developed specifically for the CODESKILLS4ROBOTICS project and its users.

5.2 Teachers Procedure

The procedure to be followed for teachers to become mentors is:

- Primary school teachers are invited to register on the CODESKILLS4ROBOTICS e-learning and e-assessment platform and self-enroll in all the available courses
- Successfully participate in the C1 Training Activity during the lifetime of the project and receive the Mentor Badge from the Consortium OR
- Read the available e-Books and successfully complete the "Become a Mentor" quiz (Annex 2)

The quiz comprises 12 questions (4 per level) and is available in Module 1 in order to receive the corresponding Mentor Badge automatically after its completion in order to automate the process, in an effort to sustain the project and exploit its results.

The passing grade is 75% i.e. users are required to answer correctly 9 out of 12 questions minimum. After the users take the quiz, it will be automatically marked and users will be able to instantly see whether they have successfully passed it or not and what grade they have achieved. Users have the opportunity for 2 attempts in case they fail the first time.

Correct and wrong answers will be highlighted for the users to see. Their final grade will be the highest (best) attempt of the two. Overall feedback will be shown to the teachers after they have completed an attempt at the quiz.

Hence, this is the second criterion, the first being to read the e-books and if users fulfil both requirements (criteria), the e-platform will automatically award them the Mentor badge. It must be noted that once teachers are awarded the Mentor badge, it is automatically displayed on their personal profile page.

5.3 Students Procedure

The procedure to be followed for students to earn badges is:

- Primary school students are invited to register on the CODESKILLS4ROBOTICS e-learning and e-assessment platform, self-enroll in the available courses of the CODESKILLS4ROBOTICS programme.
- Primary school students who attend and successfully complete the CODESKILLS4ROBOTICS course, will be able to claim/earn the available Open Badge(s)
- Mentors should award the Open Badge(s) through the e-platform to the students who successfully meet the criteria set by the consortium.

The criteria set by the CODESKILLS4ROBOTICS consortium in order for students to be eligible to earn an Open Badge are:

- Participate actively in the CODESKILLS4ROBOTICS Pilot Training Programme
- Successfully complete the exercises for Module 1
- Successfully complete the 4 cross-curricular scenarios for Module 2
- Create and account on the e-Platform
- Read and Study the e-Books on the e-Platform *
- Fill in the available questionnaires
- Show and develop Soft Skills
- Show and develop STEM Skills

* This is an automated process, hence, once the users go through all the pages of each e-book, the e-platform "understands" that the user has read the books and automatically marks the activity as "Complete" and notifies the teacher.

Upon completion of the CODESKILLS4ROBOTICS Pilot Training Programme, it is up to the Teachers/Mentors to determine whether the aforementioned criteria have been successfully met by their students in order to award them the corresponding Open Badges, which appear on their personal digital profiles on the e-platform.

5.4 e-Assessment Platform

All necessary actions were taken in order to technologically integrate the Open Badges Eco-System with the developed e-learning platform and integrate both the learning as well as the assessment aspects.

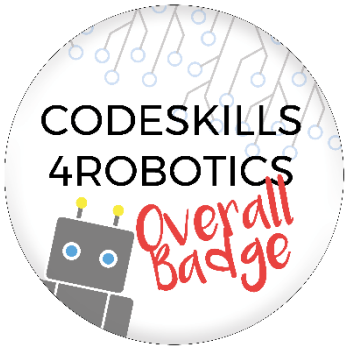
Therefore, the developed e-platform, which can be accessed at: http://codeskills4robotics.iit.demokritos.gr/ provides both functionalities to teachers and students making the e-platform both a learning as well as an assessment tool.

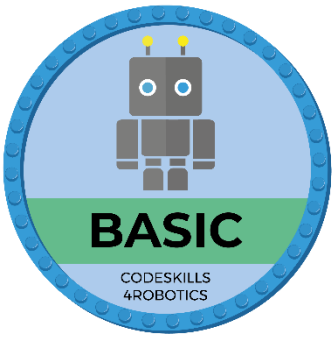
A special video clearly depicting the procedure for the awarding of the open badges by teachers to students has been created and is available on the YouTube Channel of the project here: "How to award an Open Badge".

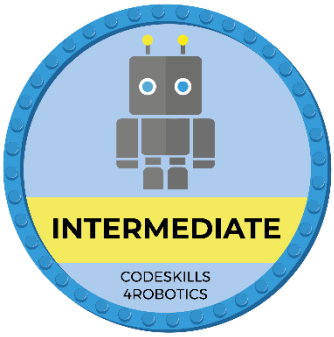
5.5 Open Badges Images and Tree Structure

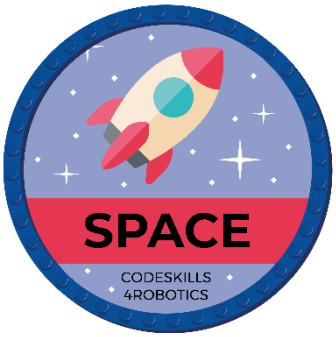
The tree structure for the CODESKILLS4ROBOTICS Badges is as follows:

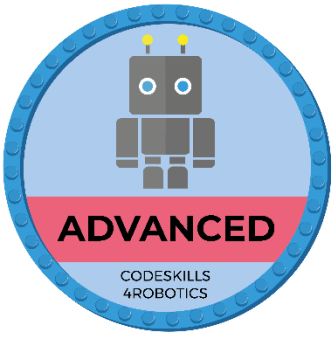
CODESKILLS4ROBOTICS Open Badges Structure











As it has been already mentioned, there is also the Teacher/Mentor Open Badge:

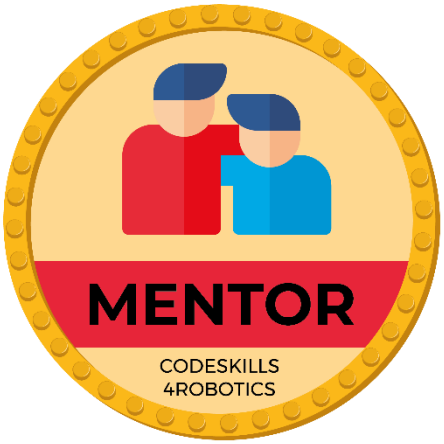


Figure 3: The Mentor Badge

Finally, some extra badges were designed for promotional purposes as part of the Campaign, namely:

- the Ambassador Open Badge
- the Pilot Training (Clubs) Open Badge

Figure 4: The Ambassadors Badge

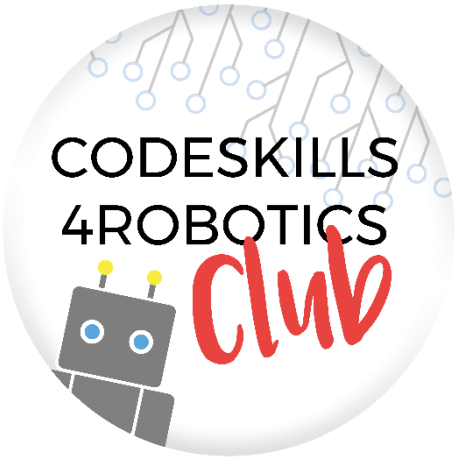


Figure 5: The Clubs Badge

5.6 Open Badges Metadata

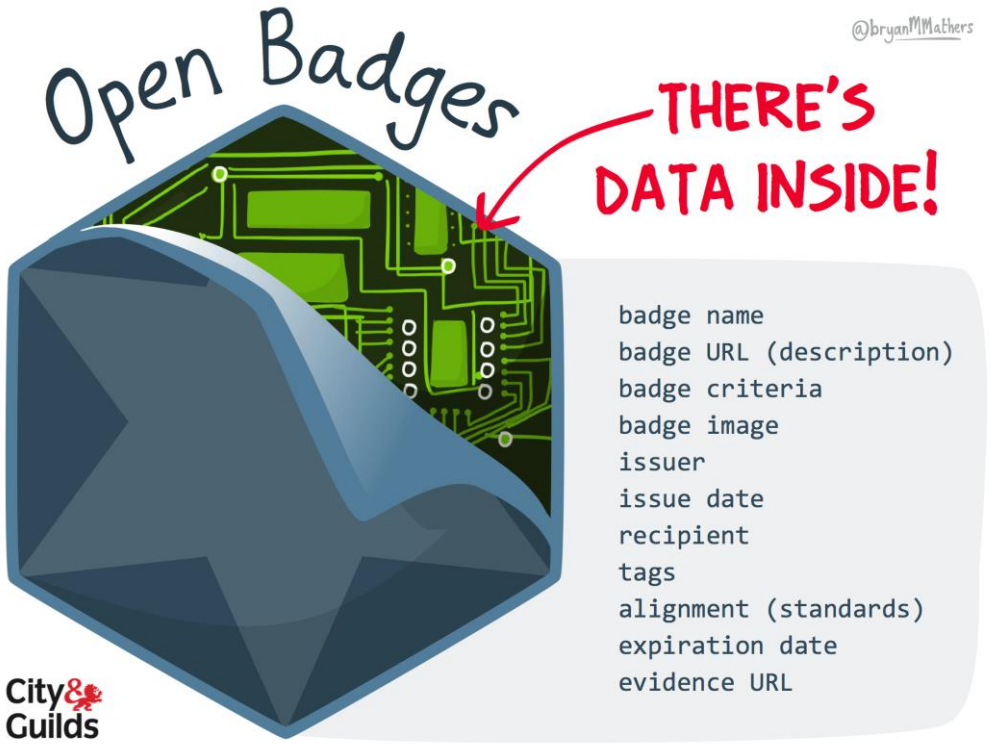


Figure 6: Open Badges Metadata

Each Open Badge will be described by the following aspects (metadata):

- **Open Badge Name:** The name of the Open Badge can be the same as the Competence
- **Open Badge Description:** A description of the Open Badge related to the main objectives of each Competence.
- **Design of Open Badge:** The Visualization (image) of the Open Badge
- **Assessment criteria:** The criteria to be used to assess whether the learning outcomes of all levels have been achieved and whether the set of skills and competences of all levels have been acquired by the primary school students.
- **Learning Outcomes:** A list of the learning outcomes to be acquired. In the Competence Framework document the learning outcomes are presented per level and chapter.
- **Issuer:** In this section the issuer of the Open Badge is specified, which in this case is the CODESKILLS4ROBOTICS Consortium.
- **Date of Issue:** Here the date the Open Badge was created i.e. was available to users is set.

- **Recipient:** An individual who earns a badge. Identified through an e-mail address
- **Badge Expiry:** For the purposes of this project, this setting has been set to "Never", which means that the acquired badge has a lifetime validity.
- **Evidence:** The proof and the evidence of the acquired skills, specified by the primary school teacher, i.e. quiz grade, task (link, photo, video) etc.

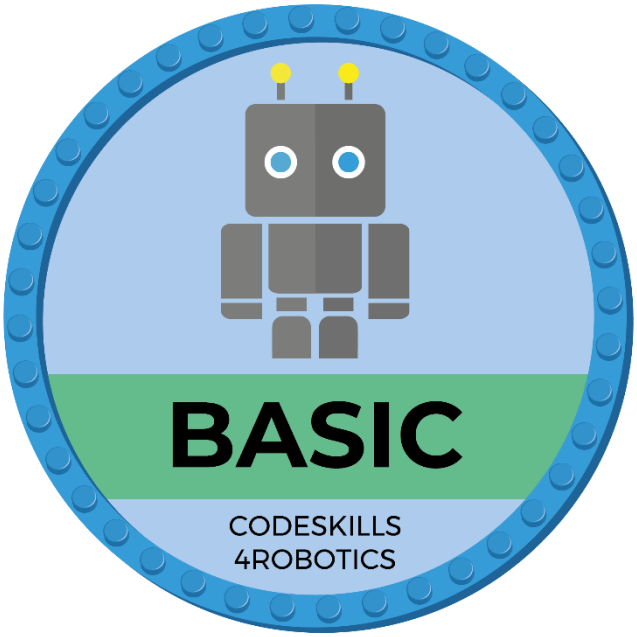
The way the educational back has been divided into levels, chapters/sub-chapter as well as information on:

- Associated Badge
- Pre-requisites
- Equipment
- Main Objective
- Duration
- General Learning Outcomes
- Robotics Learning Outcomes
- Knowledge
- Skills
- Soft Skills

is analytically presented in the following CODESKILLS4ROBOTICS Competence Framework.

CODESKILLS4ROBOTICS
Competence Framework

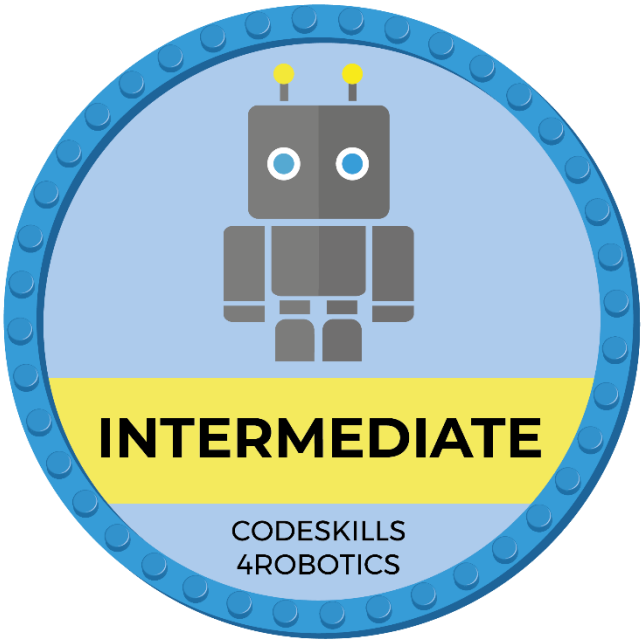
MODULE 1: DEVELOP BASIC STEM SKILLS AND PROGRAMMING

Section A:	Basic Robotics Movements
The aim of the section is to introduce students to the basic movements of robots. Students will build the robot REA and learn to program it to perform basic movements. They will also learn how to use loops to program it to make repetitive movements.	
Associated Badge:	
Chapter:	**1.1 Let's Build REA**
Level:	Beginner (Basic)
Pre-requisites:	There are no cognitive pre-requisites
Equipment:	A Lego Boost Kit
Main Objective:	Construct the base model robot - REA
Duration:	1 classroom period - 45' minutes
General Learning Outcomes:	Learn how to follow basic assembly instructions and construct a mechanical device
Robotics Learning Outcomes:	Learn how to construct a basic robotic structure with wheels for movement
Knowledge:	Students should be able to follow instructions given in a visual form and reproduce a replica of the end result
Skills:	Students should be able to: - Use and connect different Lego pieces

	- Identify ways to assemble technic and electronic parts using Technic pins and connectors - Build the recommended robot (REA) using different Lego pieces by following the step by step instructions
Soft Skills:	- Team work - Collaboration skills - Communication skills - Coordination - Problem Solving - Decision making - Experimenting - Focus - Goal setting - Creativity

Chapter:	**1.2 Moving Instructions of REA**
Level:	Beginner (Basic)
Pre-requisites:	Basic understanding of what the speed of an object is. Understanding of how an Angle is measured in Degrees and of how Time is measured in seconds
Equipment:	A constructed model of the REA Robot
Main Objective:	Program REA to perform basic movements
Duration:	2 class periods - 90' minutes
General Learning Outcomes:	Learn how to create an algorithm to solve a problem by writing sequential coding instructions
Robotics Learning Outcomes:	Learn how to write coding instructions to move the motors of a robotic device
Knowledge:	Students should be able to create and follow an algorithm to solve a problem
Skills:	Students should be able to: - Use a combination of blocks in order to move REA forward/backward in straight line - Use a combination of blocks in order to make REA turn to the left/right by setting the desired number of degrees
Soft Skills:	- Team work - Collaboration skills - Communication skills - Coordination - Problem Solving - Decision making - Experimenting - Focus - Goal setting - Creativity

Chapter:	**1.3 Using Loop Commands with REA**
Level:	Beginner (Basic)
Pre-requisites:	A basic understanding of the coding blocks used for movement
Equipment:	A constructed model of the REA Robot
Main Objective:	Program REA to repeat a set of commands by using iteration
Duration:	2 class periods - 90' minutes
General Learning Outcomes:	Learn how to create an algorithm to solve a problem by writing iteration (repeating) coding instructions
Robotics Learning Outcomes:	Understand the three types of loop blocks - For Loops which repeats code for a specific number of times - While Loops which requires a condition to be true in order to repeat a piece of code - Forever Loops which repeat a piece of code forever
Knowledge:	Students should be able to create and follow a repeating algorithm to solve a problem
Skills:	Students should be able to: - Use the different blocks for Looping commands (yellow blocks) - Use a combination of blocks in order to move REA forward/backward in straight line - Use a combination of blocks in order to make REA turn to the left/right by setting the desired number of degrees
Soft Skills:	- Team work - Collaboration skills - Communication skills - Coordination - Problem Solving - Decision making - Experimenting - Focus - Goal setting - Creativity

Section B:	Robotics Sensors
In this section, students will learn how to use environmental data (via sensors) to program the robot. They will learn how the sensors that the robot is equipped with work, while they will program it to perform tasks using the sensors.	
Associated Badge:	
Chapter:	1.4 Using Sensors with REA
Level:	Intermediate
Pre-requisites:	A basic understanding of the coding blocks used for iteration - loops
Equipment:	A constructed model of the REA Robot and the Lego Boost Color and Distance Sensor
Main Objective:	Program REA to interact with its environment with the help of the sensor and how selection coding works
Duration:	2 class periods - 90' minutes
General Learning Outcomes:	Learn how sensors are used by robots and to create an algorithm to solve a problem by receiving input from the environment
Robotics Learning Outcomes:	- Learn how to use sensors (color, sound, distance) - Learn how to program the robot to identify objects - Learn how to program the robot to recognize colors from a given range - Learn how to measure the amount of light reflection - Learn how to code using selection coding (if/else)
Knowledge:	Students should be able to understand - How a sensor works - How the received input can be used to solve a problem - How a selection algorithm works
Skills:	Students should be able to use the detect objects block (orange blocks) o Use a combination of blocks in order to make REA detect objects and colors

	○ Use a combination of blocks in order to allow REA to make decisions based on the sensor's input
Soft Skills:	- Team work - Collaboration skills - Communication skills - Coordination - Problem Solving - Decision making - Experimenting - Focus - Goal setting - Creativity

Chapter:	**1.5 Following Walls with REA**
Level:	Intermediate
Pre-requisites:	A basic understanding of the coding blocks used for recording the reflected light intensity as well as selection - if/else and iteration - loop blocks
Equipment:	A constructed model of the REA Robot and the Lego Boost Color and Distance Sensor
Main Objective:	Program REA to travel in an area by following one side of a wall or one side of an object
Duration:	2 class periods - 90' minutes
General Learning Outcomes:	Learn how sensors are used by robots in order to navigate autonomously and to create an algorithm to solve a problem by receiving input from the environment
Robotics Learning Outcomes:	- Learn how to use sensors to record the distance from an object - Learn how to program the robot to identify and avoid objects - Learn how to measure the amount of light reflection
Knowledge:	Students should be able to understand how a sensor works and how the received input can be used to solve a problem
Skills:	Students should be able to use the detect objects block (orange blocks) ○ Use a combination of blocks in order to make REA detect the distance from objects ○ Use a combination of blocks in order to allow REA to make decisions based on the sensor's input
Soft Skills:	- Team work - Collaboration skills - Communication skills - Coordination - Problem Solving - Decision making - Experimenting - Focus - Goal setting

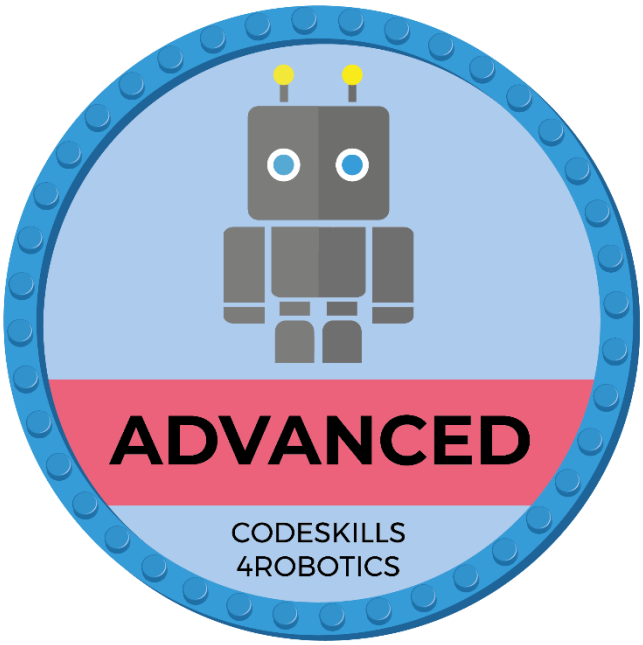
	- Creativity

Chapter:	**1.6 Following Lines with REA**
Level:	Intermediate
Pre-requisites:	A basic understanding of the coding blocks used for recording the reflected light intensity as well as selection - if/else and iteration - loop blocks
Equipment:	A constructed model of the REA Robot and the Lego Boost Color and Distance Sensor
Main Objective:	Program REA to travel in a predefined path marked with a black line on a white background
Duration:	2 class periods - 90' minutes
General Learning Outcomes:	Learn how sensors are used by robots in order to navigate in a predefined path and to create an algorithm to solve a problem by receiving input from the environment
Robotics Learning Outcomes:	- Learn how to use sensors to measure the amount of light reflection - Learn how to program the robot to adjust its path and follow a black line
Knowledge:	Students should be able to understand how a sensor works and how the received input can be used to solve a problem
Skills:	Students should be able to use the light sensor in order to measure the reflected light intensity and make REA move on a predefined path-line
Soft Skills:	- Team work - Collaboration skills - Communication skills - Coordination - Problem Solving - Decision making - Experimenting - Focus - Goal setting - Creativity

Chapter:	**1.7 Detecting Sound with REA**
Level:	Intermediate
Pre-requisites:	A basic understanding of the coding blocks used for selection - if/else and iteration - loop.
Equipment:	A constructed model of the REA Robot
Main Objective:	Program REA to react in a different way depending on the sound intensity which it receives
Duration:	1 class period - 45' minutes
General Learning Outcomes:	Learn how sound sensors are used by robots and create an algorithm to solve a problem by receiving input from the environment

Robotics Learning Outcomes:	- Learn how to use sound sensors to measure the intensity of sound - Learn how to program the robot to react based on sound intensity
Knowledge:	Students should be able to understand how a sound sensor works and how the received sound intensity can be used to solve a problem
Skills:	Students should be able to use the sound sensor in order to measure the sound intensity and program REA to perform accordingly based on the level of sound
Soft Skills:	- Team work - Collaboration skills - Communication skills - Coordination - Problem Solving - Decision making - Experimenting - Focus - Goal setting - Creativity

Chapter:	**1.8 Navigating REA with a Remote Controller**
Level:	Intermediate
Pre-requisites:	A basic understanding of the coding blocks used for iteration - loop and basic mathematical calculations (division)
Equipment:	A constructed model of the REA Robot
Main Objective:	Program REA to move with the use of a remote control device
Duration:	1 class period - 45' minutes
General Learning Outcomes:	Learn how remote-controlled robots can have various scientific uses
Robotics Learning Outcomes:	- Learn how to manually control a robot by using a remote-control device - Learn how to program the robot to move in higher precision
Knowledge:	Students should be able to understand how a robot can be manually controlled and how the input can be tweaked for precise movement
Skills:	Students should be able to learn how to use the remote control to trigger movements
Soft Skills:	- Team work - Collaboration skills - Communication skills - Coordination - Problem Solving - Decision making - Experimenting - Focus - Goal setting - Creativity

Section C:	Advanced Robotics
In this section, students will learn about specific and specialized aspects of robots and programming such as the use of gears and the concept of variables.	
Associated Badge:	
Chapter:	1.9 Using Gears with REA
Level:	Advanced
Pre-requisites:	A basic understanding of the coding blocks used for movement, basic mathematical calculations and how gears work
Equipment:	A modified model of the REA Robot which includes gears for gearing up and gearing down
Main Objective:	Use gears in order to change the speed and torque of REA
Duration:	2 class periods - 90' minutes
General Learning Outcomes:	Learn how gears can be used in order to change the speed and torque of a moving object
Robotics Learning Outcomes:	- Learn how to increase the maximum speed of a robot with wheels - Learn how to increase the maximum torque of a robot with wheels
Knowledge:	Students should be able to understand how gears are used in situations where more speed or torque is needed
Skills:	Students should be able to learn how to use gears for increased speed and torque
Soft Skills:	- Team work - Collaboration skills - Communication skills - Coordination - Problem Solving - Decision making - Experimenting - Focus

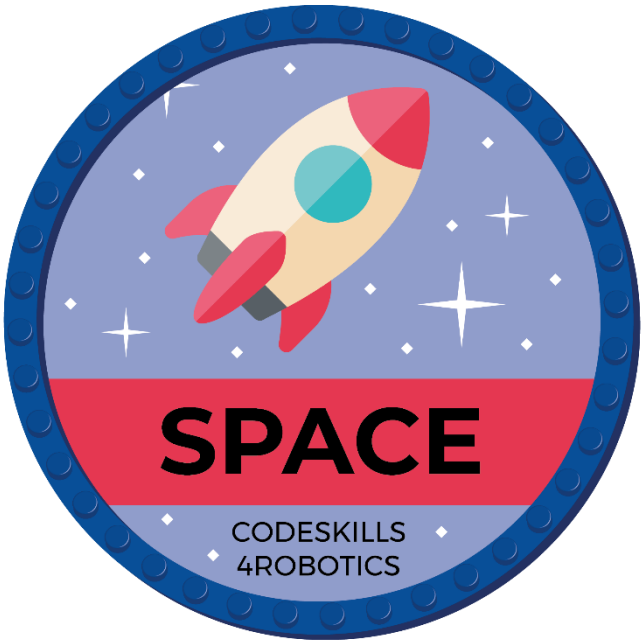
	- Goal setting - Creativity

Chapter:	**1.10 Using Variables with REA**
Level:	Advanced
Pre-requisites:	A basic understanding of the coding blocks used for selection - if/else and iteration - loop blocks as well as basic mathematical calculations
Equipment:	A constructed model of the REA Robot and the Lego Boost Color and Distance Sensor
Main Objective:	Learn how to use variables to store information
Duration:	2 class periods - 90' minutes
General Learning Outcomes:	Learn how computers and robots make calculations as well as how data are stored and used by a computer program
Robotics Learning Outcomes:	- Learn how to use operators for calculations - Learn how to store data in variables - Learn how to use the content of a variable
Knowledge:	Students should be able to understand how variables and operators are used in coding
Skills:	Students should be able to: - Use variables to program REA - Use operators and make calculations - Use the result of the calculation as input for programing REA
Soft Skills:	- Team work - Collaboration skills - Communication skills - Coordination - Problem Solving - Decision making - Experimenting - Focus - Goal setting - Creativity

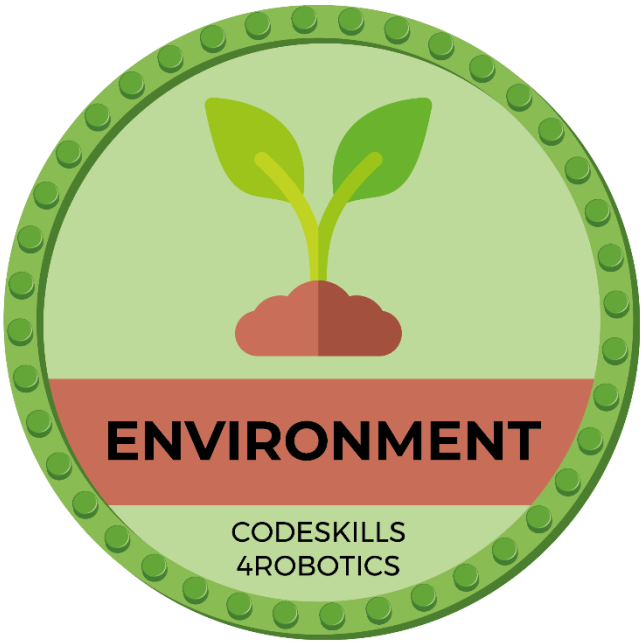
MODULE 2: THE CREATIVE SCENARIOS	
2.1 BUILDING AND PROGRAMMING SMALL ROBOTS	
Pre-requisites:	There are no cognitive pre-requisites.
Equipment:	For this scenario, you will need Lego Boost kits and tablets that are compatible with them. Pupils will be divided into groups and instructions will be given to them.
Main Objective:	Overview of the standard models in the Toolbox: Vernie the Robot, M.T.R.4, Frankie the Cat, Guitar 4000 and the AutoBuilder.
Duration:	Approximately 2,5 hours per construction
Learning Outcomes:	- Learn how to build and program Vernie the Robot - Learn how to build and program M.T.R.4 - Learn how to build and program Frankie the Cat - Learn how to build and program Guitar 4000 - Learn how to build and program the AutoBuilder - Learn how to use the standard models as a reference guide, to expand on further ideas and create programs
Skills:	Students should be able to: - Identify the available tasks and programs recommended by Lego - Use the standard models as a reference guide, to expand on further ideas and create programs - Add own techniques and imagination to extend programming options beyond the original suggestions - Customize own ideas and program them, using a combination of movements and sensor abilities
Soft Skills:	- Team work - Collaboration skills - Communication skills - Creativity - Coordination - Focus - Goal setting

2.2 THE FOUR (4) CREATIVE SCENARIOS	
2.2.1 HISTORY SCENARIO - Talos: From the Legend to Modern Robots	
Associated Badge:	
Pre-requisites:	Students should be familiar with the educational material of Module 1 and more specifically with the chapters, which are related to the basic movements of robots, loop commands, the use of sensors, following the line programs, detecting sounds and the use of remote control. (Chapters 1.2, 1.3, 1.4, 1.6, 1.7 and 1.8).
Equipment:	For this scenario, you will need Lego Boost kits and tablets that are compatible with them. Pupils will be divided into groups and instructions will be given to them.
Main Objective:	In this scenario, students will be introduced to the legend of Talos. They will construct and program a Robot just like the mythical guardian of Crete. Finally, they will discuss issues related to the protection and preservation of important cultural sites.
Duration:	Estimated Time: 8 Teaching hours - 2 hours for starting point (introduction), questions, drawing - 3 hours for the construction of Vernie - 2 hours for programming the robot and the carrying out of the assignments

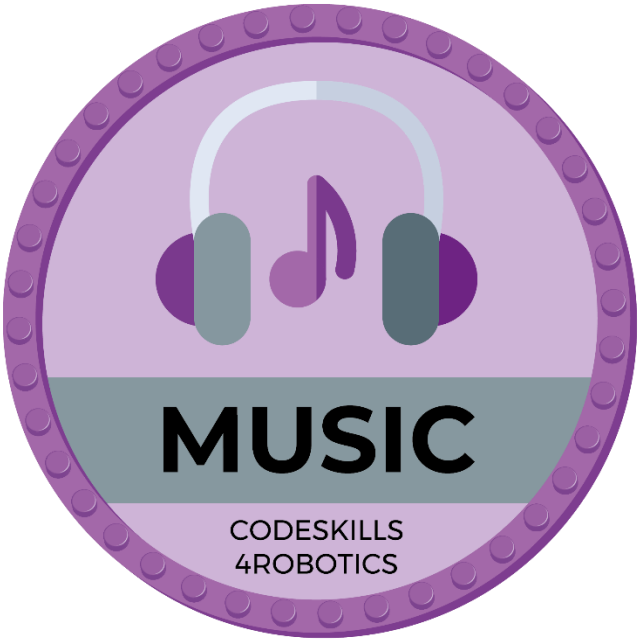
	- 1 hour for the completion of the assignments, video recording of the proceedings, discussion, analysis of the project and suggestions for new assignments/activities
General Learning Outcomes:	- Calculate the perimeter of the island of Crete - Calculate the speed of Talos
Robotics Learning Outcomes:	- Construct the robot - Get familiar with the sensors of the robot and how to use them - Get familiar with the loops coding concept - Get familiar with the if - else coding concepts
Knowledge:	- Learn simple movement commands - Be introduced to the legend of Talos and the geomorphology of Crete
Relevant Subject:	History
Soft Skills:	- Develop imagination and creativity through the construction of the robot - Develop team working skills - Coordination - Problem solving - Decision making - Experimenting - Focus - Goal setting - Creativity

2.2.2 SPACE SCENARIO - Robot from Earth to Space	
Associated Badge:	
Pre-requisites:	Students should be familiar with the educational material of Module 1 and more specifically with the chapters, which are related to the basic movements of robots, the use of sensors, detecting sounds and the use of the remote control. (Chapters 1.2, 1.4, 1.6, 1.7 and 1.8).
Equipment:	For this scenario, you will need Lego Boost kits and tablets that are compatible with them. Pupils will be divided into groups and instructions will be given to them.
Main Objective:	In this scenario, pupils will get to know the planets of our Solar System and program the robot in order to explore them. Finally, they will discuss issues related to space exploration, the difficulties, the changes that such an action will bring about and its impact on humanity.
Duration:	Estimated Time: 5-6 Teaching hours - 1 teaching hour, starting point (introduction), presentation of planets, discussion. - 2-3 teaching hours, construction of the robot. - 2 teaching hours, programming, project analysis.
General Learning Outcomes:	- Get to know the planets of the Solar System

	- Calculate the distances between them and the difficulties of traveling to another planet.
Robotics Learning Outcomes:	- Construct the robot - Get familiar with the sensors of the robot and how to use them - Get familiar with the loops coding concept - Get familiar with the if - else coding concepts
Knowledge:	- Learn simple movement commands - Learn to use the if-else coding concept
Relevant Subject:	Astronomy
Soft Skills:	- Develop imagination and creativity through the construction of the robot - Develop team working skills - Coordination - Problem solving - Decision making - Experimenting - Focus - Goal setting - Creativity

2.2.3 ENVIROMENTAL SCENARIO - The Environmental Facility	
Associated Badge:	
Pre-requisites:	Students should be familiar with the educational material of Module 1 and more specifically with the chapters, which are related to the basic movements of robots, loop commands, the use of sensors, detecting sounds and the use of the remote control. (Chapters 1.2, 1.3, 1.4, 1.6, 1.7 and 1.8). There are also general education pre-requisites: Students should be able to understand what recycling means, how people recycle and what is the expected impact. Students may make a study visit to the local recycling station.
Equipment:	For this scenario, you will need Lego Boost kits and compatible tablets, depending on the number of students in the class. You will need an extra for the teacher. Pupils will be divided into groups and instructions will be given to them. Preferably gender mixed groups.
Main Objective:	Students learn about the environment and the importance of sorting the waste that humans create. The students will build the robots Vernie and M.T.R.4 for inspiration and use them in different activities concerning the scenario environment.

Duration:	Estimated time for the scenario will be 540´ - Student´s study visit to the local environmental station, 120´ - Two groups building Vernie, 120´ - Simultaneously two groups building M.T.R.4, 180´ - Programming the robots, 120´ - Activities such as sorting waste products, 60´ - Finalizing the scenario 60´
General Learning Outcomes:	Be introduced to the recycling concept and its importance to the environment.
Robotics Learning Outcomes:	- Construct the robot - Get familiar with the sensors of the robot and how to use them - Get familiar with the loops coding concept - Get familiar with the if - else coding concepts
Knowledge:	- Learn simple movement commands - Learn to use the if-else coding method
Relevant Subject:	Biology, Social Sciences
Soft Skills:	- Develop imagination and creativity through the construction of the robot - Develop team working skills - Coordination - Problem solving - Decision making - Experimenting - Focus - Goal setting - Creativity

2.2.4 CULTURE SCENARIO - Form Your Own Robot Guitar Band!	
Associated Badge:	
Pre-requisites:	Students should be familiar with the educational material of Module 1 and more specifically with the chapters, which are related to the use of sensors and detecting sounds. (Chapters 1.4 and 1.7) Students should have basic knowledge of note learning. What does the C major scale look like? Students should also know about the regional folk music in their area and traditions connected to the music.
Equipment:	For this scenario, you will need Lego Boost kits and compatible tablets, depending on the number of students in the class plus an extra for the teacher. Pupils will be divided into groups and instructions will be given to them. Preferably, gender mixed groups.
Main Objective:	We want our students to make a simple melody by building the robot Guitar. We intend to find out what the possibilities of the Robot Guitar are. Can the students create and play a simple tune with the help of the Robot Guitar? Can we add rhythm instruments to support the melody loop? Can we find chords that fit the melody loop? Is it possible, with the help of the guitar, to arouse interest in the origin of music and how people created simple instruments that then evolved into what we today recognize as modern musical instruments? Can the

	Robot Guitar stimulate students' curiosity for increased knowledge of today's synthetic music?
Duration:	Estimated Time: 480 minutes - Building the Robot Guitar, 180 minutes - Programming the Robot Guitar, 120 minutes - Music history, Folk music 180 minutes
General Learning Outcomes:	- Learn about the history of musical instruments. - See the connection between The Robot Guitar and modern synthetic music - Learn about folk music in different countries
Robotics Learning Outcomes:	- Construct the robot - Get familiar with the sensors of the robot and how to use them - Get familiar with the loops coding concept
Knowledge:	- Learn to use the if-else coding concept - Learn to use the loop coding concept - Learn about folk music in different countries
Relevant Subject:	Music, Music History
Soft Skills:	- Develop imagination and creativity through the construction of the robot - Develop team working skills - Coordination - Problem solving - Decision making - Experimenting - Focus - Goal setting - Creativity

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7. Annex 1 – Links to Educational Material & e-Platform

The Competence Framework (IO1) and all Educational Material (IO2) can be found under the following links on the official website of the CODESKILLS4ROBOTICS project:

http://codeskills4robotics.eu/io1-competence-framework/

http://codeskills4robotics.eu/io2-educational-back-pack/

All the educational material in the form of specially designed e-Books can be also accessed through the e-learning and e-assessment platform of the CODESKILLS4ROBOTICS project at:

http://codeskills4robotics.iit.demokritos.gr/

8. Annex 2 – The Mentor Badge Quiz

1. How many motors does the Move Hub include?
   a. 1
   b. 2
   c. 3
   d. 4

2. Which of the following the Lego Boost Sensor does not detect?
   a. Colour
   b. Distance
   c. Temperature
   d. Motion

3. How many external motors are included in the Lego Boost kit?
   a. 1
   b. 2
   c. 3
   d. 4

4. How many Move Hubs can simultaneously be connected with a device (tablet)
   a. 1
   b. 2
   c. 3
   d. 4

5. What is the upper and lower boundaries of the speed of the motors which can be set through the Lego Boost App:
   a. -1000..+1000
   b. -10..+10
   c. -100..+100

d. -99..+99

6. In line following where should the sensor be located for an accurate reading?
   a. On the black line
   b. On the white surface
   c. Between the black line and the white surface
   d. All of the above will work the same way

7. The microphone used for sound detection is located in the:
   a. Move Hub
   b. The Sensor
   c. The External Motor
   d. The connected mobile device (tablet/smartphone)

8. How many conditions exist in an IF/ELSE statement:
   a. Only one
   b. Only two
   c. As many as we want
   d. Only three

9. An infinite loop is used:
   a. When we want to repeat only a specific number of times certain code
   b. When we just want to repeat code only once
   c. When we want to repeat indefinitely a certain code
   d. When we want to check if a condition is true or false

10. Geared up REA is used to:
    a. Increase the speed
    b. Increase the torque
    c. Decrease the drift

d. Increase the distance from the floor

11. Geared Down REA is used to:
    a. Increase the speed
    b. Increase the torque
    c. Decrease the drift
    d. Increase the distance from the floor

12. Variables in the Lego Boost App can store:
    a. Numbers
    b. Characters
    c. Text
    d. Dates