EARLY Teaching Scenario

Topic: Introduction to building a DIY robot

Aim(s): Students learn how to:

- Use a basic 3D modelling programme
- 3D print parts of a robot
- Install Arduino electronics
- Get support from maker communities
- Code and operate a simple robot

The National Curriculum for Polish primary schools (IT) states that by the end of class 8, students should be able to:

- Design, create and test programs in the process of solving problems
- Use in these programs (i.a.): input / output instructions, arithmetic and logical expressions, conditional instructions, functions
- Design, create and test software controlling a robot or other object on the screen or in reality
- Search the network for information needed to perform a task, using complex forms of queries and advanced capabilities of search engines

The course components that are trained in this learning scenario are as follows:

- Creating a robot from provided components
- Programming the robot with a blocks-based graphical programming language
- Problem solving
- Collaboration

Target group: pupils in primary school (grades 7 -- 8)

Age of students: 13 - 14 years old

Number of pupils: maximum of 15

Duration (estimated time/number of lessons): 3 sessions x 45 - 90 minutes each

Prerequisites (necessary materials and online resources):

- Computer lab with at least 1 PC for a pair of students
- TinkerCAD
- 3D printer
- Basic tools for 3D printouts treatment
- Projector
- Arduino Nano together with other necessary parts specified on the www.ottodiy.com website

Introduction to the scenario *(incl. possible applications, alternatives and risks)***:**

The main goal of this learning experience is to design, build and programme a simple robot. It would be great if each student had her/his own robot or if they worked in pairs. However, the most effective working group should contain up to 10 students. If you plan to implement this scenario in a bigger class, consider dividing it into small groups. At every stage you are free to decide, how much you want to teach and show to the students and how much you will require from them to find out and learn independently. Some parts of the scenario require specific equipment, for example a 3D printer, however if you don't have access to such a device, you can skip this part and focus on others.

Before the program begins (preparatory work for teacher):

- You should start with the checklist of all the equipment and necessary software. What will you need? Which programmes do you want to have preinstalled and which of them should be installed by the students? Which steps/session can be too difficult for them and when it is better to leave them alone and count on their creativity?
- You know your group the best. If you work with other teachers on this project, start the whole process with a brainstorm. Then prepare the necessary equipment and other resources.

The main part of the scenario (3 lessons):

Lesson one: Introduction to the project and 3D printing technologies

Set goals & explain the project:

- The leader should explain the whole process and the main goals at the beginning, so everybody knows what to expect. This will allow the students to be more active and creative during the whole process. Therefore, it is important to stress that they are free not only to ask questions but also suggest solutions, especially when it comes to difficult issues.

Introduce OTTO DIY:

- Next step is to introduce the OTTO DIY community. Besides the official website, they have profiles on GitHub, Facebook, Thingiverse, where one can find and share all the information necessary to build and code the robot and discuss difficult issues.
- The students should also see the Otto, either the real one (if available) or in one of the videos from the website www.ottodiy.com
- Although one can buy already printed parts of a robot or try to use other materials, it will be interesting to print at least some of them if you have access to a 3D printer (basic FDM printer is enough in this case). If you don't have such access, you can skip this part and focus on the other sessions.

Purpose:

- The purpose of this session is twofold:
    - To give students some basic information about 3D printing as such (it is still quite innovative technology and young people are usually interested in such novelties)
    - To make them aware of some limits in redesigning robot parts

- Therefore the general information about 3D modelling and 3D printing together with a short introduction to this particular 3D printing technique which you are going to use should be enough. You can use the information presented in the free online course available here: www.youthart.eu/3dlab or search together with a group for other sources.

Lesson two: Introduction to Tinkercad and redesigning OTTO robot

Tinkercad (https://www.tinkercad.com) is one of the most basic and user-friendly programmes for 3D modelling. It is free and available online – a great resource to start your adventure with 3D design.

Purpose:

- To make students acquainted with the basic commands and tasks in this programme.
- For most of them, who haven't worked in 3D yet, to start "thinking" in three dimensions will be a challenge, but after a while, they will be able to easily play with exemplary objects.

Procedure:

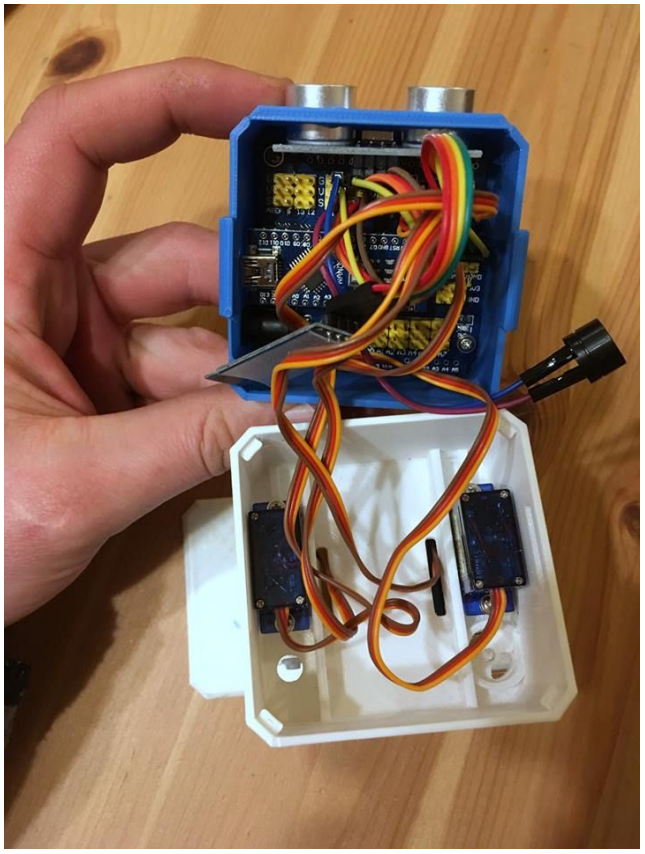
- When all group members feel comfortable with Tinkercad, just go to the project of Otto: https://www.tinkercad.com/things/1kl624iowUR#/ and experiment with its parts.
- For explaining some more advanced redesign procedures, you can use this video tutorial: https://youtu.be/6gBVEBly1lI

Groups/Individual work

- You decide if it is more group or individual work.

Shapes:

- When changing the shapes, you must always keep in mind that some of them cannot be freely changed:
    - They have to fit one another, they have to be able to move in a certain way, and they have to have the proper dimensions to fit with the electronic parts.
    - Another limit comes from the 3D printing process. Some shapes are extremely difficult or even impossible to print, especially on the basic equipment



Alternatives:

- The full process of printing an Otto robot in basic shape takes ca. 10 hours. Depending on your situation, you should decide, if
    - you want to print all the parts by yourself
    - teacher print it together or without students
    - you prefer to buy them or outsource printing to an external service

Lesson three: Assembling and programming the robot

Assembling your robot: Having all the knowledge and parts, you can start assembling your robots. It is necessary to use the scheme from Otto DYI and useful to watch some video tutorials from there.

Individually/pairs
You'll be working individually or in pairs, but feel free to exchange information and help each other around the group.

Codes available:

All the necessary codes are available at https://github.com/OttoDIY/ and at https://wikifactory.com/+OttoDIY

If time allows it's a good idea to introduce the Arduino technology through its website https://www.arduino.cc/. The original platform is in English, but there are plenty of materials in many other languages, so it won't be difficult to find the necessary information.

Methods:

- This is a great opportunity to set it as a task for each member to find some info, share them in the group and discuss.
- Focus on the Arduino Nano and parts included in the Otto project.
- Install the Arduino software on the computers.

How to use OTTO:

- There are many different ways, which you can choose to use Otto and a countless number of tasks, which it can get. The best way will be to start coding using Arduino mBlocks with Otto programme or Arduino programme.
- To make the robot move or perform any other actions, you need to provide specific data using mathematical and physical quantities.

Progression:
Think about tasks, where the students will have to count, measure, provide algorithms, etc. You can ask them to work in English or try to translate the commands into your language.

Learning outcomes
Students will be able to:

- Develop working procedures
- Design a 3D object in a simple programme
- Redesign existing objects
- Download and use free software
- Establish contacts with digital making groups for consultations and sharing their work
- Operate simple robot
- Collaborate in the group