

Carola Helletsgruber | University of Salzburg | Austria

## Urban trees as climate messengers

**Urban trees are more than just GREEN:** they provide shading, air cooling, they filter fine dust and produce oxygen. Urban trees are part of the Green Infrastructure and they are important elements of urban climate adaptation. But how much ecosystem services are they capable to provide and which tree species are adapted to climate change?



In the Sparkling Science project “**Urban Trees as Climate Messengers**”, researchers, experts, teachers and students from Austria, Germany and Hungary work together with the aim to contribute a better understanding of the linkages between growth, phenology and ecosystem services of urban trees.

By using a tailor-made App and Beacons for phenological monitoring, microclimate measurement and broadcasting information about the results we created an innovative citizen science environment in which urban trees become **SMART**.

For more information please use the QR-Code and visit our website 😊



# Sustainable Development in Science Education

SCIENCE ON STAGE 2019  
CASCAIS  
THE EUROPEAN NETWORK FOR SCIENCE TEACHERS

Huguette Thibeault M.Edu., M.Sc. | Retired Biology professor |  
Cégep de St-Hyacinthe | St-Hyacinthe | Quebec | Canada |



## Doctor is my watercourse sick?

Can we cure it? adopt it? Let's think environmental education  
in real time in partnership, for everyone!



**What about macroinvertebrates?** Are they bioindicators recognized scientifically? Our partner **G3E.EWAG** online programs, as **Adoption of a Water Plan and Benthos Overview**, largely met logistical and educational needs.



A partner in education and monitoring water action as group G3E.EWAG <https://www.g3e-ewag.ca> can help you to reach pedagogical goals, objectives or competencies in having **real time laboratory in ecology**. They apply a differential diagnosis based on macroscopic and microscopic observations as well as bio-physico-chemical analyzes with an **ecosystem approach** adapted at **different levels: primary, secondary and collegial**.

Vera Koudelkova, Faculty of Mathematics and Physics, Charles University, Prague

## Drops and droplets

### Introduction

Capillarity and wetting play a very important role in many peoples' everyday activities – from agriculture on one side to washing dishes on the other side. In recent years some hydrophobic coatings have become available for uses such as walls from which water would flow right off; terrace without rime; car window which is (according to advertisement) always clean; impregnation for clothes and many other.

The topic is interesting for students. They ask about impregnation, detergents, behavior of materials for outdoor activities etc. It is possible to show students many applications for their normal life as well as some experiments, which are very attractive for them.

### Water droplets

What is the difference between these water droplets?  
Which of them is the most (or the least) adhesive?  
What surfaces are these droplets on?



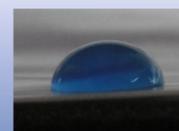
- ⇒ Contact angle between a droplet and a surface depends on both, not only on the liquid.
- ⇒ The adhesion can be measured using contact angle between the droplet and the surface.



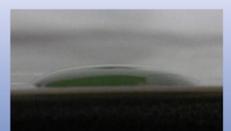
We need smaller contact angle

We need bigger contact angle

### Using of detergents



water



water with detergent

### Impregnation



without



with

### Hydrophobic surface

- It is possible to use it on nearly any surface.
- Two coatings, first of them acts as a glue for the second one.
- Contact angle about 170°.



plexiglass

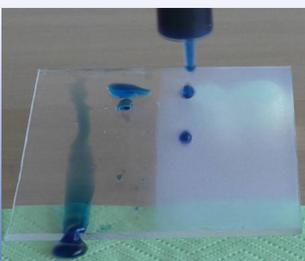


paper

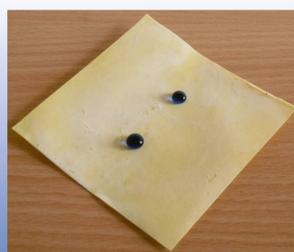


cloth

### Other experiments with hydrophobic surfaces



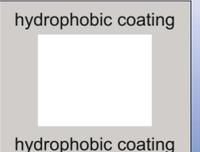
Comparison between behaviour of water on hydrophobic and normal surface



Hydrophobic paper

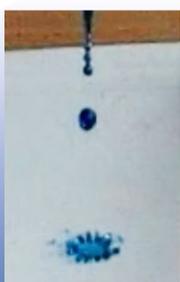


„Water rectangle”

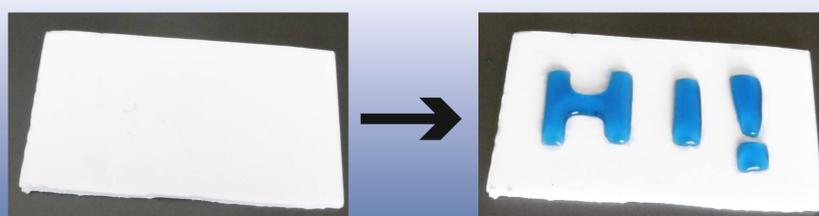


hydrophobic coating

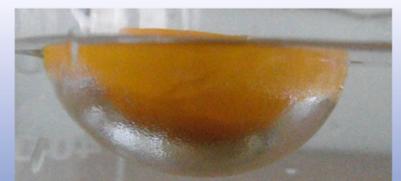
hydrophobic coating



Slow motion movie of water falling on hydrophobic surface



Secret text



Total internal reflection  
Hydrophobic ping-pong ball in water

Pernille H. Jensen, Amager Beach Nature Center, Copenhagen Denmark

## Your best mistake - 3rd grade engineering

### School partnerships: Solving an authentic problem

How do you construct a wind powered car?

Students solve the problem by building prototypes, testing and improving them. During this process, the most important thing is failing and learning from your mistakes. In this way students practice using their science knowledge to develop and test practical solutions to real problems.



### Why engage in school/nature center partnerships?

The nature center offers:

- Realistic and practical surroundings, materials and tools
- Didactical knowledge on working with the engineering method
- Insight into how teachers work within primary and lower secondary school

School/nature center partnerships create the opportunity for continuous visits that are integrated in the classroom allowing for developing and anchoring the knowledge of the students.

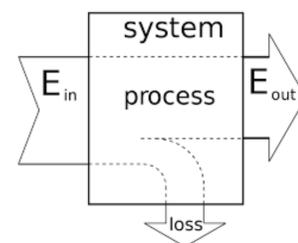
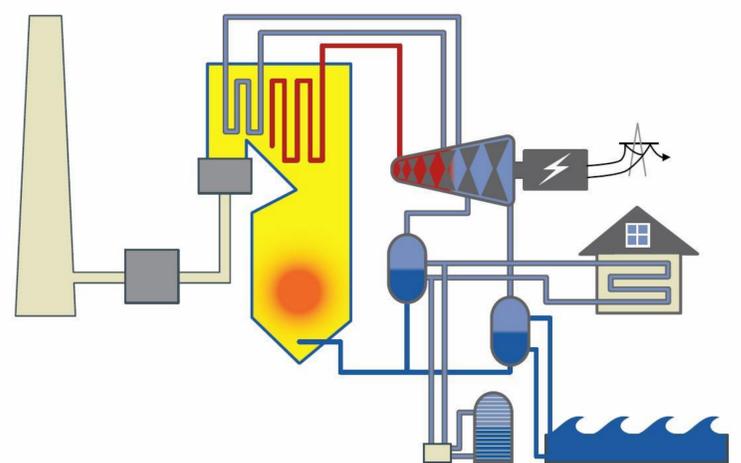
**Finding:** Preparation and active participation of the students are equally important factors as the efforts made by the Nature Center itself.

Lars Elkjær Jørgensen | Allerød Gymnasium | Copenhagen area | Denmark

## A physics unit for sustainability -in analogy to the Joule unit for energy

A key insight in physics education is that various forms of energy for widely different physical processes can be transformed into other energy forms, and that energy quantities associated with the transformations can be calculated in one calculation and with one energy unit - the Joule. In this project, students are urged to create their own unit for the environmental sustainability of a given process in analogy to the Joule unit.

For the 9<sup>th</sup> or 10<sup>th</sup> year of education.



$$\eta = \frac{W_{out}}{W_{in}} \times 100\%$$

$$\eta = \frac{150 \text{ J}}{650 \text{ J}} \times 100\%$$

$$\eta = 23.1\%$$

**Conclusion:** Small groups of pupils invent their own unit for environmental sustainability of a given process and the groups present their units to a class discussion. An inquiry-based and innovative approach to CO<sub>2</sub> equivalents.

Marie-Amélie Cazelles-Serin | Anna de Noailles Middle School | Larche | FRANCE

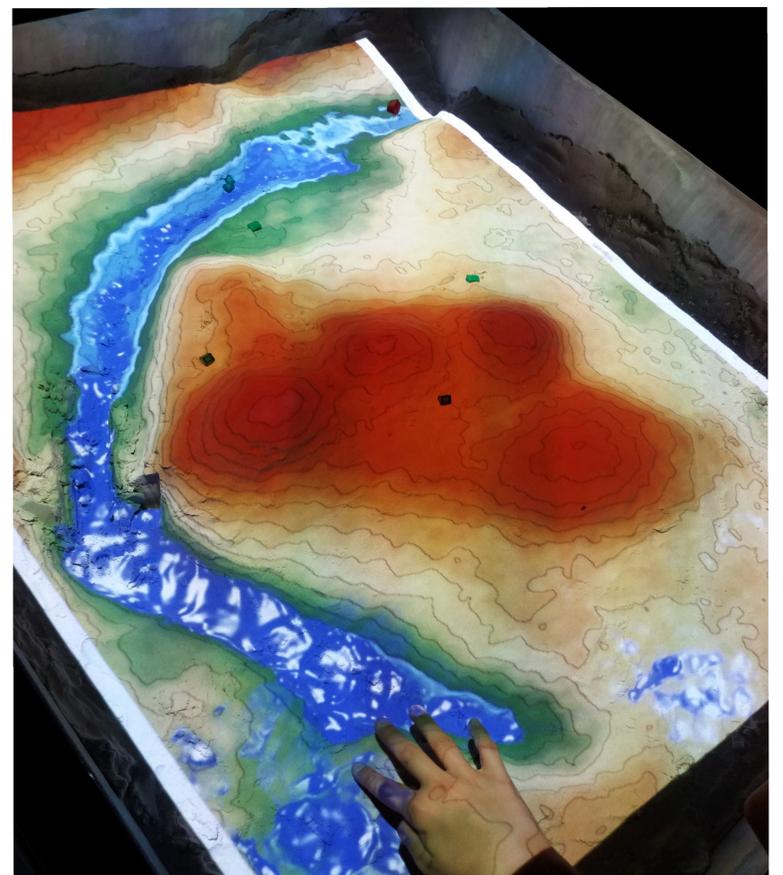
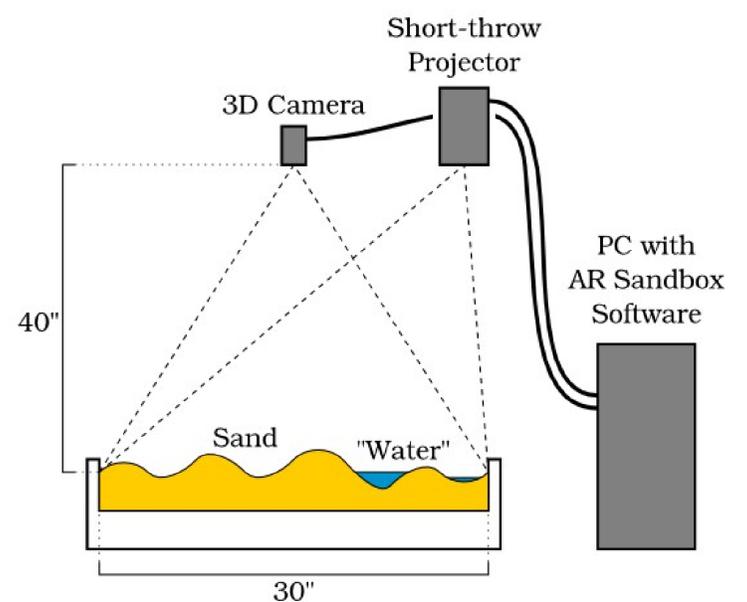
## Augmented Reality Sandbox

### From maps to 3d Models

The Augmented Reality Sandbox is a technologic device which combines a real situation and virtual elements. The real data, usually collected outside, can be greatly enhanced through the use of virtual resources which helps to increase the students' knowledge as it relates to real life situations.

In other words, the AR Sandbox allows us to understand, in a more efficient way, the circumstances that lead to natural events such as floods, tsunamis, volcanic eruptions along with the associated risks and the measures that can be taken to decrease the negative effects of such natural events.

### General Operating Principle



Positive points for the pupils :

- Group work involving a strong involvement
- Flood risk awareness
- Investigative processes including an outside session and leaflets making

The AR Sandbox is an innovative and motivating device that allows students and teachers to build analogic models reinforced by 3D technology.

# Sustainable Development in Science Education

Anne-Claire CHENUS | Saint-Charles High School | Orléans | FRANCE

## DusTrack'R

### The low-cost particulate matter sensor

#### Air pollution :

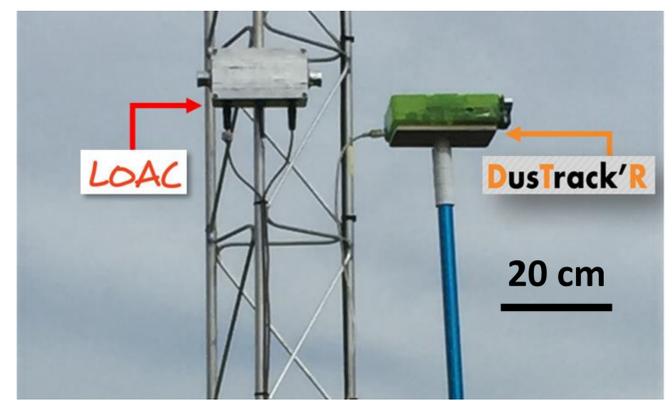
Urgent environmental challenge impacting both **air quality** and **climate change**.

**Problem** : Standard pollution measurement systems require expensive infrastructure, are cumbersome and provide a limited set of information.

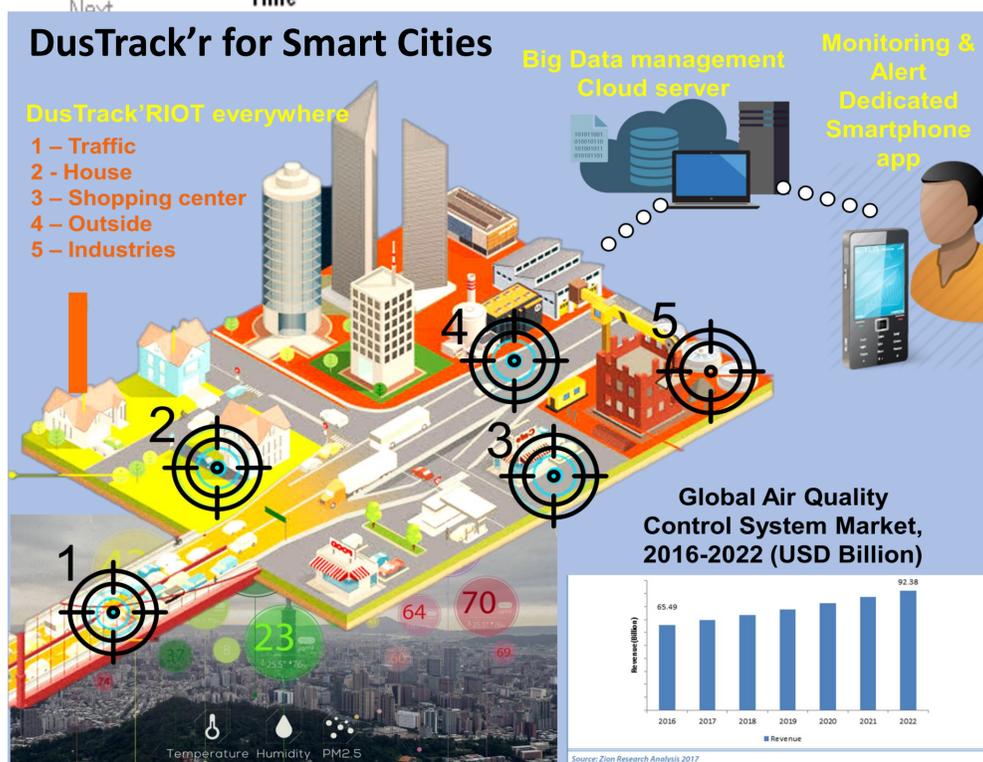
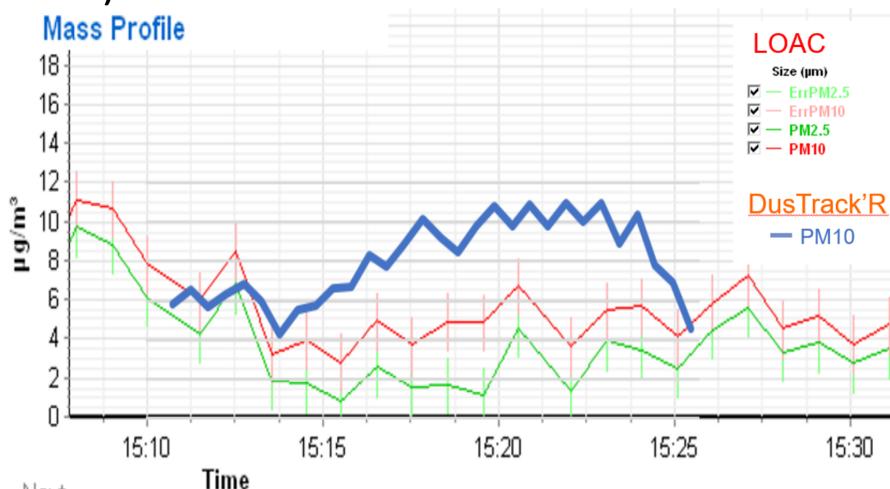
#### Our solution :

**DusTrack'R** is a versatile platform for measuring precisely air pollution in real-time based on open hardware solutions (Arduino + commercially available sensors).

**Comparison in real condition between LOAC (Light Optical Aerosol Counter) developed by LPC2E-CNRS laboratory and DusTrack'R developed by the students**

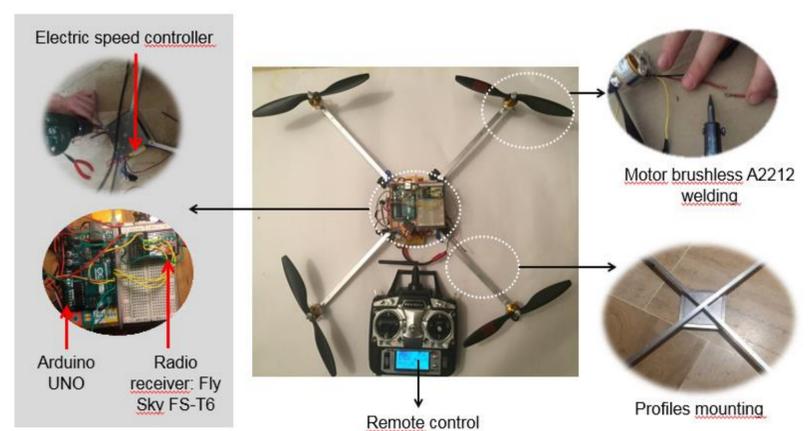


Average concentration PM10 ( $\mu\text{g}/\text{m}^3$ )	
LOAC	$6.3 \pm 2.3$
DusTrack'R	$8.0 \pm 2.1$
Lig'Air	$6.5 \pm \text{nd}$



#### Advantages of DusTrack'R :

- ✓ Low-cost
- ✓ High-precision
- ✓ Lightweight : Drone compatibility
- ✓ Portable
- ✓ High availability



**Conclusion** : **DusTrack'R** has been designed to be integrated in Smart Cities with the final goal to inform users in real-time about air pollution and associated risks (data analysis).

# Sustainable Development in Science Education

Anne-Claire CHENUS | Saint-Charles High School | Orléans | FRANCE

## DusTrack'R

### The low-cost particulate matter sensor

#### Air pollution :

Urgent environmental challenge impacting both **air quality** and **climate change**.

**Problem** : Standard pollution measurement systems require expensive infrastructure, are cumbersome and provide a limited set of information.

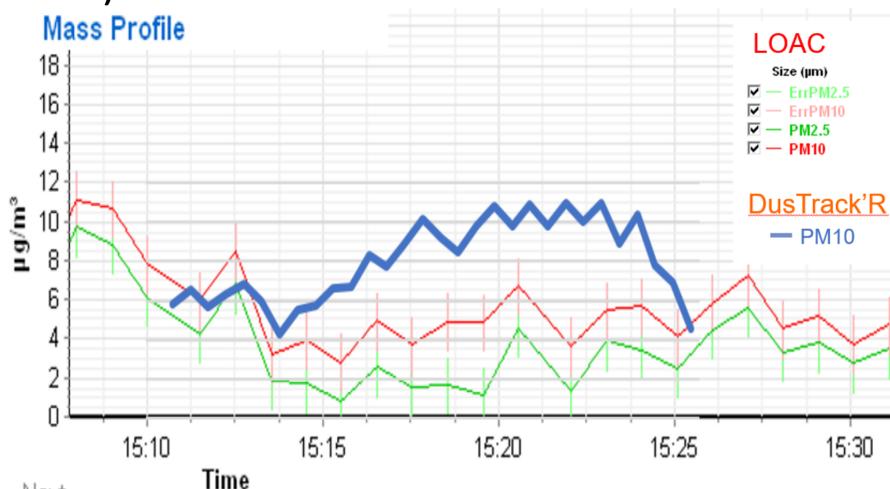
#### Our solution :

**DusTrack'R** is a versatile platform for measuring precisely air pollution in real-time based on open hardware solutions (Arduino + commercially available sensors).

**Comparison in real condition between LOAC (Light Optical Aerosol Counter) developed by LPC2E-CNRS laboratory and DusTrack'R developed by the students**



Average concentration PM10 ( $\mu\text{g}/\text{m}^3$ )	
LOAC	$6.3 \pm 2.3$
DusTrack'R	$8.0 \pm 2.1$
Lig'Air	$6.5 \pm \text{nd}$



**DusTrack'r for Smart Cities**

DusTrack'R IOT everywhere

- 1 - Traffic
- 2 - House
- 3 - Shopping center
- 4 - Outside
- 5 - Industries

Big Data management Cloud server

Monitoring & Alert Dedicated Smartphone app

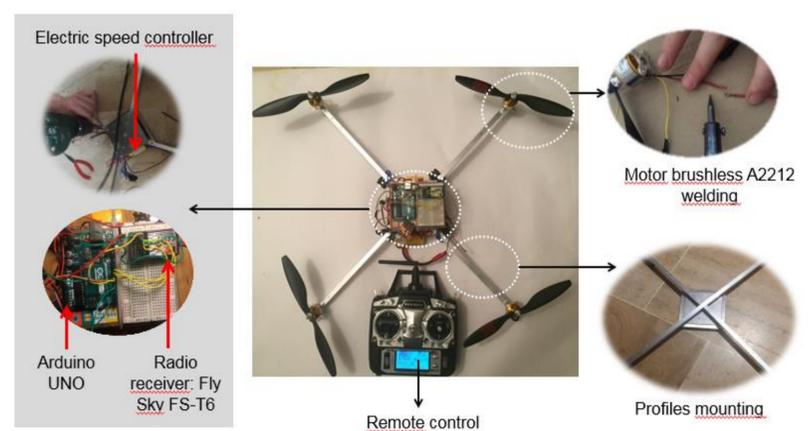
Global Air Quality Control System Market, 2016-2022 (USD Billion)

Source: Zion Research Analysis 2017

Temperature Humidity PM2.5

#### Advantages of DusTrack'R :

- ✓ Low-cost
- ✓ High-precision
- ✓ Lightweight : Drone compatibility
- ✓ Portable
- ✓ High availability



**Conclusion** : **DusTrack'R** has been designed to be integrated in Smart Cities with the final goal to inform users in real-time about air pollution and associated risks (data analysis).

# Sustainable Development in Science Education

Christophe DAVY - Vincent GUILI - Véronique RIDARD | Lycée Descartes | St-Genis-Laval | France

## Weather RotoSmart



### Automated plant wall to grow crops while optimizing water intake

An interdisciplinary project meant to :

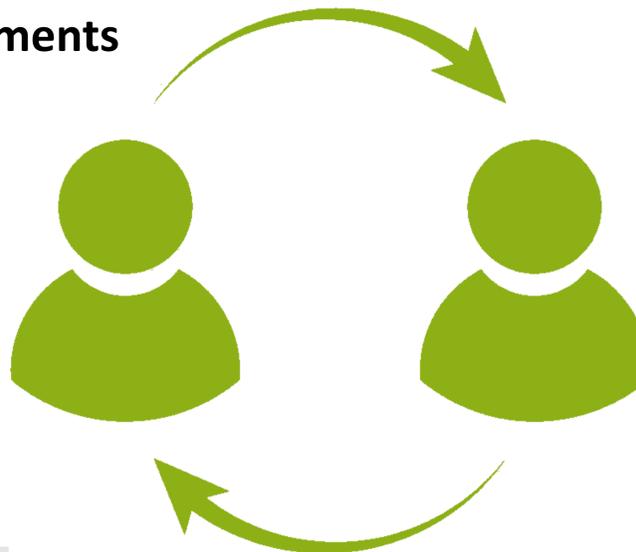
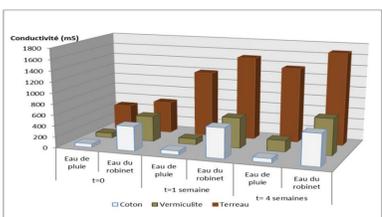
- ▶ **limit water intake** on a planetary level because lentil and buckwheat **co-cultivation** can provide all **essential amino acids** and therefore replace meat food which requires large amounts of water to be produce ;
- ▶ **limit water loss** of our culture thanks to the **rainwater recycling** and the integrated pump ;
- ▶ **optimize crop growth** thanks to **seedling** spatial distribution, the panel's rotation and the **symbiosis** provided by Rhizobium bacteria on the lentil crops ;
- ▶ **limit fertilizer intakes** which are harmful for groundwater and thus provide cleaner drinking water for the living world.

#### NATURAL SCIENCES

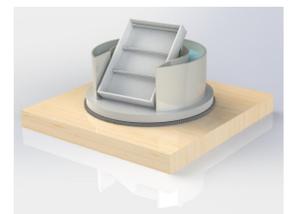
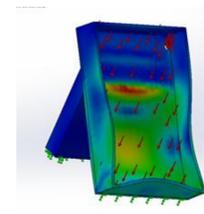
Interplay between  
&

#### ENGINEERING SCIENCES

##### Working hypotheses and experiments



##### Design and implementation



#### KEYPOINTS

- ▶ Teachers' willingness to work together
- ▶ Workshops for brainstorming and building of collective knowledge
- ▶ Online tools (drive) to cooperate and share resources and productions
- ▶ Motivation of students by participating in numerous competitions
- ▶ No academic curriculum constraints, freedom to create

# Sustainable Development in Science Education

Catherine Demangeat & Rémy Greiner ; Jean Moulin Secondary School ; Rouffach ; FRANCE

## Rouffach, a terroir of vines and wines

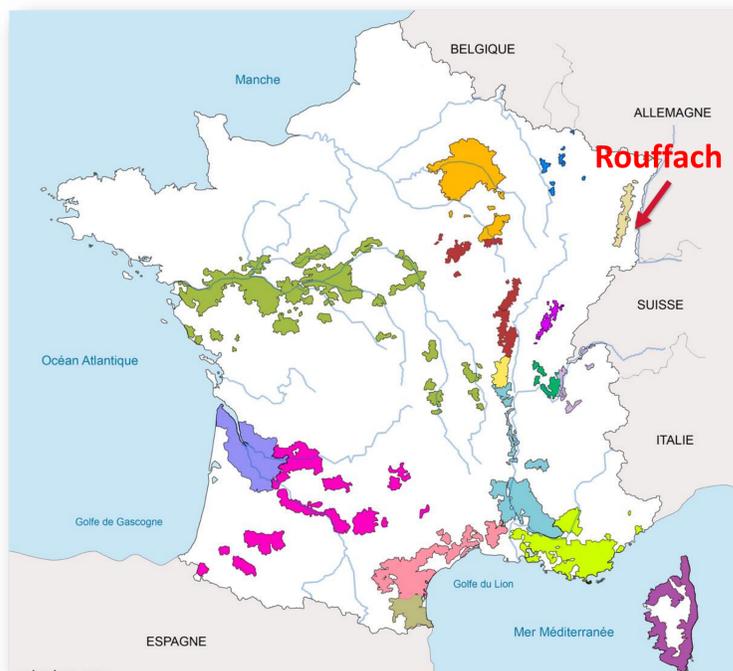
### Scientific workshop open to 21 volunteer students

#### Context

The city of Rouffach is located in one of the best known French vineyard regions, the Alsace. It is also situated close to a national research center and an agricultural school, both focusing on grapevine. Most of our students are interested in or directly connected to the grapevine industry.

#### Objectives:

- Developing our students' scientific thinking, spirit of research, systematic analysis as well as sound academic methods.
- Raising our students' awareness concerning new (bio)technologies to develop a sustainable viticulture, preserve biodiversity and landscapes while producing quality grapes and wines.



Map of viticulture region in France

#### Activities performed along the project

☐ In partnership with an agricultural school (Lycée Agricole de Rouffach)

- Presentation of the 7 Alsatian varieties and their specificities
- Grape harvesting
- Visit of the winery : how to make to make a wine?



☐ In class

- Production of flyers describing the main diseases that affect the vineyard sustainability.
- Initiation to wine flavours with of an oenologist.
- Micro-vinification in class



☐ At the discovery of a research center dedicated to the grapevine !

- Overview of the research programs developed to protect the vineyard against grapevine pathogens by the head of Inra Colmar Center
- Interview of researchers led by the students about scientific careers
- Visit of an experimental vine plot developed to introduce plant biodiversity in vineyard
- Visit of the experimental facilities of the Colmar Center
- DNA extraction and virus detection (ELISA test) in the labs following established protocols led by students



**Based on the local viticulture context, this project was stimulating for students to develop their scientific skills.**

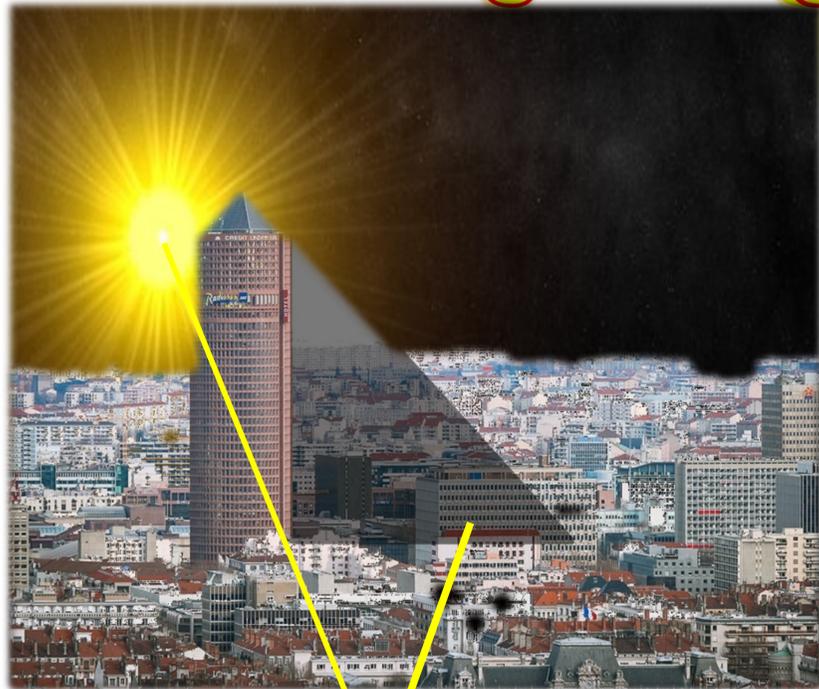
# Sustainable Development in Science Education

Emmanuel RICHIT - Olivier METZLER - lycée CHARLIE CHAPLIN - DECINES—FRANCE

## Solar Lighting

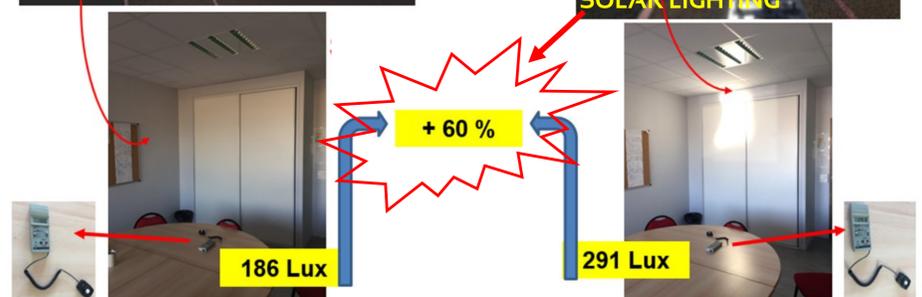
Lycée Polyvalent CHARLIE CHAPLIN

Function: natural lighting of a dark room

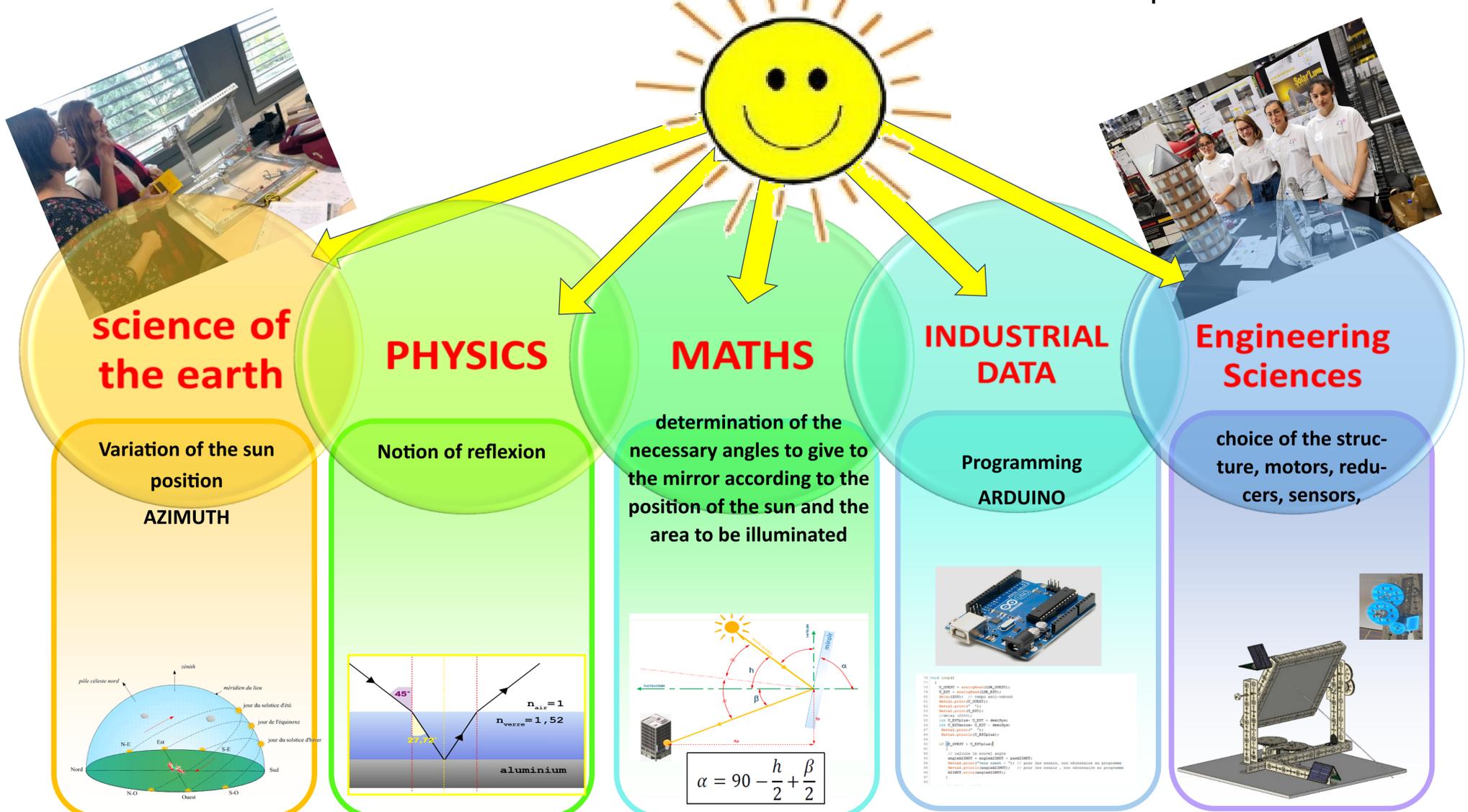


The goal of the project is to use the sunlight present around the building. The principle of the mirror will be used to reflect the natural light in the dark part of the building, through its windows.

For this, we will put in a nearby place and exposed to the sun (roof of another building for example), our system which will reflect, whatever the position of the sun, the outside light in the dark room.



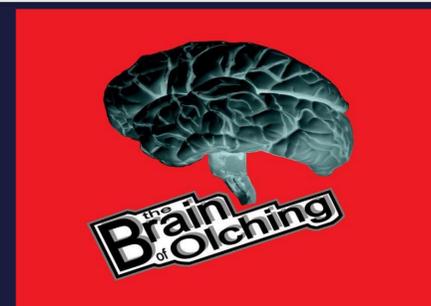
The reflected area is fixe (the room to be illuminated) but the position of the sun varies. The automatic inclination of the mirror will have to take into account these 2 parameters.



Gymnasium Olching / Bavaria / Germany

## The Brain of Olching

casting tomorrow's scientific talent



### taking science to the stage

#STEM\_event #secondary\_education #interest\_driven #educational\_profil #awesome

#### research and topic establishing

students choose a topic from the  
topic complex  
*„sustainable development / visions of  
a sustainable future“*

#### science fair

presentation of finalized projects

#### auditions

students present their scientific idea  
on stage, trying to convince a coach

#### finales



#### coaching phase

- students work independently
- coaching by teachers
- workshops
  - \* how to write a scientific paper
  - \* how to design a poster
  - \* presentation techniques

#### coaching phase

- students work independently
- coaching by teachers
- workshops
  - \* how to generate a hypothesis
  - \* how to design an experiment
  - \* how to plan your investigation
  - \* how to interpret data

#### battles status report

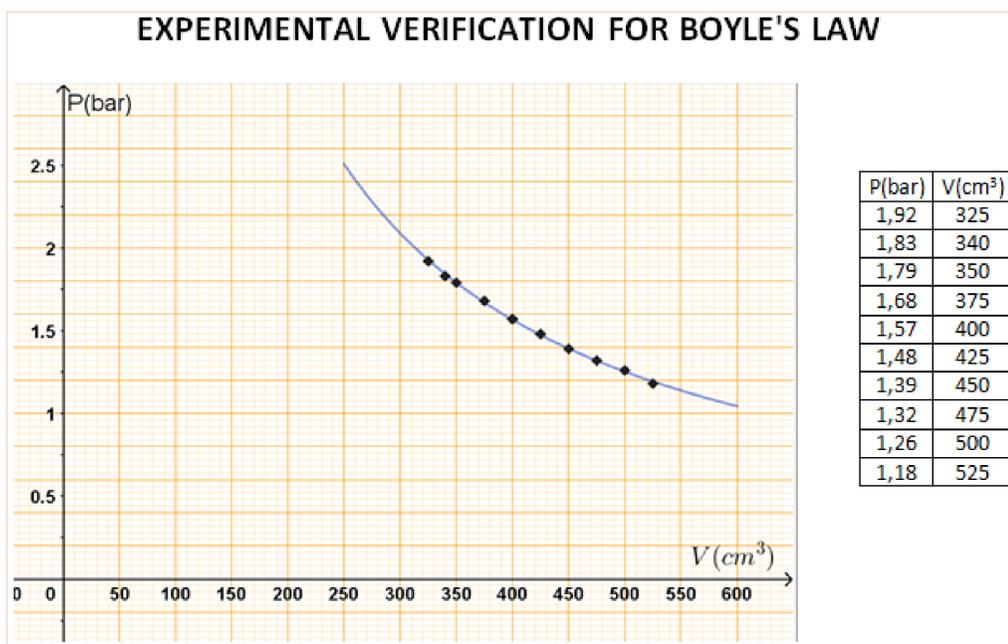
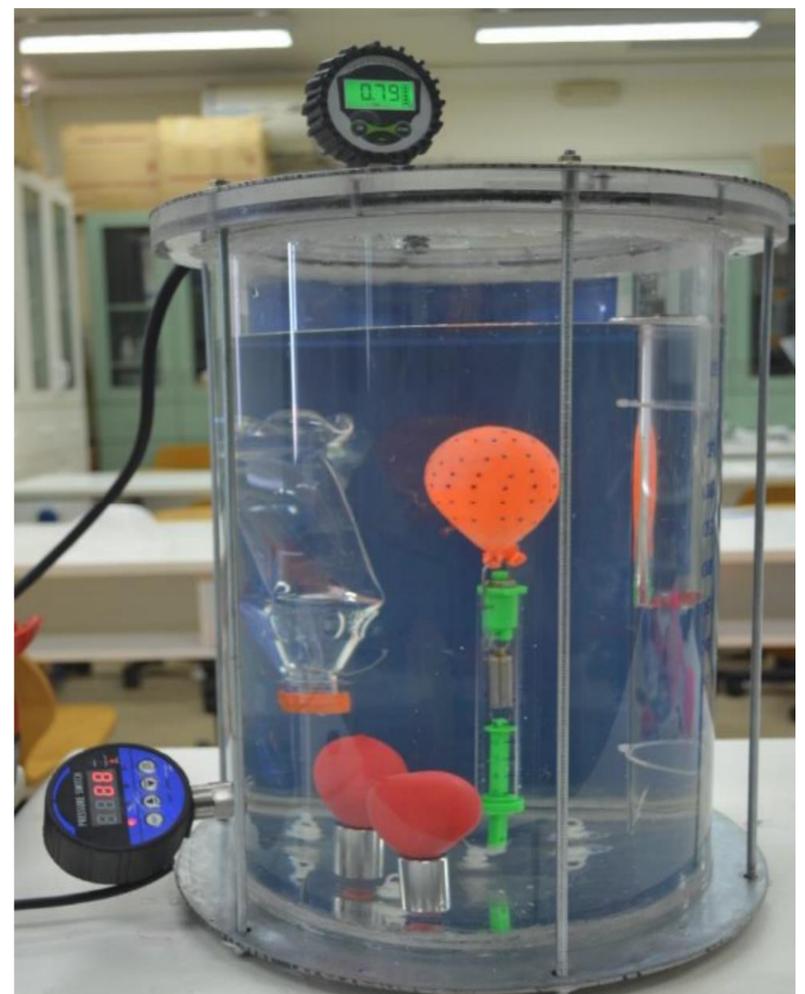
two teams face each other in a duel of  
questions

for further information please contact: [myscience@gymolching.de](mailto:myscience@gymolching.de)

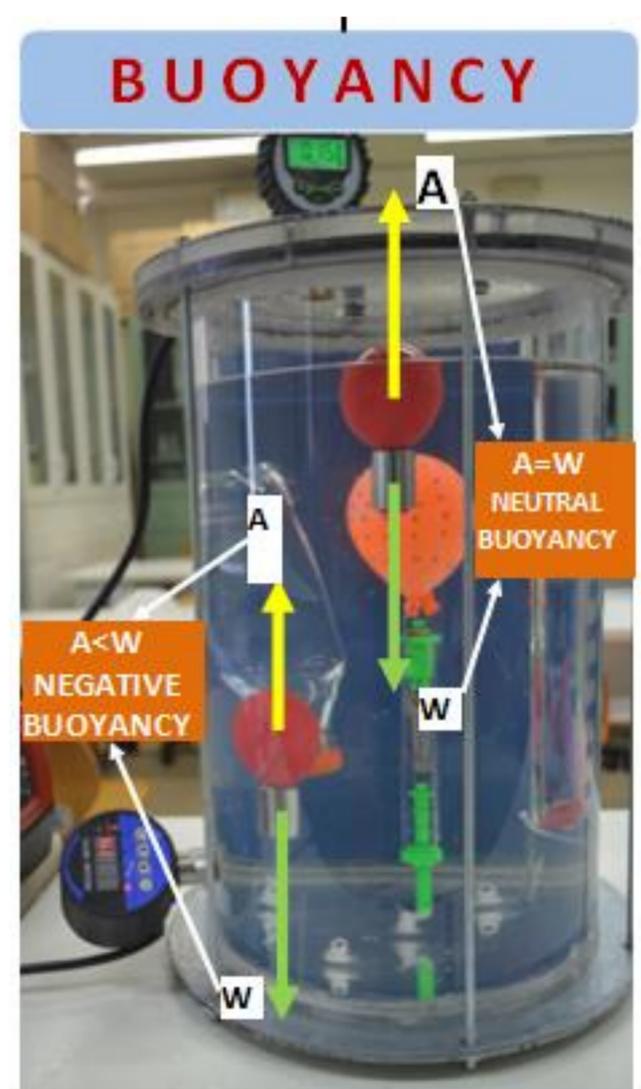
Antonios Margaritis, Georgios Marakis | Experimental High School Of Iraklion Greece | Iraklion | Greece

## Hyperbaric Chamber

It is well known that the pressure exerted by a fluid at equilibrium at a given point within the fluid, equals the sum of the external and hydrostatic pressures. According to the Pascal principle, the external pressure exerted on the free surface of the stationary fluid is transferred unaltered to all points of the liquid. Hydrostatic pressure is due to the force of gravity of the liquid above the given point and increases in proportion to its depth. According to Boyle-Mariotte law, high pressure causes inversely proportional variation in the volume of gases by altering the power of buoyancy of the objects. With the help of this prototype transparent **Hyperbaric Chamber**, we can study these phenomena in a prudent manner.



This prototype **Hyperbaric Chamber** is transparent, making it possible to present a number of principles of physics in a high pressure environment, while at the same time allow high precision measurements without a precedent.



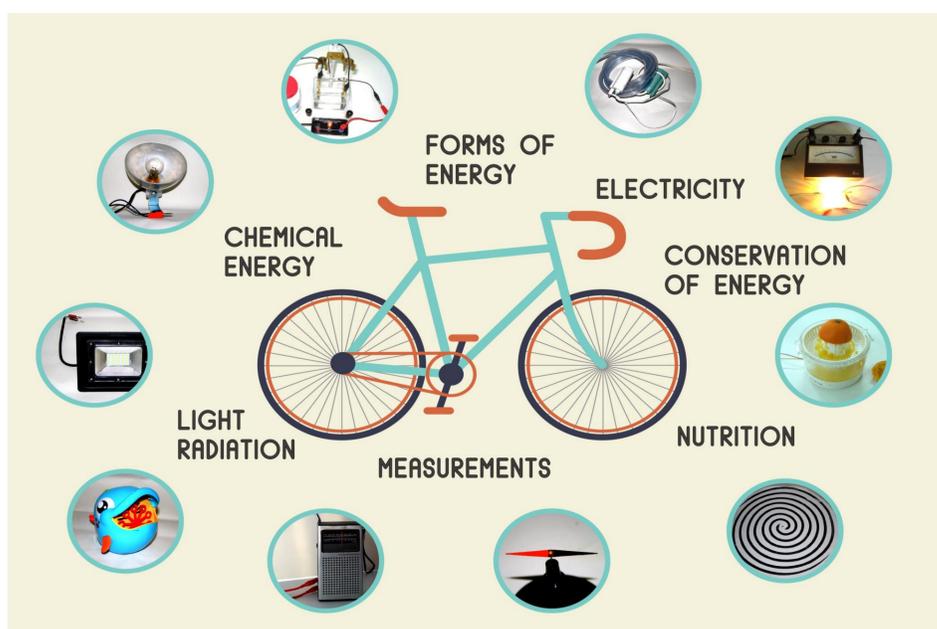
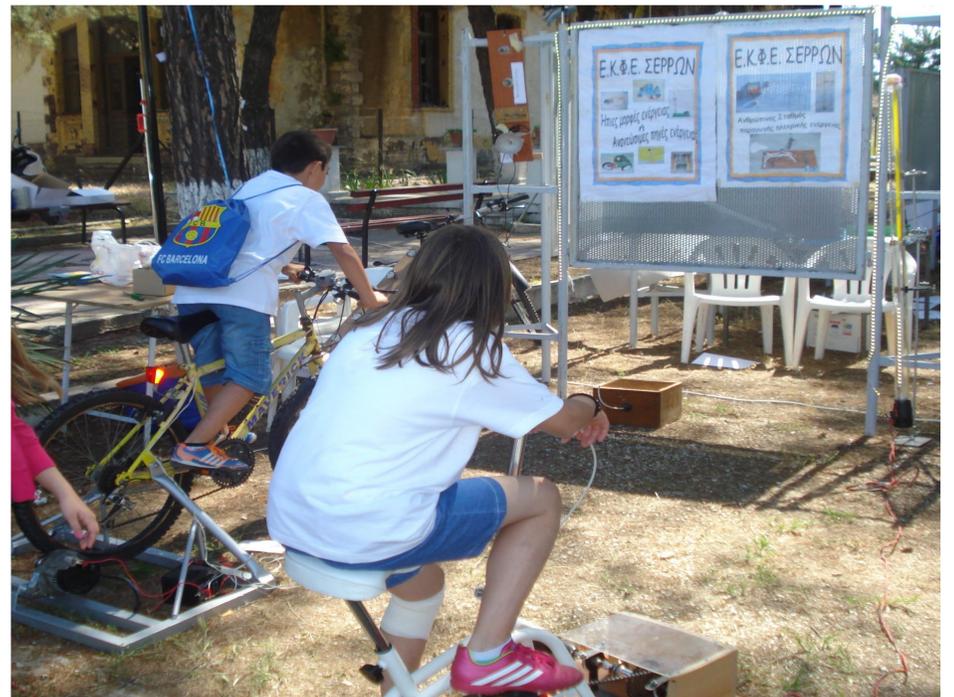
# Sustainable Development in Science Education

Sotiris Mandiliotis | School Science Laboratory Center of Serres | Serres | Greece  
Eleni Paloumpa | School Science Laboratory Center of Sparta | Sparta | Greece

## Energy: Look at its Forms!

And find out its Conversions, in a ... Fantastic Bike Ride!

Teaching about Energy is not an easy task. In this work, with a fitness bicycle connected with many different devices, a multidimensional school experiment is attempted. The bicycle works as a generator in which the cyclist's kinetic energy (from the chemical energy of the food) is converted into electrical, chemical, potential, light and other forms of energy. This experiment mainly aims in the cultivation of students' skills for the future, by understanding the concept of Energy, its forms and its uses.



Both, the whole experimental set and each of the individual experiments, attract the interest and magnetize the children's mind, leading to a higher motivation for pupils to participate, and to a satisfying didactic result for the teachers.

Science-Economy-Sport-Entertainment-Food-Health etc. are unified around this "special" bicycle. Inclusive Education is achieved in an innovative way; Different topics with different levels of difficulty can be taught to different students!

Magyar Csabáné and Pataki Zsuzsanna | Eötvös József High School | Tata | Hungary

## Earth Day – Our Earth is our worth

### About our special atmosphere – for everyone

Let's make the planets of the Solar System!

What do we know about them?

- What's their size compared to the Sun
- Do they have an atmosphere? Which gases is it made of?
- What about pressure and temperature?

Let's visit the planet using our phones.

**What an extremely great place the Earth is!**

Let's model the air around the Earth:

- measure and calculate
- make the scale layer out of plasticine

**Did you know how little air we have?**



Let's model the green house effect:

- examine how high the heat retention capability of CO<sub>2</sub> is: without this, it would be 30 degrees cooler
- however, too much CO<sub>2</sub> makes the Earth too hot, the ice caps are melting releasing methane, which makes this place even hotter

**What can you do about it?**

Student experiments for every age group,  
using simple tools.

Surprising and thought provoking experience.

Efficient development of approach and skills.

[www.eotvos-tata.sulinet.hu/jogyakorlatok.htm](http://www.eotvos-tata.sulinet.hu/jogyakorlatok.htm)



# Sustainable Development in Science Education

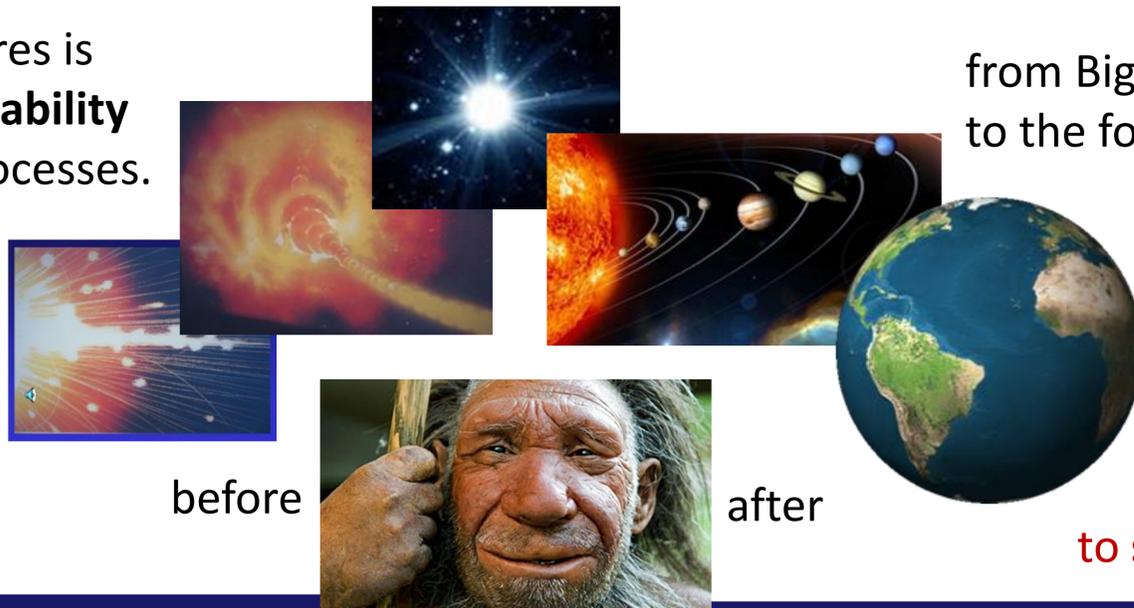
András Róka Eötvös Loránd University, Budapest, Hungary



## The fight of spheres

Can be sustainable anything which could go wrong?

Formation of spheres is the age of **unsustainability** due to irreversible processes.



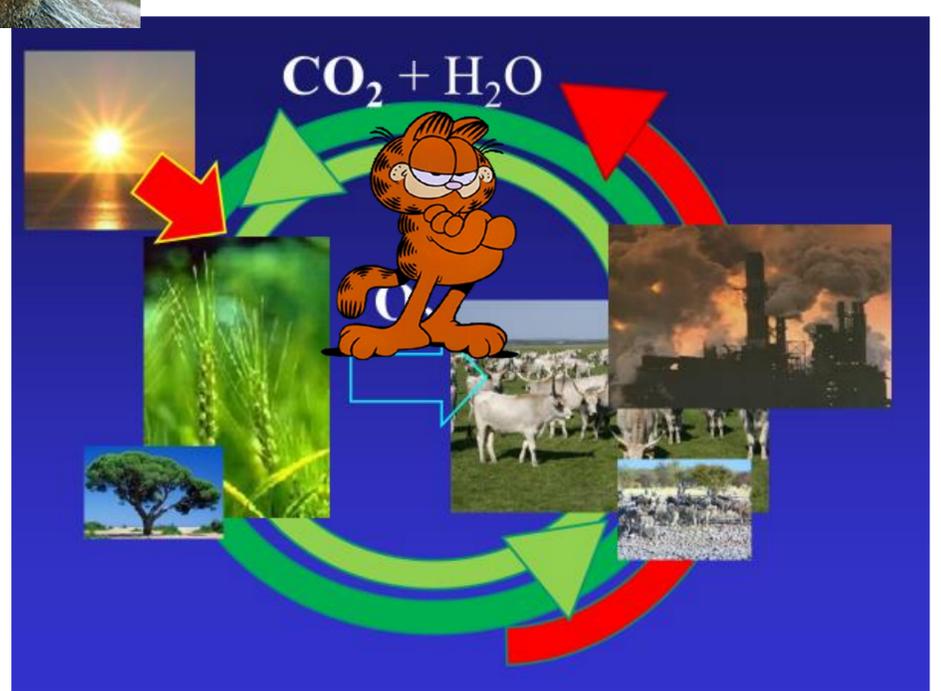
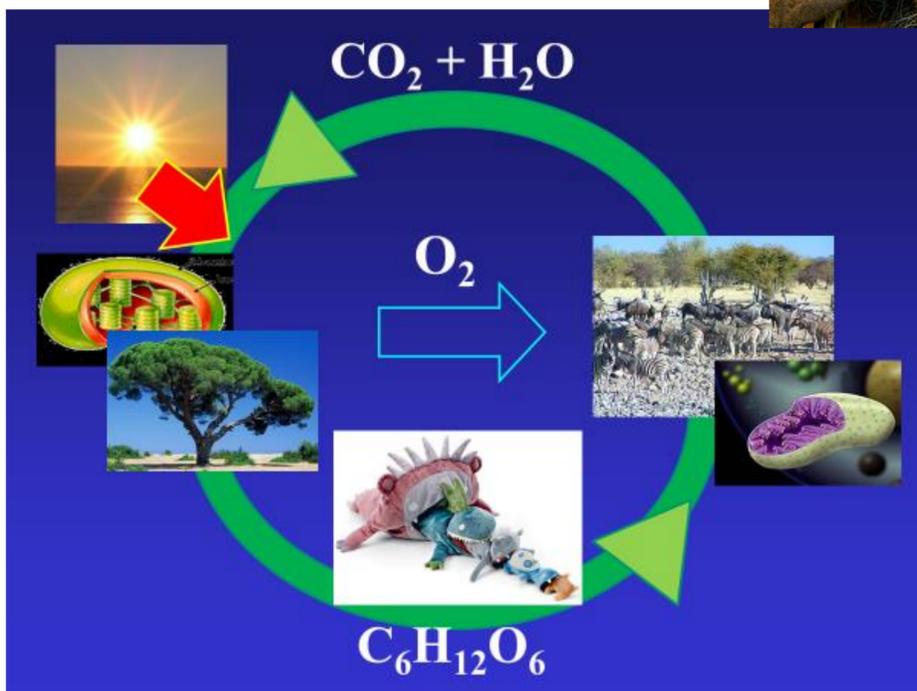
from Big Bang to the formation of the Earth

from **self-sustaining**

before

after

to **sustained systems**



The Garden of Eden was a „self-sustainable” system, with victims.

Environmental and social consequences of artificial biosphere (food chain) and industrial sphere **sustained by interest people.**



„Der Abbau des Menschlichen”



„The Garden of Eden is no more!”

We have only one chance of sustainable development:

We must save our humanity!

While the sphere of interests has no interest, **sustaining of our humanity is also our mission!**

# Sustainable Development in Science Education

SCIENCE ON STAGE 2019  
CASCAIS  
THE EUROPEAN NETWORK FOR SCIENCE TEACHERS

Dobóné Dr. Tarai Éva | Berzsenyi Dániel Highschool, Budapest | Hungary



## The colours of nature

The jeweller's rouge, the azure of the sea, the red of the berries

It is not only a chemistry  
club ...

...but creating

... and art

... and a lab

... and friendship

... and science

... and experiments

...and exhibition.



All in all, preparing pigments from plants is a  
really good fun.



<https://www.berzsenyi.hu/>

Sinéad Kelly | St. Oliver's Community College | Louth | Ireland

## The Importance of Water

### The need to raise awareness of a Water Footprint

While studying the conservation of water & discussing how we could make the little amount of water on earth that is made available to us more sustainable, students researched & completed projects on 'The Water Footprint', 'Water for Life'; they made models of the Water cycle and a Water filter system.

Collaborating with a primary school we tested their beach water samples for micro-organisms.



Available water on earth

70% of the earth's surface is covered in water

2.5% is Fresh Water

1% is **only** accessible for us to use

The *water footprint* measures the amount of water used to produce each of the goods and services we use.



**Every Water Droplet Saved Counts.**

# Sustainable Development in Science Education

Marina Porta Liceo Scientifico Antonio Banfi | Vimercate | Italy  
Angela Colli President ANISN, Pavia | Italy

## SMARTPHONES AS DIDACTIC TOOLS FOR APPROACHING GEOSCIENCES

How to link Chemistry and Earth Sciences in high schools? We realized our project in a secondary school (students aged 14-16) with the aim to link Chemistry with Geoscience. Teaching Science in high school allows to get in touch with students difficulties, misconceptions, to try to overcome them linking together different topics and disciplines and stimulating students' interests.

We adopted an inquiry based methodology: students pose and answer questions in different steps.

Starting from students' answers different activities were carried out.

The questions / answers methodology open the possibility to introduce the concepts of environmental sustainability, 3Rs (Reduce Reuse Recycle) and Circular Economy.

We submitted to the students an initial questionnaire to analyse their misconceptions about the topic. The same questionnaire was repeated at the end: students increased knowledge and understanding on the chemical elements, especially those of the mobile phone.

How many chemical elements can we find in a mobile phone?

Which metals, which non-metals, which semi-metals?

Do you think the mobile phone is like a mine for elements?

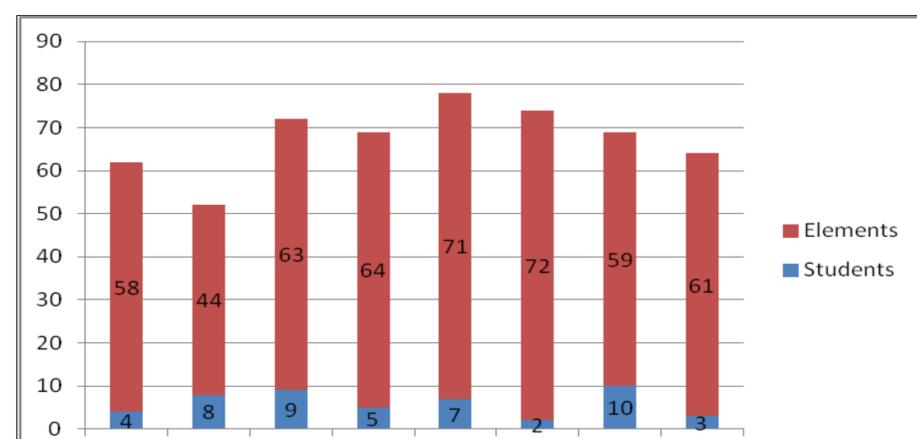
Where these elements are coming from in nature?

Which minerals are used to extract them?

Advertising urges us to buy more smart and powerful mobiles, what do you do with your old cell phone?

**How many chemical elements can we find in a mobile phone?**

At the beginning the maximum number of elements known to students was 8, at the end it was 72. All students have improved their knowledge also on the properties of the elements and the minerals from which they are extracted .



Answers to the first question of the final questionnaire



Treasure hunt: Components of smartphone

Different activities were carried out in groups.

We organized a treasure hunt: the teacher draws on a large sheet a diagram of the different parts of the mobile phone and prepares cards with all the elements of the periodic table present in the mobile. Students in groups must complete the scheme with the correct elements. Near each card there is a Qr code that can be read with the smartphone or students have a sheet with clues. In order to get in touch with the territory and allow students to contextualize their chemical knowledge, we organized a visit to a still active mine, in Valgraveglia, near Chiavari (Liguria, Italy).



Qrcode of the card

VIDEO MADE BY STUDENTS:  
<https://www.youtube.com/watch?v=quWY-CFI3A&feature=youtu.be>

**Au** GOLD  
Atomic number : 79  
Atomic mass : 196,96655 u

Gold is a yellow metal. It is the most ductile and malleable known metal; It is found in its native state, often accompanied by a fraction of silver, in the form of electron.

Gold and its alloys are used in jewelry, in minting coins and are a currency exchange standard for many countries. Thanks to its resistance to corrosion and its remarkable electrical properties, it has found more and more space in industrial applications.

1st Wtwatersrand area (Johannesburg, South Africa)  
2nd Carlin Trend (Nevada, United States)  
3rd Irian Jaya (Indonesia)

In the microphone components and in the memory circuits on the green card, in the chips.

Cards with elements

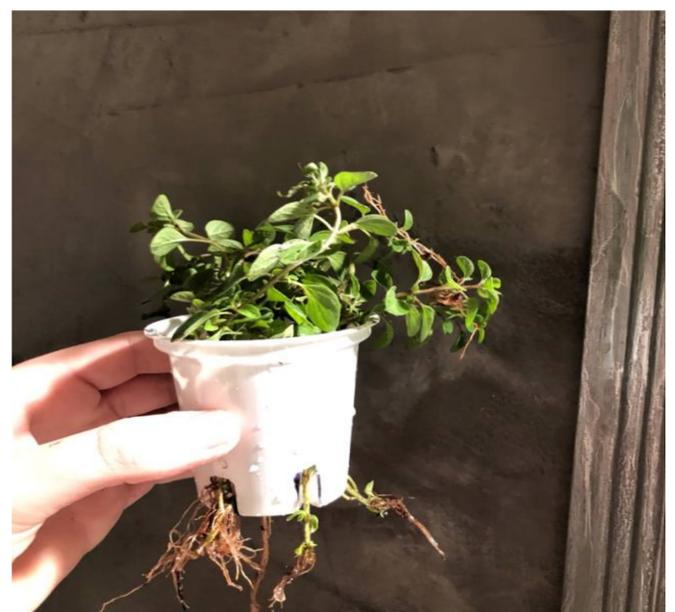
Barbara Callerani | I.E.S.S. European High School | Reggio Emilia | Italy

## LET'S BUILD A HYDROPONIC!

Depletion of food resources? Maybe a solution



One of the most serious scourges afflicting humanity today, and a threat to future generations, is the impossibility of obtaining food sources in every part of the Earth and the possible depletion of food resources in the face of an exponential growth of the world's population. For some years now, an innovative method of cultivation has been proposed, called indoor or above-ground farming. This is a new agricultural technique that could become the solution to the problem of world hunger, as it can be implemented without the use of soil as a basis for plant growth, without natural sunlight as a light source for photosynthesis and without continuous flow water sources.



Our project wants to prove that it is possible to build a prototype of hydroponics through medium skills and easily available recycling materials, and that the possibilities to overcome the collective problem of hunger can be within everyone's reach.

Prof.ssa Michela Poggi | Istituto San Giuseppe De Merode | Rome | Italy

## Seismograph with Accelerometer

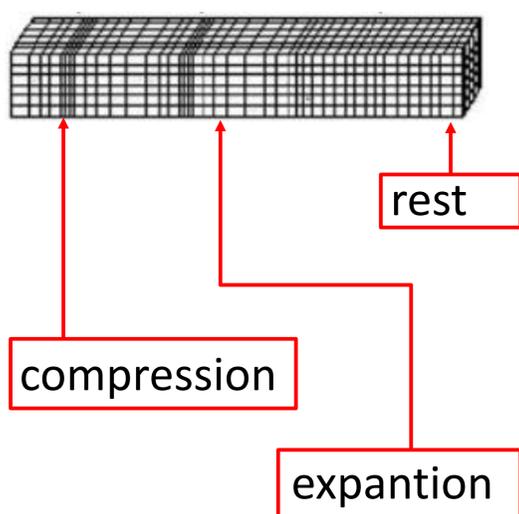
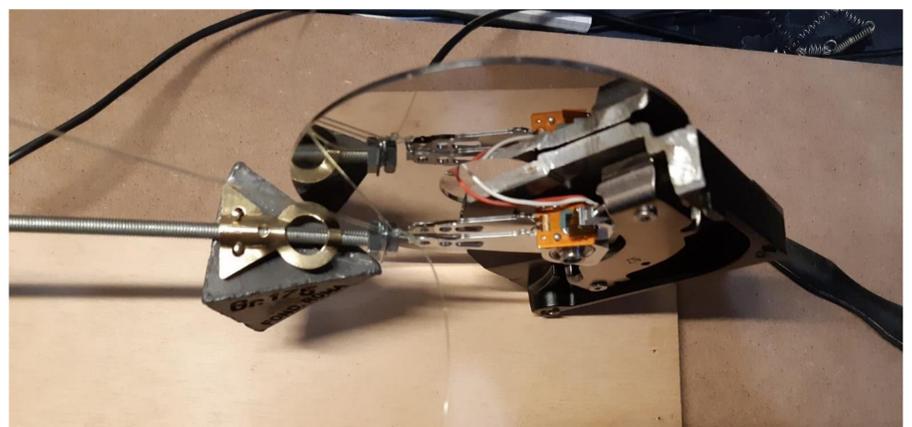
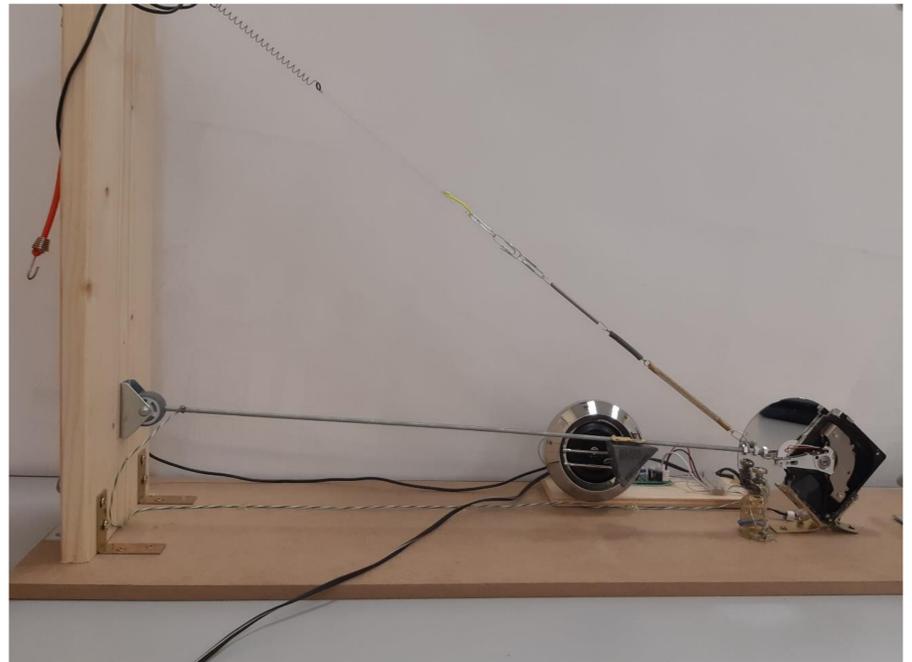
Basic mechanical device for detecting seismic waves

The laws behind the functioning of the **seismograph** are based on the capability of an accelerometer to detect the inertia of a mass when it is subject to acceleration.

The **accelerometer** is composed of an elastic **spring system** that oscillates vertically due to vibrations.

The sensor, which is the head of the Hard Disk connected to the rod, generates with the oscillatory movement a magnetic field capable of changing the polarity of the system and inverting the direction of the electric current within the cable, generating an electrical signal picked up by the PC through the Audacity software.

The software then provides a visual representation by turning mechanical waves into sound waves.



The accelerometer analyzes the longitudinal P waves spreading through the ground, warping its volume by compressing it and are the first to be detected on the surface.

In the experiment these waves are simulated by beating on the bearing surface.

**Conclusion:** Applying the laws of electromagnetism and statics, it's possible to construct a mechanical device capable of detecting seismic waves.

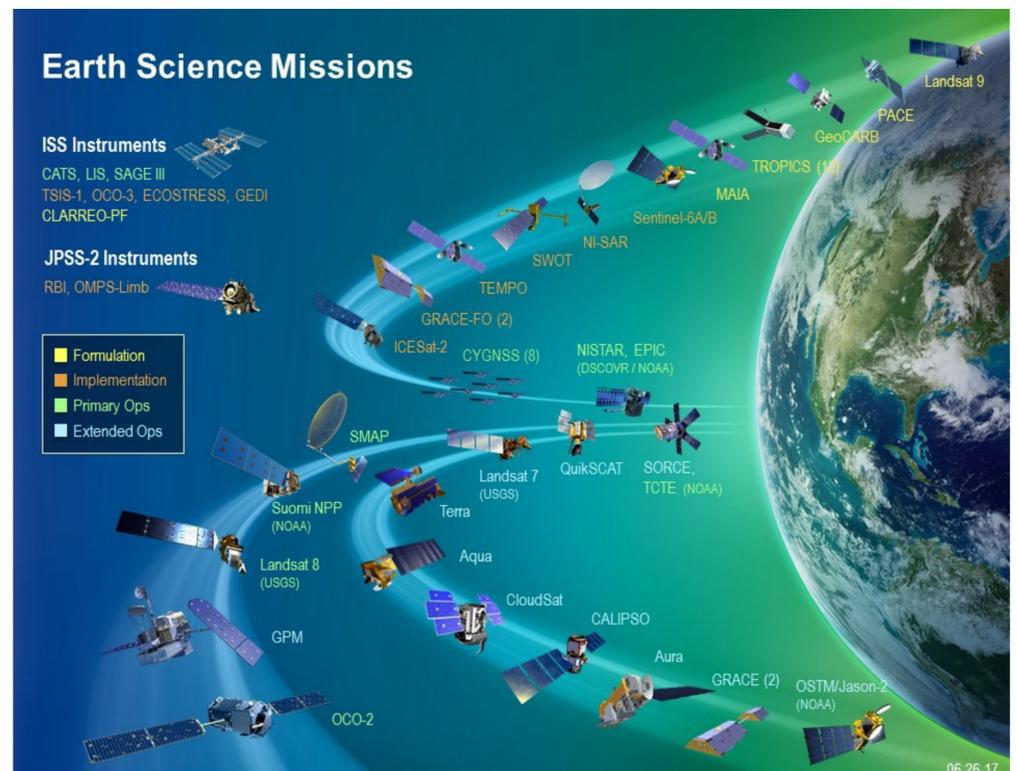
# Sustainable Development in Science Education

Franca Sormani - Liceo Statale Scientifico e Classico 'Ettore Majorana', Desio, Italy

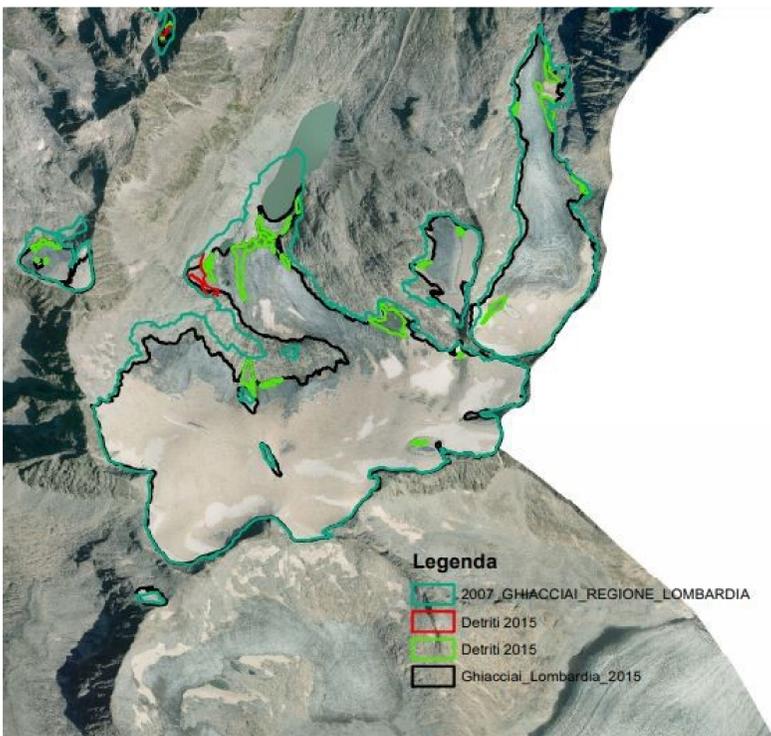
## eHAND

### Effects of Human Activities on Natural Disasters

The Erasmus+ Project E-HAND, which involves 7 partners, aims at arming students with the necessary skills to be future "good citizens" and contributes to the achievement of the goals of Europe 2020 strategy and Agenda 2030 focusing specifically on complex social issues such as the links between environmental quality, human equality, human rights and peace as well as on the critical role of science and technology in understanding and mitigating the effects of extreme natural events. It inquires also about the way we can lessen our impact on the environment as individuals and as communities



Earth monitoring from space



Ice melting on the Alps- Adamello Glacier.



Monitoring of extreme events

The European Union's Earth Observation Programme is looking at our planet and its environment for the ultimate benefit of all European citizens. The future is in our HANDs: be responsible, think sustainable, act safe

# Sustainable Development in Science Education

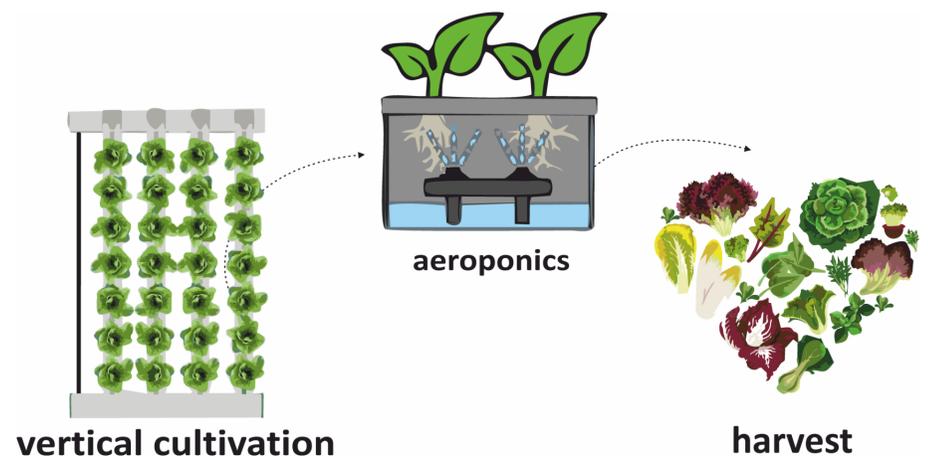


Nazarbayev Intellectual School of Astana  
Kymbat Dyussebayeva, ICT teacher  
Serik Mukanov, ICT teacher  
Nur-Sultan city | Kazakhstan



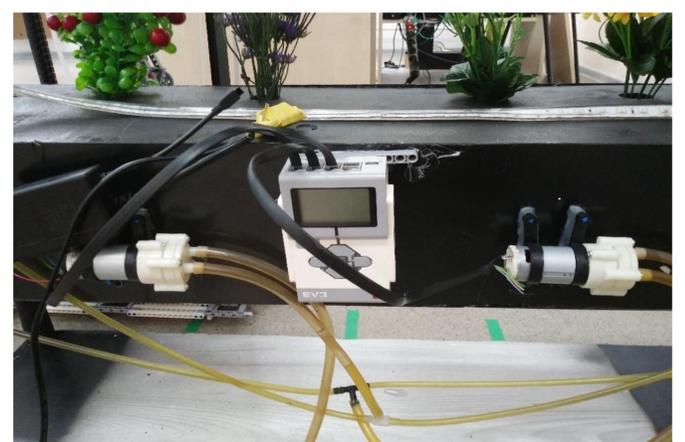
## AirGarden

The goal of this project is to give students understanding that it is possible to integrate knowledge from many subjects, eg.: Biology, Chemistry, Physics, Robotics, Design and Mathematics in ONE project. This project aims to display students the process of vertical growing of plants based on the automated aeroponic system. By creating a visual model it is possible to demonstrate the interconnection of STEM subjects.



During the creation there were used various improvised items: Plexiglas, black paint, hoses, nozzles, pump for watering plants, RGB light tape, LEGO EV3 microcomputer, cables, containers for water, ingredients to create a nutrient solution (calcium nitrate, phosphate potassium, magnesium sulphate, potassium chloride, potassium chloride, ferric chloride), relay for connection EV3 block and lighting tape, T-shaped connectors. The programs of automatic watering and lighting were written in the the software Lego Mindstorms EV3.

The project has a sustainable effect, the design may remain the same or scaled vertically and horizontally, depending on the predicted harvest. From harvest to harvest, it is only necessary to plant the seedlings on time, collect harvest, and charge the Lego EV3 rechargeable battery.



# Sustainable Development in Science Education

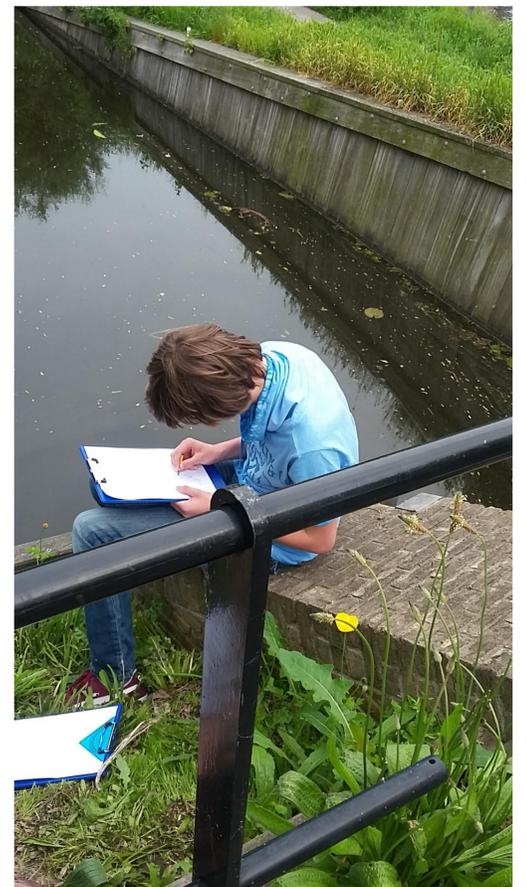
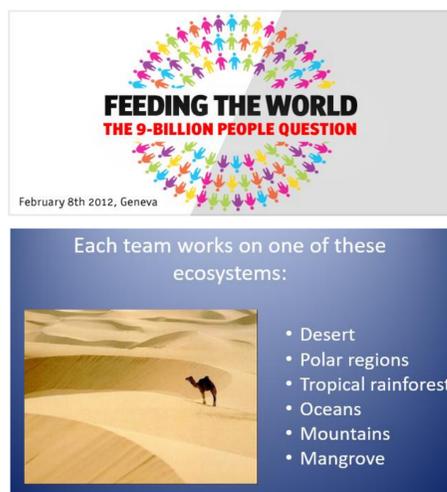
Saskia van der Jagt, PhD | Coornhert Gymnasium | Gouda | The Netherlands

## Cultivating crops under extreme circumstances

### Lesson series for upper secondary school students

#### Aim of lesson series

In this project we look forward to **the year 2050**. During a **period of eight weeks** the students work around the issue of feeding 9 billion terrestrials while the worldwide area for agriculture will be shrunken due to climate changes. **How can we, future terrestrials, cultivate enough crops to feed those 9 billion people?**



#### Guiding themes in classroom

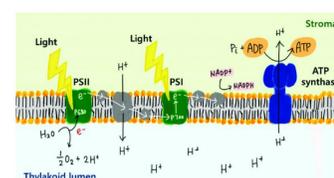
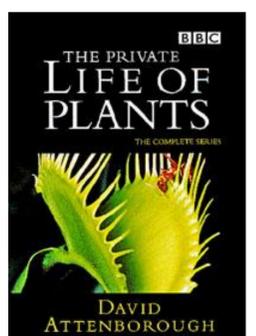
We use a blended learning mix wherein a **variety of tasks** about cultivating crops under extreme circumstances are supported by lectures. The **central themes** are:

#### Student teams & presentations

Each class is divided in **six teams**. Each team focuses during the tasks on sustainable solutions for cultivating crops in **one of the ecosystems** desert, mangrove, tropical rainforest, mountains, polar regions or the oceans. Finally, each team **itches their solutions** as were they on an international conference about the world food problem. By voting the best solutions are chosen.



- growth of plants
- (self) defence of plants
- photosynthesis
- dissimilation
- natural cycles
- dynamic equilibrium
- modelling of ecosystems



#### Forum discussion

Can we prevent the expected world food problem in 2050 by further developing and cultivating the crops from our solutions?

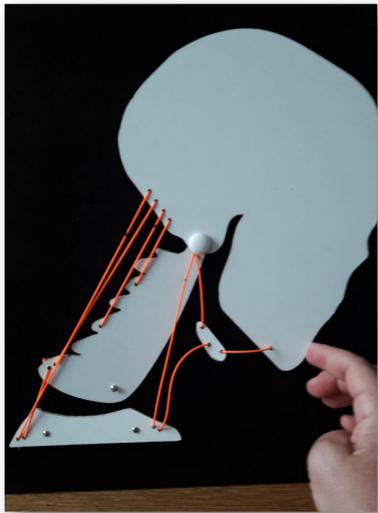
Which possible obstructions and other issues should be taken a closer look by scientists?



**Result:** Our students have a better understanding about 1) processes in plants and ecosystems and 2) sustainability, compared to the years we taught these issues in a more traditional and less coherent way.

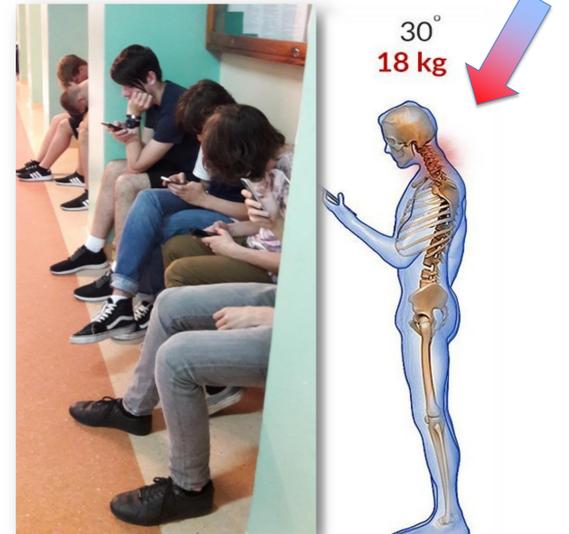
Dr Aneta Mika | College of Education and Therapy / Teacher Training Centre | Szczecin | Poland

## How does your smartphon hurt your body



In today's world, smartphones have become the most essential everyday object for the young people. Students spend tons of hours in front of smartphones screens, which in result gives an astronomical number of almost

**5 000 hours per year!**



It is impossible to reduce smartphones usage, technological progress is elementarily an unstoppable process, nevertheless it is worth knowing how to use this invention without harming one's health.

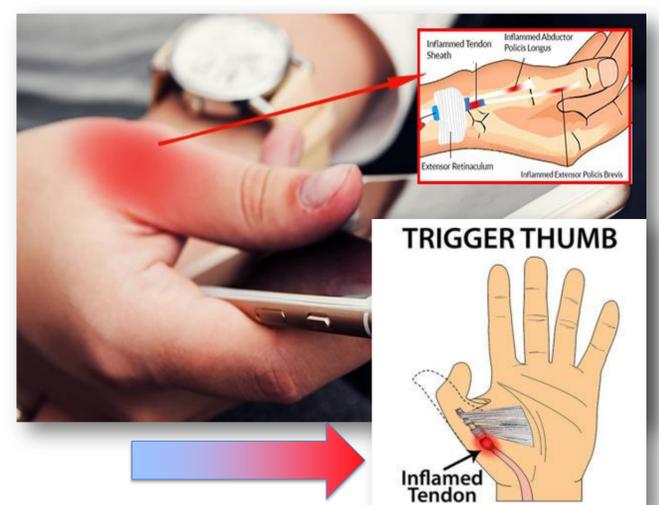
The main goal of this project is to present with a simplified model, the effects caused on the spine while bending a head in front of smartphone.



Deformation occurs not only in cervical spine, but also in the whole spine which in result bends in three basis. As a result, the discopathy and degeneration of the spine occurs more and more frequently with younger people.

Persistent front bending of the head causes a characteristic neck deformation called in medical environment the „sms neck” („text neck”).

Since the screens of the smartphones are getting bigger and bigger, another problem occurs. Children stretch their thumbs as much as possible to reach the furthest corners of the screen. As a result that, leads to unnatural wrists distortion, which in time can eventually become the main reason of inflammation of the joint sheaths leading to further thumb degeneration as well as to the carpal tunnel syndrome.



**Conclusion:** It is essential to teach young people how to use modern technology without harming their health. The most convenient way to do so is to create dedicated biophysical models, which can allow youth to get familiar with such a problem in the easiest way.

Elżbieta Nowak, Bartosz Piechocki | 4th Secondary Grammar School | Poznań | Poland

## Safe flight – innovative modification of a wing

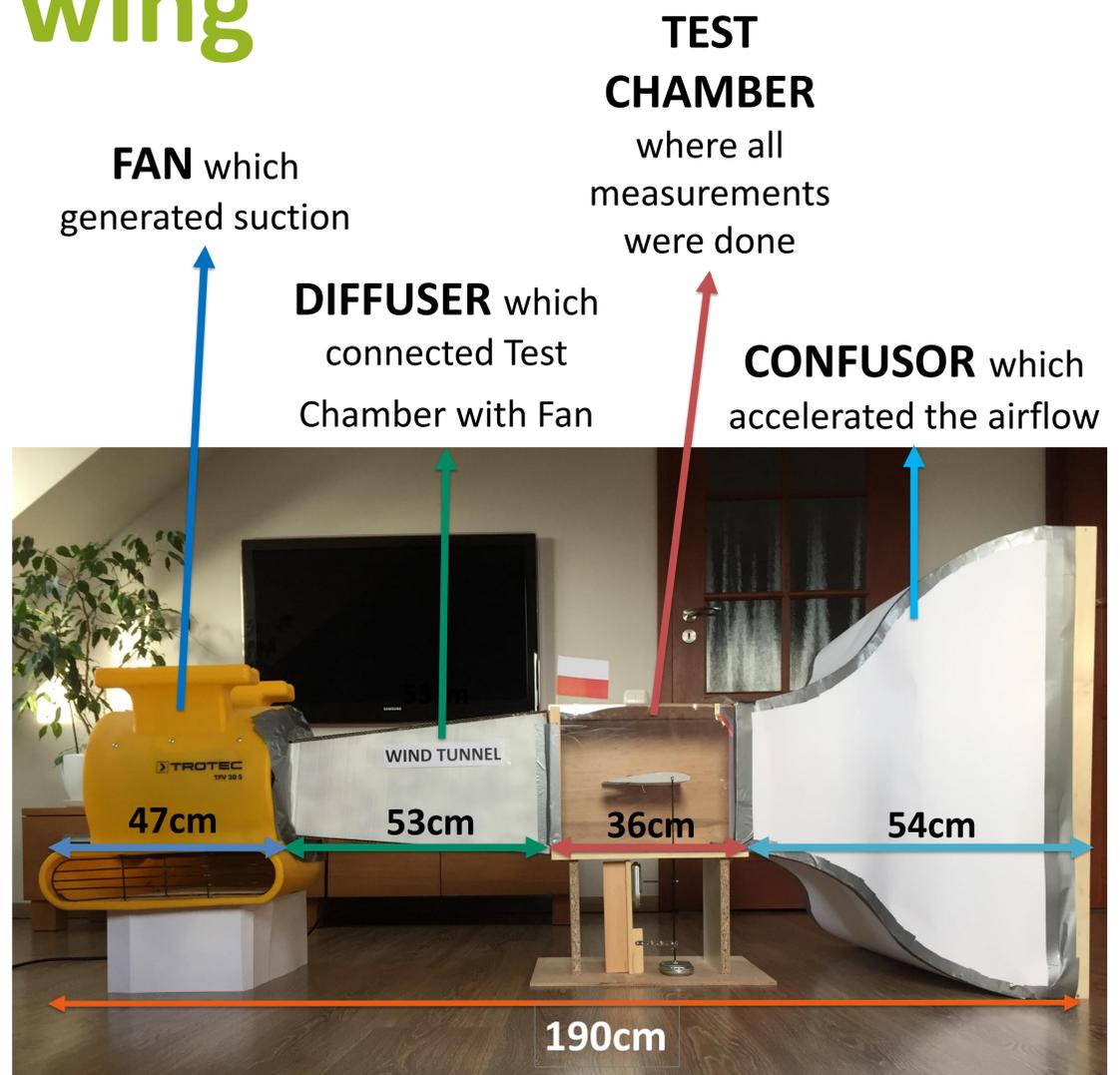
Project created by: Bartosz Piechocki  
Supervised by: MEng Elżbieta Nowak

Nowadays the aviation industry is developing quickly and everybody wants to fly safer and cheaper. That is why I came up with the **idea of a wing modification**. A standard plane has gaps between a wing and an aileron or a flap, but my modification covers these gaps (see photo below). **The model of a wing was tested in the wind tunnel which I created** (see photo on the right). Below the photo of the wind tunnel there is a chart which shows the results of my investigation (**1500 measurements were made**). There can be clearly seen the improve in aerodynamic characteristics. **Modified wing increased lift and decreased drag of the wing** (the higher the line on the chart goes, the better).

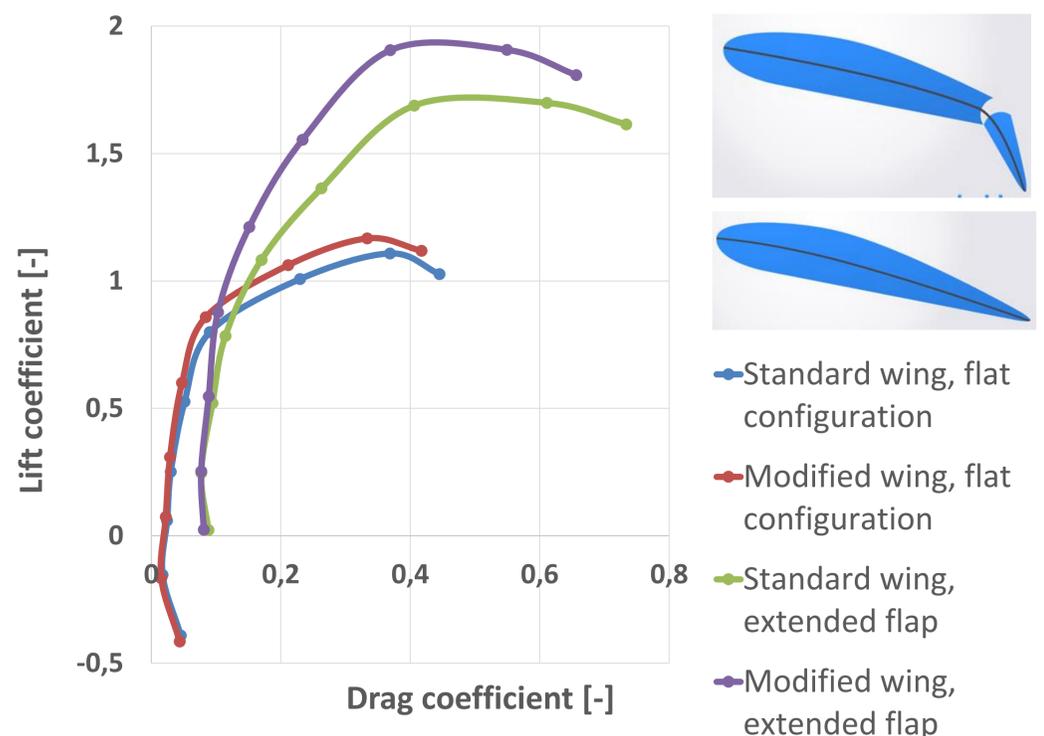
### The idea for a wing modification



Smooth transition between the wing and the flap/aileron



Polar curve of an airfoil;  $v = 6 \frac{m}{s}$



**Conclusion: Modified wing effectively improves aerodynamic characteristics. This solution decreases fuel consumption but most importantly, increases safety of a flight.**

# Sustainable Development in Science Education

| Teresa Diniz | Rosário Proença | Elsa Vieira | Isabel Paulos | Livia Silva  
| Agrupamento de Escolas Francisco Simões | Almada | Portugal

## Low-Cost Science

The goal of the Science Club is to make science available to all ages and schooling levels, aiming to instill in our students a special love and curiosity for all scientific phenomenon's and the will to make science. For that we use, whenever possible, low cost materials, preferably recycled, in a framework focused on sustainability and respect for the environment.

We aim also to give to our older students the capacity and necessary abilities that they need to help their younger colleagues, as well as the entire schooling community, to reach a higher level of scientific knowledge, in a way that they enjoy and that keeps them motivated.

This Project is rooted in the collaborative work between the teachers of Ciências Naturais and Física e Química subjects, and also in the sharing of knowledge and experiences with other teachers, students, their parents and even the rest of the population, by meeting them in their schools or by participating in initiatives created by the local authorities, eg. Almada. It's also in our plans to establish a partnership with a school from a Portuguese-speaking African country, .

Whenever possible we reach for the support and sponsorship of scientific institutions, like the "Chamalimaud Centre for the Unknown", that has made possible for us to develop studies in the genetics field at no cost.



**Conclusion: It's our goal to contribute for the scientific literacy of our students and we hope that in their consequent act of citizenship, they are able to make informed decisions regarding the issues and problems which resolution requires contributions from all of us.**

Maria Henriques | Agrupamento de Escolas de Valongo | Valongo | PORTUGAL



## Light on the risks of UV and skin cancer

One of the major risk factors for skin cancer is ultraviolet (UV) radiation. UV radiation comes from the sun, ultraviolet lamps and solariums. The risk of developing skin cancer is related to exposure to UV radiation during life.

The best way to prevent skin cancer is to protect yourself from the sun. Children, in particular, must be well protect so it is important to limit the time of exposure to the sun and avoid other sources of UV radiation.

What protects us from UV radiation can reduce the risk of developing skin cancer.

**How can you protect yourself from the sun's UV rays?**



### Materials:

UV sensible beads; UV torch; Different fabrics; Sunglasses; Water; Sunscreens.



In this activity, students are asked to consider different ways to protect against UV rays, i.e. how to prevent them from reaching their bodies. For this investigation, something that detects UV rays, such as UV beads (or a UV detector or UV sensor) is needed, as well as different types of materials that may stop the rays, such as sunscreens, different types of fabric, water, sunglasses, etc.



Inspire the students to try coming up with different ideas of variables and to give them a try. Just remember them that they should only change one thing at a time. If they are testing different sunscreens, make sure that the other factors remain the same!

Simply staying in the shade is one of the best ways to limit your UV exposure. If you are going to be in the sun...



**“Slip!**



**Slop!**



**Slap! and**



**Wrap”**

Key steps you can take to protect yourself from UV rays:

☀ **Slip** on a shirt.

☀ **Slop** on sunscreen.

☀ **Slap** on a hat.

☀ **Wrap** on sunglasses to protect the eyes and skin around them.

Leal, S.; Mota, C.; Neves, P. | Agrupamento de Escolas Leal da Câmara | Sintra | Portugal

## Serra em Si(ntra) Mountain in (you) Sintra

This project is based on the need to preserve the **World Heritage - Sintra**. Because the mountain is the center of the region, the preservation of its ecosystems, living beings and especially its native forest was defined as the problem to which we had to find answers. Plants are the basis of these ecosystems, their multiplication for reforestation purpose was the starting point for our research.

### How do environmental factors influence germination?

Lettuce and watercress seeds were used as a model in the research.



The results were used for the creation and maintenance of native plant nurseries - *Pinus*; *Quercus suber*; *Myrtus* and *Ruscus aculeatus* and triggered new investigations: Hydroponic Agriculture; Forestry Careers; Sustainable use of forest resources and European Medicinal Plants.

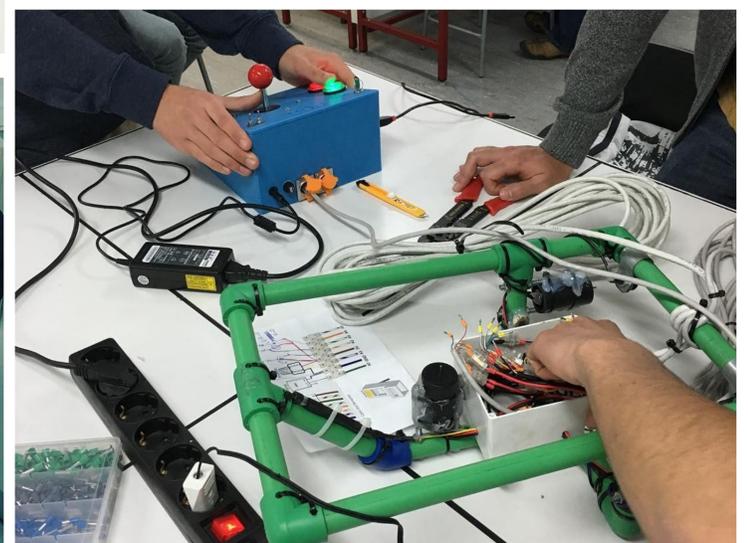
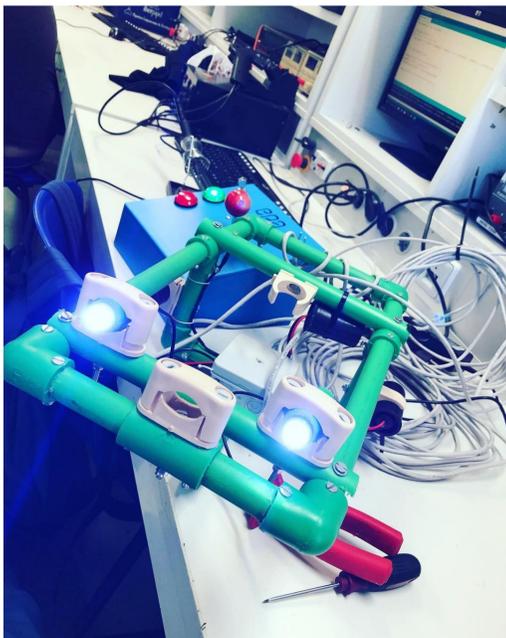
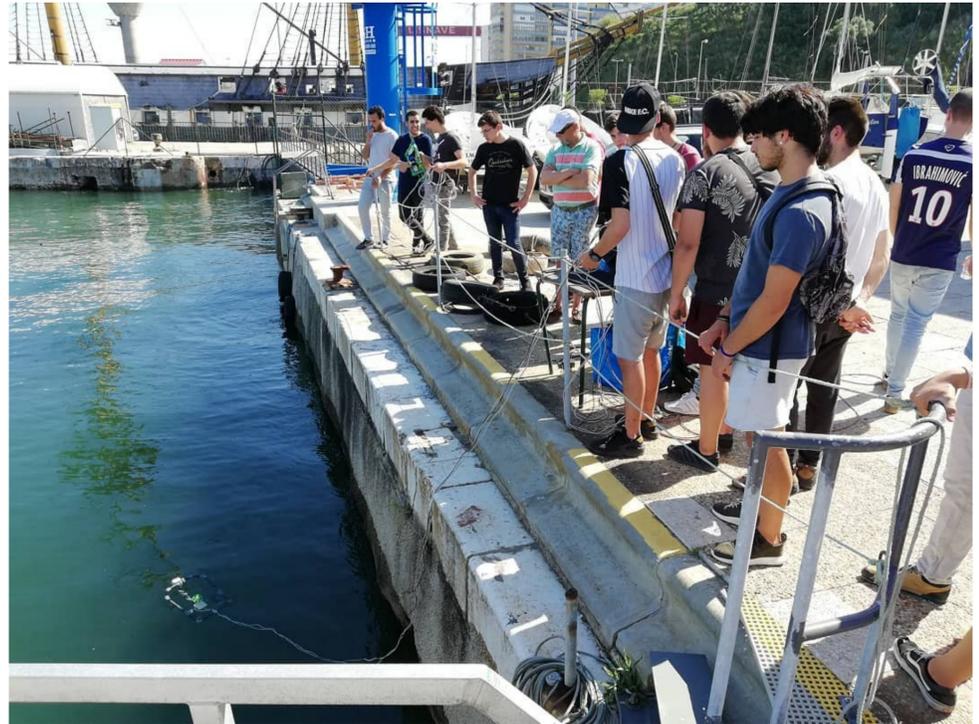
**Conclusion: Earth** protection is the sum of our actions. **Forests** conservation is mankind responsibility. Everyone can make their small **contribution**. Find your way to help and add **value** to the **planet**.

# Sustainable Development in Science Education

César Marques, [csrnrqs@gmail.com](mailto:csrnrqs@gmail.com) | João Batista, [j.batista.epa@gmail.com](mailto:j.batista.epa@gmail.com) | Almada | Portugal

## Studying the environment using DIY ROVs and Drones

In this project students build ROVs and Drones, create and develop a scientific mission to perform using the machines they constructed. The ROVs and Drones are equipped with a set of sensors, connected to an Arduino, which serves to fulfill the scientific mission. Students receive the data remotely, at a control station or on their mobile phones.



Starting from ROVs and Drones (RC Airplanes) plans that are available on the internet, students build these ROVs and Drones and add sensors, connected to an Arduino, to fulfill a scientific mission to be accomplished in water or air.

Ivana Sotáková | Faculty of Science, P. J. Šafárik University | Košice | Slovakia



## Inquiry Activities with Bicarbonate Soda and Vinegar

### Energy Changes in Chemical Reactions

#### 1. Exothermic and Endothermic Reactions

Inquiry activity is focused on exothermic and endothermic reactions. The students examine the heat changes in the reactions – vinegar with sodium bicarbonate (baking soda) and sodium bicarbonate (solution) with calcium chloride. They expand their knowledge about exothermic and endothermic reactions – their use in bags with immediate cooling or warming effect or in self-heating cans.

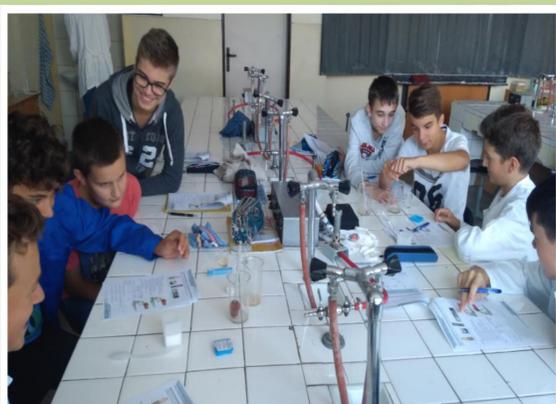
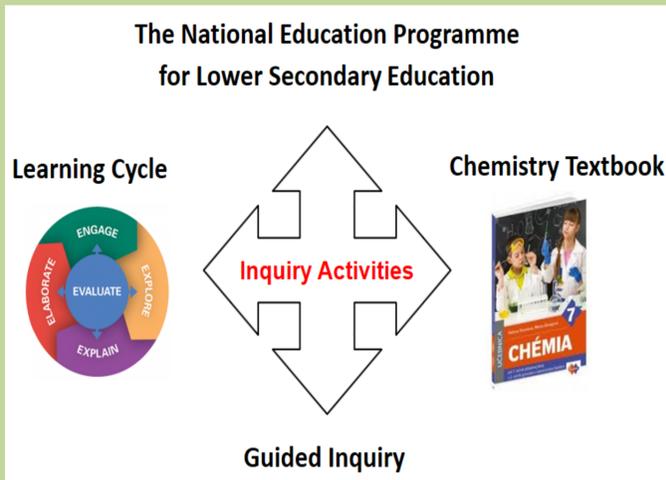
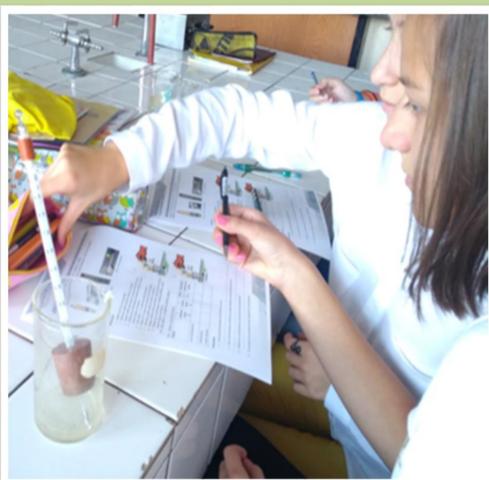
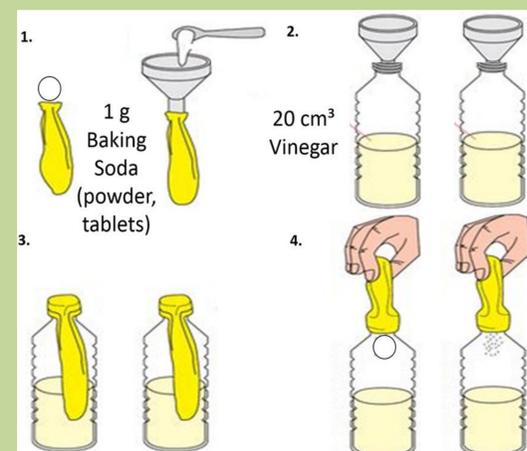
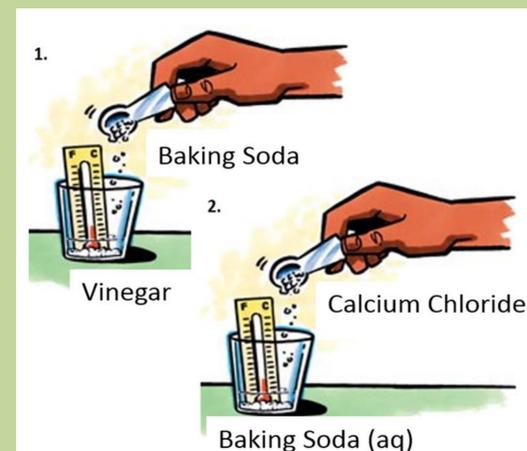
### Factors Affecting the Rate of Chemical Reactions

#### 2. The Effect of the Reacting Particles Amount on the Rate of Chemical Reactions

#### 3. The Effect of Temperature on the Rate of Chemical Reactions

#### 4. The Effect of Surface Area of the Solid Reactant on the Rate of Chemical Reactions

Inquiry activities are aimed at examining the effect of various factors on the rate of reaction of vinegar with sodium bicarbonate (baking soda). Students observe process of reaction in a simple apparatus – a bottle with a balloon on its throat. The rate of reaction is affected, e.g., by diluting the vinegar, raising the vinegar temperature, or crushing the bicarbonate soda tablet. The influence of these factors is manifested by the different blowing speed of the balloon produced by carbon dioxide. The learning outcomes of students can be applied in the life situations such as fire setting, food storage, remove limescale from kettle, and so on.



Daša Sojer | Primary school Domžale | Domžale | Slovenia

## Soap bubbles on wood

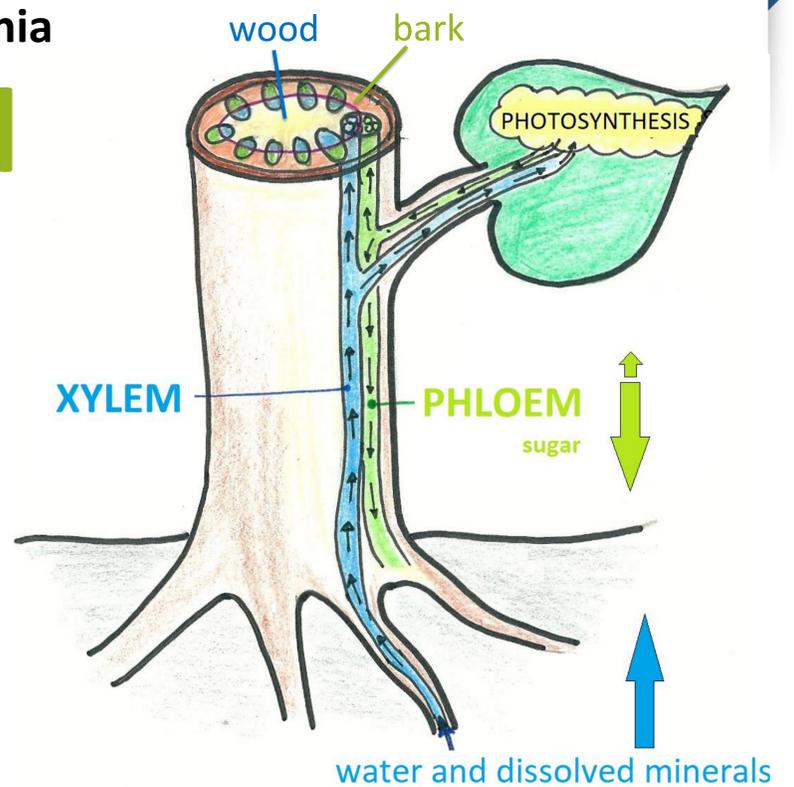
or how to prove conducting tissue in a trunk and why dry firewood is so important for the environment.

### The vascular tissue – small tubes in the wood

The stem transports needed materials throughout the plant via two complex tissue: xylem and phloem. Woody stem – trunk is made of bark (phloem) and wood (xylem).

### The water in the wood

There is more than 50 % moisture in freshly cut down wood. It reduces with drying in the wind and it becomes dry in 1 to 3 years. Dry wood contains less than 20 % of water.



### WOOD + SHAMPOO + BLOWING = BUBBLES

When xylem is free of water it becomes transient to air. Our representative species were beech (*Fagus sylvatica*) which is the most common firewood in our region. One can blow bubbles through logs that are up to 1 m long.

\*Blowing bubbles through logs does not work in any tree species, also it depends on their growth.



### How do we know that the wood is dry?

The most reliable method is using moisture measuring device or measuring density – dry wood is lighter than the wet one. Our experiment is applicable to beech firewood.

		Beech ( <i>Fagus sylvatica</i> )		Oak ( <i>Quercus sp.</i> )		Spruce ( <i>Picea abies</i> )	
Log length		10 cm	33 cm	10 cm	33 cm	3 cm	33 cm
moisture	16 %	✓✓	✓	✓	✗	✓	✗
	35 %	✓	✓✗				
	50 %	✓	✗	✗	✗	✗	✗

### Burn only seasoned firewood

Higher value of moisture has negative impacts on the environment, our health and also our wallets. Wet or 'green' firewood produces more smoke, pollutants, small particles such as PM10 and PM2.5 and also causes creosote build up in a chimney. Wet firewood creates less energy than dry firewood, because a lot of heat from the fire is consumed for water evaporation.

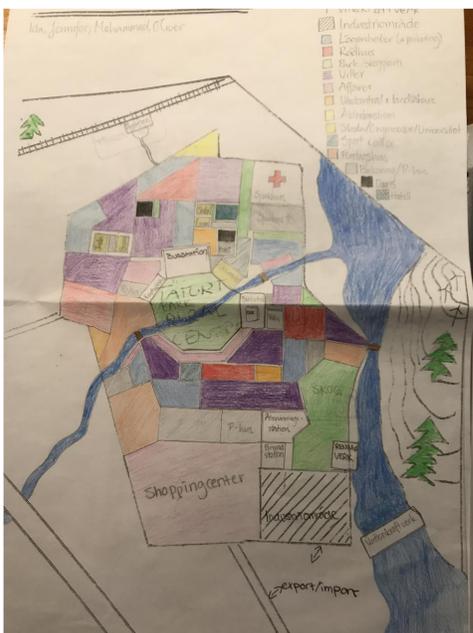


# Sustainable Development in Science Education

Pernilla Malmgren | Paradisskolan | Trollhättan | Sweden

## The Sustainable City

How do we build a city that is sustainable in many different aspects? This is the question that meets the students of grade 9 at Paradisskolan. It is a multidisciplinary project which includes most of the school subjects. The project is designed to make them see the connections between school subjects and the reality outside of school. We work in cooperation with the municipality to get that “real” feeling and that their ideas really matter. Together the class is making a city from scratch, planning everything from the outline of the city, to the housing and everything that a city needs to work. It ends up with a fair where they show the model of their city to interested visitors



Examples of a city plan and the model houses.

To work with “real” projects make the school work come to life. The enthusiasm that the students put into the project is shown on wonderful models and great presentations.

Patricia Descombes & Annick Vidonne | Gymnase de Renens | Lausanne | Switzerland

## The hiLyte battery

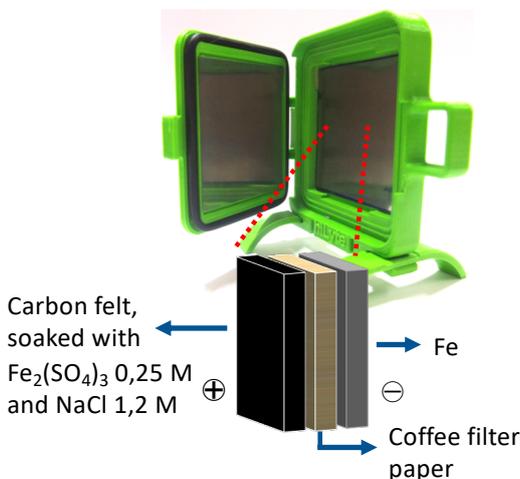
### Goals

The main goals of our project are to help teachers :

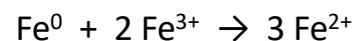
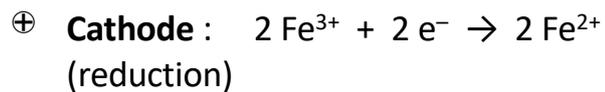
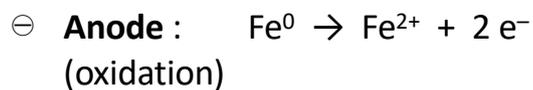
- to explain the working principle of a battery
- to demonstrate energy conversion (chemical energy to electric energy)
- to discuss sources of renewable energy

### How does it work ?

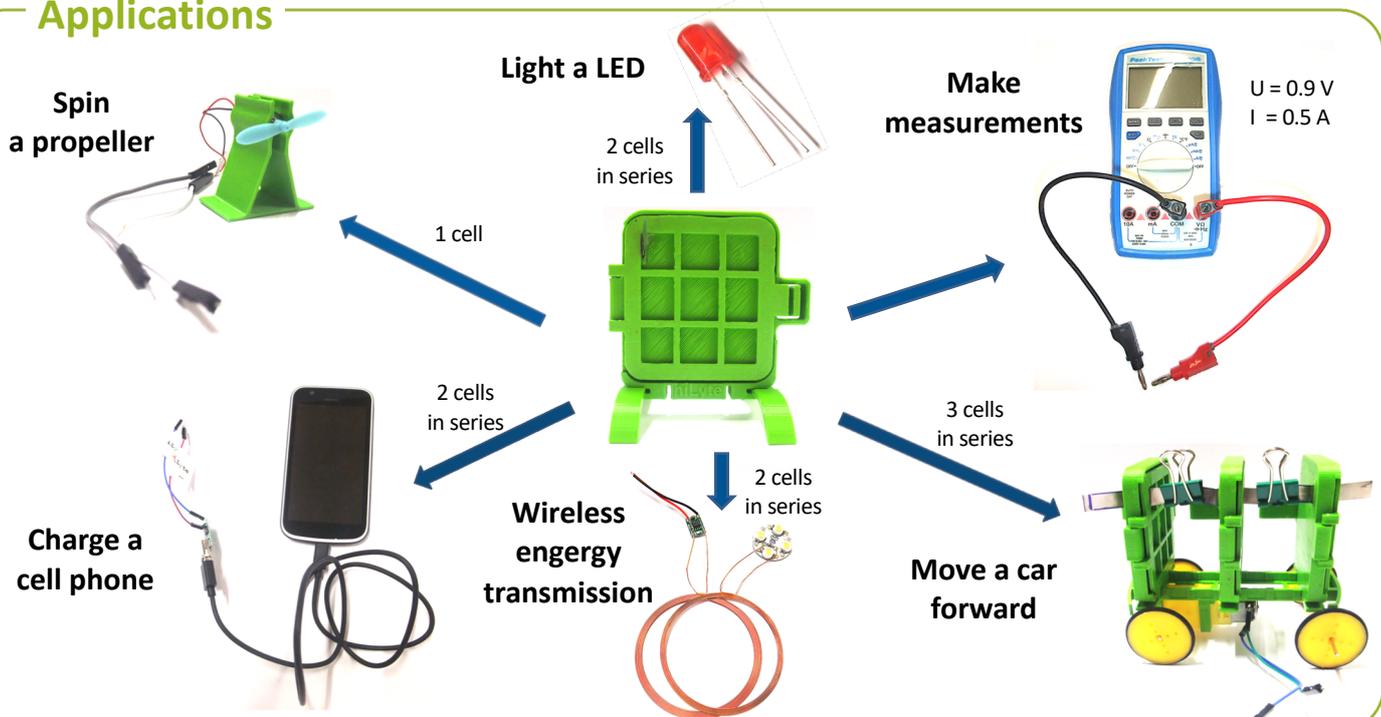
The hiLyte battery is an iron-based electrochemical cell, which is made of very affordable and non-toxic materials. The whole concept is based on the different oxidation states that exist for iron.



### Chemical reactions :



### Applications



Louise Maule | North Tyneside Learning Trust | UK

## Global Goals, Global Inventors with Mighty Futures

Can you help the United Nations reach their goals?

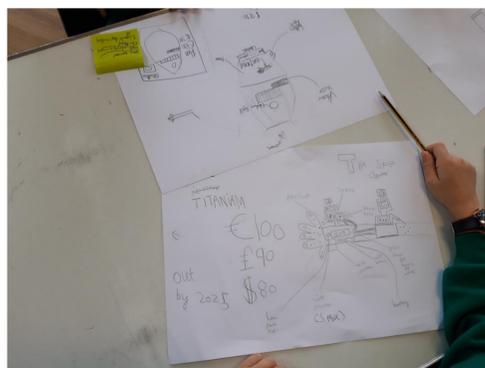
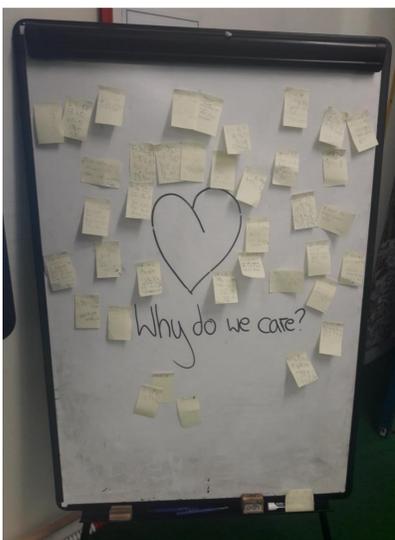


17 goals. To make the world a better place by 2030. Can you help?

The Global Goals aim to fight inequality, end poverty, and stop climate change.

Mighty Futures is a project about new ideas, with no barriers, based around the goals. We help children to **invent, innovate, and campaign.**

So far we have looked at ideas to tackle plastic pollution, habitat loss, spread of disease, and to conserve water.



Using examples of young inventors, innovators and campaigners, plus a lot of encouragement and positivity, children see they have the potential to become change-makers.

The project encourages children to empathise and care, and realise how STEM can be used to change the world for the better. All children in the project design an idea that could make the world a better place.

This project can be carried out with very few resources. Take a problem to solve, some good ideas, then let the children use their skills to come up with a solution!

@NTLT\_ScienceLP  
@emgarrick21



Liubov Morozova | Secondary School №11 | Pavlohrad | Ukraine

## COSMIC ROLE OF PHOTOSYNTHESIS

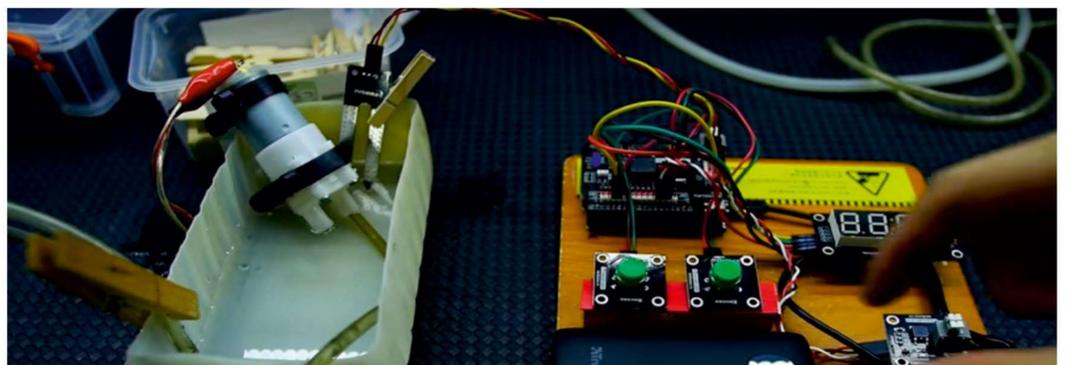
### How can we encourage students to discoveries?

**Objective:** To create the project "Automated School Oasis", where lighting, watering and heating processes will be monitored automatically. As a basis, we can take already existing art-recreation school "Green Corner", which will become the center of scientific creativity for students.

**Current experience:** We can promote students to study using study-and-research method. For example, experiment with wheat sprouts that includes exploring the most appropriate conditions for plant growth such as amount of light, water, heat. Students are able to search and use the necessary information, to make conclusions.



**Impact:** To develop the idea of creating artificial system for photosynthesis — a way to produce organic substances from inorganic. If there was a similar artificial laboratory, a number of problems would be solved: energetic, ecological, food resources problem.



Learning goes beyond the classroom, children are immersed in a scientific problem, not limited in space and time. They begin to think globally.