ROBOTICS CURRICULUM

FOR SECONDARY SCHOOL EDUCATION

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INBOTS
Inclusive Robotics for a better Society

EDUMOTIVA
EUROPEAN LAB for EDUCATIONAL TECHNOLOGY

INTRODUCTION

The suggested curriculum smoothly introduces young learners (13+ years old) into the creation of robotic artefacts through open-source technologies. First, the learners are familiarized with the concept of robotics and specifically those of electricity and conductivity through hands-on activities (i.e., paper circuits). Then they are invited to create a number of Arduino based robotic artefacts through circuit making, block-based programming and crafting processes. Therefore, through several sessions, and by gradually getting familiar with different sensors and electrical components, as well as with more advanced programming methods, students are progressively engaged in more complex projects until they are becoming capable of creating their own robotic artefact.

All the proposed sessions bolster team-work, sharing in the class and exploration of concepts from different disciplines. 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: Introduction to Arduino through Snapino and TinkerCAD circuits	2 hours
Session 3: The lighthouse project	2 - 3 hours
Session 4: The sunflower project	3 hours
Session 5: The smart light project	2 hours
Session 6: The Theremin project	4 - 6 hours
Session 7: The DIY automobile project	6 - 8 hours
Session 8: Open projects	...

Session description:

Introductory session: In this session students are introduced to the field of robotics and their impact on their daily lives through short presentations (focusing on everyday examples) and discussions in class and/or in groups, while being engaged in paper circuit making processes.

Prerequisites:

- Basic programming skills
- Basic knowledge of electricity and electrical circuitry

Indicative materials:

- copper tape, LEDs, batteries, paper, scissors, clips, conductive ink, jumpers, resistors etc.

Session 1

Session outline:

1. Brainstorming supported with video projections/ exploration of robotic applications in different domains/ discussion with an expert (optional)
2. Forming groups and discussion around the topic
3. Short tasks in electrical circuit making
4. Wrap up

Objectives:

Students will be able to:

- perceive robotics through the lens of everyday examples and processes
- explain the very basics of circuitry

Students' activities:

- Discussing in groups to define what a robot is and brainstorming on the use of robotics in everyday life
- Creating simple circuits by using simple and common materials (i.e., paper, copper tape, battery, plasticine, clips etc.)
- Sharing in the plenary

Resources:

- Warm up activities: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/WarmUp_activities.pdf
- Paper circuit guidelines and patterns: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Paper_circuit_resource_PE.pdf

Session description:

Introduction to Arduino through Snapino and TinkerCAD circuits: In this session students are getting familiar with Arduino board through SnapIno (an easier version of Arduino, as far as electrical circuit making is concerned), Snap Circuits, and TinkerCAD circuits software.

Prerequisites:

- Basic programming skills
- Basic knowledge of electricity and electrical circuitry

Indicative technologies:

- Hardware: Arduino, Snapino, Snap Circuits
- Software: TinkerCAD, mBlock, Snap4Arduino

Session 2

Session outline:

1. Short tasks in electrical circuit making (creating parallel and series circuits)
2. Short tasks in block-based programming environments and software for simulating circuits/ introduction to breadboard
3. Discussion

Objectives:

Students will be able to:

- explain the basic concepts related to Arduino board
- explain the differences between parallel and series circuits
- create circuitry simulations using TinkerCAD circuits
- assemble a simple script in a block-based programming environments

Students' activities:

- Creating simple circuits by using Snap Circuits: testing the differences between parallel and series circuits
- Composing simple script (i.e. blinking) in block-based programming environments
- Getting familiar with breadboard through TinkerCAD circuits software
- Experimenting with the block-based programming environment of TinkerCAD, while exploring the instant translation of the code to text-based script (optional)

Resources:

- Snapino Guidelines: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/SNapino.pdf
- From Snapino to Arduino board: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/SNapino_to_Arduino.pdf
- Guidelines for using TinkerCad: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/TinkerCAD.pdf

Session description:

The lighthouse project: In this session students will be engaged in the first robotic project with Arduino: the construction of a lighthouse that blinks in the dark and/or according to the distance of the sailing ships.

Prerequisites:

- Basic programming skills
- Elementary knowledge of electricity and electrical circuitry
- Basic knowledge of Arduino-based technologies

Indicative technologies:

- Hardware: Arduino
- Software: mBlock, Snap4Arduino, Open Roberta Lab

Session 3

Session outline:

1. Discussion about the context of the project (i.e., lighthouse)
2. Planning (i.e., how the lighthouse will work, which sensors will be used etc.)
3. Hands-on practice (crafting, circuitry & programming)
4. Sharing

Objectives:

Students will be able to:

- reflect their ideas on design and programming
- work in groups, allocate roles, and present the results of teamwork
- understand the importance/value of crafting
- use simple materials towards creating a meaningful artefact
- search for information and use them in their projects
- explain what sensors are and use them in a specific context

Students' activities:

- Discussing in groups and searching information on the topic (i.e., lighthouses in the past/present, the life of lighthouse keepers etc.) and accordingly planning
- Creating the basic circuit (LED light) and programming the blinking
- Crafting a lighthouse paper model, where the circuit will be embedded
- Adding sensors to the circuit (i.e. photoresistor, ultrasonic sensor) and programming them to control the lighthouse
- Remodeling the lighthouse based on the new needs
- Sharing their project in the plenary

Resources:

- Guidelines for Lighthouse project: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Lighthouse_project.pdf
- How do lighthouses work: https://www.youtube.com/watch?v=072wpvM7aS8

Session description:

The sunflower project: In this session students will be engaged in a slightly more advanced robotic project with Arduino by constructing a robotic artefact (e.g. sunflower) that follows the light.

Prerequisites:

- Basic programming skills
- Basic knowledge of electricity and electrical circuitry
- Basic knowledge of Arduino-based technologies

Indicative technologies:

- Hardware: Arduino
- Software: mBlock, Snap4Arduino, Open Roberta Lab

Session 4

Session outline:

1. Discussion about the phenomenon of Heliotropism
2. Planning (i.e., which sensors and electrical components will be used etc.)
3. Hands-on practice (crafting, programming and circuitry)
4. Sharing

Objectives:

Students will be able to:

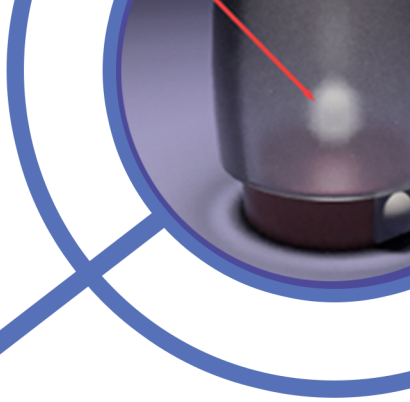
- reflect their ideas on design and programming
- work in groups, allocate roles, and present the results of teamwork
- make models using crafting materials
- reflect upon optimal programming solutions
- describe the phenomenon of Heliotropism
- use variables in order to address programming solutions
- control multiple sensors

Students' activities:

- Exploring the phenomenon of Heliotropism
- Creating the circuit (i.e., two photoresistors and a servo motor) and programming by implementing more advanced programming methods (e.g. using variables)
- Crafting a paper model (e.g sunflower), where the circuit will be embedded
- Thinking of alternative scenarios or programming solutions
- Sharing their project in the plenary

Resources:

- Guidelines for the project: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Sunflower_project.pdf
- Exploring sunflower and heliotropism: https://www.youtube.com/watch?v=5FAP2utITqo
- Additional solution: https://www.youtube.com/watch?v=aiMhgFSSWz0



Session description:

The smart light project: In this session students are engaged in a slightly more advanced robotic project with Arduino, which is also relevant to interactive architecture: the creation of their own smart light (e.g., a smart table lamp, a smart street lamp etc.).

Prerequisites:

- Basic programming skills
- Basic knowledge of Arduino-based technologies

Indicative technologies:

- Hardware: Arduino
- Software: mBlock, Snap4Arduino, Open Roberta Lab

Session 5

Session outline:

1. Discussion around the concept of “Smart” and the impact of robotics to smart and eco-friendly solutions, as well as the implementation of embodied skills and movements as actuators of specific events (e.g. turning on a light)
2. Planning (i.e., which sensors will be used, how they will be programmed etc.)
3. Hands-on practice (crafting, programming and circuitry)
4. Sharing

Objectives:

Students will be able to:

- express their ideas on the crafting part of the artefact
- work in groups, allocate roles, and present the results of teamwork
- implement hands-on and crafting ideas
- integrate electrical circuit making to their projects
- write programming scripts in block-based programming environments
- describe how robotics can impact the creation of smart and eco-friendly solutions

Students’ activities:

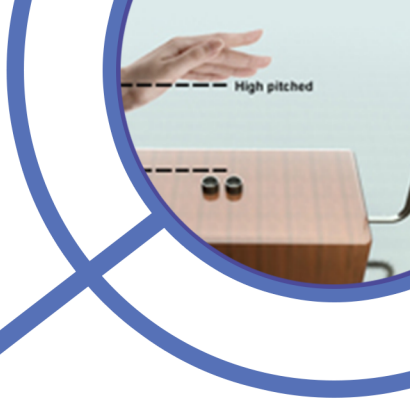
- Searching for the notion of smart combined with robotics and anthropocentric parameters
- Getting involved with more advanced electrical components (i.e PIR sensor) and programming methods
- Crafting a paper model that reflects their idea. The creation of a bigger project that is produced through the collaboration of more than one teams (i.e. a street with multiple smart street lights etc.) can be also considered
- Sharing their project in the plenary

Resources:

- Guidelines: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/smart_light_guidelines.pdf
- Ideas for crafting: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Smart_light_crafting.pdf
- How PIR sensor works : https://www.youtube.com/watch?v=6Fdrr_1guok

Session description:

The Theremin project: In this session students are engaged in a slightly advanced but also fun robotic project with Arduino, namely the Theremin project; an electronic musical instrument controlled by the performer without any physical contact.



Prerequisites:

- Basic programming skills
- Basic knowledge of Arduino-based technologies

Indicative technologies:

- Hardware: Arduino
- Software: mBlock, Snap4Arduino, Open Roberta Lab

Session 6

Session outline:

1. Discussion about the Theremin: what is a Theremin? / Demonstration of videos / Explanation of basic terminology in music
2. Planning (i.e., which sensors will be implemented, how they will be programmed etc.)
3. Hands-on practice (crafting, programming and circuitry)
4. Sharing

Objectives:

Students will be able to:

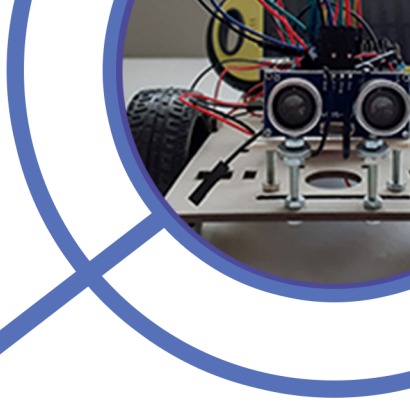
- reflect their ideas on design and programming
- work in groups, allocate roles, and present the results of teamwork
- implement hands-on and crafting ideas towards creating a paper model
- integrate electrical circuit making in the paper model
- write programming scripts in block-based programming environments
- explain what a Theremin is and how it can be controlled
- adapting the solution to additional fields or scenarios

Students' activities:

- Exploring the mechanisms behind Theremin
- Implementing of gestures as methods for controlling and producing sounds and music
- Creating the circuit (i.e photoresistor, buzzer, ultrasonic sensor) and programming the Theremin in two different ways
- Creating a paper model that reflects their idea
- Exploring how this concept can be applied for facilitating other needs (i.e., parking systems, walking stick for visually impaired people etc)
- Sharing their project in the plenary

Resources:

- Guidelines in mBlock: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Theremin_project_mBlocks.pdf
- Guidelines in Snap4Arduino: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Theremin_project_Snap4Arduino.pdf
- Physics behind Theremin - Youtube video: https://www.youtube.com/watch?v=KDG15-iTJLw



Session description:

The DIY automobile project: In this session students are engaged in a more advanced robotic project with Arduino, by creating an automobile that can freely move around space while detecting and avoiding obstacles.

Prerequisites:

- Basic programming skills
- Basic knowledge of Arduino-based technologies

Indicative technologies:

- Hardware: Arduino
- Software: mBlock, Snap4Arduino, App Inventor

Session 7

Session outline:

1. Discussion about the DIY automobile: main functionalities
2. Planning (i.e., what materials should be used for the chassis, which electronic components will be implemented etc.)
3. Hands-on practice (crafting, programming and circuitry)
4. Sharing

Objectives:

Students will be able to

- work in groups, allocate roles, and present the results of teamwork
- implement hands-on and crafting ideas towards creating the model of the automobile
- integrate electrical circuit making to their models
- write programming scripts in block-based programming environments
- elaborate on their design decisions
- apply eco-friendly solutions towards energy autonomy
- name and assembly the different electrical components
- realize the interrelation between engineering and robotics and the relevant emerging issues in regards to ecology and innovation

Students' activities:

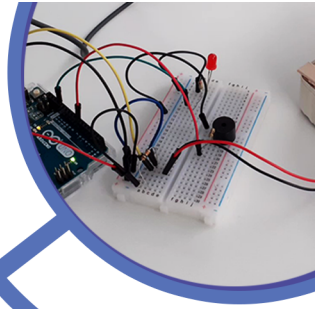
- Exploring the emerging issues related to engineering, ecology and innovation through the implementation of autonomous solutions
- Creating of a robust structure/model that can bear movement
- Creating and adjusting the circuit (i.e. DC motors, motor driver etc.) on the construction (chassis) and programming the automobile to freely move around space, as well as avoiding obstacles
- Sharing the current status of work/ or the completed project in the plenary
- Exploring how this concept can be applied to other emerging issues and/or can be enhanced/ combined with remote controlling (optional)

Resources:

- Crafting guidelines and ideas: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Guidelines-for-assembling-the-DIY-automobile.pdf
- Wiring and programming guidelines: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/Guidelines_For_DIY_Automobile.pdf
- App Inventor guidelines: http://edumotiva.eu/edumotiva/wp-content/uploads/2021/03/App_Inventor.pdf
- Youtube video (crafting guidelines): https://www.youtube.com/watch?v=Mls7UzdeLMk

Session description:

Open project: In this session students will combine previous gained knowledge in order to produce freely their own robotic artefact.



Prerequisites:

- Intermediate programming skills
- Intermediate knowledge of Arduino-based technologies

Indicative technologies:

- Hardware: Arduino
- Software: mBlock, Snap4Arduino, Open Roberta Lab, App Inventor

Session 8

Session outline:

1. Discussion in groups about the main idea
2. Planning
3. Hands-on practice (crafting, programming and circuitry)
4. Sharing

Objectives:

Students will be able to

- put previously gained knowledge under a new concept
- reflect their ideas on design and programming
- work in groups, allocate roles, and present the results of teamwork
- develop new ideas towards robotic artefact construction
- propose solutions and provide feedback to other groups in the class

Students' activities:

- Searching for and recording topics and ideas that are related to their own interests
- Planning and discussing on the ways that their idea can be realized
- Deciding about the needed equipment and programming methods
- Creating their own artifact (circuitry, programming, crafting)
- Thinking of the possible impact of their idea to other fields (ecology, art etc.)
- Sharing their project in the plenary

Resources:

- Ideation in teams: https://www.youtube.com/watch?v=pOqfKEocHHs
- Ideation in the plenary: https://www.youtube.com/watch?v=KASmme8jH08
- The video game joypad project: https://www.youtube.com/watch?v=QZHyYlv87no
- The shy rabbit project: https://www.youtube.com/watch?v=TryERYW835w

APPENDIX

Technologies and tools (mentioned in this curriculum):

Kits and open-source technologies:

SnapIno: https://shop.elenco.com/consumers/snapino.html

Arduino: https://www.arduino.cc/

Software and apps:

mBlock: https://mblock.makeblock.com/en-us/

Snap4Arduino: http://snap4arduino.rocks/

Open Roberta Lab: https://lab.open-roberta.org/

TinkerCad: https://www.tinkercad.com/learn/circuits

App Inventor: https://appinventor.mit.edu/