ROBOTICS CURRICULUM

FOR PRIMARY SCHOOL EDUCATION

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INBOTS
Inclusive Robotics for a better Society

EDUMOTIVA
EUROPEAN LAB for EDUCATIONAL TECHNOLOGY

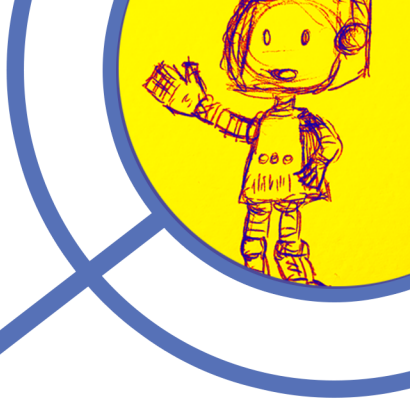
INTRODUCTION

The suggested curriculum introduces smoothly the young learners 7-12 years old into the concept of robotic artefact creation. First, the learners are familiarized with the concept of robots and their functionalities. Then they are invited to control robots by engaging in programming tasks and experimenting with their sensing functionalities. Electrical circuit making is recognized as an important aspect of robotic artefact creation thereby several sessions invite students to playfully explore circuitry. Finally, programming, crafting and circuitry are brought together towards the creation of programmable artefacts that connect the digital and physical world, bringing students a step closer to scientific experience.

A wide range of technologies and tools (see appendix) can be used for carrying out the sessions presented below. This is a high priority in the INBOTS curriculum design process as we would like to push against tool-oriented curricula. A variety of everyday materials and crafting tools can be also used for carrying out the proposed activities. Having a plan on how to manage materials and organizing a functional and creative working place for exploring robots is important. Towards this end, a file with tips and guidelines for teachers has been created.

The table below presents how the curriculum is structured in sessions. The time per session may vary. A session can be extended or shortened given your students' needs and group dynamics. Sessions can be skipped or merged. If time is tight, teachers can consider leaving out a particular project or activity, giving students enough time to really understand and work with the ideas they are introduced to rather than skimming over all the activities presented in this curriculum.

Sessions	Estimated time
Session 1: Introductory session	1 hour
Session 2: Simple scenarios with floor robots	2 hours
Session 3: Robotic challenges in mathematics with floor robots	2 hours
Session 4: Block based programming for controlling floor robots	4 hours
Session 5: Creating circuits with simple materials	2 hours
Session 6: Electrical circuit making for creating interactive artefacts	4 hours
Session 7: Programming tasks	3 hours
Session 8: Building interfaces for controlling computer-supported artefacts	6 hours



Session description:

Introductory session: In this introductory session, the students are invited to explore what a robot is and what functionalities may have. The students are encouraged to identify the features of the robots through discussions with their teacher and/or an invited expert, video projections of relevant educational content and a number of educational games and activities (role-playing, sketching and more) that aim at helping them understand what a robot is and how it receives instructions.

Prerequisites:

- None

Indicative technology:

- Not applicable at this session

Session 1

Session outline:

1. Warm up activity: What is a robot, how does it look like?
2. Discussion with the teacher and/or an invited expert
3. Video projections (optional)
4. Forming groups and discussing around the definition of robots
5. Role playing activities (i.e., students adopting the roles of the “robot” and the “programmer”).
6. Wrapping up

Objectives:

Students will be able to:

- explain what a robot is
- collaborate with others to define what a robot is and identify several different robots and the tasks they can do
- formulate relevant questions to explore what a robot is
- express orally/verbally or written their thoughts and ideas related to what a robot is
- use key terminology from the area of programming to address basic commands for the robot
- unveil their personal interactions with robots and smoothly raise awareness on how robots perform real-life activities

Students’ activities:

- Discussing in groups to define what a robot is
- Reflecting upon their experiences, discussions that took place and/or visual material that has been demonstrated and expressing their thoughts around robots verbally or written (i.e. through sketches)
- Exploring the intricacies of robotic programming through a role-playing activity where they act as robots and programmers.

Resources:

- Warm up activities: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/WarmUp_activities.pdf
- What is a robot:
  https://www.pbslearningmedia.org/resource/eng06.sci.engin.design.lp_robot/what-is-a-robot/
  https://www.digitaltechnologieshub.edu.au/teachers/topics/robotics

Session description:

Simple scenarios with floor robots: This session revolves around the familiarization of students with key concepts of programming in an age-appropriate manner. The students will learn how to instruct floor-based programmable robots (e.g. Bee-bot, Pro bot or others) to perform simple tasks based on a specific scenario. Storytelling practices can also be used in order to create scenarios that trigger students' interest.

Prerequisites:

- None

Indicative technologies:

- Bee-bot, Blue bot, Pro-bot, Bottley, Roamer and more

Session 2

Session outline:

1. Showcasing key instructions through experimentation
2. Working in groups on a simple scenario: Moving from spot A to spot B
3. Extending the scenario collaboratively
4. Sharing the scenario according to which the robot operates in the class

Objectives:

Students will be able to:

- learning to write a set of directions
- direct a floor robot to move in different directions
- instruct the robots perform a simple scenario/challenge
- learn to use directional words
- build upon a given scenario further extending it
- make basic measurements and predictions
- present their scenario in the class

Students' activities:

- Exploring in groups the floor robot
- Discussing in groups and write a set of directions for a specific challenge/scenario
- Testing their solutions using trial and error
- Extending the scenario and work on new challenges based on their interests
- Presenting in the class their solution to a specific challenge

Resources:

- Blue-bot guidelines (applicable for Bee-bot as well) : http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Blue_bot.pdf

Session description:

Robotic challenges in mathematics with floor robots: This session builds on session 2 and aims at bringing forward geometry and mathematical challenges. Students will be encouraged to use the floor-based programmable robots to create different shapes (rectangles, polygons and circles). This session can be further extended to accommodate Arts: paintings of cubism, de Stijl, constructivism etc. can be presented to students providing opportunities for artistic expression.

Prerequisites:

- Basic skills in addressing directional commands (as derive from session 2)

Indicative technology:

- Pro-Bot

Session 3

Session outline:

1. Demonstration on how to give basic commands to the robot and make it move or turn in different directions.
2. Experimentation in small groups with the floor robot as part of the familiarization stage
3. Working in groups on specific challenges and scaffolding by the teacher/class facilitator
4. Introducing the aspect of arts and student engagement in new robotic challenges
5. Discussion on the aforementioned tasks and wrapping up

Objectives:

Students will be able to:

- define a geometrical shape
- make measurements in order to instruct the robot reach a goal
- work in groups towards solving a mathematical challenge
- use numerical instructions in order to draw a shape
- reflect upon optimal programming ways in drawing shapes
- explain what the “repeat” construct does
- reflect creatively upon pieces of art
- express and/or replenish their creativity

Students’ activities:

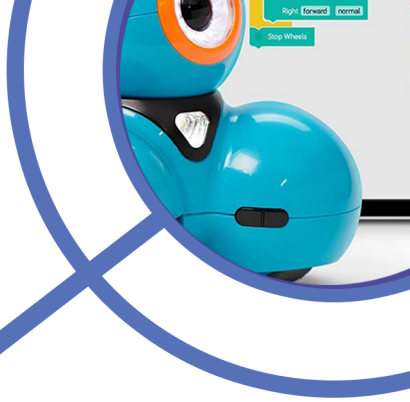
- Taking turns at directing the floor robot to different routes as part of the familiarization stage
- Working in groups on specific robotic challenges that include engagement in measurements, maths and geometry
- Raising questions and express their thoughts and ideas in the group and the plenary
- Getting involved in creative tasks inspired by pieces of art
- Presenting the solutions for the robotic challenges in the plenary

Resources:

- Pro-Bot guidelines: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Pro_bot_PE.pdf
- Command cards for Pro-Bot: https://simonhaughton.typepad.com/files/command-cards-for-pro-bot.pdf
- Lesson plans for grade 2-6 with Pro-Bot: http://movemyrobot.blogspot.com/p/lesson-plan-hour-1-introduce-pro-bot.html

Session description:

Block based programming for controlling floor robots: This session builds on the previous ones and goes a step further by inviting students to make their first steps towards controlling floor-based robots through age-appropriate block-based programming applications/ environments.



Prerequisites:

- Carrying out session 2 and 3 is recommended

Indicative technologies:

- Hardware: Dash and Dot / Edison / Thymio
- Software: Wonder Workshop Inc/ EdScratch /Scratch

Session 4

Session outline:

1. Introducing the robot and the included sensors
2. Demonstration of the programming app for controlling the robot
3. Running short familiarization tasks through playful exploration
4. Setting the challenge: “Navigate the robot through a maze to find the treasure”
5. Working in groups on the robotic challenge under teacher’ facilitation
6. Sharing in the plenary
7. Wrap-up and documentation of ideas for new challenges

Objectives:

Students will be able to:

- define sequences and algorithms.
- relate coding to their lives at home and school.
- design an algorithm navigating the robot so that to reach a set target
- practice spatial reasoning, carry out measurements and use sensors

Students’ activities:

- Familiarization tasks with the selected robot through engagement in mini-challenges
- Designing in groups their own mazes for the robot to go through
- Controlling the robot through the maze through block-based programming apps/environments
- Providing feedback to one another and sharing their work in the plenary
- Documenting ideas for future development

Resources:

- Dash & Dot guidelines: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Dash.pdf
- Lesson ideas: https://d4iqe7beda780.cloudfront.net/resources/static/main/pdf/dw001_dash_&_dot_lesson_plans.pdf
- Edison Robot: https://meetedison.com/robot-programming-software/edblocks/#edblocks-resources
- Edison Lesson plans for educators: https://meetedison.com/content/EdBlocks-lesson-activities-complete-set.pdf
- Thymio: https://www.thymio.org/creations/

Session description:

Creating circuits with simple materials: In this session, students will be introduced to electrical circuit making through hands-on practice with simple materials (i.e. plasticine, copper tape, conductive paint etc.). They will be encouraged to create their own circuits through paper modelling and the implementation of basic electronic components (battery, LED lights).

Prerequisites:

- None

Indicative materials:

- Conductive items (i.e.copper tape), leds, batteries, clips, paper, scissors

Session 5

Session outline:

1. Discussing about electricity and circuit making
2. Experiment with different materials
3. Creating different patterns/ layouts of circuits
4. Sharing in the class and wrapping-up

Objectives:

Students will be able to:

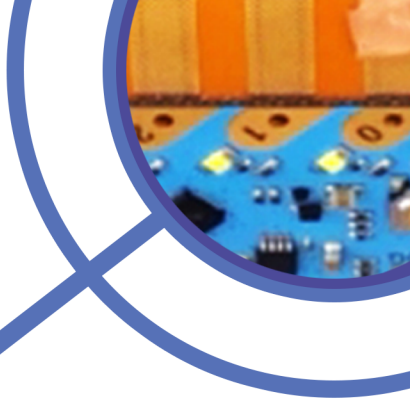
- create a simple circuit
- name conductive items
- experiment with different patterns/ layouts for creating a circuit
- explain what an electrical circuit is
- use key terminology in order to present their circuit in the plenary

Students' activities:

- Being involved in discussion about electricity and circuits
- Selecting materials and working in small groups on pre-developed easy to start with patterns
- Working on more advanced patterns (optional and dependent on the age of the students)
- Developing their own ideas and patterns based on their preferences and interests
- Presenting in the plenary and/or discussing with classmates the results

Resources:

- Paper circuit guidelines and patterns: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Paper_circuit_resource_PE.pdf
- PHET simulator: https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_en.html
- Additional material: https://www.exploratorium.edu/tinkering/projects/paper-circuits



Session description:

Electrical circuit making for creating interactive artefacts: In this session, students will be encouraged to combine circuitry, crafting and programming towards creating interactive light-up artefacts that operate according to specific scenarios, by using electrical circuit making kits (i.e. Little Bits, Chibitronics), crafting materials and visual programming platforms.

Prerequisites:

- Basic understanding of what an electrical circuit is and its main components (see previous session)

Indicative technologies:

- Chibitronics/ Microsoft Makecode Editor, Little Bits /Sphero littleBits Code Kit App

Session 6

Session outline:

1. Interactive demonstration of the electrical circuit making kits
2. Exploration of key functionalities through mini familiarization challenges
3. Working in groups on a specific project towards the creation of an interactive artefact
4. Sharing in the class and wrapping-up

Objectives:

Students will be able to:

- identify and recognize basic electronic parts: batteries, LEDs, wires, switches
- create basic circuits
- elaborate on solutions to design challenges
- use key terminology (i.e. voltage, current, conductivity) in order to present their work/artefact to the public
- design interactive light-up projects using crafting material
- recognise how physical and digital environments interact

Students' activities:

- Engaging in short rounds of mini-challenges to explore and become familiar with the electrical circuit making kits/platforms
- Ideation and planning collaboratively on the artefact to be created and the materials to be used
- Creating circuits and models to embed them
- Experimenting with circuit boards allowing the interaction with the digital environment
- Engaging in programming tasks towards giving specific behaviours to their artefacts
- Presenting in plenary and reflecting upon their work

Resources:

- Little bits guidelines and models: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/LIttle_bits.pdf
- Little bits guide for educators: https://d2q6sbo7w75ef4.cloudfront.net/littleBitsEducatorsGuide_FINAL.pdf
- Examples of mini challenges: https://chibitronics.com/things-connected-switches-lesson-plan/
- Chibitronics-Craft Meets Code (Video tutorials): https://chibitronics.com/lovetocode/
- INBOTS Webinar where Chibitronics are introduced: https://www.youtube.com/watch?v=INt0n84NCRo

Session description:

Programming tasks: This session focuses more on programming activities in block-based programming environments (such as Scratch). The students will be encouraged to create a game in Scratch with the aim to build physical controllers for it later on.

Prerequisites:

- Basic programming experience in block-based environments

Indicative technology:

- Scratch

Session 7

Session outline:

1. Demonstration of games designed in Scratch
2. Brainstorming on the game to be designed and creating a storyboard
3. Designing the stage and the sprites
4. Programming in groups in Scratch facilitated by the class teacher
5. Sharing in the plenary
6. Planning the next steps towards physical controlling of the sprite (which can also be described as a 'digital robot')

Objectives:

Students will be able to

- apply programming concepts in the selected block-based programming environment
- design storyboards and scenarios
- design avatars/sprites and scenes in Scratch
- solve programming problems/challenges
- create a Scratch project
- elaborate on their ideas for combining physical and digital world

Students' activities:

- Brainstorming on the game to be designed
- Designing a scenario for a game/challenge
- Programming/instructing objects and characters according to a specific scenario
- Presenting and discussing in class

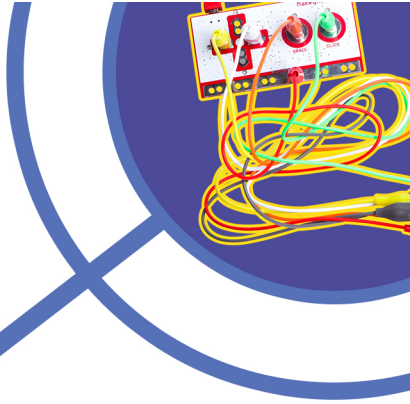
Resources:

- Scratch guidelines: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Scratch.pdf

* **Note:** Session 7 and Session 8 (see below) can be merged into one.

Session description:

Building interfaces for controlling computer-supported artefacts: This session revolves around tasks related to the creation of robotic-enhanced interfaces in which physical objects are implemented as input materials, allowing the interaction with the computer environment and the digital objects. The students will be involved in programming, crafting and circuitry towards making a physical controller for the Scratch project, the digital designed in session 7.



Prerequisites:

- Basic knowledge of electrical circuit making and programming in block-based environments

Indicative technology:

- Makey-Makey kit

Session 8

Session outline:

1. Familiarization challenges with Makey-Makey
2. Carrying out embodied learning familiarization activities around conductivity (optional)
3. Presentation of the project to work on: “Making a physical controller for the game avatar”
4. Carrying out the project in groups under the class teacher facilitation
5. Sharing in the plenary
6. Extension and review of new ideas for implementation (i.e. The fruit piano)
7. Discussion upon human-robot interactions

Objectives:

Students will be able to

- explain what an electrical circuit is and how current flows
- identify conductive items
- determine the meaning of symbols, key terms, and other programming blocks in Scratch
- design interfaces through hands-on practices
- program sprite’s behaviour
- build a physical controller that communicates with the Scratch project
- follow a multistep procedure towards connecting digital and physical world

Students’ activities:

- Brainstorming around the type of physical controller that will be created
- Experimenting in groups with circuit boards allowing the interaction with the digital environment
- Working on connecting the controller with the Scratch project
- Presenting of the controllable game in the plenary and setting future plans
- Discussing how robots are controlled with handheld controllers and other devices

Resources:

- Lesson plans in Makey-Makey and example of familiarization challenges in Makey- Makey (p.24): https://www.kookaburra.com.au/documents/2017/Makey_Makey_lesson-plans.pdf
- Makey-Makey guidelines: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Makey_Makey.pdf
- Inspiring classroom practices: https://www.instructables.com/Makey-Makey-Chibitronics-Light-up-Houses/

APPENDIX

Technologies and tools (mentioned in this curriculum):

Robots:

Kubo: https://kubo.education/

Blue-bot: https://www.terrapinlogo.com/products/robots/blue/blue-bot-family.html

Bee-bot: https://www.terrapinlogo.com/products/robots/bee/bee-bot-family.html

Pro-Bot: https://www.terrapinlogo.com/products/robots/pro/probot.html

Botley: https://www.learningresources.com/shop/collections/botley

Roamer: https://www.roamer-educational-robot.com/

Colby mouse: https://blog.generationrobots.com/en/tutorial-robot-mouse-colby/

Thymio: https://www.thymio.org/

Dash: https://www.makewonder.com/robots/dash/

Dot: https://www.makewonder.com/robots/dot-creativity-kit/

Edison: https://meetedison.com/

Kits and open-source technologies:

Little Bits: https://sphero.com/collections/all/family_littlebits

Chibitronics: https://chibitronics.com/

Makey-Makey: https://makeymakey.com/

Software and apps:

Wonder Workshop INC: https://play.google.com/store/apps/developer?id=WONDER+WORKSHOP,+INC.

Edscratch: https://meetedison.com/robot-programming-software/edscratch/

Scratch: https://scratch.mit.edu/

Microsoft Makecode Editor: https://makecode.chibitronics.com/