Co-funded by the
Creative Europe Programme
of the European Union
Project 2020-1-TR01- KA201-094533

STEM E-CONTENT 3D VIRTUAL REALTY

The Key To Global Life,
Digital Change Of Nature

Total Duration: 20 hours

Student's Age: 16-18 Years

Application Area:

- Water conservation,
- Climate change,
- Sustainable agriculture,
- Product design

Keywords: Climate, agriculture, construction, prototyping, engineering, programming, irrigation, water conservation.

R1 - Strawberries On Rooftop

Module

- Renewable Energy
- Water and healthy food

R1 - English Version

Materials:

- **Various materials for planters (wooden panels, large flower pots, pallets…)**
- **Strawberry plants**
- **Potting soil**
- **Polymethylmethacrylate (plexiglas, perspex)**
- **Laser cutter**
- **Soil moisture sensor**
- **Tubing**
- **Rod nozzle**
- **Reducing tee**
- **Capillaries**
- **Tubing**
- **Pump**
- **Channel 5v relay module**
- **Paper (a3)**
- **(colored) pencils**
- **Laptop**
- **Arduino**
- **Breadboard**
- **Jumper wires**

Notes:

- Size of each group: 3-4 students
- This project must be spread over a school year and takes about 20hrs at least
- The project consists of different activities, some activities like plant watering system are described in a separate document
- Important is that the students feel free to think out-of-the-box. Don't give them too much information about possible solutions. Let them know that you will evaluate them on the process, not on their solution
- Give them the freedom to work out their own solution if it is relevant and meets the objectives of the project

Introduction

The purpose of the activity is to get students acquainted with design principles, prototyping techniques, programming related to monitoring systems: using sensors for collection of data, letting actuators react to sensory data, … The challenge is to build a working system not only to work out a proof of concept on paper. They also get acquainted with new farming systems, e.g. aquaponics, and reflect on the farming problems we are challenged with. They also reflect on the needs arising due to climate change, the strawberry case is just one of many (Picture 1).

The students design and build a strawberry cultivation system on the rooftop of the school using an automatic irrigation system using an Arduino Uno and a soil moisture sensor.

Teacher needs a basic knowledge of Arduino.

Picture 1. The strawberry project

Considerations

- Size of each group: 3-4 students
- This project must be spread over a school year and takes about 20hrs at least
- The project consists of different activities, some activities like plant watering system are described in a separate document
- Important is that the students feel free to think out-of-the-box. Don't give them too much information about possible solutions. Let them know that you will evaluate them on the process, not on their solution
- Give them the freedom to work out their own solution if it is relevant and meets the objectives of the project

Aim of the Activity

- The purpose of the activity is to get students acquainted with design principles, prototyping techniques, programming related to monitoring systems: using sensors for collection of data, letting actuators react to sensory data, … The challenge is to build a working system not only to work out a proof of concept on paper. They also get acquainted with new farming systems, e.g. aquaponics, and reflect on the farming problems we are challenged with. They also reflect on the needs arising due to climate change, the strawberry case is just one of many.

Activity Process

Before Activity

Picture 2. Plastic bags

Design and build a system to grow strawberries on the rooftop with appropriate irrigation (Picture 2).

- Explain the assignment: background, aim, time frame for each part
- Divide the class in groups 3-4 students, each group at their own table. Each group has a laptop, paper and pencils.

Let's Start

1 Presentation preparation:

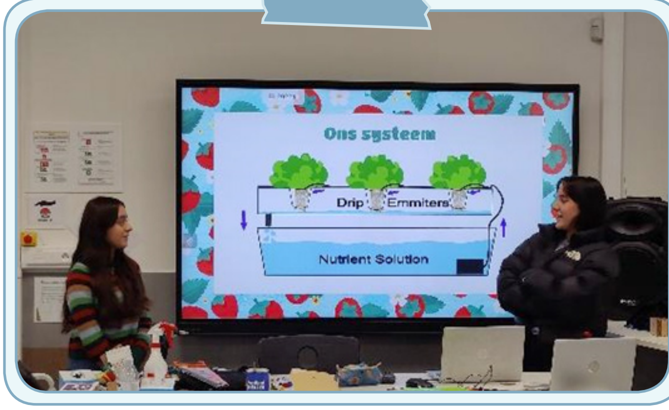
Considerations the students can take in account:

- What equipment do you need? Consider location and appropriate size or number for equipment involved (e.g. location and volume water tank, surface growing beds, number of plants)
- Which parameters need to be monitored? Hence, which sensors are needed?
- Are there any 'seasonal' parameters to take into account? (e.g. growing speed of the plant with different amounts of sunlight)
- What irrigation techniques exist, and which technique is feasible for your project?
- How could you monitor, store and visualise the growing process, irrigation, soil moisture? Can you use a cloud-based dashboard?

Once they have designed the system, they have to make a presentation (max. 5 minutes for each group). The students choose how to do this themselves (Picture 3, 4).The presentation should include:

- A detailed building plan of the system with focus on the irrigation technique
- An overview of the electronics involved

Picture 3. Presentation



Picture 4. Presentation

Each group will present their solution to the rest of the class. The other students listen to the presentation and in the end they ask questions. Critical thinking and respectful communication has to be encouraged. Aim is by presenting the solution and discussing it with the rest, the quality of the solution will improve.

2 Make it so!

Over the next few weeks, students will continue working to make their project a reality. The first step is to construct the planter where their strawberries are to be planted (Picture 5). They gather their own material for their planter, preferably recycled. The intention is not yet to provide irrigation, although they should keep that in mind during their construction (Picture 6, 7).

Picture 5. Materials

Picture 6. The making steps

Picture 7. The making steps

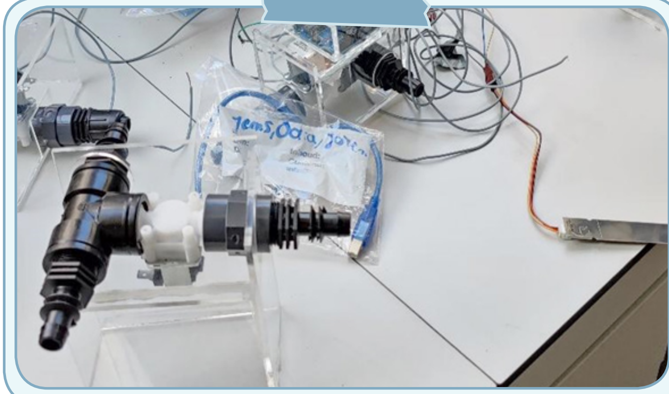
3 Learn to make a plant watering system

This is an optional part. Students will learn how to create one specific system to provide automatic irrigation (Picture 8). Therefore, it is covered in a separate document. It can be seen as additional training of competencies in physical computing and programming. After that, you can choose to let everyone build this system, or it can be skipped if you decide to let the students work out their own irrigation system. The latter is preferable because it includes more STEM competencies, but it can put more demands on school infrastructure and material costs.

Picture 8. The making steps

Another possible configuration with valves and irrigation system (Picture 9, 10). (taken during the activity, with valve instead of pump)

Picture 9. Posible configuration



Picture 10. Possible configuration

4 Prototyping

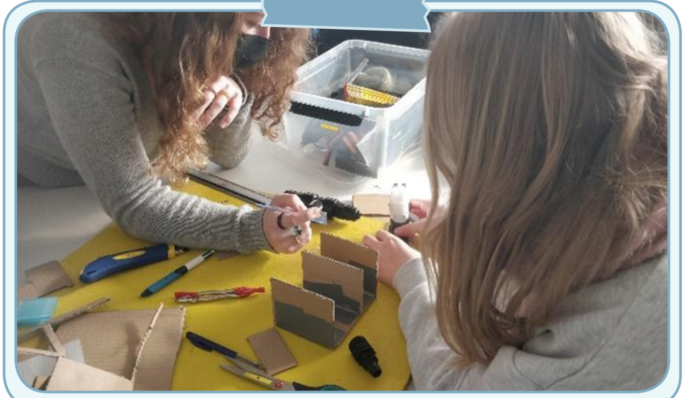
It's preferable that the students decide themselves what they want to do. An alternative approach is that the teacher defines the subject of prototyping, for example:

Prototyping housing plant watering system:

Students design the housing of the plant water system, i.e. electronics and water pump (Picture 11). The design has to meet following requirements:

- Waterproof, in particular housing electronics.
- Economic use of material, correct sizing.

Picture 11. Prototyping



Picture 12. Prototyping

Prototyping is a very important part of the product design process (Picture 12). The purpose of prototyping is many-fold:

- Research
  - is it what the user wants
  - does it work as it should
  - is it commercially viable
- Exploration
  - exploring the possibilities and limits of materials
  - aesthetics and ergonomics
- Verification: are the assumptions correct
- Communication with other departments such as marketing and engineering.

Considerations:

- Define first what you want to investigate, what is the purpose of your prototype? Write it down.
- If possible, make 'low fidelity' prototypes. A quick and cheap prototype is best as long as it matches the purpose of what you want to achieve with it
- Size does matter (sometimes). Sometimes it doesn't, and you can make it smaller (=cheaper, faster)
- Use the right prototyping technique at the right moment. Often cardboard and tape is suitable, sometimes you have to use 3D printing, laser cutting or other techniques
- Play angry birds, not chess: don't be afraid to put your prototype to the test (Picture 13, 14).

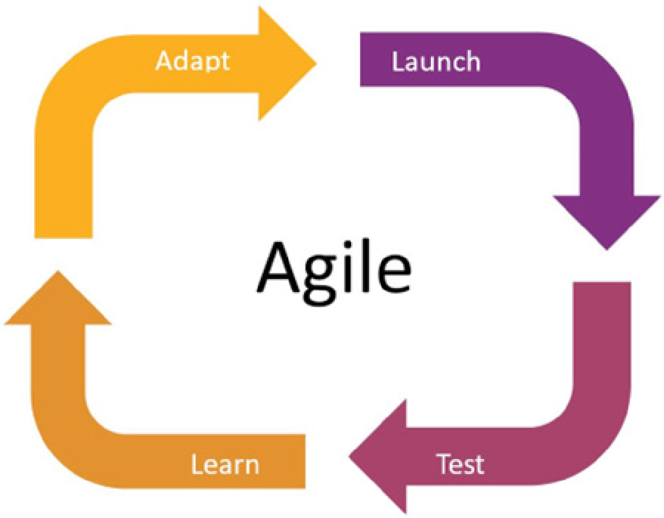
Picture 13. Considerations

Picture 14. Considerations:

The agile process:

Be sure to use this checklist before you start (Picture 15):

- WHAT do you want to test (PURPOSE)
- What exactly are you going to measure?
- Determine with whom you want to test
  - Consumer
  - Stakeholder
  - Your own staff
- Build a prototype that allows you to test and evaluate effectively
- Learning from the process is much more important than trying to get everything right the first time
- If possible, test different aspects one after the other
- Evaluate, write down your findings, note what you are going to adjust
- Use the iterative agile process: test, learn, adapt, launch and test again (Picture 15).



Picture 15. The agile process.

Closure

- It is now time to effectively put their design into practice. The students will install their irrigation system on the roof. The school provides the general resources such as electricity and water supply (Picture 16).

Picture 15. Results.

Assesment

Evaluation

- ***Brainstorming part Evaluation:***
- The design of students can be displayed within the school. Different products can be created by diversifying waste materials used.

Goals	Must be Improved (1)	Medium (2)	Good (3)	Very Good (4)
Identifying and refining the research question	(.....)	(.....)	(.....)	(.....)
Active participation in the discussion	(.....)	(.....)	(.....)	(.....)
Thinking out of the box	(.....)	(.....)	(.....)	(.....)
Finding multiple solutions and filter out the best	(.....)	(.....)	(.....)	(.....)
Formulating your own opinion in the group	(.....)	(.....)	(.....)	(.....)
Critical thinking	(.....)	(.....)	(.....)	(.....)
Correct presentation (language, clean)	(.....)	(.....)	(.....)	(.....)
Goal oriented presen-tation	(.....)	(.....)	(.....)	(.....)
Students agrees on fair task distribution	(.....)	(.....)	(.....)	(.....)
Student focuses on task	(.....)	(.....)	(.....)	(.....)
Total				

- ***Prototyping part Evaluation:***
- **The design of students can be displayed within the school. Different products can be created by diversifying waste materials used.**

Goals	Must be Improved (1)	Medium (2)	Good (3)	Very Good (4)
The student describes goal and stakeholders of the project.	(.....)	(.....)	(.....)	(.....)
The student makes a list with all requirements, imposed by teachers and personal requirements	(.....)	(.....)	(.....)	(.....)
Students show drawings on paper to the teacher and explain how compo-nents will be assembled.	(.....)	(.....)	(.....)	(.....)
The student takes into account: - dimensions; - right technique at right moment, - quick and cheap, - effective testing	(.....)	(.....)	(.....)	(.....)
The student describes work and test method-ology.	(.....)	(.....)	(.....)	(.....)
The students writes down observations and for-mulates conclusion and possible improvements to prototype	(.....)	(.....)	(.....)	(.....)
The student reflects on the first prototype; what would you do differently. The student reflects on the next actions and describes the goal of the next version of the prototype.	(.....)	(.....)	(.....)	(.....)
The student focuses on the target and provides useful ideas, guides the team, and completes tasks as needed by the team	(.....)	(.....)	(.....)	(.....)
Students agrees on fair task distribution	(.....)	(.....)	(.....)	(.....)
Student focuses on task	(.....)	(.....)	(.....)	(.....)
Total				

- ***Realisation part Evaluation:***
- **The design of students can be displayed within the school. Different products can be created by diversifying waste materials used.**

Goals	Must be Improved (1)	Medium (2)	Good (3)	Very Good (4)
Larger problems can be independently simplified into smaller (previously solved) problems.	(.....)	(.....)	(.....)	(.....)
Active participation	(.....)	(.....)	(.....)	(.....)
Finding a possible technical solution and translating it into a technical design	(.....)	(.....)	(.....)	(.....)
Selecting and implementing useful information from specified source	(.....)	(.....)	(.....)	(.....)
Critical thinking	(.....)	(.....)	(.....)	(.....)
Process- or plan-based work attitude	(.....)	(.....)	(.....)	(.....)
Realizing an existing design and Applying subject-specific knowledge and skills	(.....)	(.....)	(.....)	(.....)
Choosing and adopting an appropriate systematic approach in seeking solutions	(.....)	(.....)	(.....)	(.....)
Total				

Links

- Hackerstore.nl for the components
- All other pictures taken during the STEM activity at College Hagelstein, Belgium