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STEM
E-CONTENT
3D VIRTUAL REALTY

The Key To Global Life,
Digital Change Of Nature

Total Duration: 12-18 hours

Student's Age: 14-18 Years

Application Area:
- Climate change,
- Physics,
- Electronics,
- Product design

Keywords: Temperature, data analysis, climate, arduino, technology, weather

R4 - Prototyping: Make a Weather Station

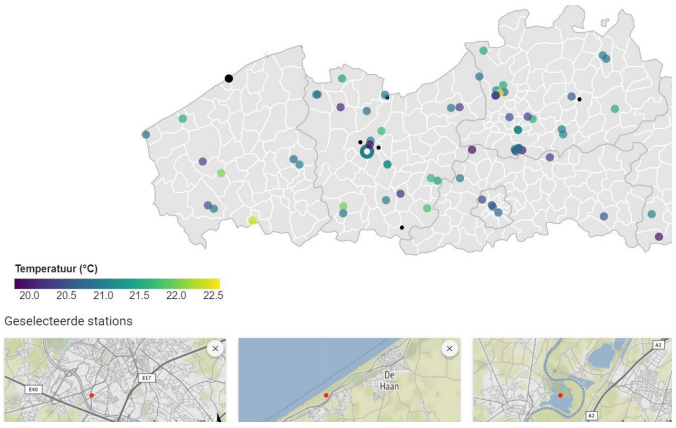
Module
- Renewable Energy
- Environmental pollution
- Global Warming

R4 - English Version

Materials:
- Paper (A3)
- (Colored) pencils
- Laptop
- Beamer
- Other materials depending on the project details

Notes:
- Size of each group: 2–4 students
- Focus on individual students' strengths and complementary competences when composing each group
- 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
- This is a complete project, from the brainstorming and presentation to building it in real life.

Introduction



Picture 1. *VLINDER*

There has never been a more important time in the history of mankind for students to understand how the weather can be measured. Powerful computers enable weather models running at high resolution, but this requires a lot of local weather data.

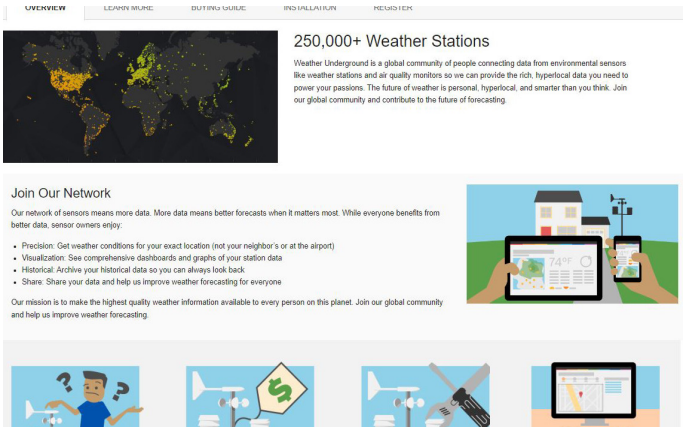
Students have to design a feasible, innovative and sustainable weather station extension to monitor parameters like rainfall, wind speed and direction.

Students can gain an insight in how aspects of the weather are measured and explore the concepts of data acquisition. They will also see how using low-cost materials and 3-D printing can make science accessible to a wide range of people. As few secondary schools could afford a weather satellite, this project provides the tools to measure tangible weather changes and hence make the study of our weather, and evidence of global warming, more credible. It gives them the skills to make up their own mind.

Weather and climate are of great importance today. Powerful computers enable weather models running at high resolution, but this requires a lot of local weather data. Imagine every school monitoring weather...

In this activity, the students will work in a group to design an affordable, portable DIY extent for a weather station monitoring chosen weather parameters like rainfall or wind speed and direction. All data will be collected, shared and visualised graphically on a common online dashboard, like the *VLINDER* dashboard (Picture 1), a Belgian network of citizen weather stations that collect meteorological data in landscapes we do not have information of today. Another example is *Weather Underground* (Picture 2).

During the process, students are introduced to each phase of product design, including research, brainstorming, presentation, agile development, iterations, project management, planning, communication and prototyping.



Picture 2. Weather Underground

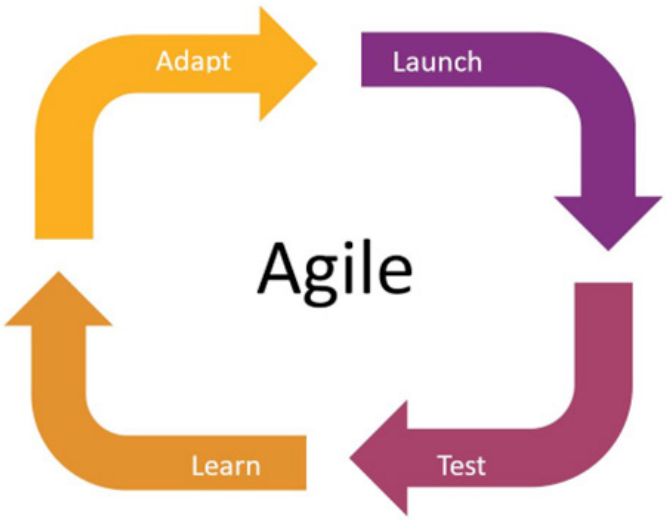
Considerations

- Size of each group: 2–4 students
- Focus on individual students' strengths and complementary competences when composing each group
- 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
- This is a complete project, from the brainstorming and presentation to building it in real life
- It is necessary that at least some students in the group already have experience with physical computing and programming, basic knowledge of soldering

Students could work in teams of 2-4 to produce a complete station. In that case, some 'project managers' should be assigned. Tip: you can assign a product owner and a scrum master and use Agile Development to reach your goals!

- Team 1: Wind speed
- Team 2: Wind direction
- Team 3: Rainfall gauge
- Team 4: Arduino interfacing
- Team 5: Building the supporting structures
- Team 6: Siting and mounting the System
- Team 7: Cloud storage of the data
- Team 8: Data visualisation

If you can cooperate with other European schools to use the same weather station in each country and gather data, you can compare weather patterns across Europe.



Picture 2. Agile Development

Aim of the Activity

- Raising awareness about climate change by studying weather data
- Make it easier to measure weather parameters at regular intervals
- Learn to work with sensors in general to collect data:
  - understand the relationship between measured voltage and the physical quantity to be measured
  - learn the concept of calibrating a sensor
  - learn to work with a technical data sheet
- Learn to program in C++ or Python depending on the chosen technology
- Introduction to the Internet of Things

Activity Process

Before Activity

Teacher separates the students into groups (Picture 1; to create groups randomly - https://www.classtools.net/random-name-picker/).

1. Explain the assignment: background, aim, time frame for each part
2. Divide the class in groups 2-4 students, each group at their own table. Each group has a laptop, paper and pencils

Let's Start

Design and build an Internet of Things weather station. Considerations the students can take in account:

1 Design

- What parameters determine weather and how can you measure them? Sum them up.
- Use the above to determine what components a weather station consists of.
- Are there certain requirements a weather station must meet? Consider location, weather resistance, power supply, connection to the internet, accessibility, vandalism...
- Make a sketch and place the different components on the drawing
- Divide the project into sub-projects
- Which subproject(s) would you like to carry out as a team? Tell us why you think so
- How could you monitor, store and visualise these weather parameters on a cloud-based dashboard?

2 Presentation preparation

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. The presentation should include:

- A detailed building plan of the weather station
- An overview of the sub-projects
- What they want to do themselves and why they think they are the best team to do this.

3 Presentation (5 min for each group):

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.

4 Project management:

- Explain to the students what agile development ('scrum') is and how to apply it, using the 'product backlog', 'sprint backlog' and 'scrum board'
- Assign one overall product owner responsible for the final product
- Assign one overall scrum master to keep an eye on the process itself. This should ensure that the teams communicate smoothly and interpersonal problems in the teams are addressed
- Each group completes the scrum template (in attachment). This means:
  - Complete the team information
  - Divide the subproject into 'sprints'. Each sprint has a deadline and a defined goal to be reached by then
  - Define a number of subtasks for each sprint. Assign a team member to each subtask to do that task by the next sprint
  - Start with a list of supplies needed for your subproject

You can get much information from this link:
https://www.nutsvolts.com/magazine/article/the-graphing-weather-station

5 Work out the project:

How it proceeds next depends on the group composition and background knowledge of the students and of course how far you want to go. Keep an eye on the process. Can they set realistic goals, are they in control of their schedule, do they deliver what they promise, ... The teacher coaches the teams, helps clearing insurmountable obstacles and ensures that the scrum master and product owner can do their job in the group. The end product is not the most important thing, it is the process of getting there that counts!

Assesment

Evaluation

- If possible, the projects can be worked out further in real life in a later phase, maybe downscaled or altered to make it easier to do.

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 presentation	(.....)	(.....)	(.....)	(.....)
The take-up of all roles within a group assignment happens spontaneously	(.....)	(.....)	(.....)	(.....)
A realistic work plan is drawn up and fully completed	(.....)	(.....)	(.....)	(.....)
Total				

Links

- https://www.nutsvolts.com/magazine/article/the-graphing-weather-station