

TECHNOLOGIES IN STEM EDUCATION

Pia Lindgren Jeppesen | Odense Katedralskole | Odense | Denmark

Human Influence on the Global Carbon cycle

First, students will be introduced to oil geology. Students will learn to determine different rocks that are important for the formation and extraction of gas and oil. These rocks are basalt, sandstone, limestone, slate and black slate. Students will add a little drop of water to each rock and if the drops enter the rock, it will be able to store oil. If it is not, it will be able to prevent the oil from escaping. Or it may even be a source for the oil formation. Students will match a short description of each rock with the correspondent rock.

Second, students will learn to create a model for the formation of faults to trap the oil and gas.

Third, they will extract oil from chalk cores. They will receive two cores – one with oil and one without oil. Since we know the density of calcite (the mineral the chalk cores are built from), we can calculate the volume without airholes (only the mineral). And by using math we can calculate the total volume of the chalk core (the mineral and air bubbles). The difference between these numbers, are the volume of air bubbles. These air bubbles are very interesting, since they may store oil. Therefore we can calculate the maximum amount of oil in the chalk core and compare it to the volume gained from the experiment. Student will gain oil from the chalk cores by submerge it into water.

Finally, students will learn they can use their knowledge from oil geology to find suitable underground storage facilities for captured CO₂. This is very interestingly since geologist initially explored the underground to obtain oil. But today, geologists are starting to explore the underground to store captured CO₂ and thereby reducing the effects of global warming. Student will discuss whether it is a great and safe opportunity to prevent global warming or if there are better alternatives.



Fig. 1: Different rocks that are important for the formation and extraction of gas and oil.



Fig. 2: A model for the formation of faults to trap the oil

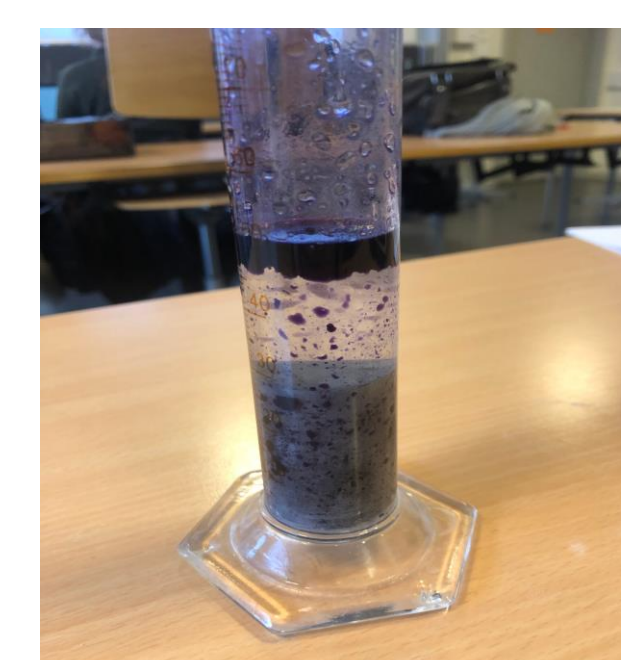
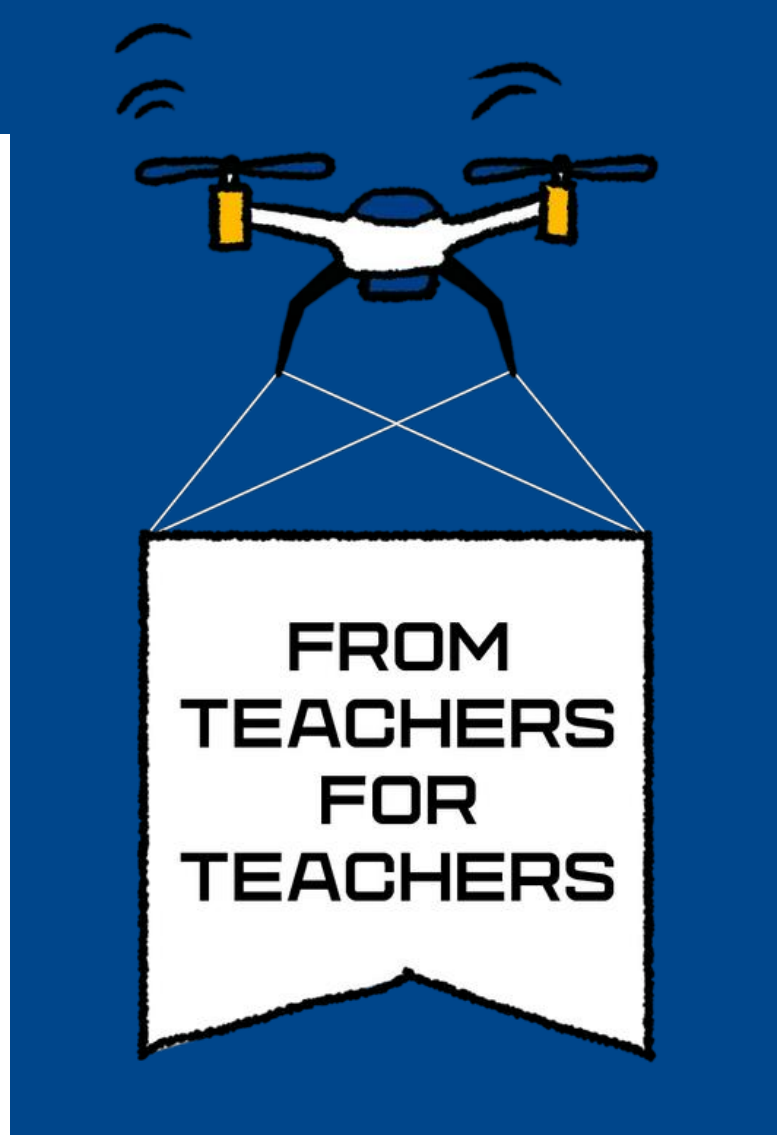


Fig. 3: Extraction of oil from chalk cores



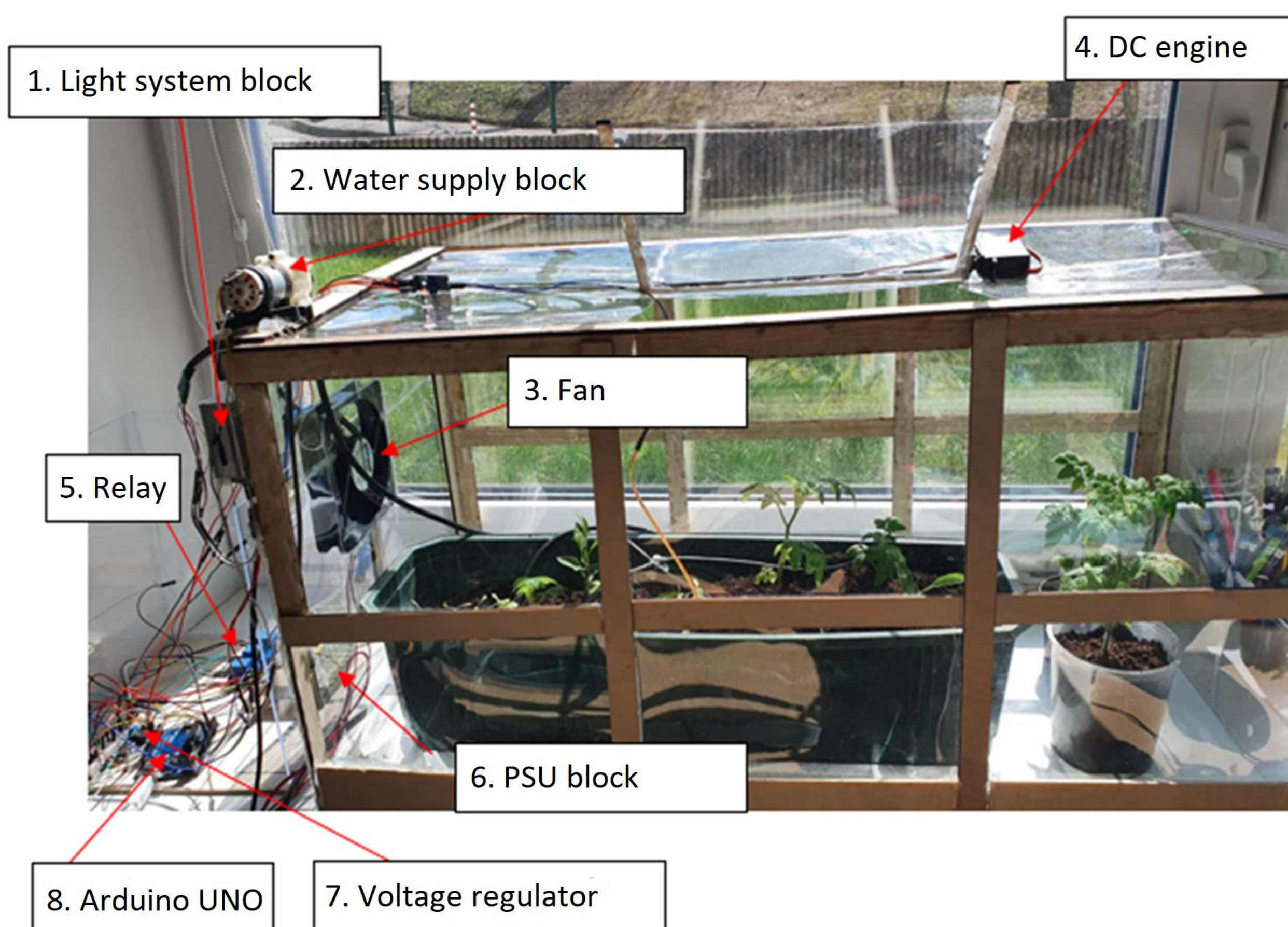
TECHNOLOGIES IN STEM EDUCATION

Snieguolė Bagočienė | Vilniaus „Sietuvos“ progimnazija | Vilnius | Lithuania

A smart greenhouse

The point of this project is to promote and develop practical prototyping and development skills in children by making a smart greenhouse from scratch.

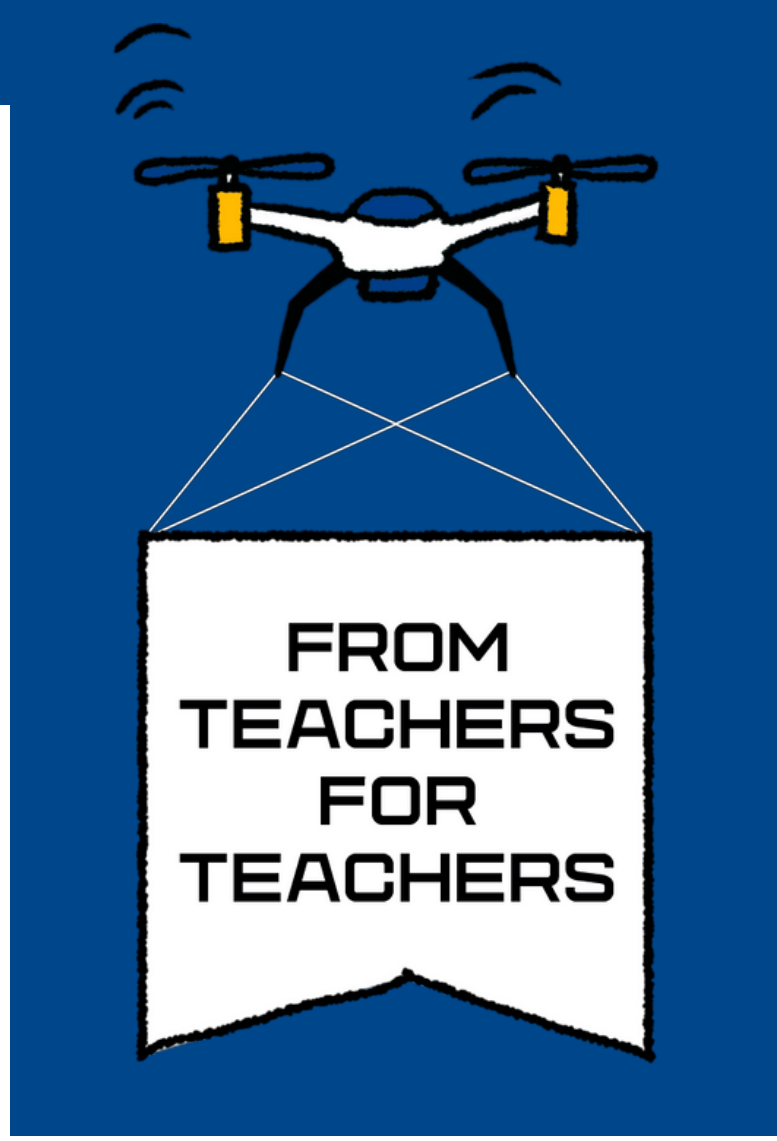
The smart greenhouse works automatically by lowering the temperatures, changing the levels of humidity, soil moisture, reading the levels of water capacity that it still has, watering the plants. By having a system that is mostly self-sufficient at growing the plants we can enable older people, or the disabled to have an easy-to-use garden in the reach of their hands.



The smart greenhouse is built with the following parts:

- 1 - light system block;
- 2 - water supply pump;
- 3 - fan;
- 4 - DC engine;
- 5 - relay;
- 6 - power supply block;
- 7 - voltage regulator;
- 8 - controller "Arduino UNO".

Conclusion: The smart greenhouse project has been successful. Currently, our goals are set on making an aesthetically appealing variant that then could be launched onto the market.

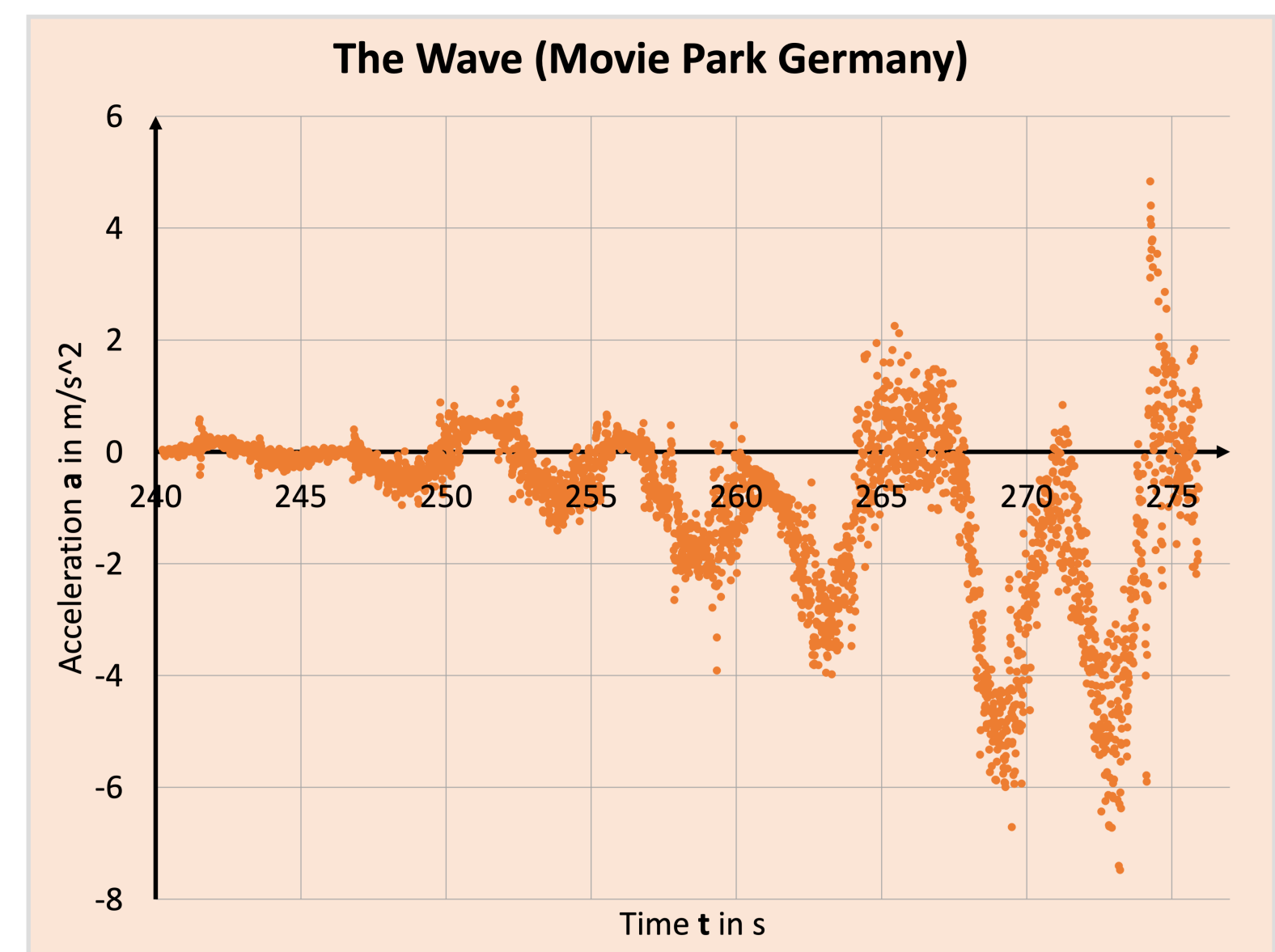
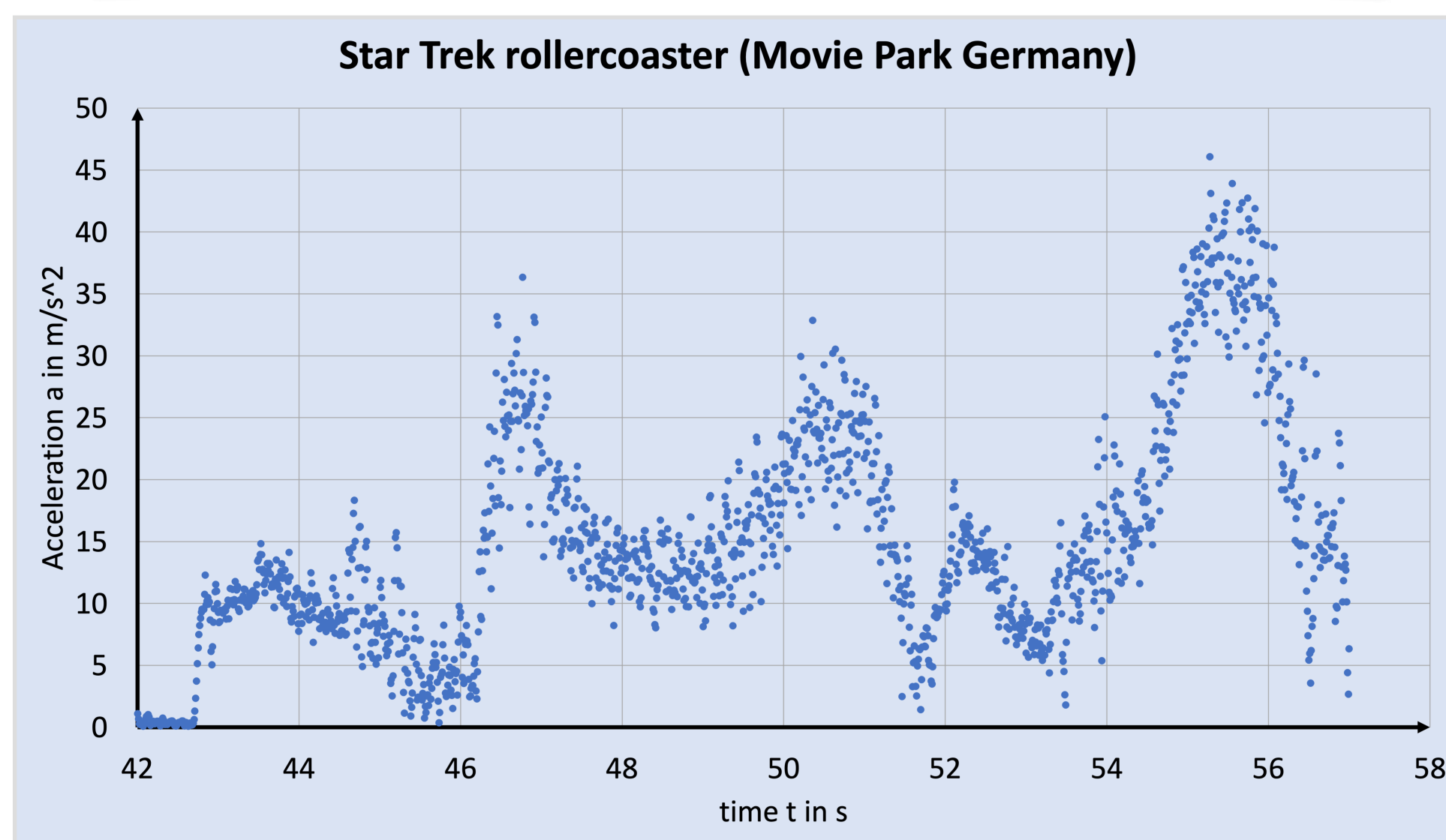


Technologies in STEM education

Robin Rozmann, M. Ed. | Städt. Leibniz-Gymnasium | Gelsenkirchen | Germany

Pupils become measuring devices

Digital examinations on amusement park rides

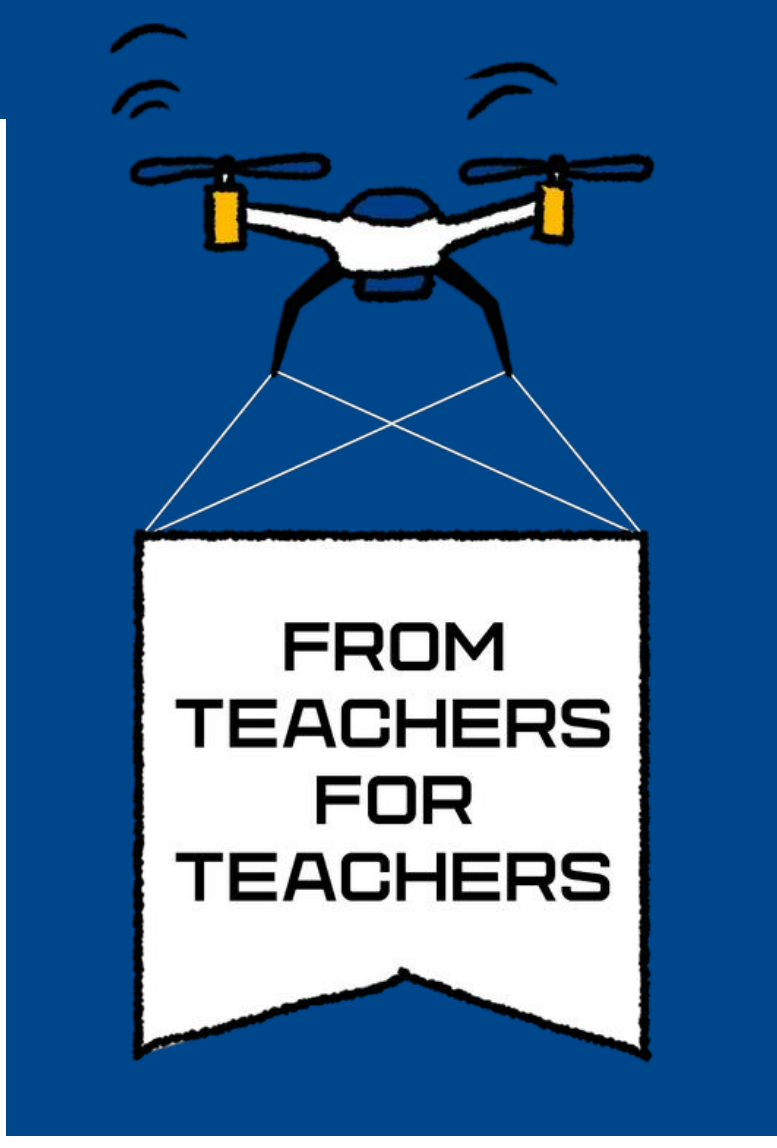


The **smartphone** has become an indispensable part of our everyday lives and those of our students. In this project, they learn in different grades about **the smartphone as an extremely precise and useful measuring device** with which they can quantitatively explore their surroundings. With the smartphone in their closed pockets, learners ride a ride together, **combining a lot of fun with recording quantitatively good data**. The recorded data file is uploaded to a folder in our educational network immediately after the ride and evaluated and interpreted in subsequent lessons.

In preparation for the excursion, **low-cost experiments** that I have developed and built myself with the help of a 3D printer **will be used in class**. The focus of these experiments is on working with the smartphone as a measuring device and using the necessary free apps. In doing so, the **necessary physical basics** for the analysis of the rides in the amusement park are being developed on the basis of the students' own guiding questions.

Experience shows that this approach **increases the intrinsic motivation** of the students.





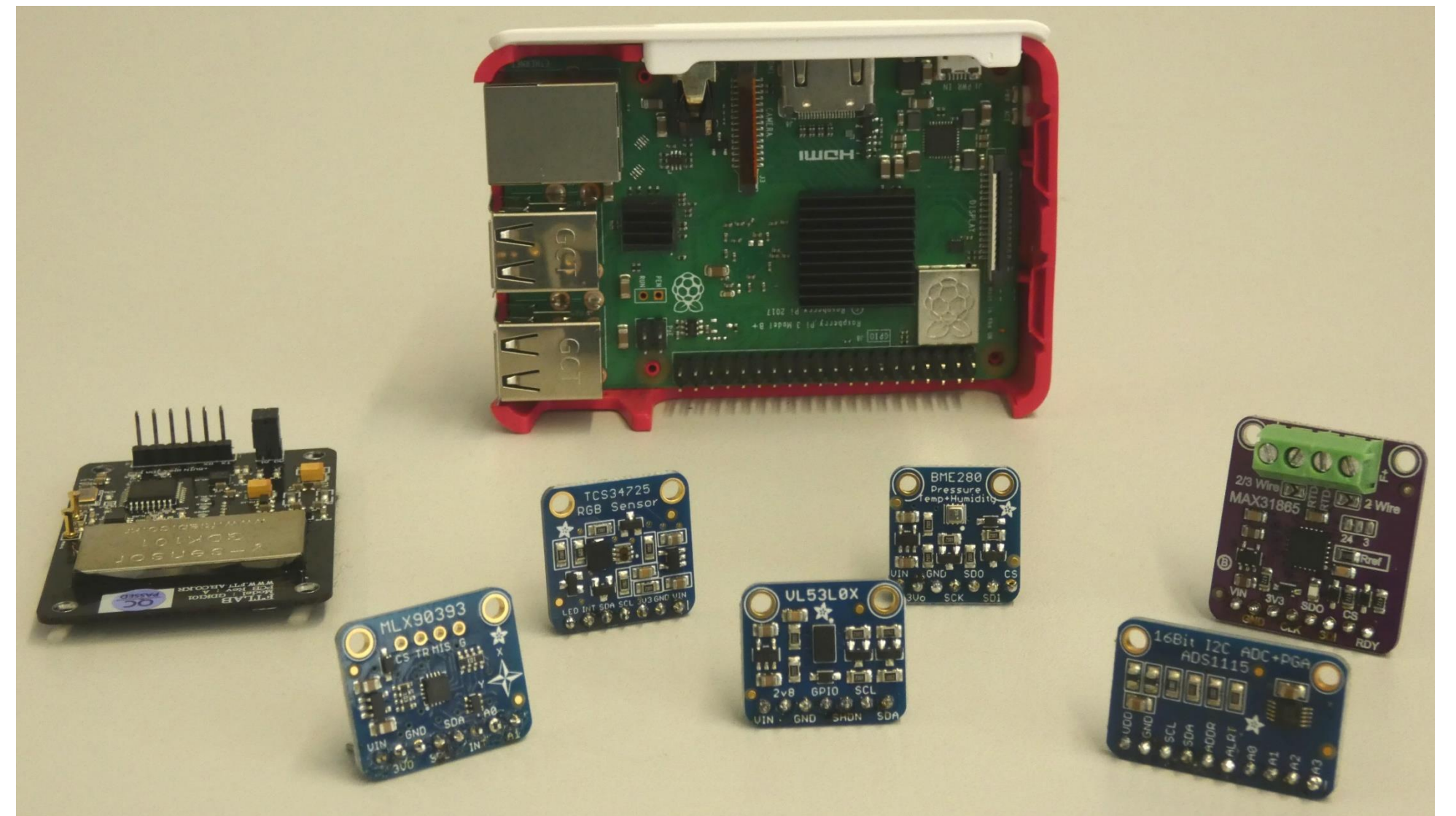
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Marinela Wong | Heinrich-Wieland-Schule | Pforzheim | Germany

Digital Measurement System in Physics Education Based on Raspberry Pi

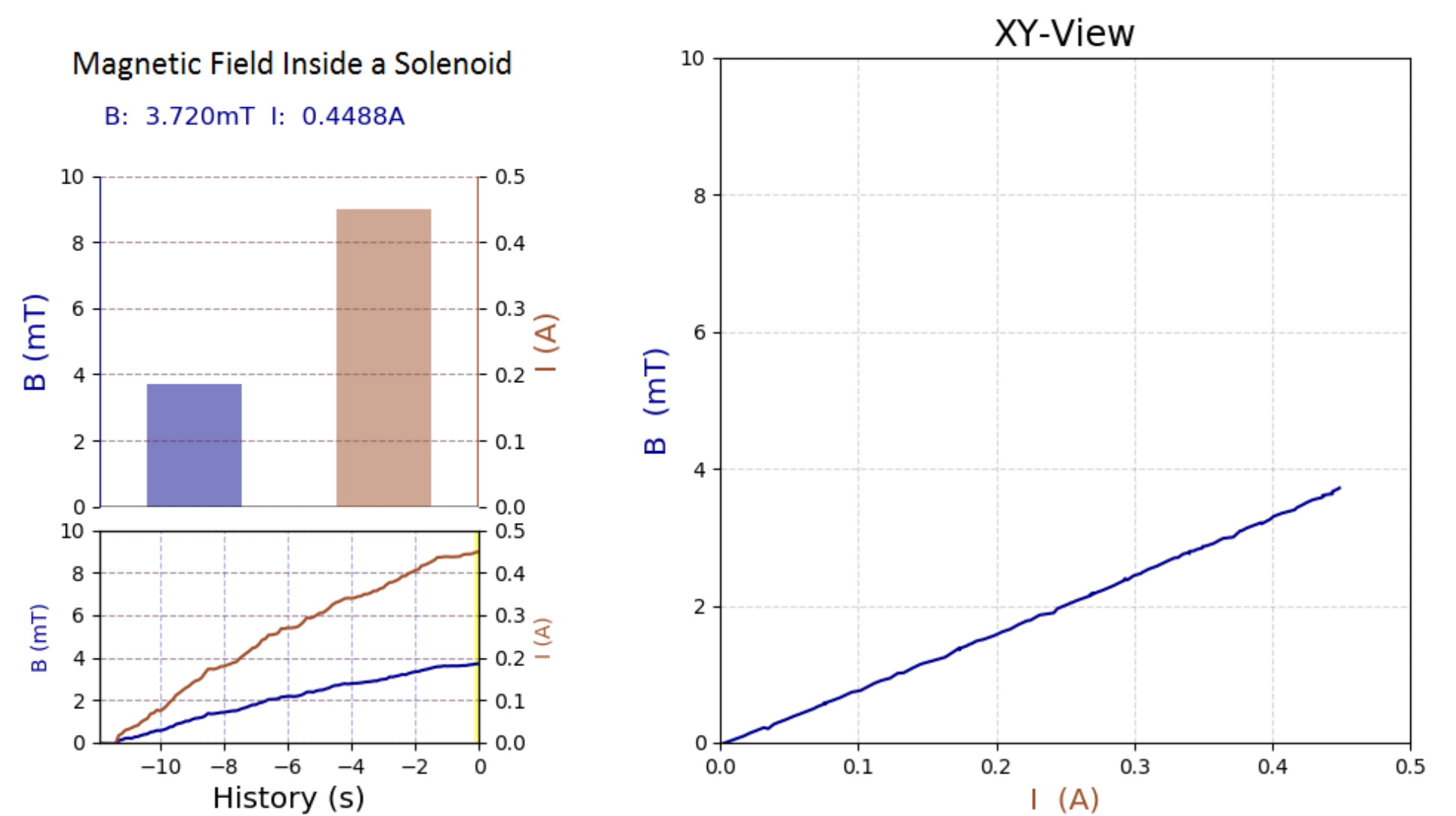
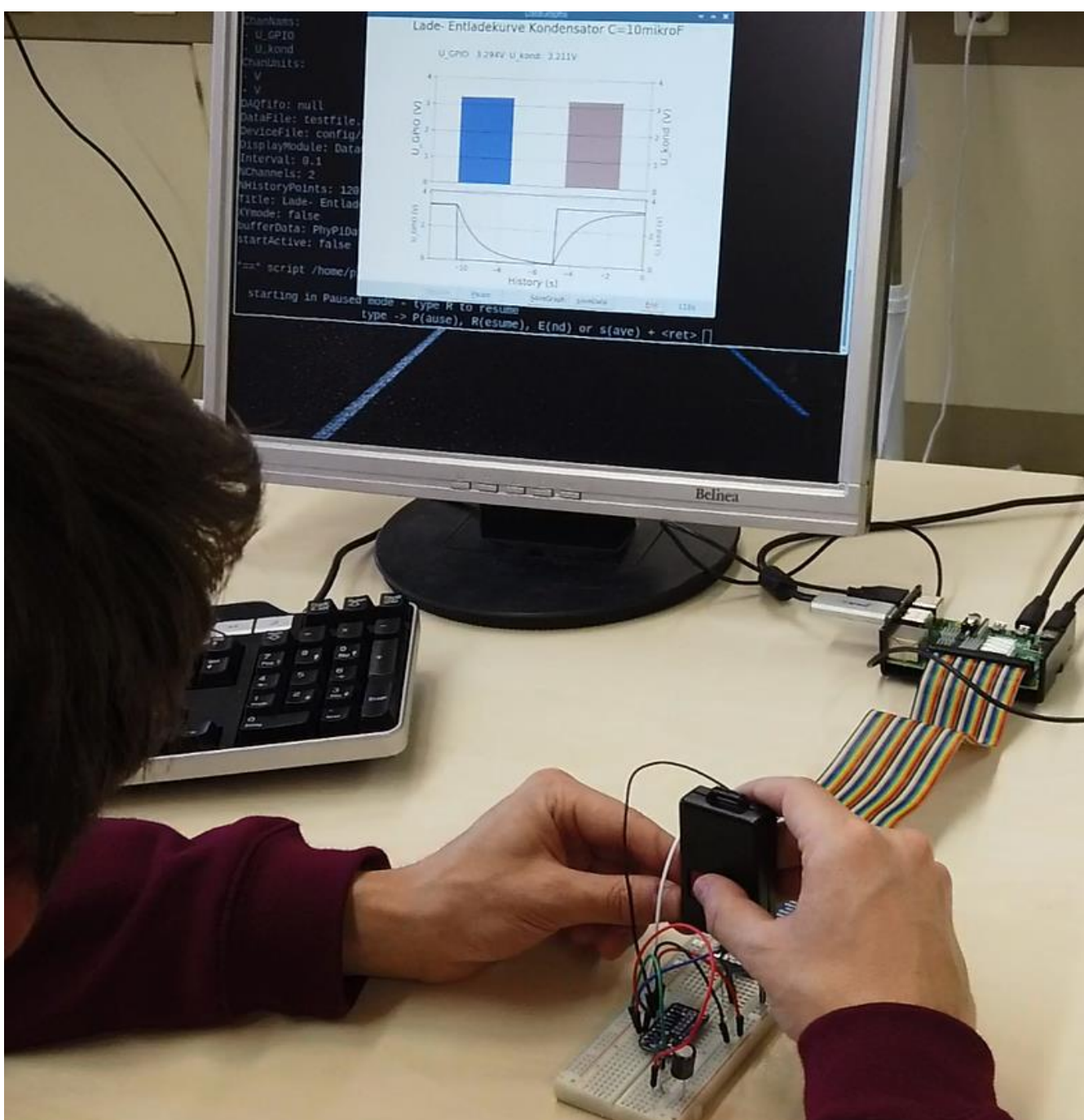
Measurement System Features:

- low-cost, accurate measurement system with a wide range of sensors for teacher-led and student-centred physical laboratory experiments
- open-source PhyPiDAQ-Software manages acquisition, display and storage of data obtained from physical sensors through one Graphical Interface
- multiple graphical representation such as graph of one or more measured quantities over time, bar charts and XY-graphical relationships of physical quantities for the display of real-time data
- numerous capabilities like adapting the range of measurement to the characteristics of the sensors and to the experimental goals, or adding formulae into the configuration of a sensor to obtain a direct visualization of a desired quantity

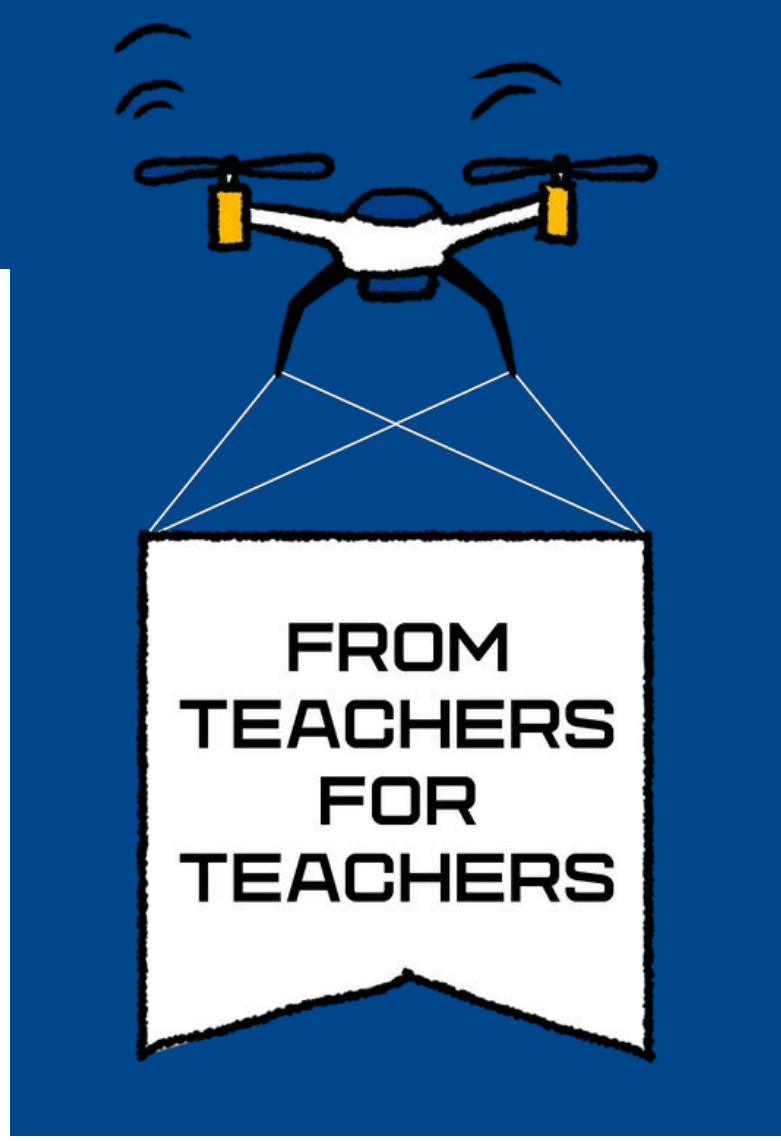


Didactical Aspects:

- promote scientific inquiry process and engineering design
- stimulate students to interact directly with various electrical components
- measurement data used in interdisciplinary ways can enhance the students insight in mutual relationships between Physics concepts and mathematical tools in modelling them



The Raspberry Pi based Digital Measurement System offers a wide range of learning opportunities for STEM concepts and practices spreading within and across the disciplines and grade levels in an integrated curriculum.



Technologies in STEM education

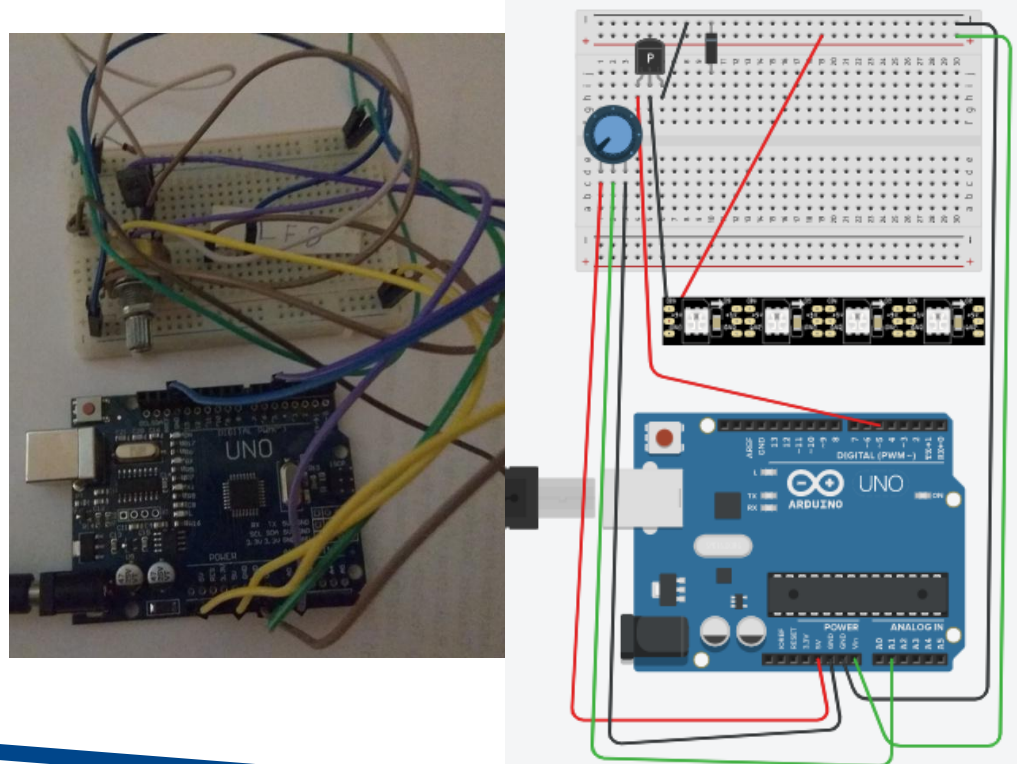
Georgios Chatzisavvas | Model General Lyceum of Heraklion | Heraklion | Greece
Kalliopi Giannakoudaki | 1st High-school of Malia | Malia | Greece

“Defying” Gravity!

Many of human inventions are intertwined with man's need to “see” beyond his senses. His need to see beyond the limits of his vision led to the invention of the microscope and the telescope. When he constructed machines that moved much faster than the human eye could follow, he invented the **stroboscope**. Although most students are familiar with the microscope and the telescope, few have heard of the **stroboscopic effect**. In the present work, the basic principle of stroboscopy is applied in a different context. We study the **motion of the droplets** of a liquid and this leads to the creation of very impressive visual illusions. Through an **STEM** approach students combine basic principles of Physics (optics - sound - kinematics), with knowledge of **Technology** (Arduino), **Mathematics** (equations and statistics) and **Engineering** and they finally succeed to “trick” their senses and “see” beyond them.

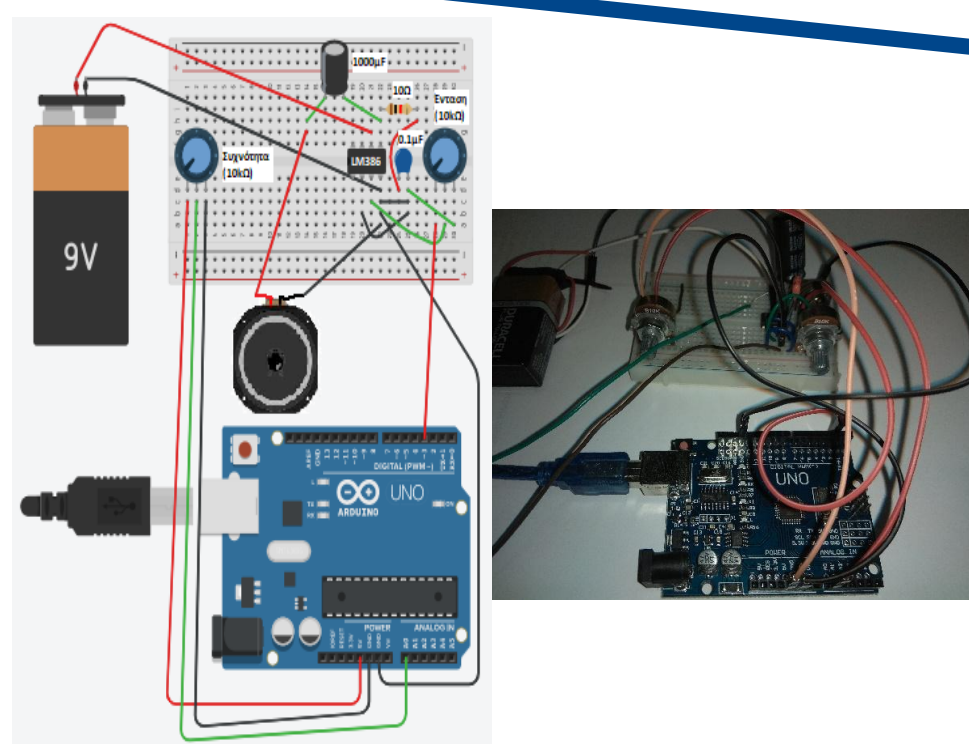
Stroboscopic System

This system is responsible for the production of short, repetitive flashes of light. The flash frequency is determined by an Arduino UNO microcontroller and it is regulated by a potentiometer.



Sound System

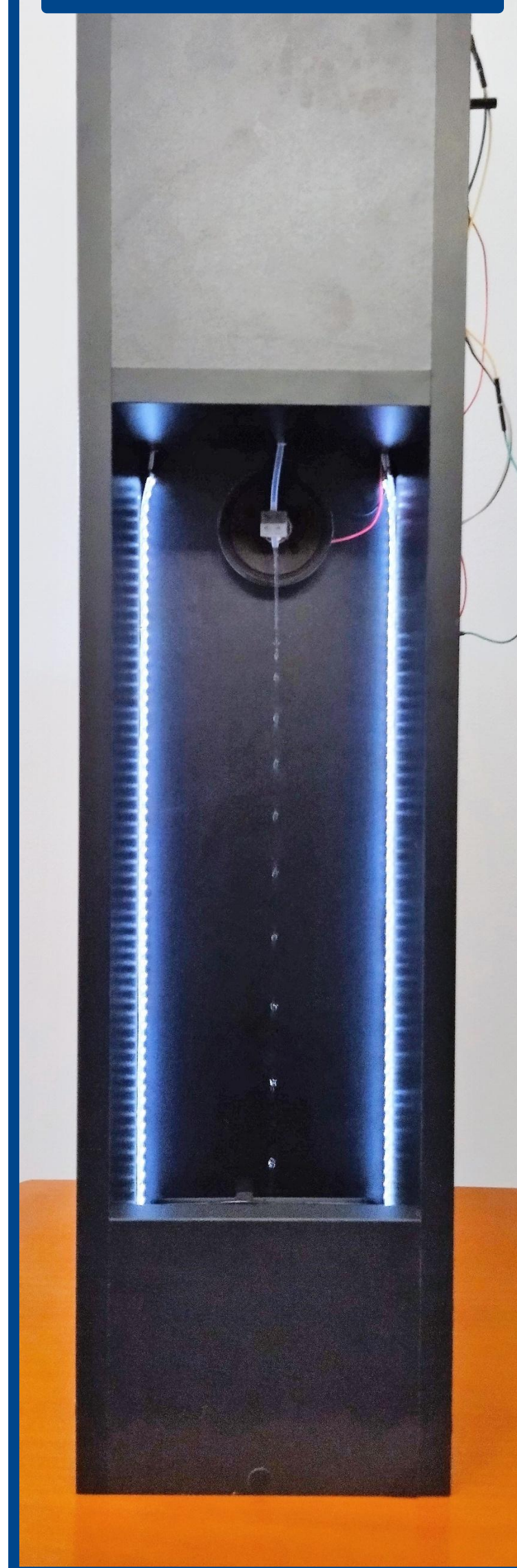
This system is responsible for the controlled vibration of the water droplets. The device uses a speaker, an electrical circuit acting as an amplifier, an Arduino UNO microcontroller and a potentiometer so as to adjust the audio output frequency.



Hydraulic System

This system is responsible for the flow of the water in the chamber and it is composed of two containers with a capacity of 1 liter each, a plastic pipe and the water flow controller.

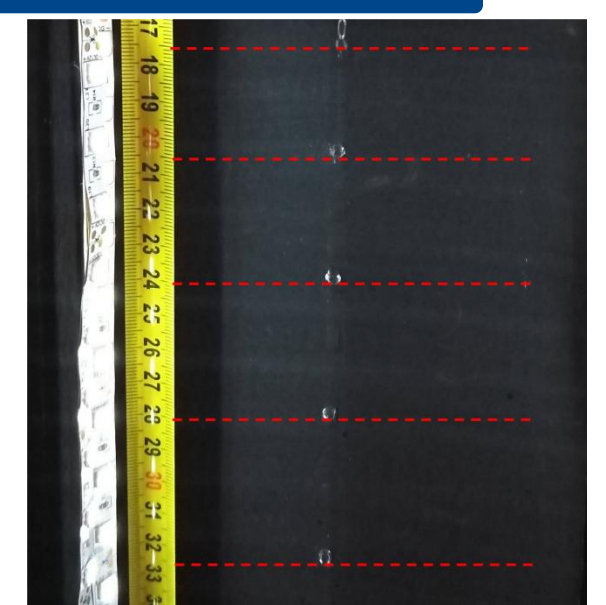
The Set-up



The Experiment

$$g = \frac{\Delta y' - \Delta y}{T^2}$$

$$T = 0.02s$$



y (cm)	Δy (cm)	g (m/s ²)
18.0	---	---
21.2	3.2	---
24.8	3.6	10.0
28.9	4.1	12.5
33.5	4.6	12.5
38.4	4.9	7.3
Average g (m/s ²)		10.6

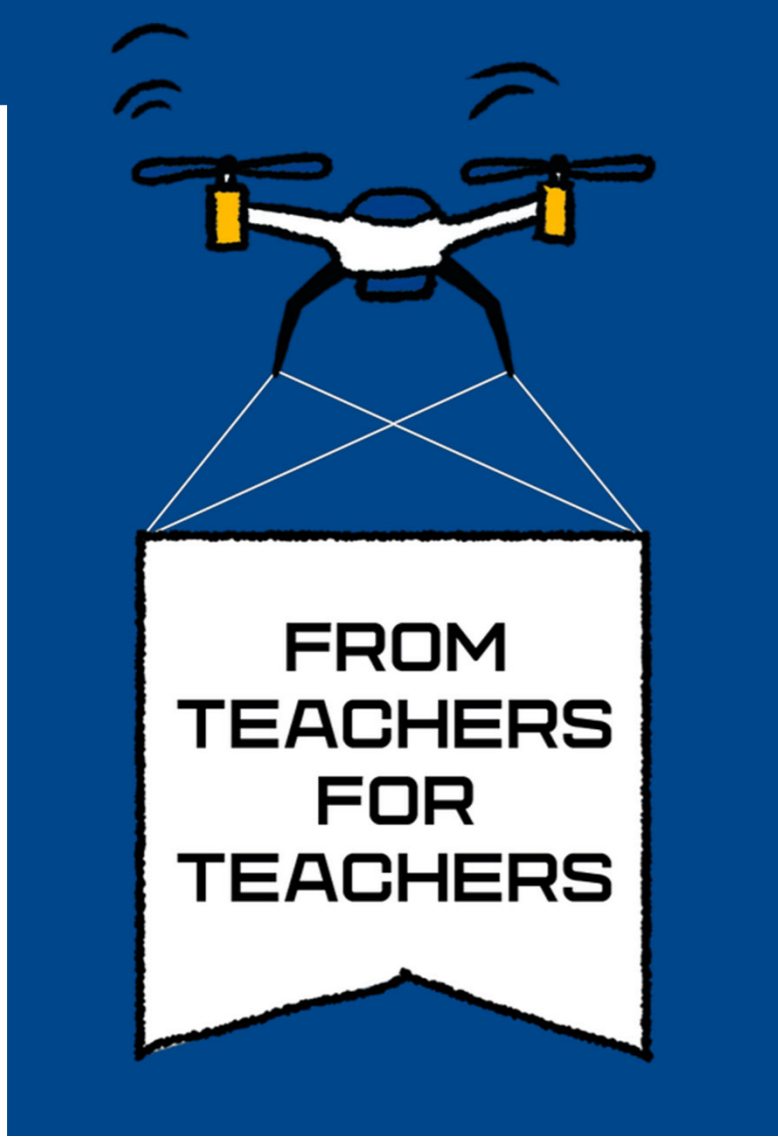
From Teachers For Teachers

A constantly enriched digital repository has been created that offers information about the theoretical background of the phenomenon, simulations, the materials used in the project, photos, videos and educational worksheets.

<https://sites.google.com/view/scienceonstage2022>



It is the first time in Secondary Education that strobe light is used in this way. It is a novice, low-cost experimental set-up, that you can easily try with your students in the school lab!



TECHNOLOGIES IN STEM EDUCATION

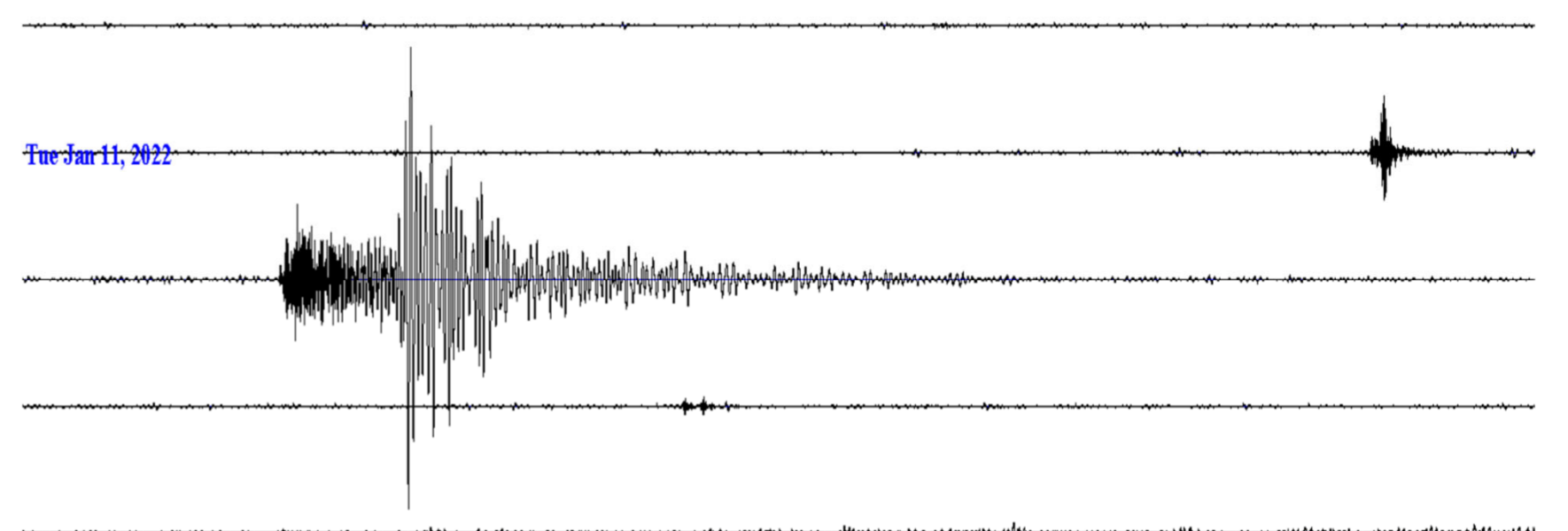
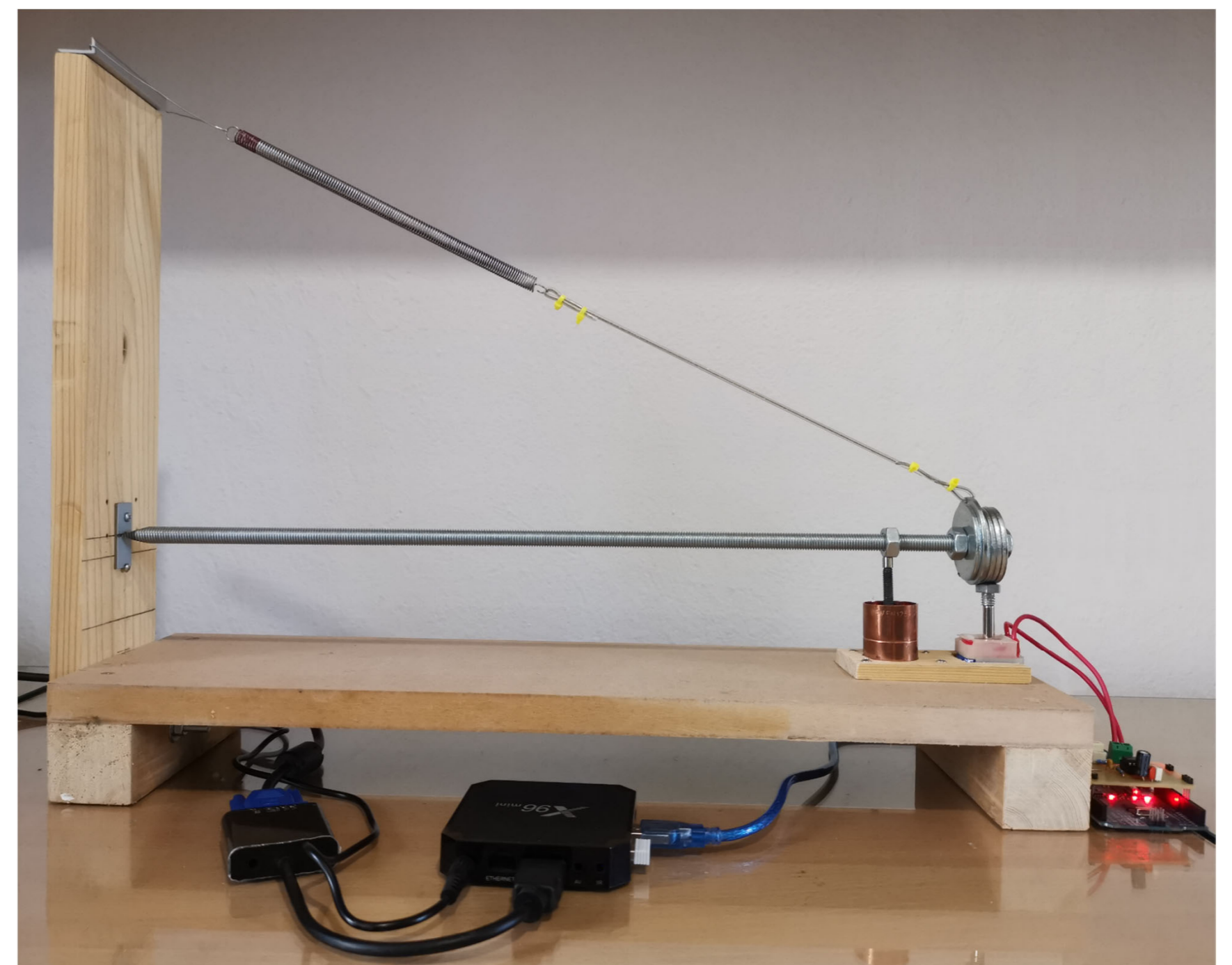
Vasilis Nousis | Laboratory Center | Igoumenitsa | Greece

A simple yet sensitive seismometer

Our seismometer, which is capable of recording local earthquakes greater than 3R and teleseismic earthquakes greater than 6R, consists of a ground-motion detection sensor coupled with an appropriate recording system.

The ground-motion detection sensor is a mass-spring system combined with suitable electromagnetic and electronic devices to convert ground vibrations into electrical signals.

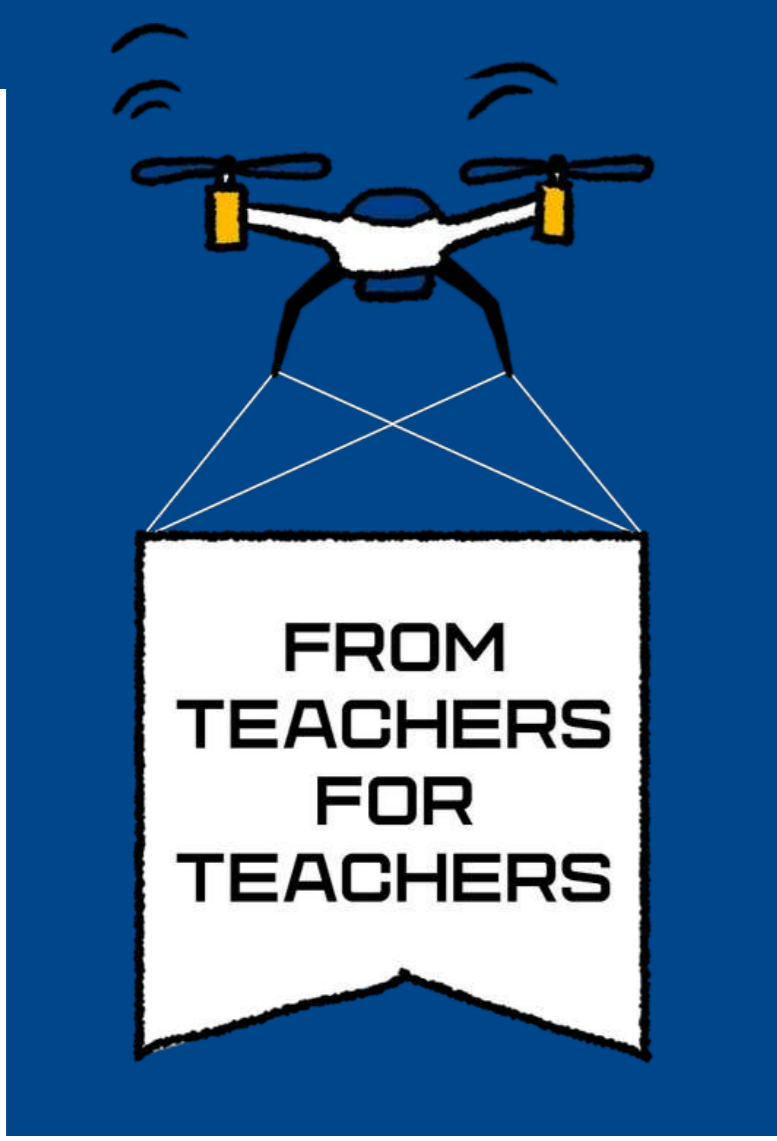
The recording system consists of an Arduino, to digitize and filter the seismic data and a computer running jAmaseis software, which receives the digitized seismic data and undertakes their recording, display, archiving and analysis. It also can send the data to the IRIS network, so that it can be accessed online by everyone.



Students can:

- Learn the basic points concerning the causes of earthquakes, the propagation and the differences of the different types of seismic waves.
- Recognize and understand the scientific principles on which the operation of a seismometer is based, i.e. issues from electromagnetism and oscillations.
- Deal with printed circuit board making techniques.
- Carry out experiments, to be able to adjust the device for proper operation.
- Install a Linux (Armbian) distribution on an Android TV Box, turning it into a system capable of "running" the jAmaseis software.
- Work like a real seismologist works, determining for example the epicentre of recorded earthquakes.

An active learning project to increase students participation and motivation and improve understanding and performance in STEM disciplines



TECHNOLOGIES IN STEM EDUCATION

Petros Poutos

1st Vocational -Technical Lyceum of Salamis Island

Salamis - Greece



" the robotic arm as a representative teaching tool for STEM approaches "

In this project is presented an effort to show how an impressive device as the robotic arm, can be done representative **STEM teaching tool**.

❑ First of all, the **basic specifications** of the arm are defined, such as its type, work space, degrees of freedom (DOF), etc.

❑ Next comes the **design** of components and generally all moving and stationary parts.

❑ Then, coming the **mathematical calculations**. Using simple geometry and trigonometry, are **calculated the equations** of the joints angles, by solving the **inverse kinematic problem**.

❑ The equations are then written in **code** in the excellent **LabView** software, in a graphical environment, that is more understandable to students.

❑ The **results** are transmitted to microcontroller of robotic arm, (**Arduino**) to move the servomotors of the joints at the **correct angles**. Thus, the end of the arm reaches the **desired point** in space (X,Y,Z).

❑ Finally, the robotic arm **is made**, with 6 DOF using the **principles and rules** of **physics, engineering, technology and electronics**.

✓ The code can be **changed**, giving the arm **new possibilities**, such as remembering the movements indicated to it manually and being able to repeat them. Thus, students appreciate and understand the **"importance"** and **"flexibility"** of the code.



Robotic arms in action

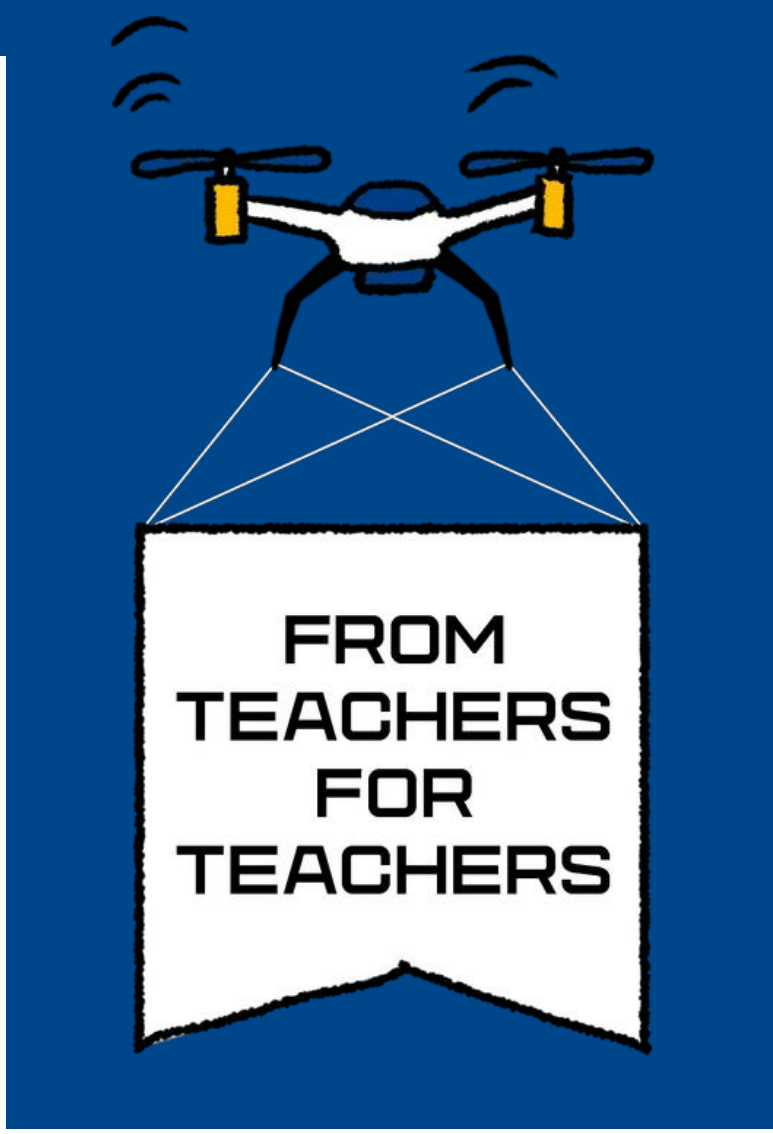


Interactive environment of LabView software

Educational Benefits:

- ✓ Teamwork but at the same time development of individual innovations.
- ✓ Growth students' perception and ingenuity.
- ✓ Finding solutions to real problems that arise.
- ✓ Dealing with new technologies and materials.
- ✓ Constructive acquisition of skills for measuring instruments and handling tools.
- ✓ Learning basic principles to write code in different environments.

The project provides a fulfill and impressively **STEM teaching approach**, with an emphasis on **problem analysis and coding**, where students will love it.



TECHNOLOGIES IN STEM EDUCATION



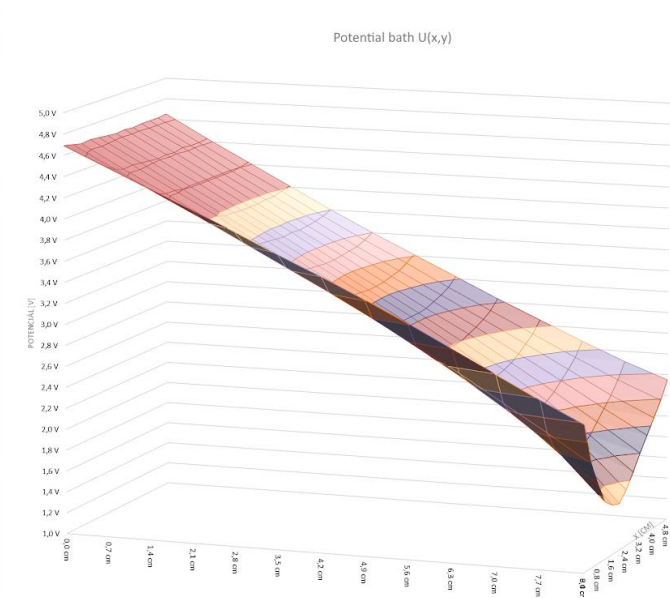
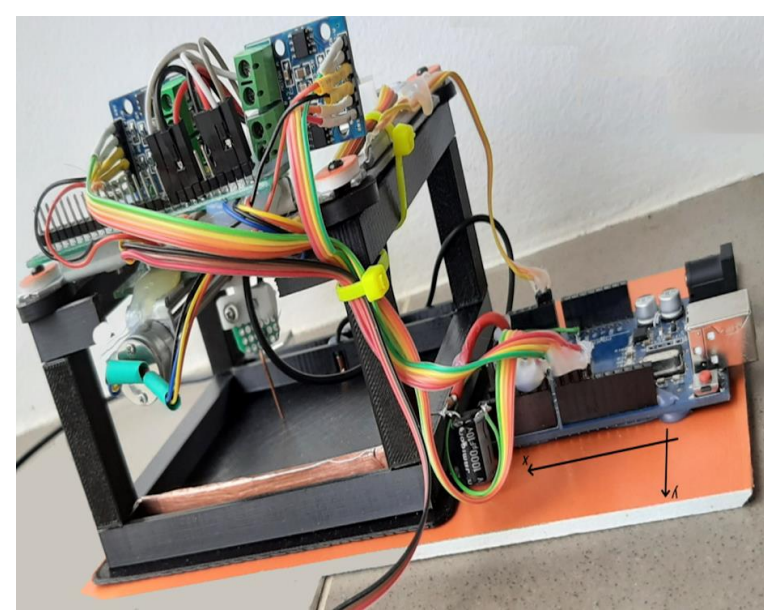
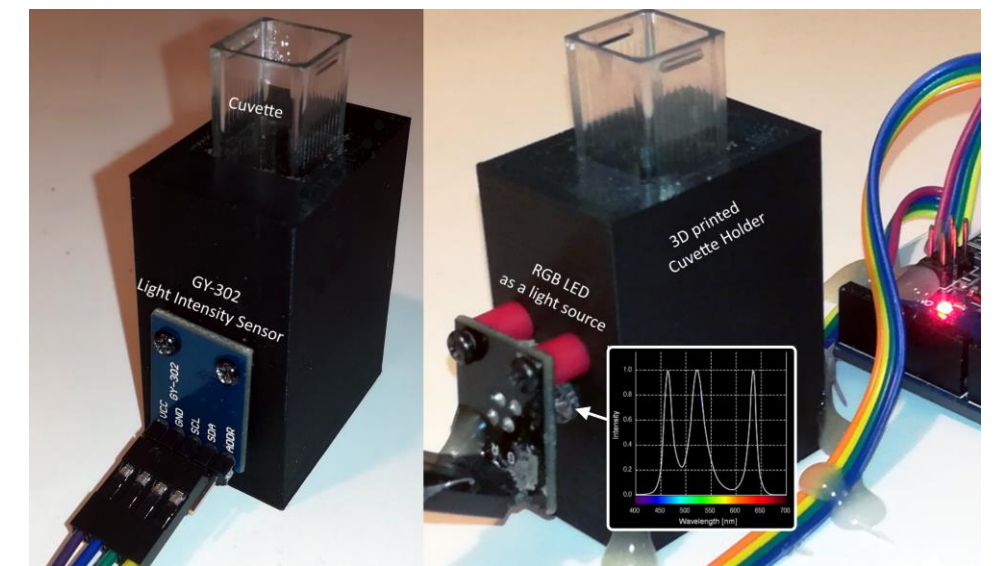
Dr. Károly Piláth | ELTE Trefort Ágoston Grammar School | Budapest

STEM recipes for digital natives

This FAIR is a platform which will show my cooking processes for the microcontroller-based experiments. My recommended recipes may not fit on this poster, so if you want to rebuild one of them, read in the QR code that will take you to a detailed description of how to build the equipment.



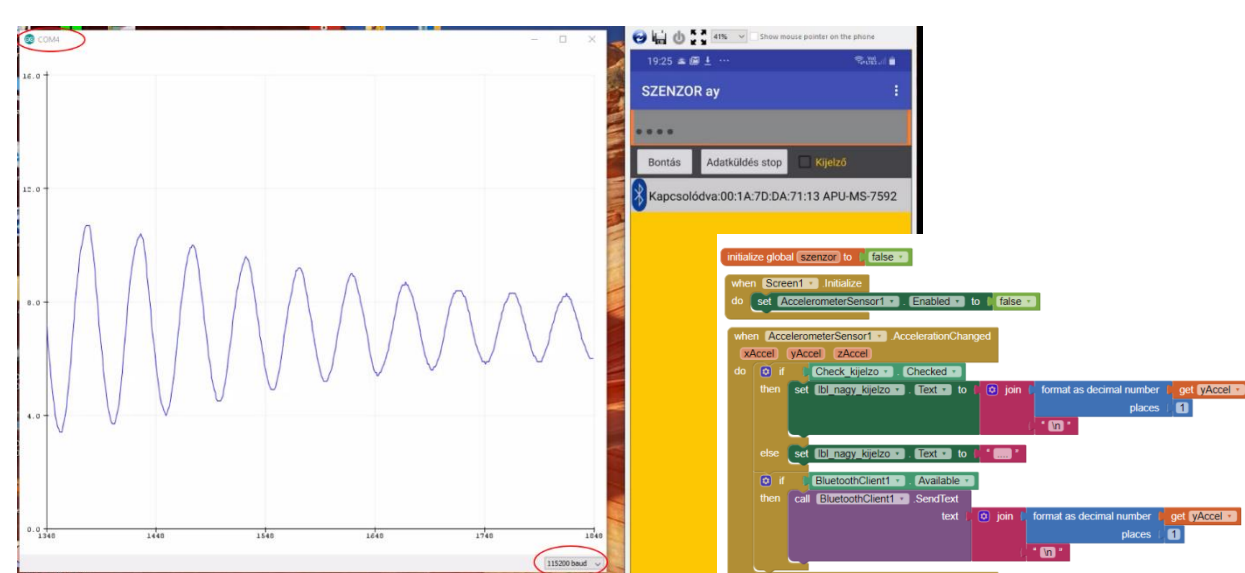
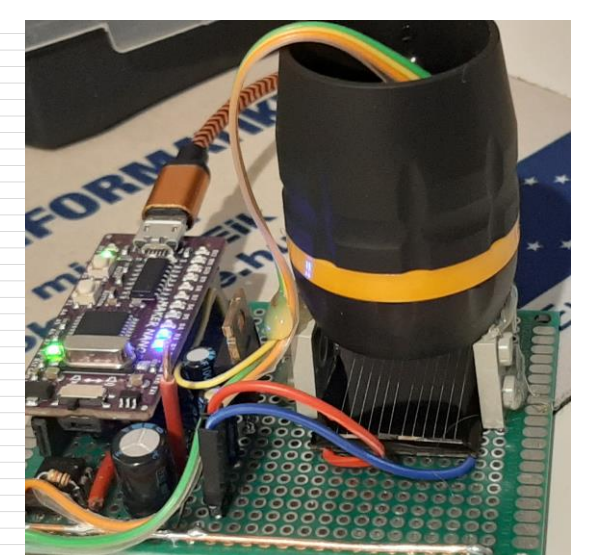
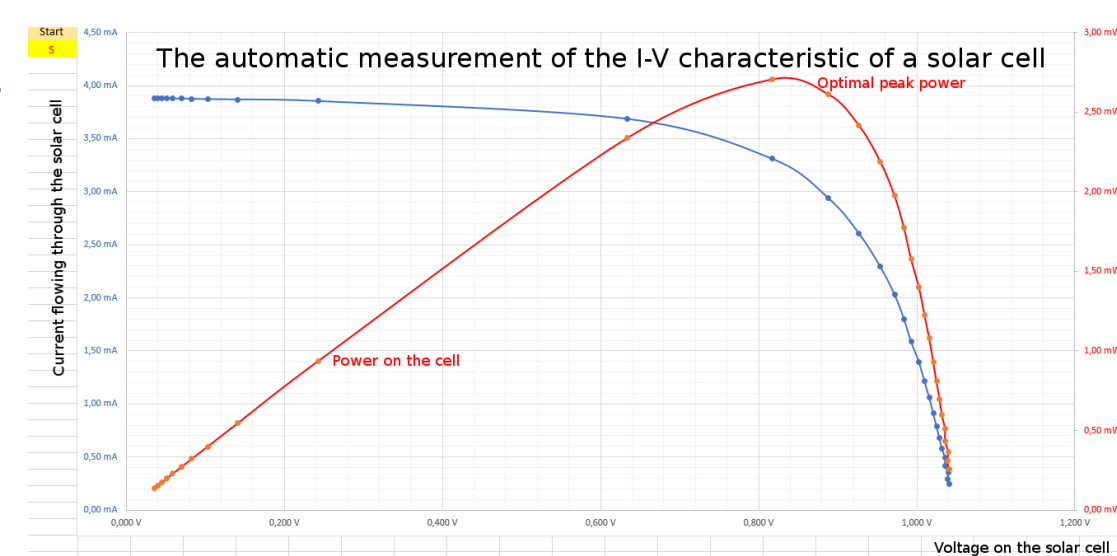
First, I would like to present my 3D printed, LED based, inexpensive photometer developed for chemistry and biology teachers that can be controlled by a mobile-phone. The Arduino card that controls the measurement communicates with the phone via a Bluetooth module.



I also would like to present my automated potential bath, which was successful in the European Code League final 2020. This Arduino and Excel DataStreamer based project has been developed together with my students.



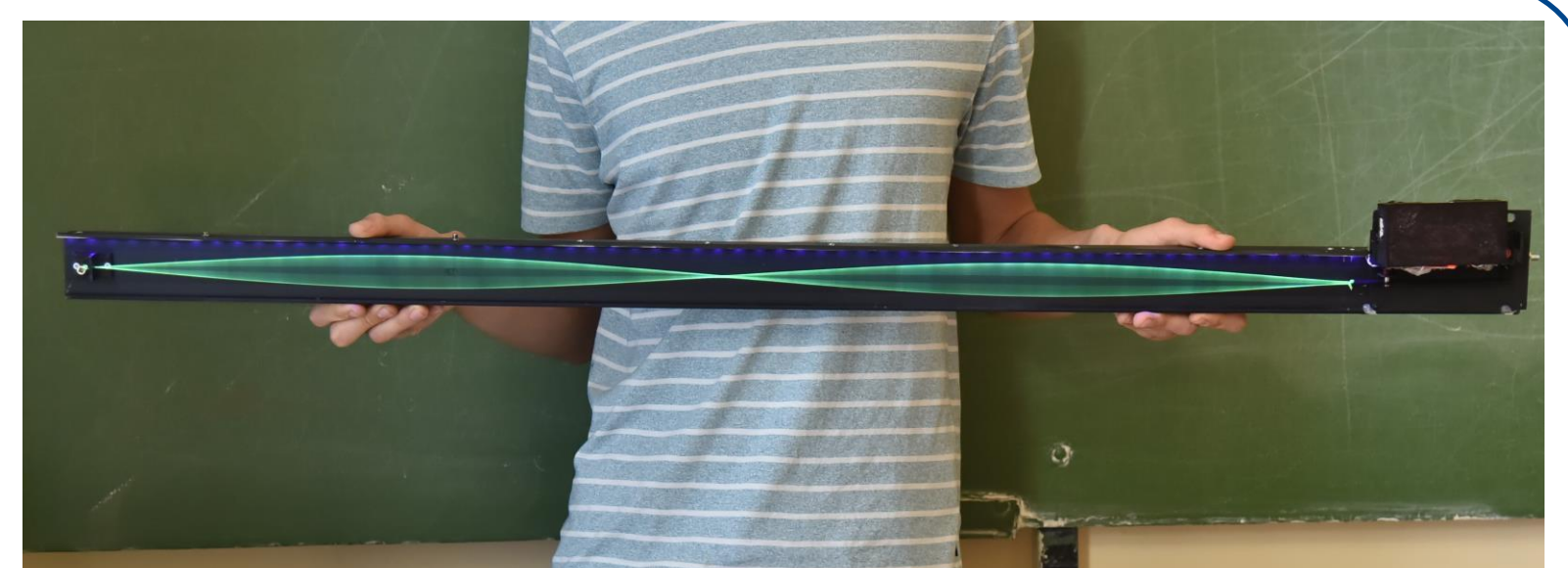
My third recipe is an automatic testing of the solar cells. This Arduino and Excel DataStreamer based equipment can test automatically the efficiency of solar cells.



I'm introducing another mobile-phone app coding in the AppInventor for the physics teachers. The app sends real-time data from sensors built in our Android phone via a Bluetooth channel to a DataStreamer.



At the end I will show you a beautiful physics experiment that can be shown in a classroom. I'll demonstrate the standing waves on a vibrating fluorescent rubber string is illuminated by an UV stroboscope, controlled by mobile-phone app.





TECHNOLOGIES IN STEM EDUCATION

Team GRLSAT | Reformed High School of Gödöllő | Gödöllő | Hungary

CUSTOM SENSORS FOR GRLSAT

A SATELLITE LAUNCHED IN THE 2019 CANSAT COMPETITION

What is a CanSat?

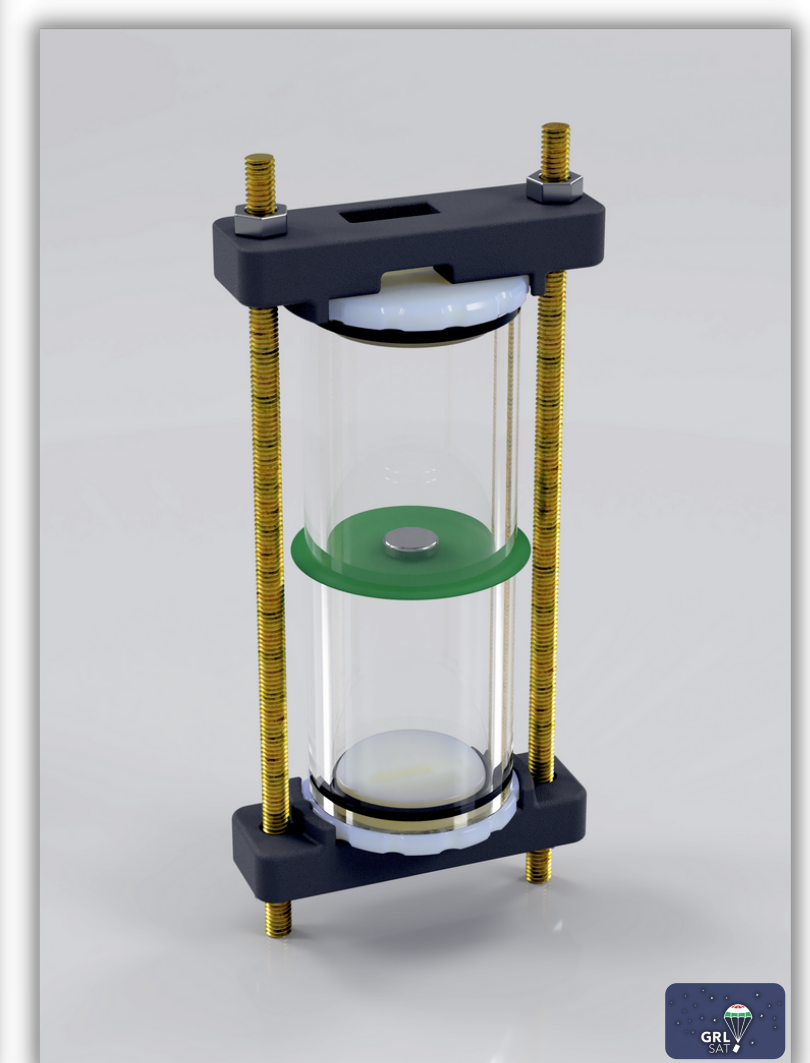
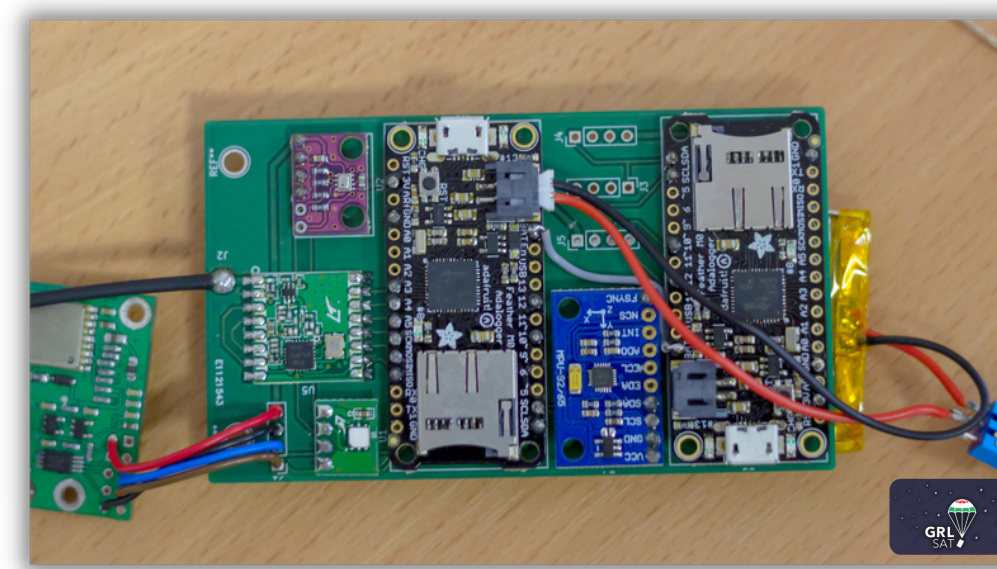
A CanSat is a simulation of a real satellite, integrated within the volume and shape of a soft drinks can. The CanSat is launched by a rocket to an altitude of 1000 meters and returns by a parachute. During the flight, it transmits all measurements to a ground station.

Sensor development

It all started with a few ideas, which we turned into plans and built a scientific instrument from scratch. Using computer aided design, 3D printing and basic programming skills, we built working prototypes in-house. Finally, we verified our hypothesis with calibration measurements.

Educational value of the CanSat project:

- learn by doing
- get acquainted with the inquiry-based methodology that is typical of real-life scientific and technical professions
- acquire and/or reinforce fundamental technology, physics, and programming curricular concepts
- understand the importance of coordination and teamwork
- enhance communication skills
- make international connections

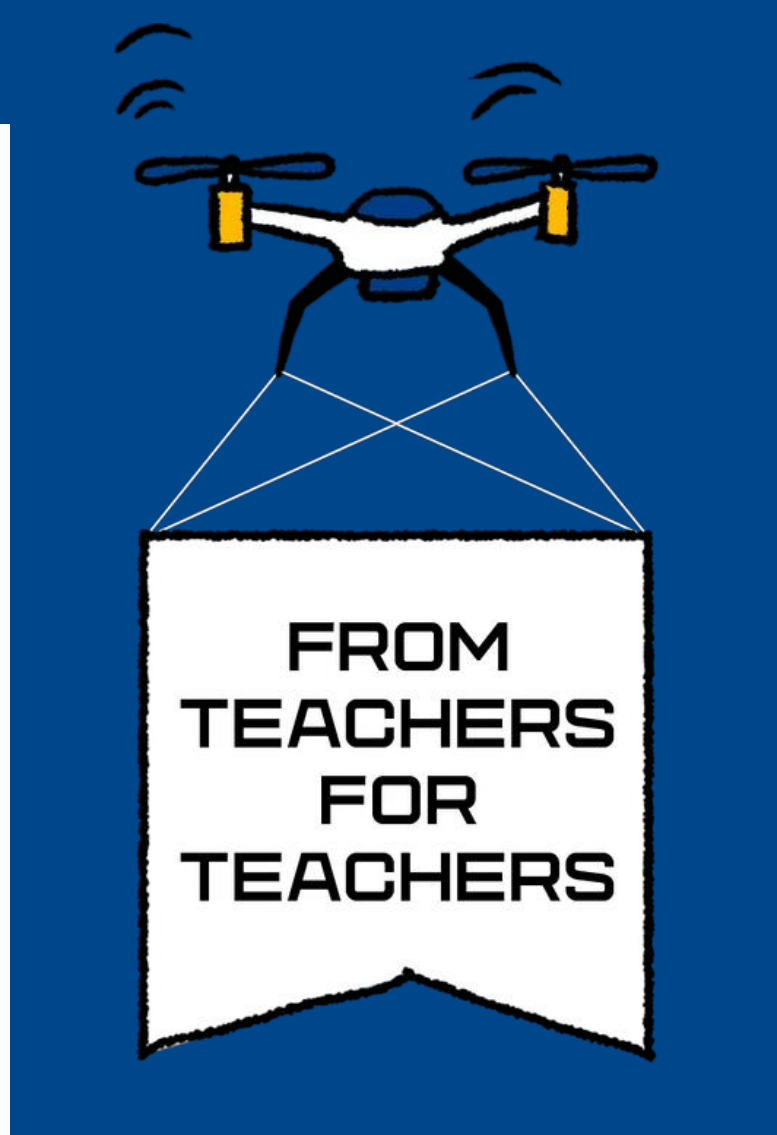


Conclusion: Do you want to know what it is like to take part in a real space project?

Work together as a team to imagine, build and launch a CanSat!

Team Members: Botond Bán - Csenge Napsugár Dénes - Kristóf Tóth - Márton Krasznai - Márton Reményi - Péter Unyi

Team Mentor: Dr. István Seres

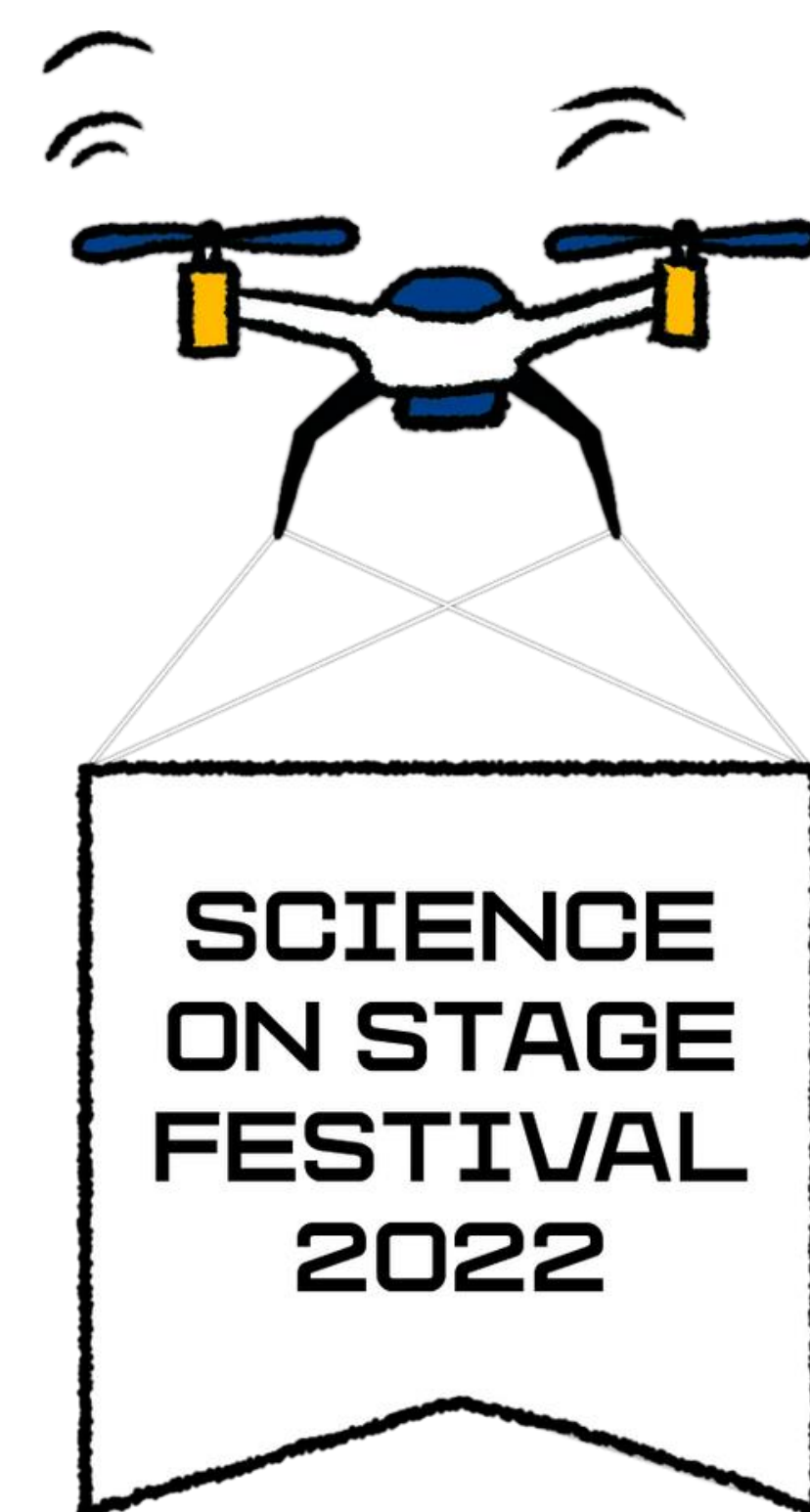


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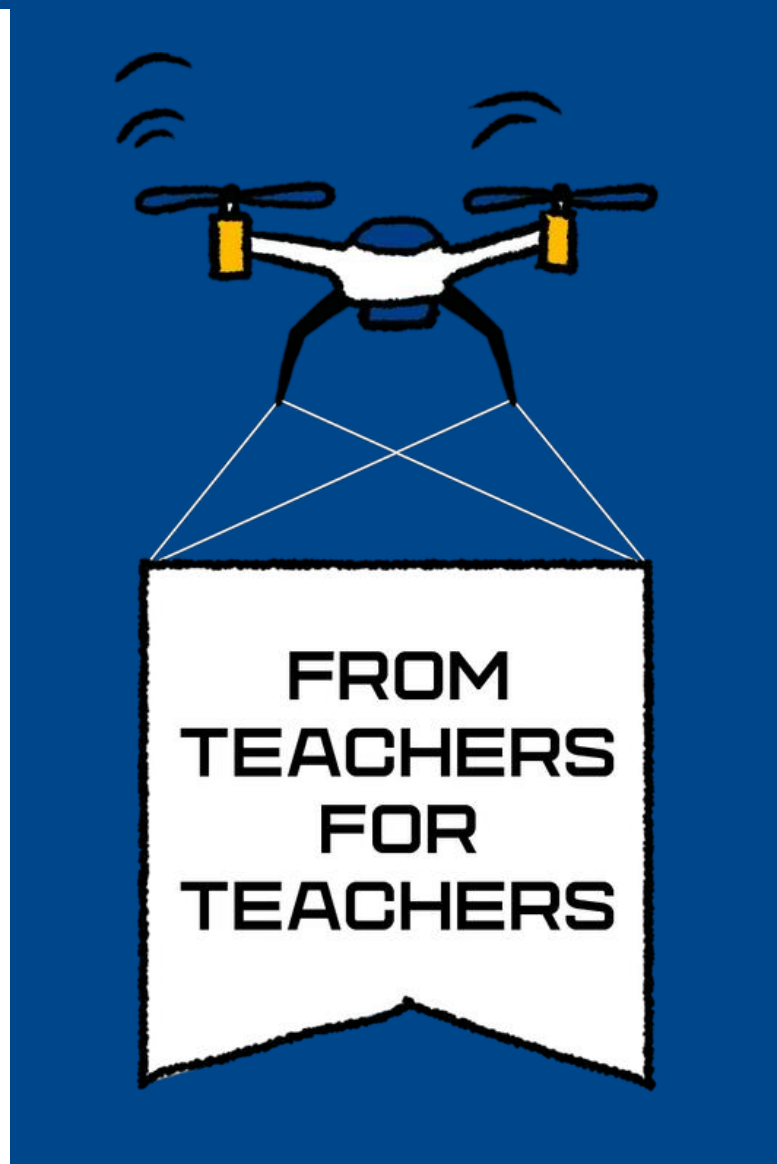
János Szabó - Edit Lévai - Tímea Kasztiné Végh | Somogy County Duráczky József
Primary School | Kaposvár | Hungary

Improving Scientific Thinking by Programming a Makeblock Neuron Creative Lab Kit

Children are usually interested in the work of automatic systems in their environment for example railway crossing, alarm systems, or smart crosswalk. We are analysing and modelling operation of these during our collective creative work. Our goal is to be able to create self made projects in the future, which are usable in everyday life. The technical solutions of our environment are modelled by the electronic modules of Makeblock Neuron Creative Lab Kit in our project. In each microproject the description of the model, the interconnectivity of the electronic modules, the operational programme code and the functional environment of the model are presented. We use visual development environments for programming. The adaptations of these microprojects are offered to primary pupils aged 8-12. These pursuits apply incorporate several fields of knowledge and science such as environmental studies, technology and design, digital culture. Thus it undoubtedly enhances the cooperation of educationalists.



The key of success is the cooperation.



TECHNOLOGIES IN STEM EDUCATION

Paolo Gondoni | Istituto di Istruzione Superiore "A. Badoni" | Lecco | Italy

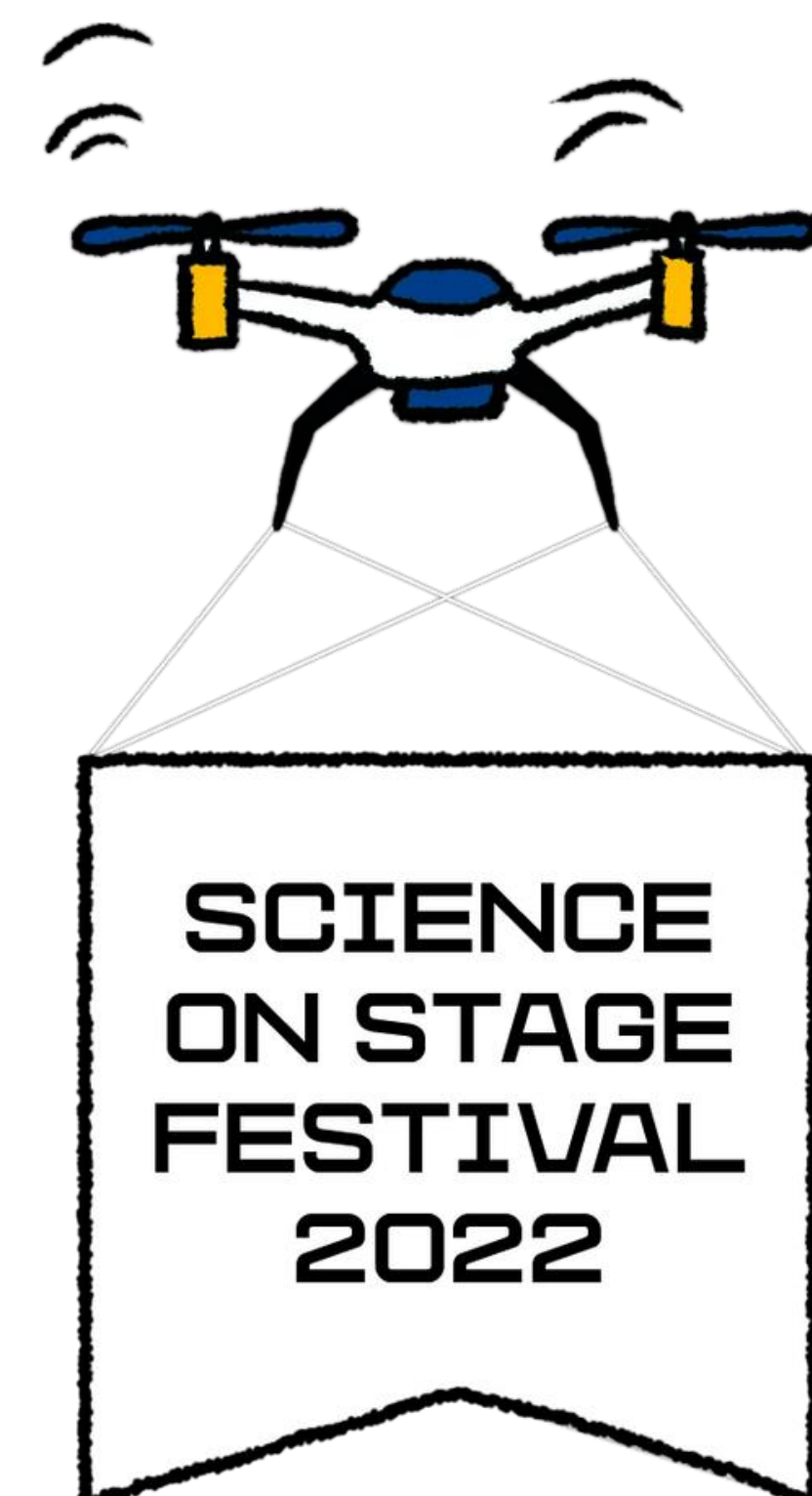
Albert vs. Coronavirus and phy6games.com

Physics videogames for remote learning

The website phy6games.com is a collection of online videogames covering different physics subjects: kinematics, thermodynamics, special relativity. In every game, the player must use the laws of physics to defeat the Sars-Cov-2 coronavirus and save the world from the pandemic.

The games were developed during the first lockdown of winter 2020, when the sudden closure of schools required to quickly develop remote activity to keep the students engaged without knowing when schools were going to open again.

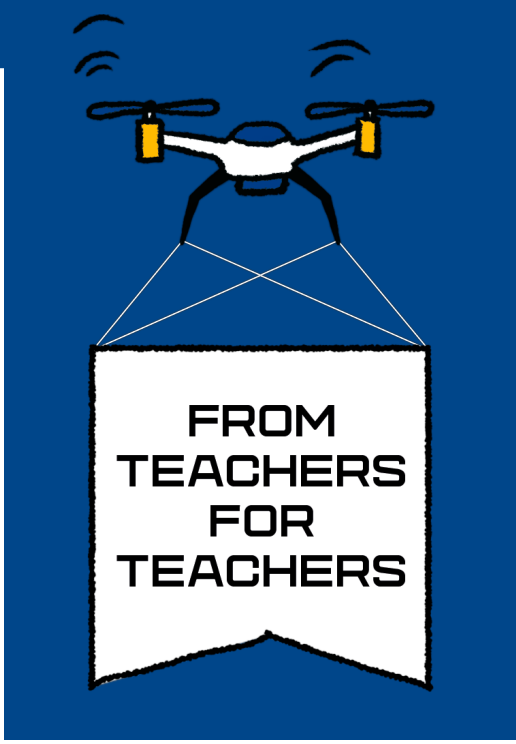
The game format is somewhere in between old gamebooks and digital escape rooms, in which correct answers must be provided in order to advance in the game, and different answers lead to different paths.



Why is this desk empty?



PHY6GAMES

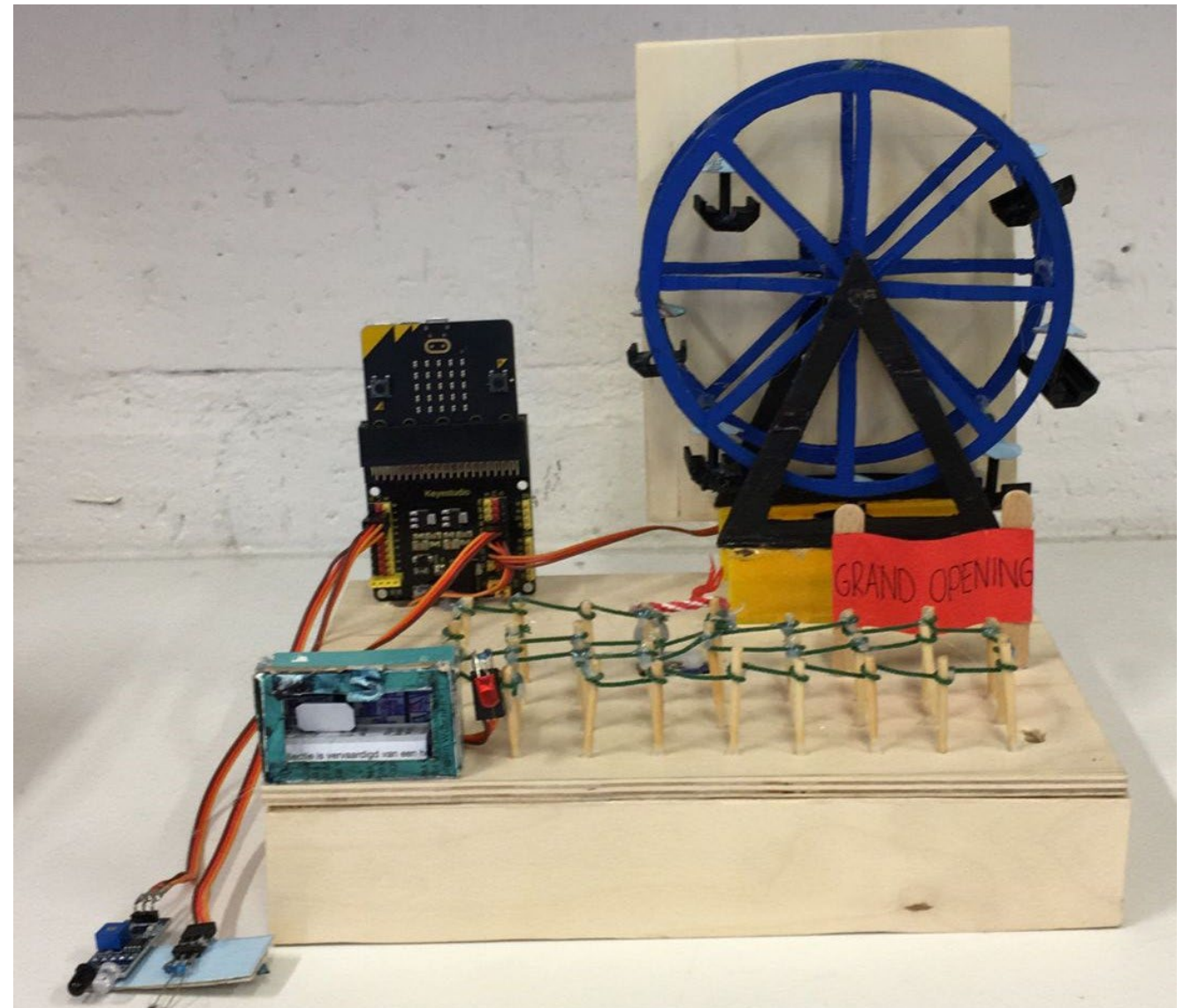
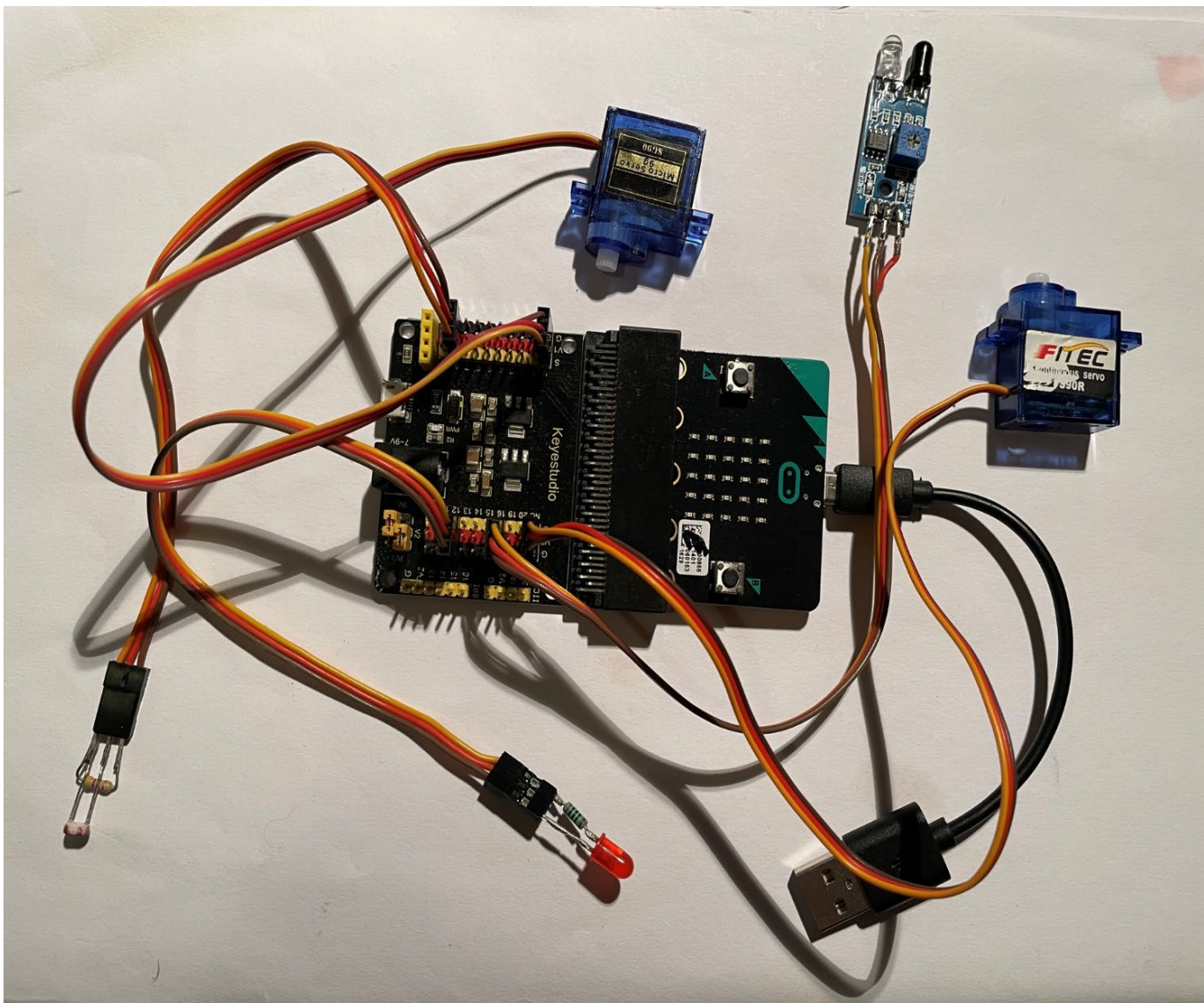


Technologies in STEM education

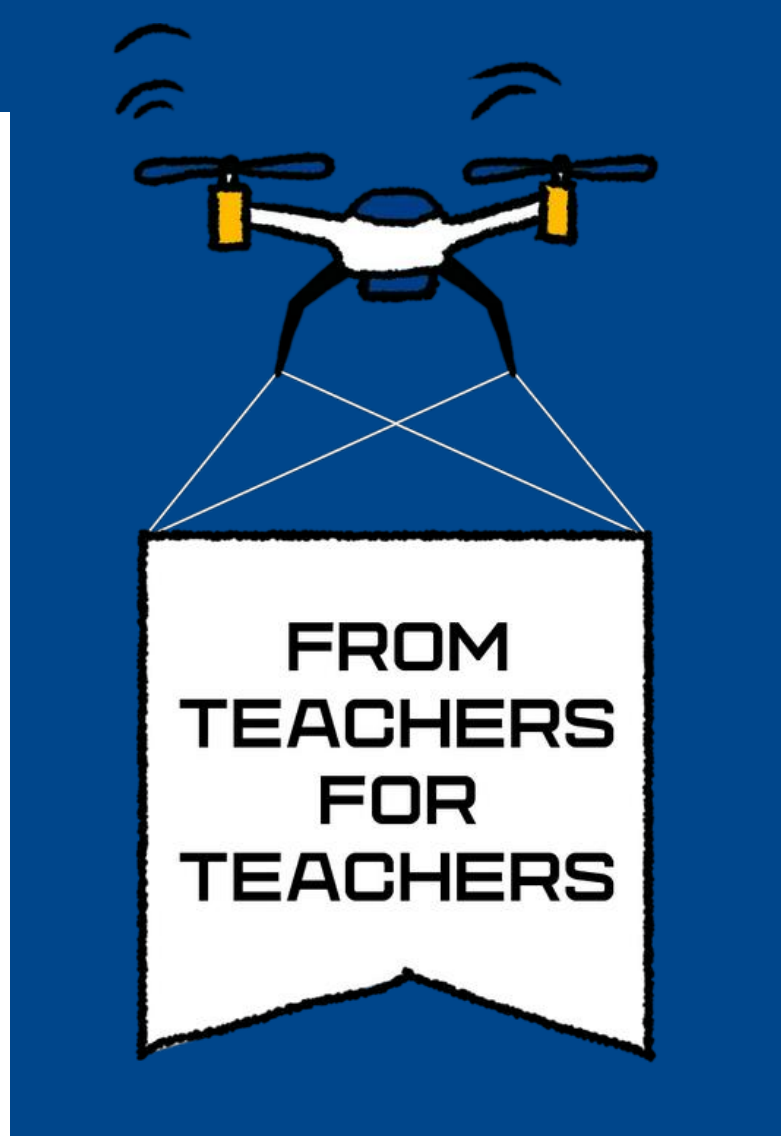
Ellis van Kemenade | Huygens Lyceum | Eindhoven |
Netherlands

Design, Construct and Code a Robot

Students aged 12-14 yrs with no coding experience are going to design, construct and code a robot. The robot works with a step and continuous servomotor, Infra-Red sensor and a Light Depending Resistor. It's a combination of creativity and technology and it's an exciting challenge for the students.



Learning by doing
Deep Learning
Challenging
Fun



TECHNOLOGIES IN STEM EDUCATION

Samuel Branco e Inês Madaleno | Externato Cooperativo da Benedita | Benedita | Portugal

Solving problems caused by the pandemic with robotics

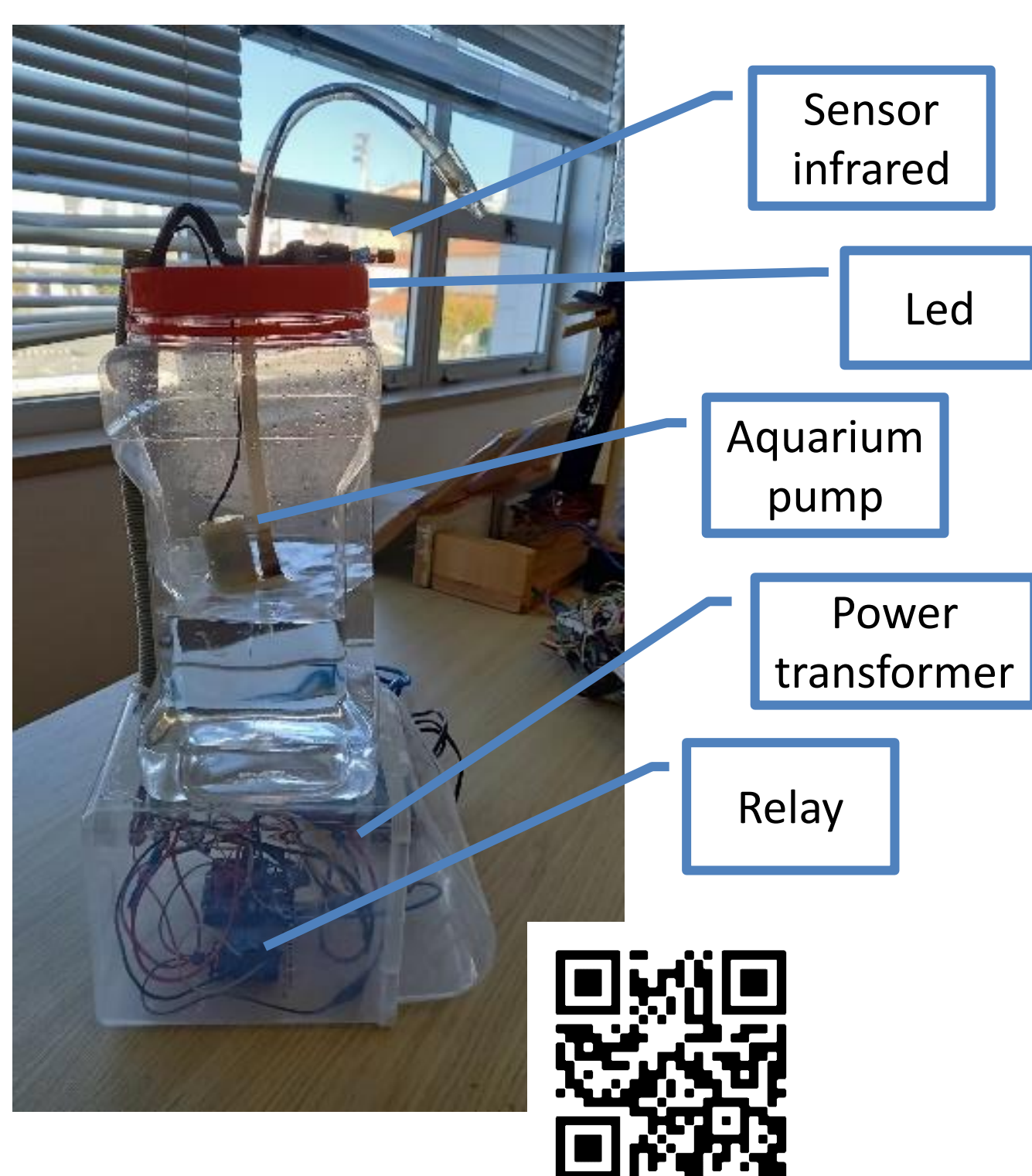
About

The teachers challenged the 10th year students of the Vocational Mechatronics Course to find solutions to the problems or situations identified by the students that were created by the pandemic (disinfection, protection, distancing), which could be applied at school. Inquiry-Based Learning teaching methodology was used.

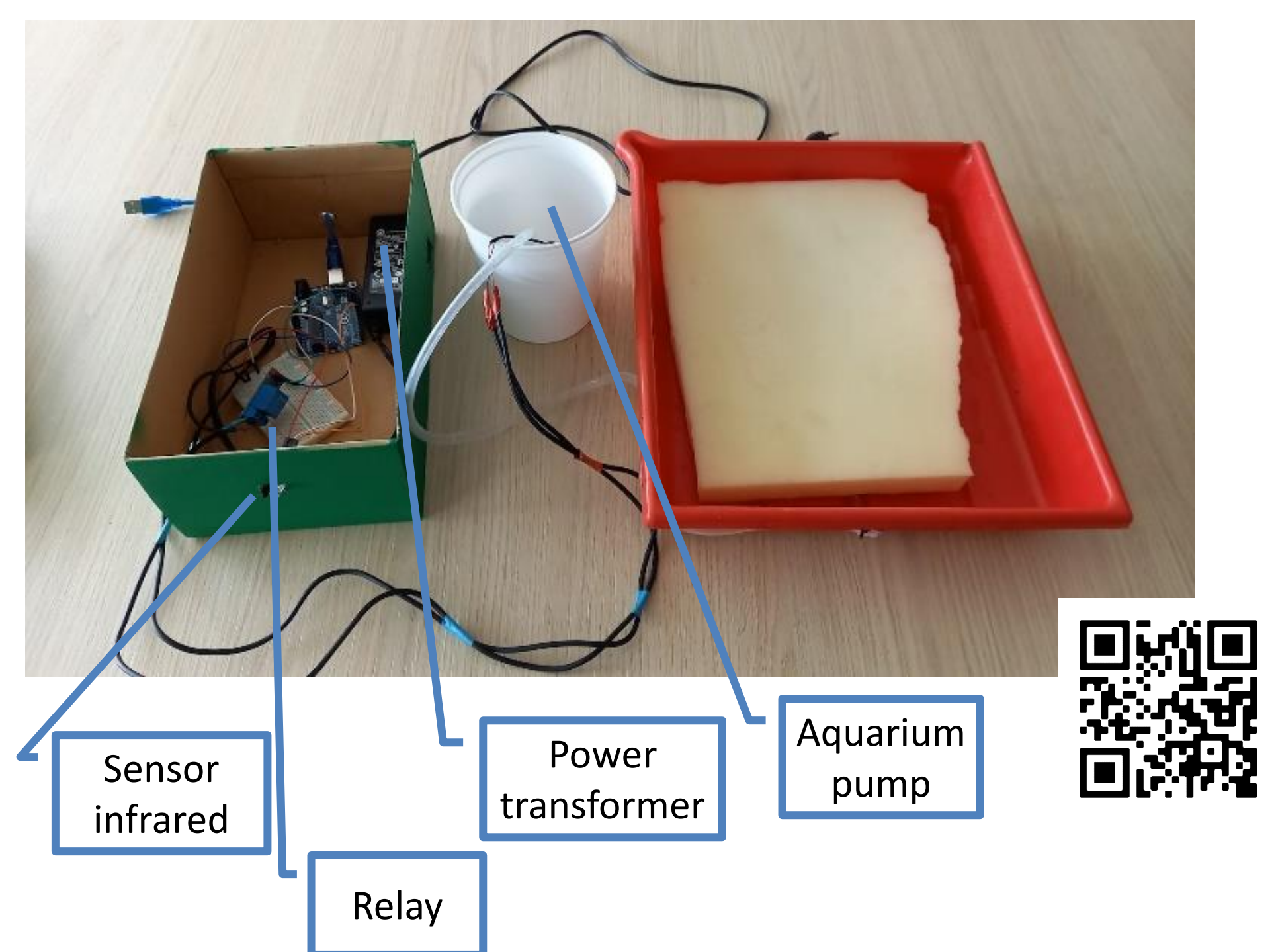
How does it work? How can others also too?

The designs are made up of simple electronic circuits, use a few sensors and are easy to program. Electronic components are low cost and programming software is free. All you need is basic programming knowledge. Students created support reports.

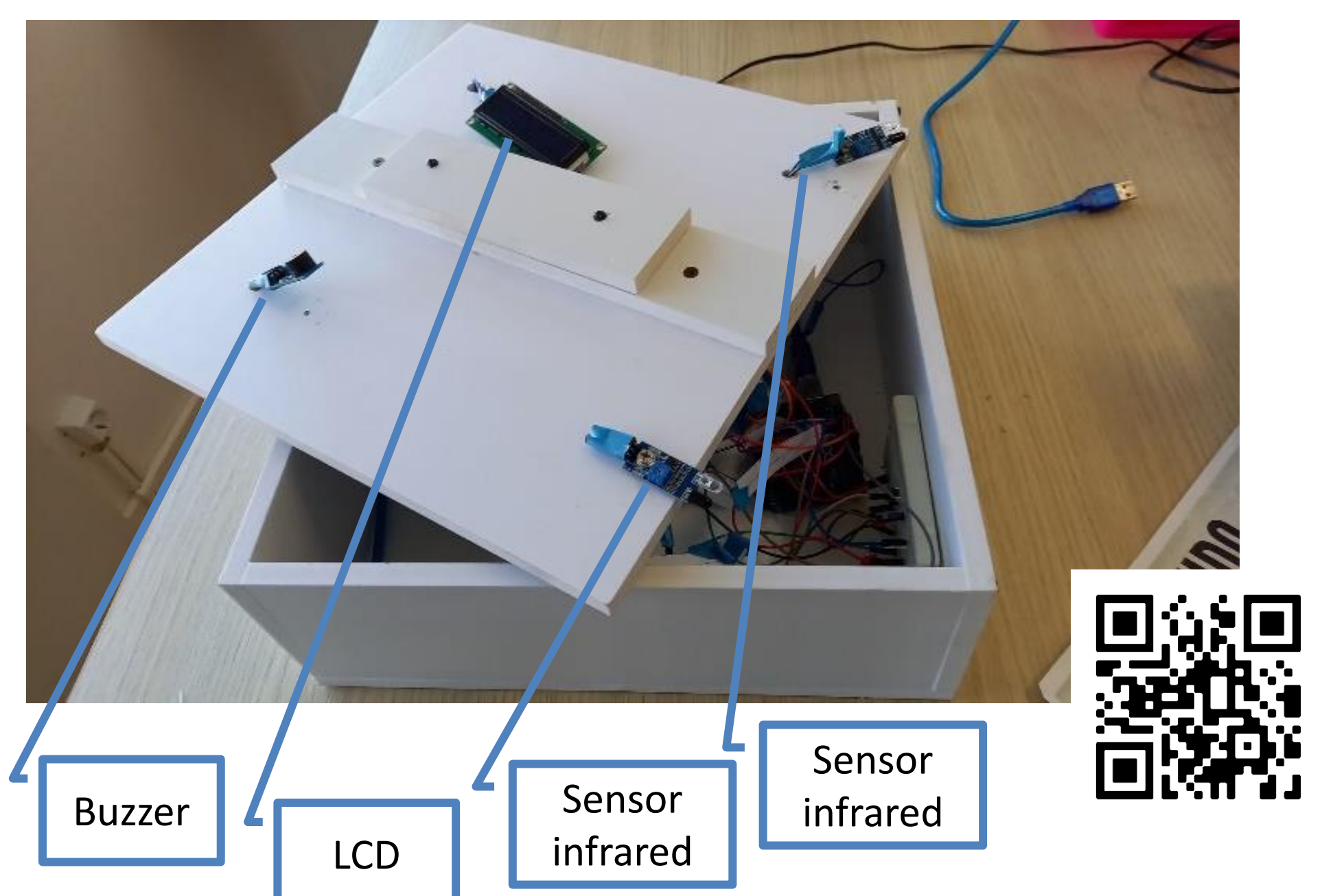
PROTOTYPE 1 - Automatic hand sanitizing gel dispenser



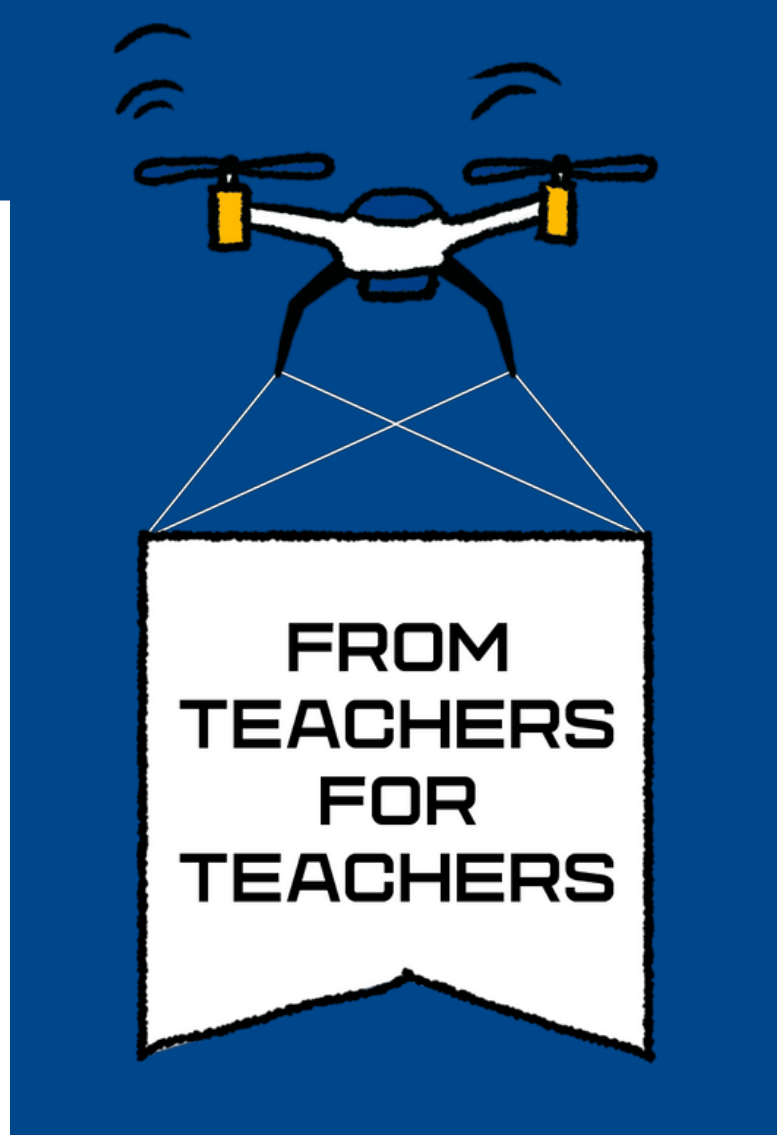
PROTOTYPE 2 - Automatic disinfectant for footwear



PROTOTYPE 3 - System to control the number of people in a room/space



The development of this type of projects allows students to be more responsible for their learning and therefore they are more motivated and involved. These projects are easy to replicate and accessible to everyone!



TECHNOLOGIES IN STEM EDUCATION

Emelie Reuterswärd | Sanoma Utbildning | Stockholm | Sweden

Graphing stories

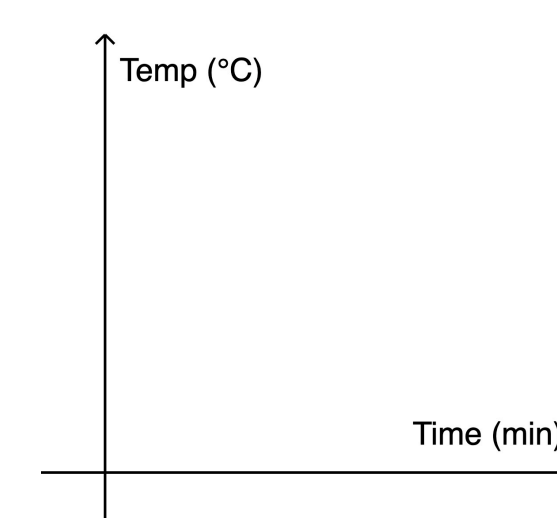
A graphing story is a classroom routine that develops secondary school students' knowledge of graphs, functions and mathematical models.

How?

1. Students see a **short film** of an everyday event, such as a glass filling with water, a piece of salmon cooking in the oven, or a swing moving back and forth.



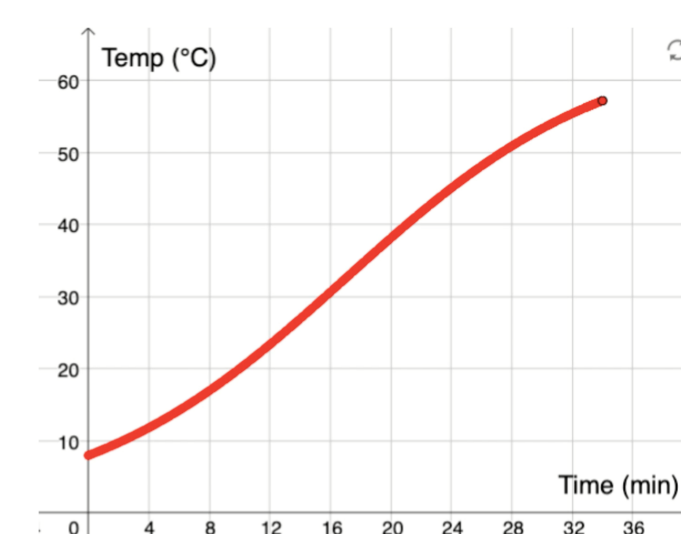
2. The students **draw a graph** to describe the event, e.g. how they think the height of the water, the temperature of the salmon or the speed of the swing changes with time.



3. In the ensuing discussion of the students' graphs, there is a natural need to **introduce mathematical concepts** such as *slope* and *y-intercept*, and to name the graphs as *linear*, *periodic*, *exponential* etc.



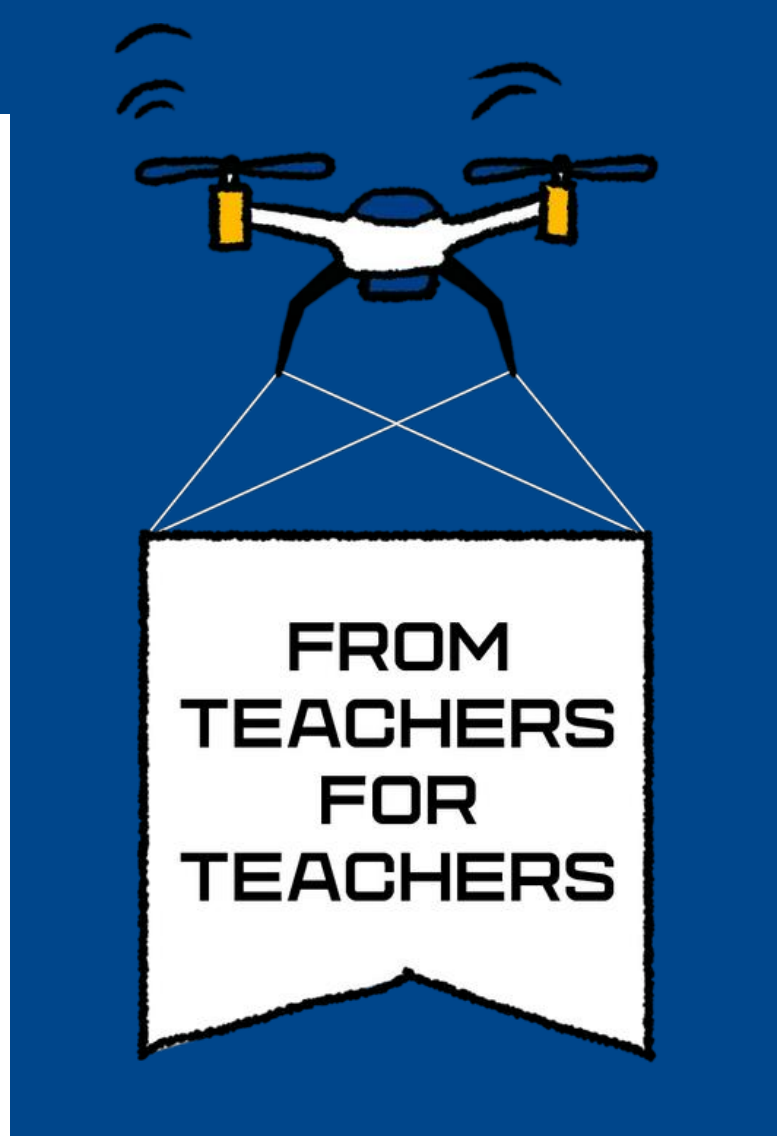
4. Each film ends with the **correct graph** being shown. The correct graph is then compared with the students' graphs. How are they similar? How are they different?



Why?

1. Graphing stories connect math to students' **everyday life**
2. The video format makes it easier for students to see the **connection** between the real-life event and the mathematical representation
3. Graphing stories provide a relevant context for **introducing new mathematical concepts**, such as *slope*, *maximum*, *linear*, *exponential* etc.
4. The graphing story routine can be **adjusted, varied and developed** to suit groups of students of different ages and abilities. To find out how, visit www.matemagi.com.

Read more and access resources at www.matemagi.com

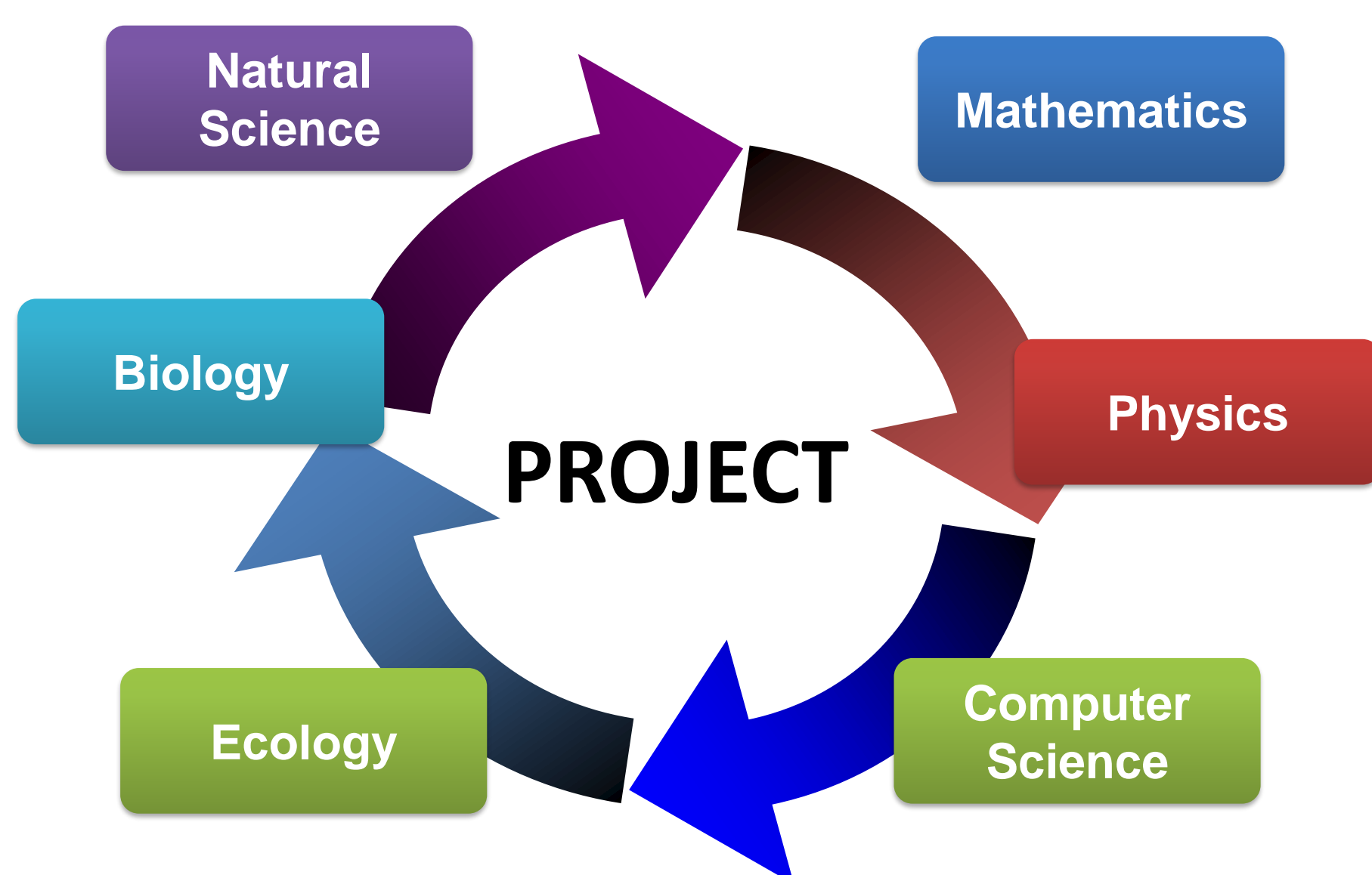
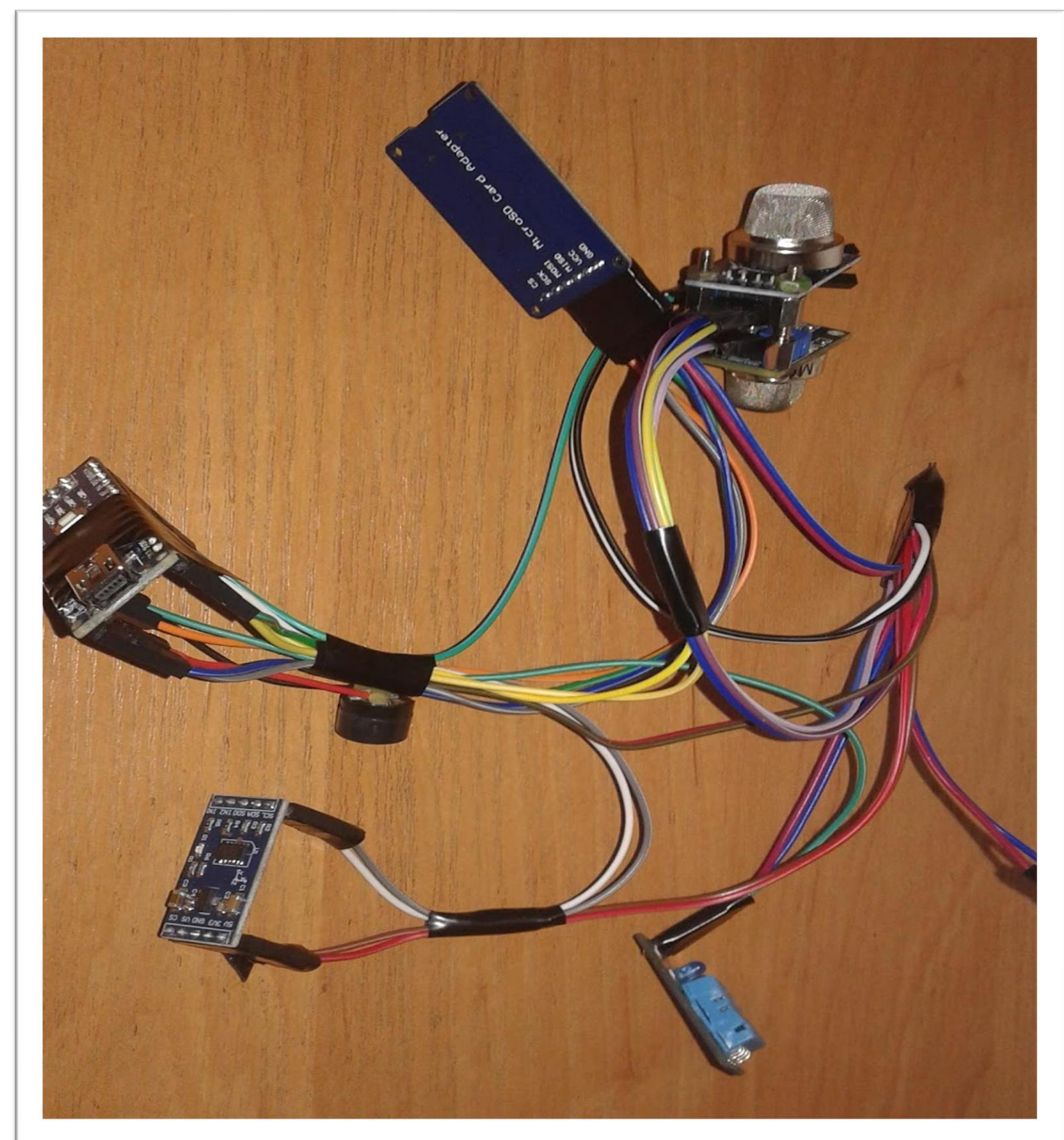


Technologies in STEM education

Julia Melnyk | Secondary School № 1 | Melitopol | Ukraine

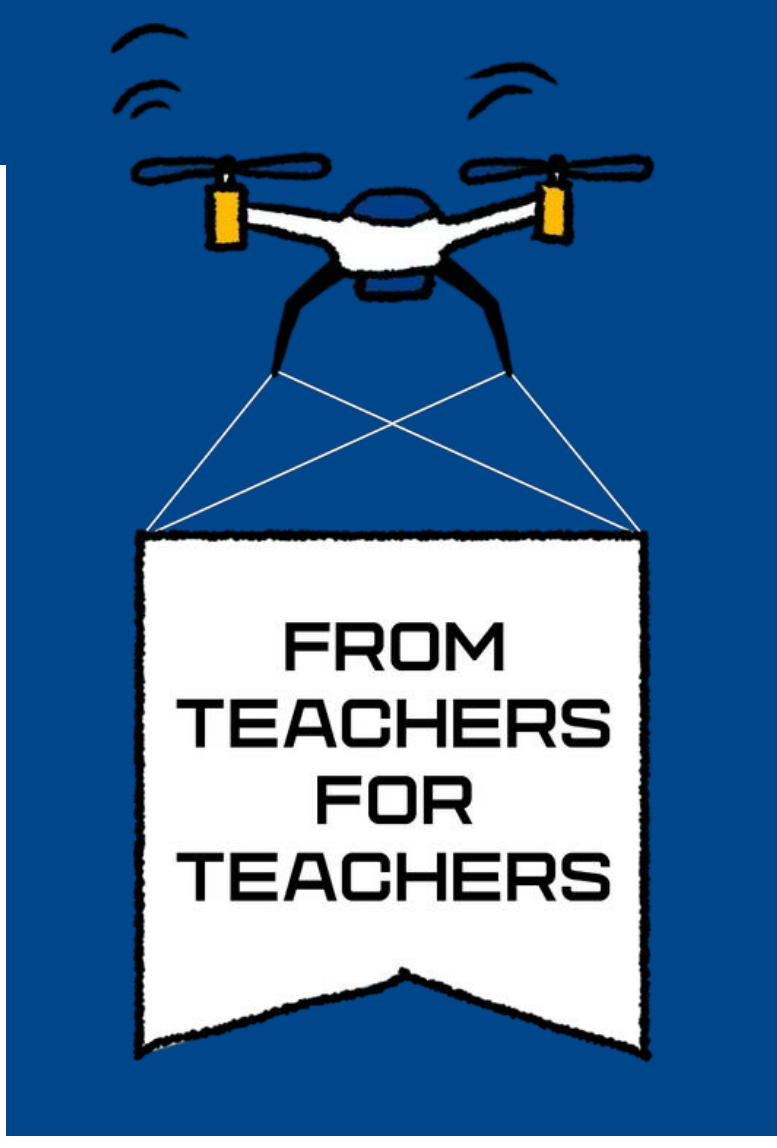
The aeronaut based on Arduino

An electronic aeronaut gone up into the sky a device, which consists of a set of microelectronics: a microcomputer, the sensors for collecting data about atmosphere (pressure, temperature, humidity, smoke) and a video camera. The video camera is used to film a panorama of video surface below at the same time. Our students use their own observations to check how pressure, humidity and temperature can be changed by an increasing altitude. The obtained data can be used at the lessons of Physics, Biology, Geography, Natural Sciences, Mathematics, Computer Science, Ecology. The sensors information also made it possible to assess air quality and compare it over different places of the city.



The sets of microelectronics have become as the motivational tools of the project. They have helped to expand the range of activities at and beyond the lessons, as so as coordinally improve the computer skills of the students. Moreover after the project the communication between students have become much better. Working with microcontrollers has given our students knowledge about the relationship of various school subjects. The data from sensors about the atmosphere and aerial photographs have been received by themselves.

The project introduced students to the basics of electronics, explained what programming is and why it is needed, showed the connection between different sciences.



TECHNOLOGIES IN STEM EDUCATION

Nataliia Naidon | School №1 | Horishni Plavni | Ukraine

Transmission of Audio Information Using a Laser Pointer

Creating and research a device for transmitting audio information using a laser

It is impossible to imagine our life without communication. The most developed technology of that kind is a laser communication, created in the USA. Due to the low power of the pointer it is defined as the safest for human health. Our teaching technique solves some communication problems between buildings where it is impossible to lay a cable. To test the laser connection, a device has been made that will transmit audio information by the laser beam. The students can investigate the transmission of sound through the green laser pointer. The experiments had been performed in light and dark times of the day and in different weather conditions (cloudy, clear, fog and rain).

This project requires:

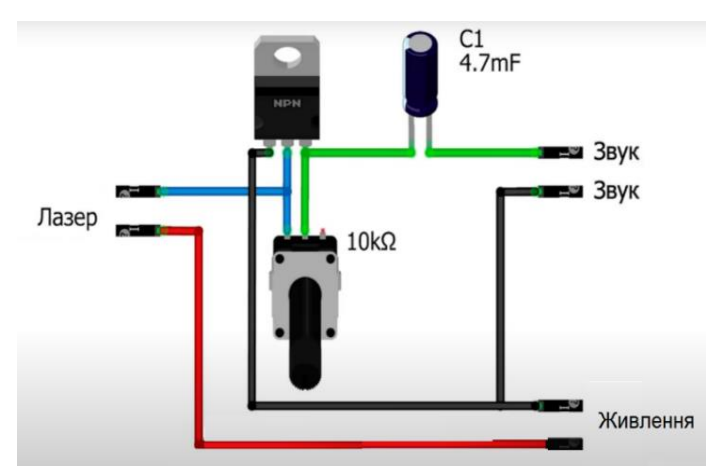
- laser (green 303, 100 mW)
- sound source (mobile phone)
- power supplies (batteries 18650 Li-ion Samsung 2600mAh ICR18650-26J M - 4 pcs)
- step-up voltage converter (DC-DC MT3608);
- capacitor (3.3 μ F 50V)
- transistor (bipolar KT805)
- potentiometer (10 kOhm - 1 piece)
- photocell (3W solar panel)
- sound amplifier (on the TDA7297 chip with volume control)
- speaker



Stages of research of the device for transmission of sound information by means of a laser according to educational disciplines

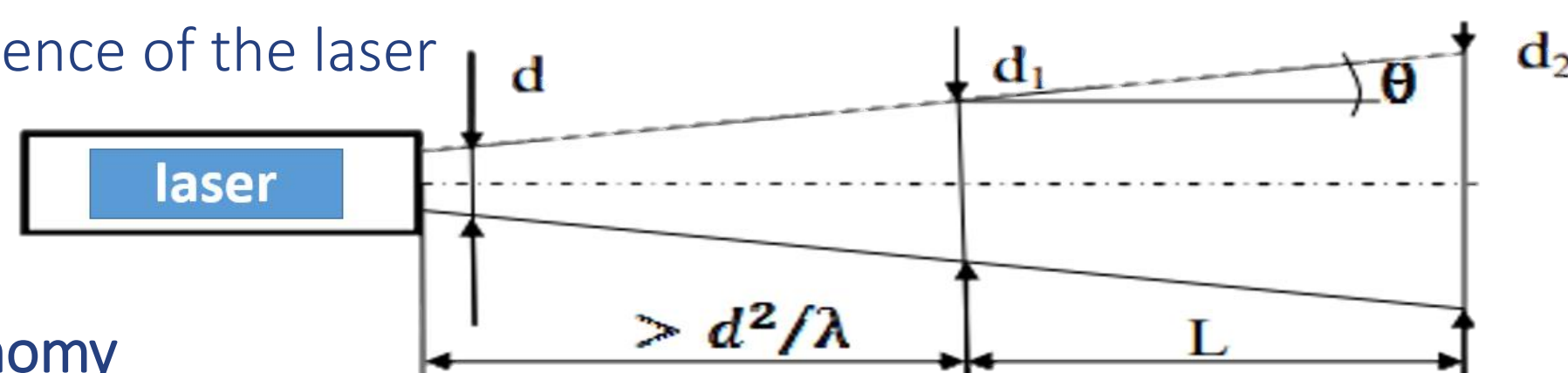
Circuitry

students assembled a transmitter and a receiver according to the scheme



Maths

students measure the values of the diameters of the laser beam at a distance of up to 500 m and calculate the divergence of the laser



Astronomy

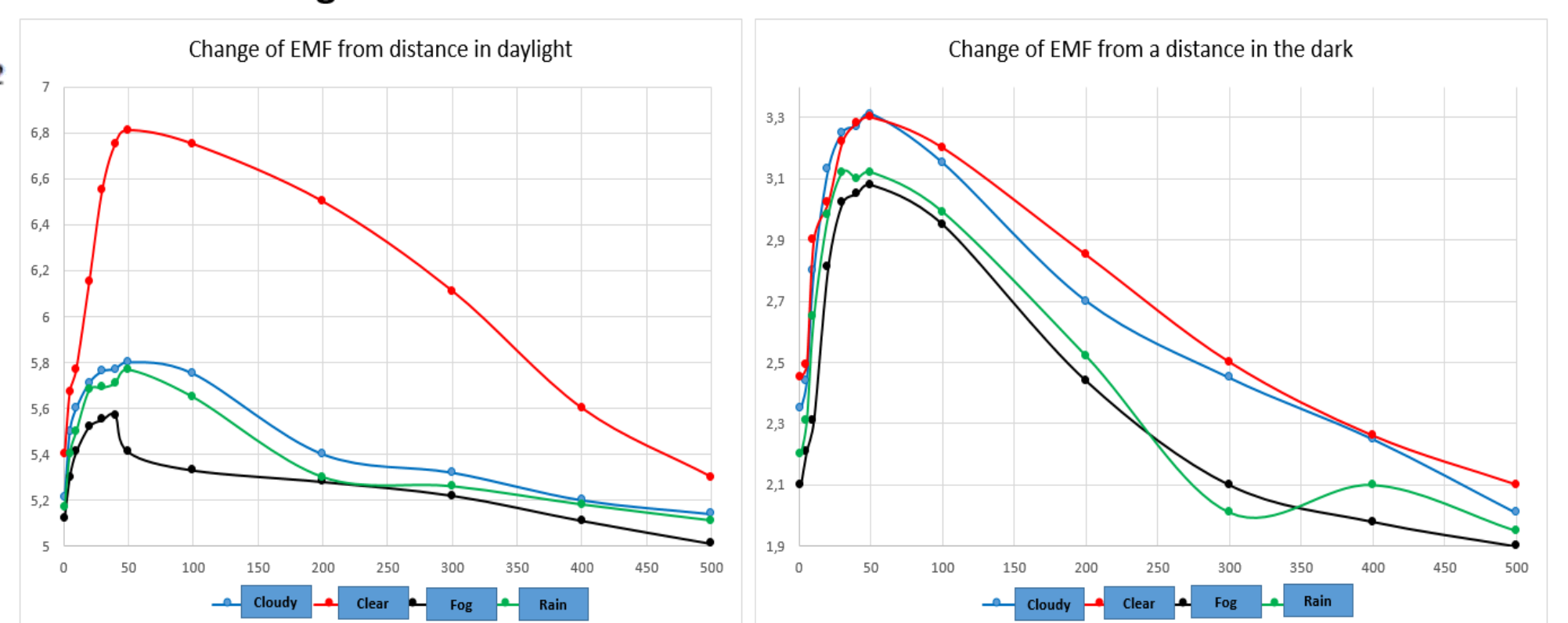
students explore the use of laser communications in space and create Power Point presentations. They calculate how long it takes for a signal from Earth to reach Mars

Physics

students measure the produced EMF with a photocell in light and dark times of the day and write data in the table

Computer science

students create graphs of EMF dependences on the distance from transmitter to receiver using EXCEL



CONCLUSION

- this project combines lots of STEM subjects
- it is a low cost project
- it can be used at any secondary schools at the lessons and beyond
- it improves students knowledge and increases the cognitive interest to learn STEM subjects
- it motivates students to do hands-on experiments themselves



TECHNOLOGIES IN STEM EDUCATION

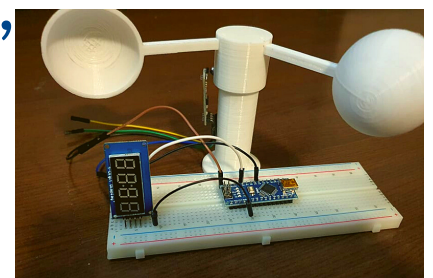
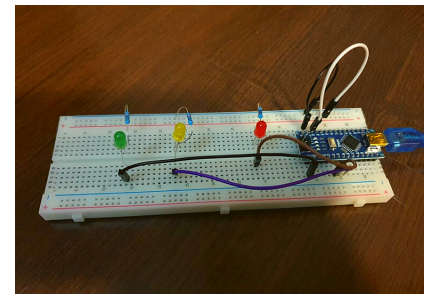
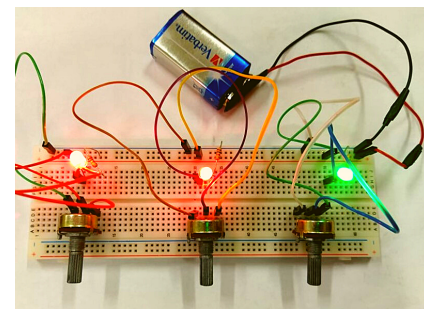
projects involving coding, ICT, big data, AI, VR, network security, etc.

Vocational High School for Electronics, Sofia, Bulgaria

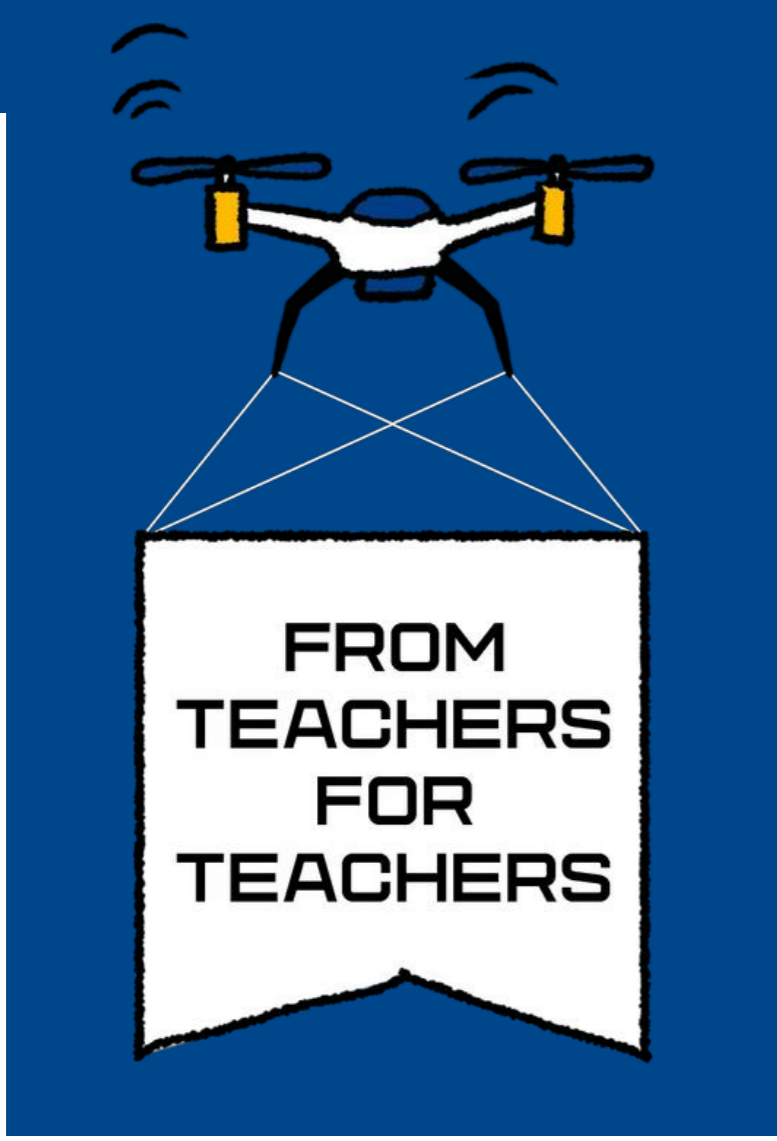
Educational kit

STEM workshop

- **Aim:** To show the connection between science and technology
- **Task:** To build kits together using the laws of Physics and the skills to work with microcontrollers
- **Designed** for 14-18 year-old Ss
- **Demonstration of**
 1. **Ohm's law** with a Bradboard, LEDs, resistors and potentiometers
 2. **Traffic light system** with Arduino microcontroller, LEDs and a button
 3. **Anemometer** with Arduino microcontroller, 7-segment display and 3 cups
 4. **Alarm** with pegs and batteries



Encourage students to share ideas
and practice together!



TECHNOLOGIES IN STEM EDUCATION

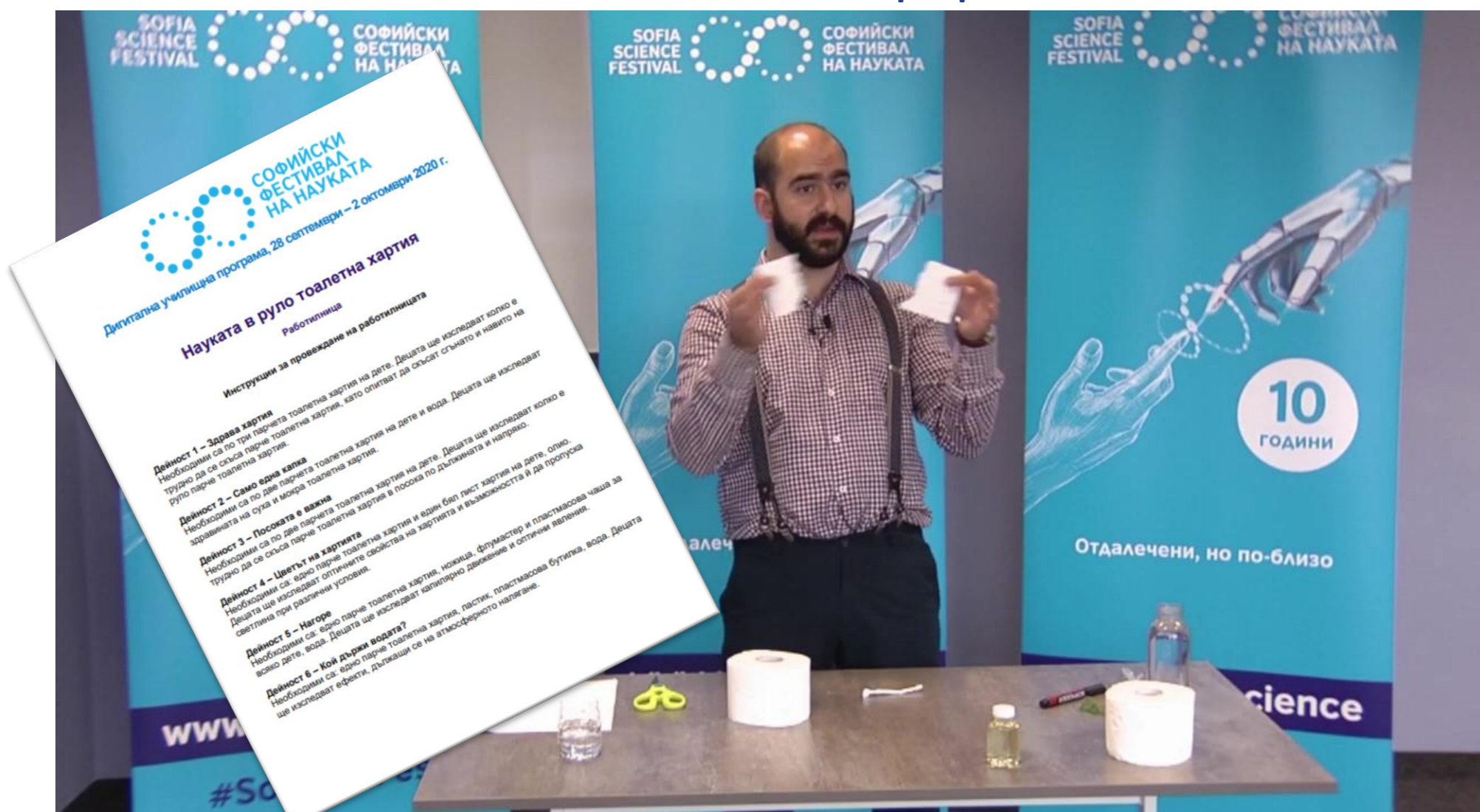
Nasko Stamenov | National High School of Science and Mathematics | Sofia | Bulgaria

Distance learning – when the kitchen is the lab

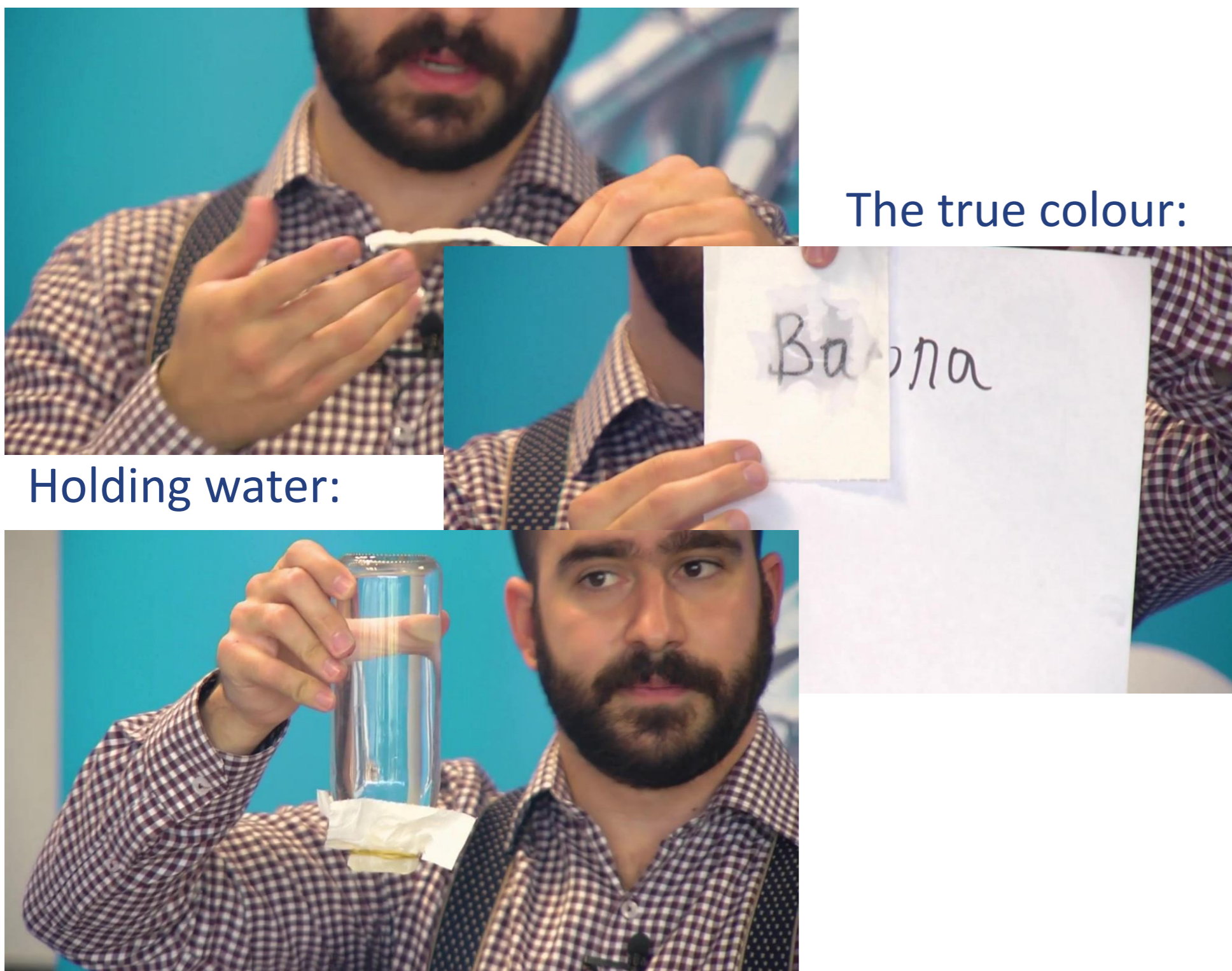
Summary:

In times of a pandemic we need to improvise. If the school is closed does that mean that we need to forgo the classroom experiment? Of course not! The experiment just need to be modified to accommodate what every student has at home. This project shows two types of experiments done in two different age groups.

1. Science in a toilet paper roll:



Strength test:



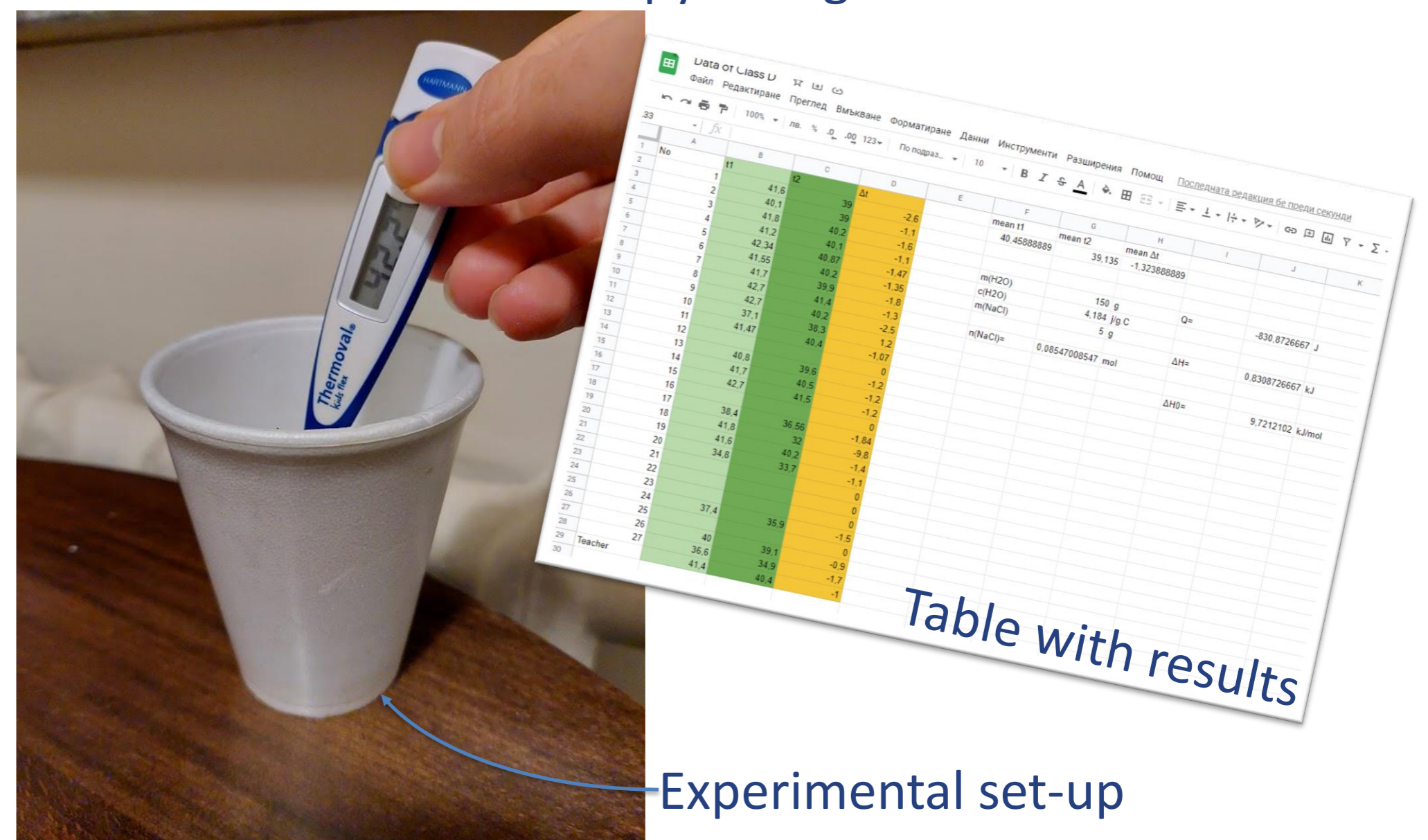
The true colour:

Holding water:



A full 40 minute workshop, that was done at the same time in more than 10 schools with 5th graders, as part of the Sofia science festival. It contains six experiments which show interesting properties of paper.

2. Enthalpy changes:



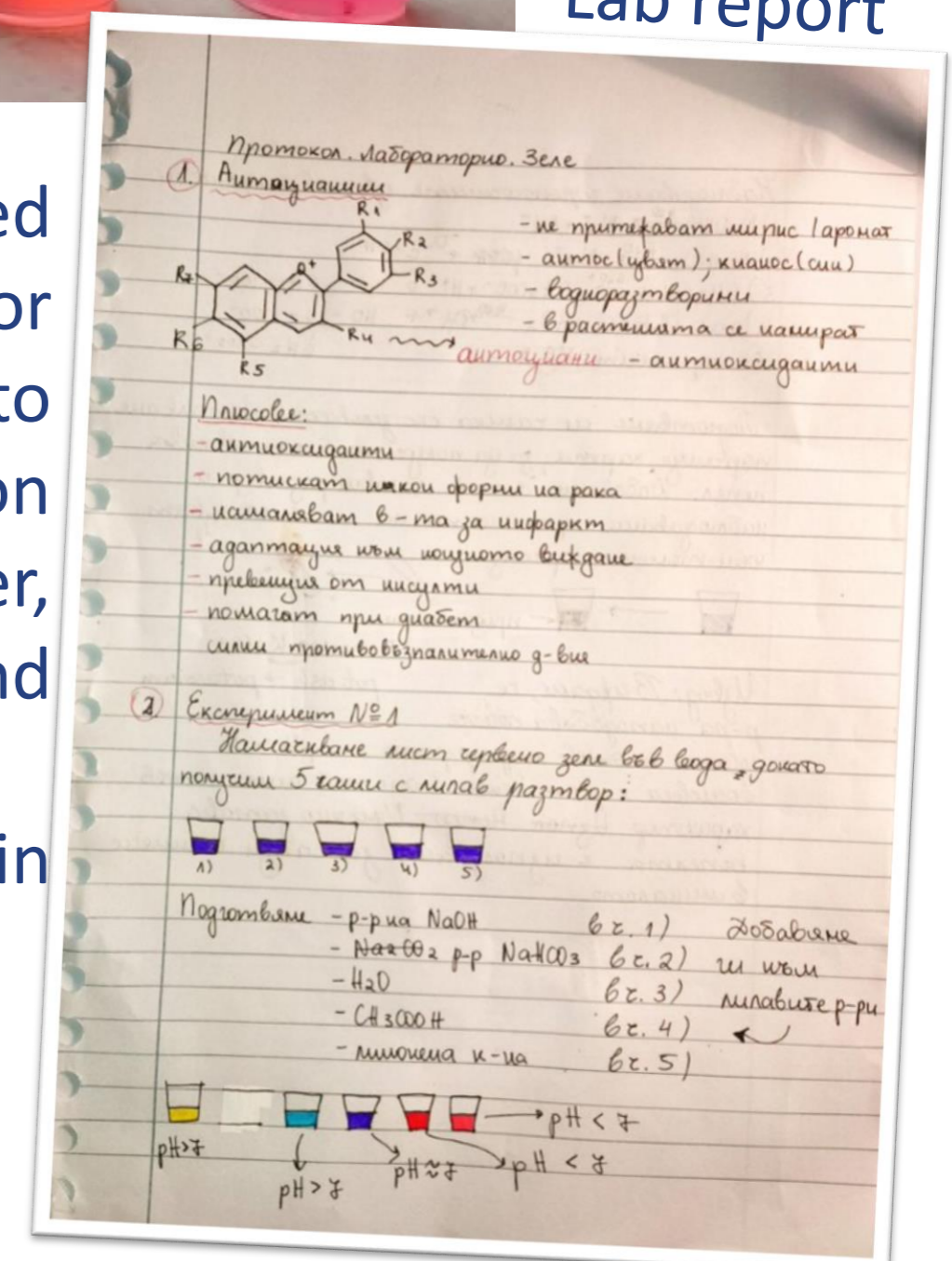
Students in 11th grade dissolved salt in warm water. They have measured the temperature at the beginning and in the end and together we calculated the enthalpy change. All students were in their homes and measured with home thermometers.

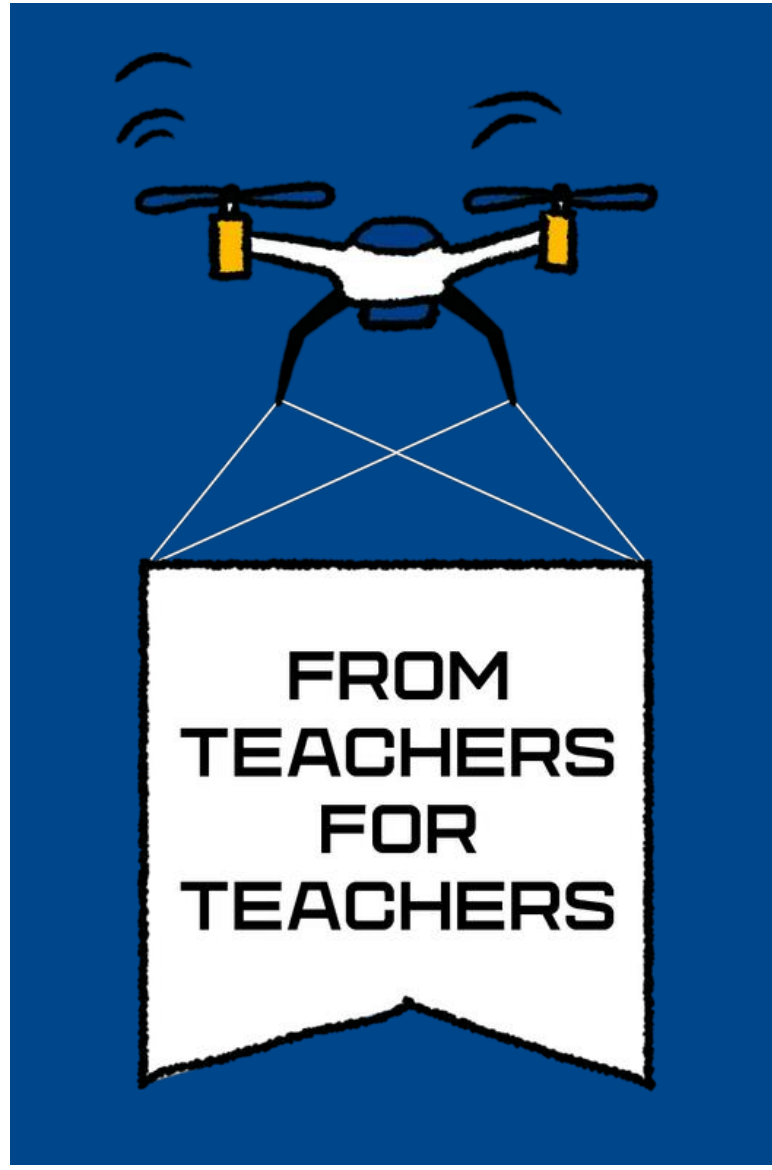
3. pH and cabbage indicator:

Result, obtained by a student



Students in 10th grade prepared their own universal indicator solution, which they used to check the pH value of common household items as: degreaser, baking soda, water, vinegar and lemon juice. They explained their results in a lab report.





TECHNOLOGIES IN STEM EDUCATION

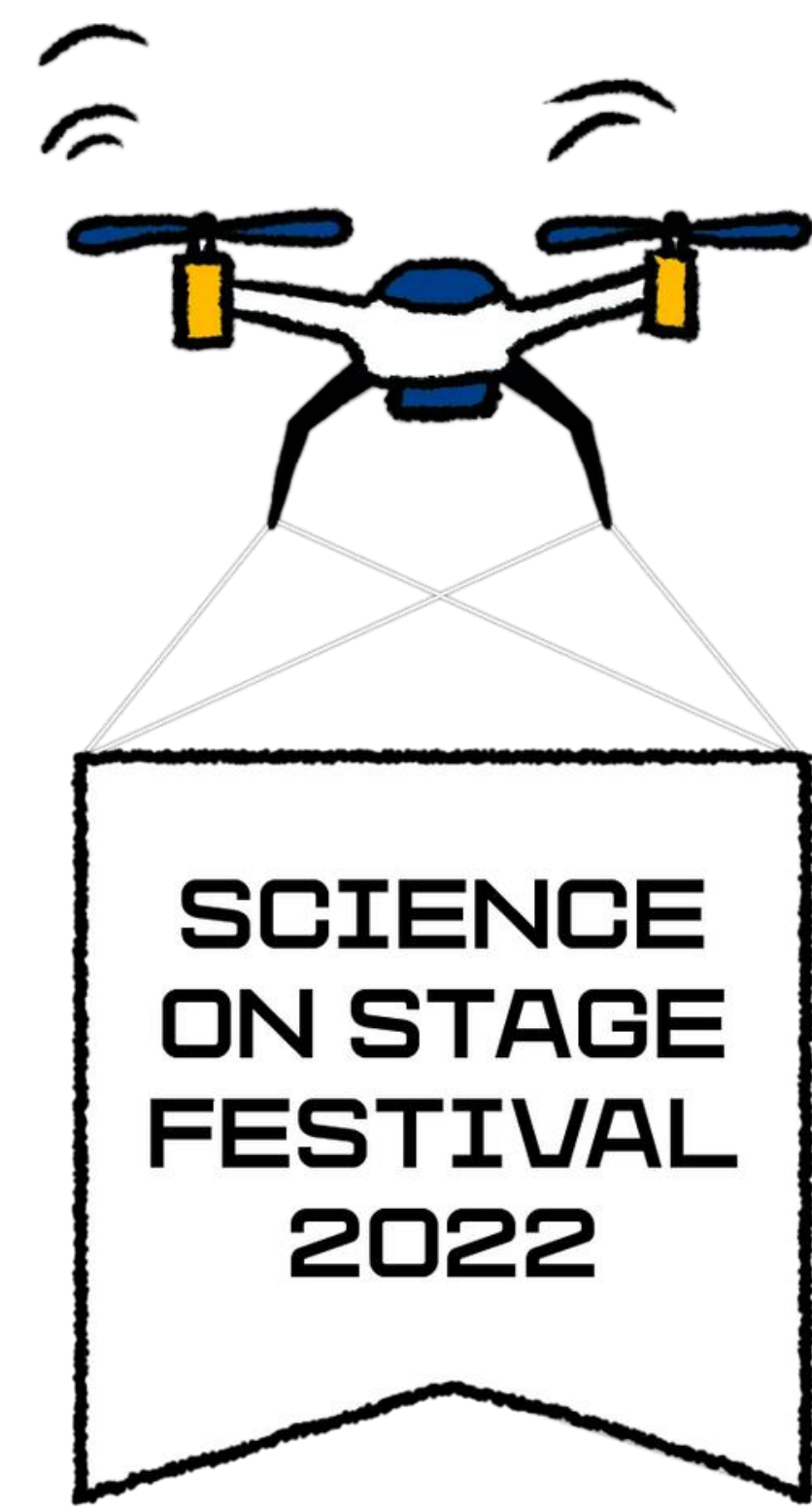
Aristodimou Christina | Laniteio Lyceum | Limassol | Cyprus

Shape it like a Sunflower

Biomimetics is the imitation of the models, systems, and elements of nature for the purpose of solving complex human problems.

Using several biomimetic designs processes the students explore the extraordinary characteristics and biological strategies that the species have developed through billion years of evolution, analyse the scientific support of their mechanisms and develop their own bio-inspired solutions

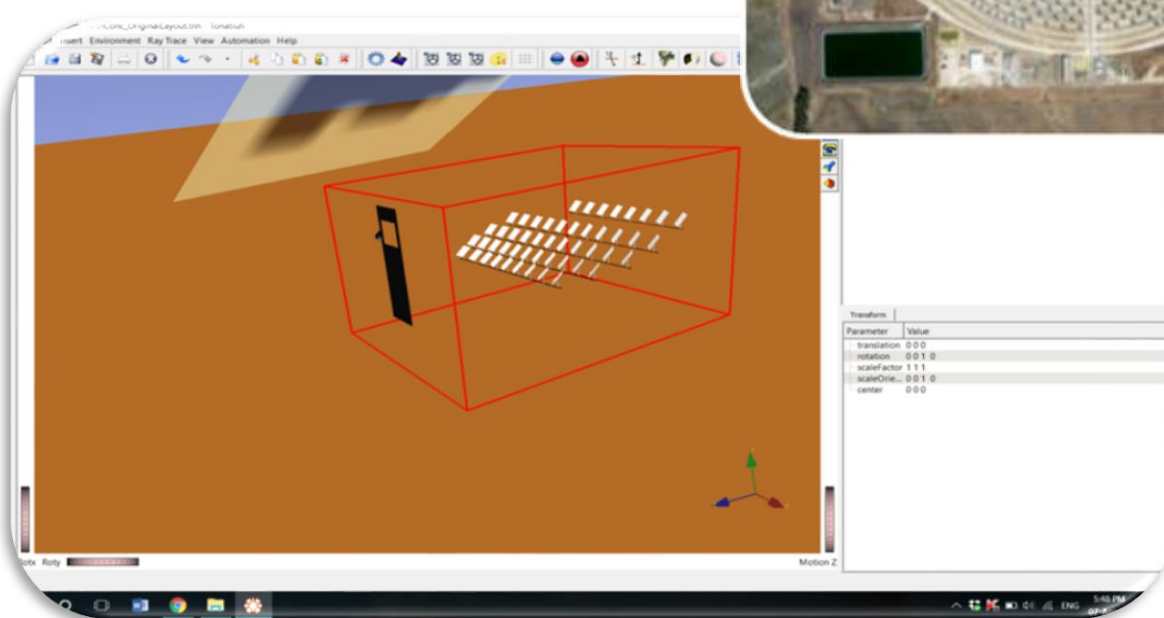
At first students were given some successful examples of biomimetic applications to introduce them to biomimetic. Then students are asked to select and study an organization that interests them and applies biomimetics. Using various valid sources, they study the bibliography of the organism they are interested in.

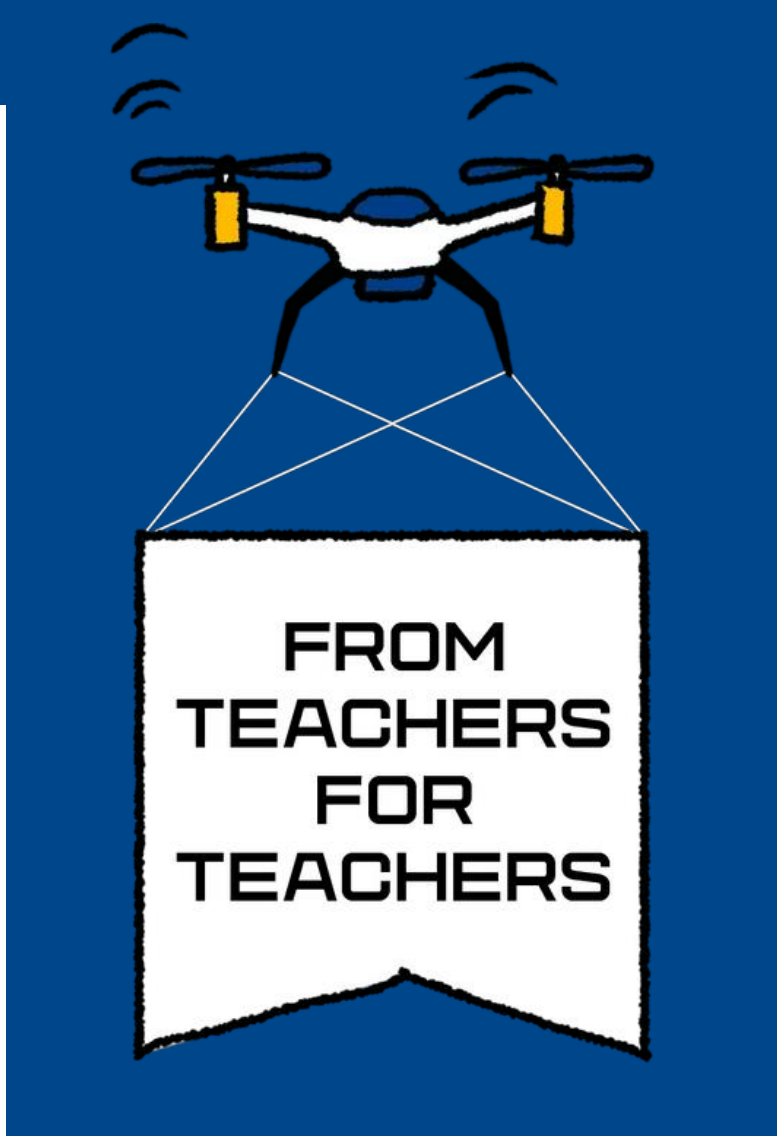


Sunflower

Biology - Physics - Technology – Geography

- ❖ Through Biology students study the structure of the plant
- ❖ Studying the arrangement of the spirals of a sunflower, the students study the possibility of a biomimetic application for the optimization of the arrangement of the sun visors in solar thermal parks
- ❖ Using Tonatiuh Ray Tracing Software students study of the number and position of sunscreens





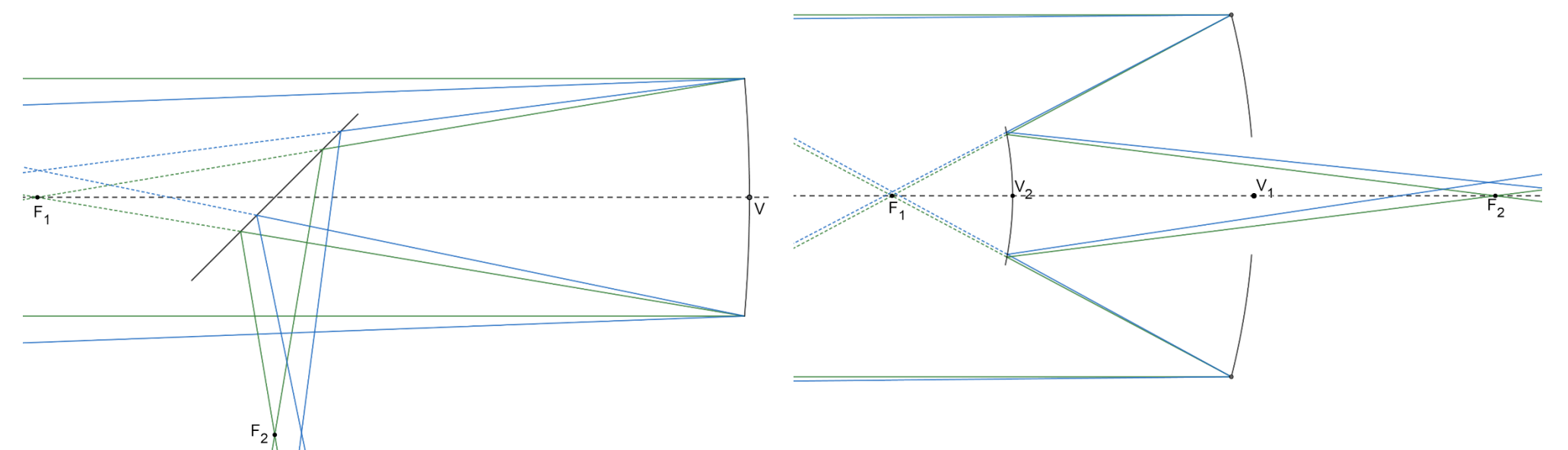
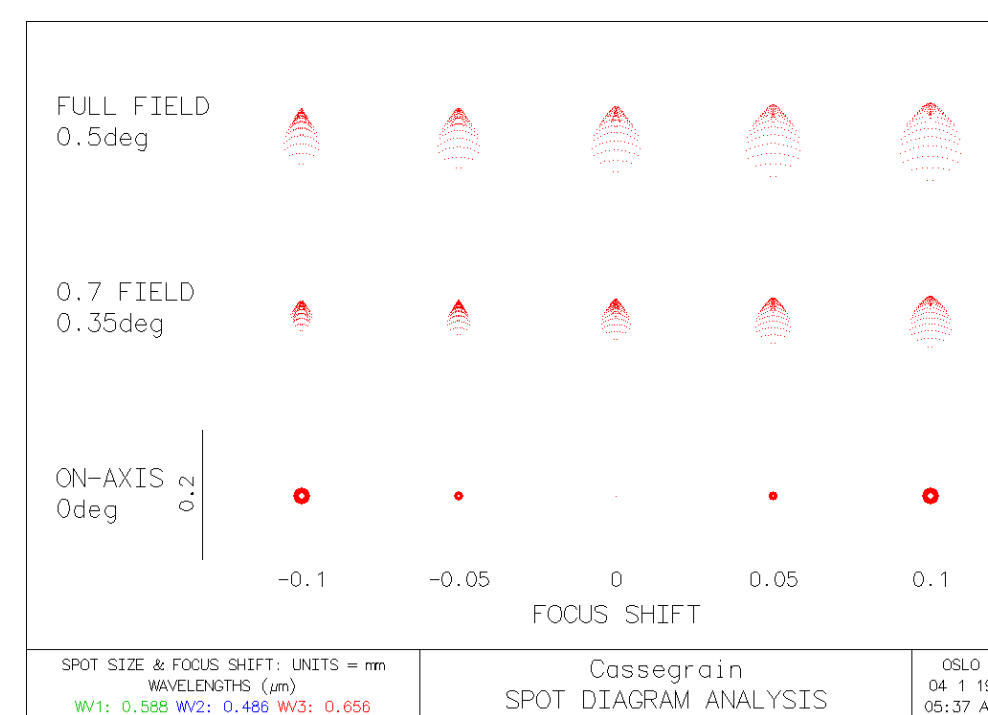
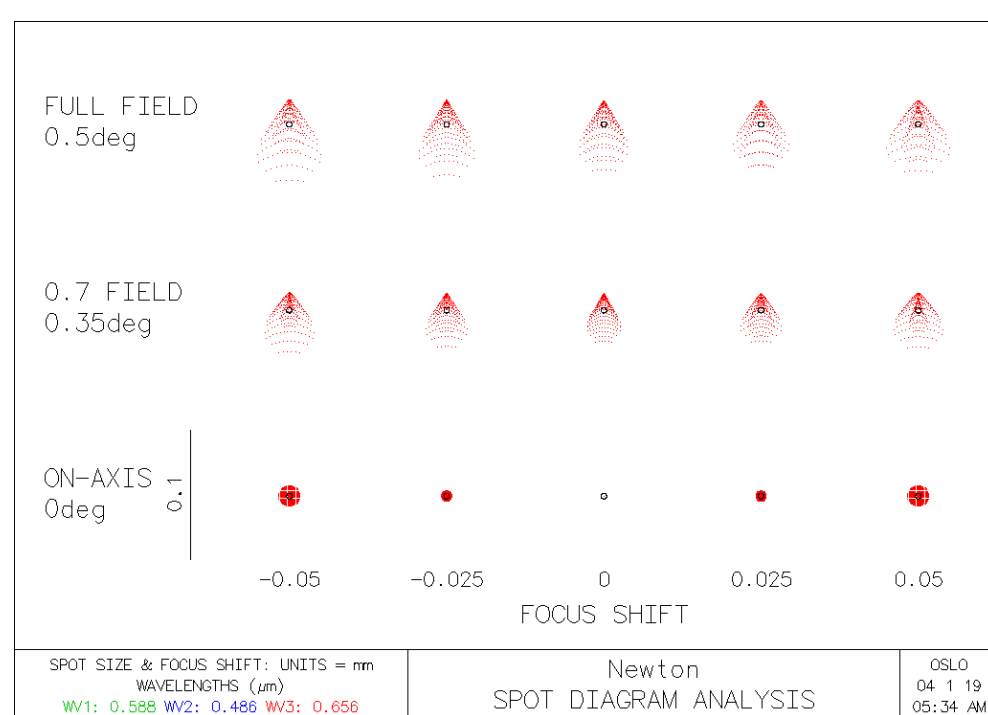
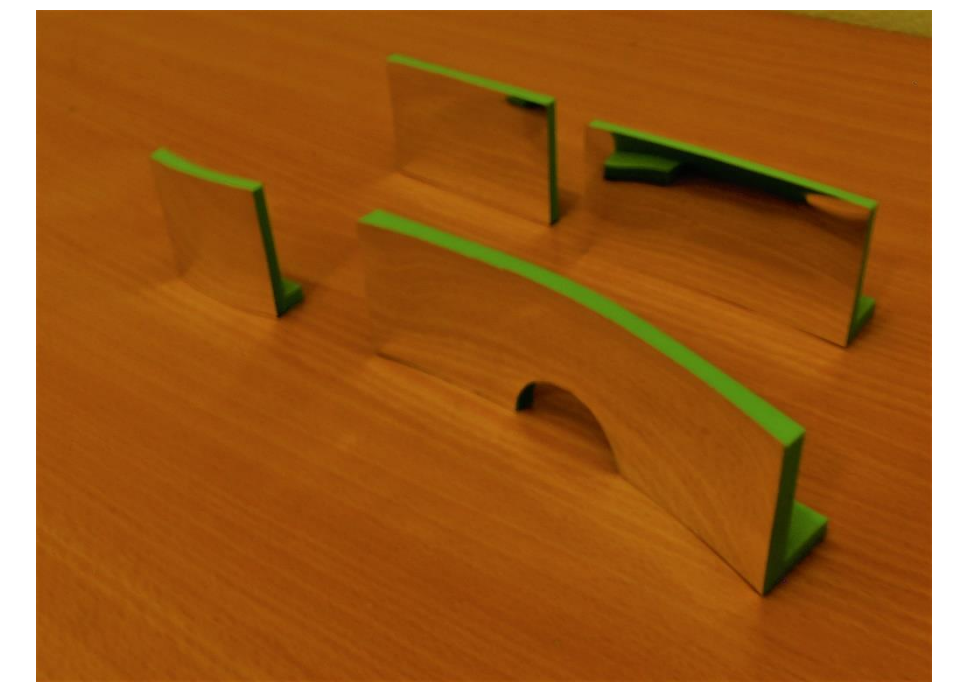
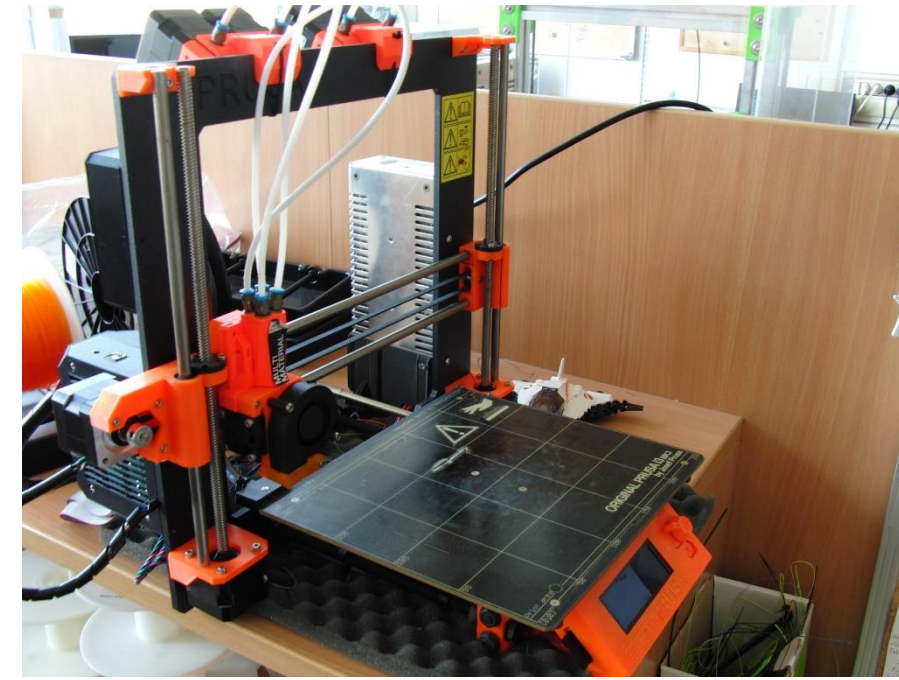
TECHNOLOGIES IN STEM EDUCATION

Filip Hložek | Gymnázium Přírodní škola | Prague | Czech Republic

Mirror Telescopes Models

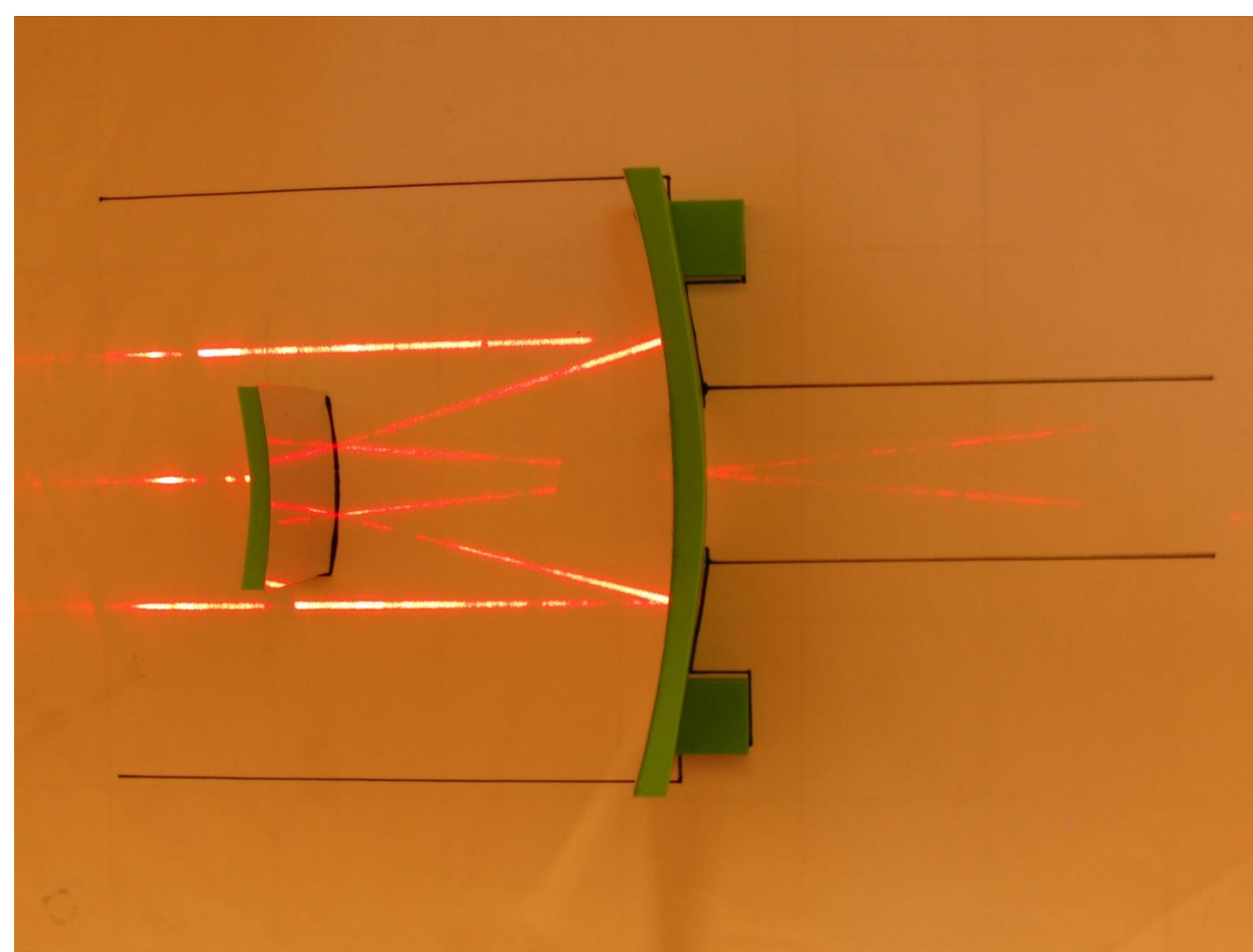
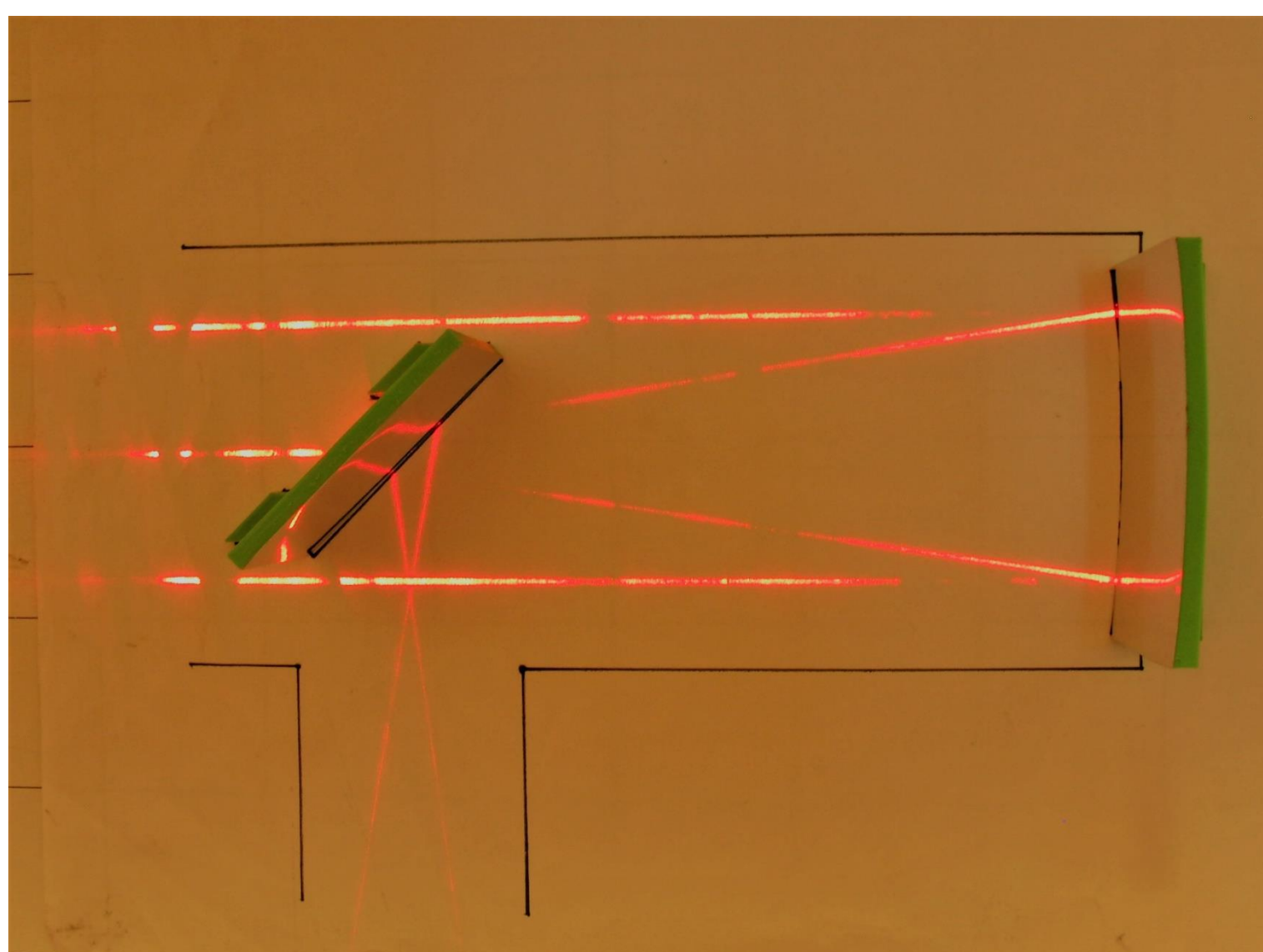
Newtonian and Cassegrain telescope models can be created on a 3D printer. These models are available for download from <https://kdf.mff.cuni.cz/optickasada>. After printing the body of the model, it is necessary to glue a mirror foil on it. Carefulness is required, otherwise the mirror imaging would be inaccurate.

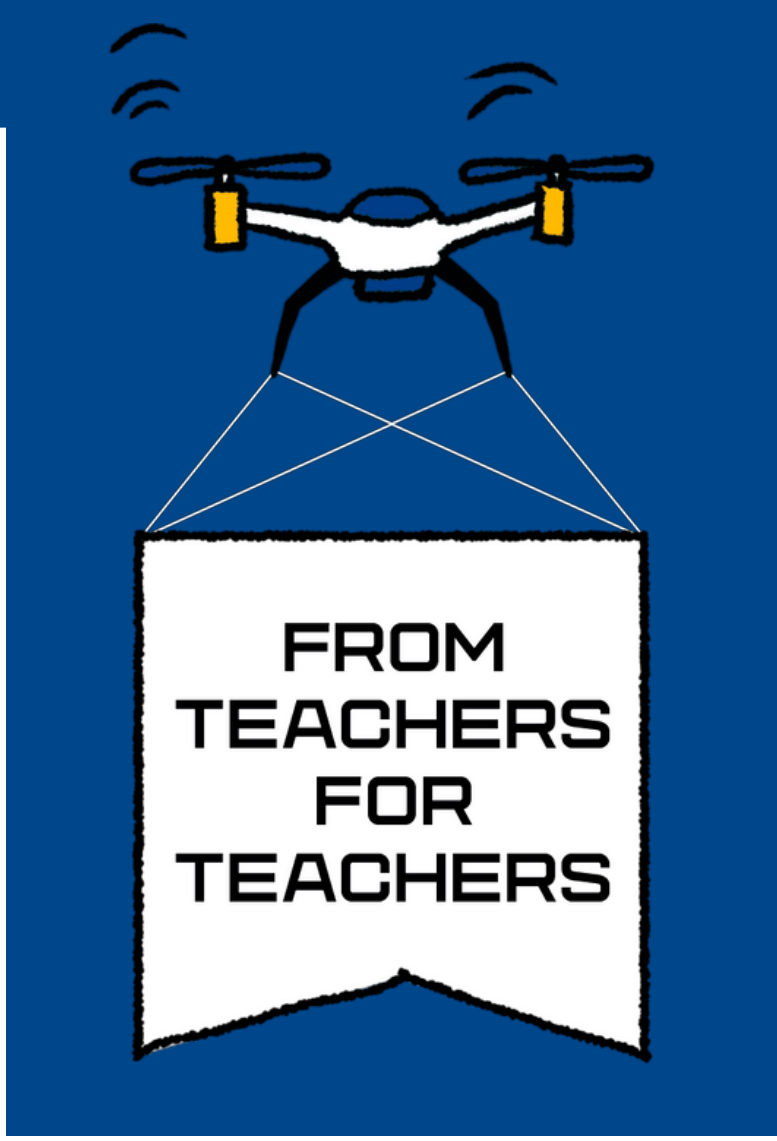
There is also a possibility to add four magnets (6 mm diameter) to the bottom of the model, so it may be used on a magnetic board. Two sheets with outline of the telescopes can be downloaded from the webpage above.



These models have the ability to show not only ray paths, but also mirror optical aberrations, like spherical or commatic aberration.

If usage of software is preferred, Geogebra or OSLO EDU can be deployed. The figures above were designed with them. OSLO EDU is commonly used among astronomers when developing optical systems because of its comprehensive analysis of optical aberrations. Secondary and high school students can work with both these programs themselves.





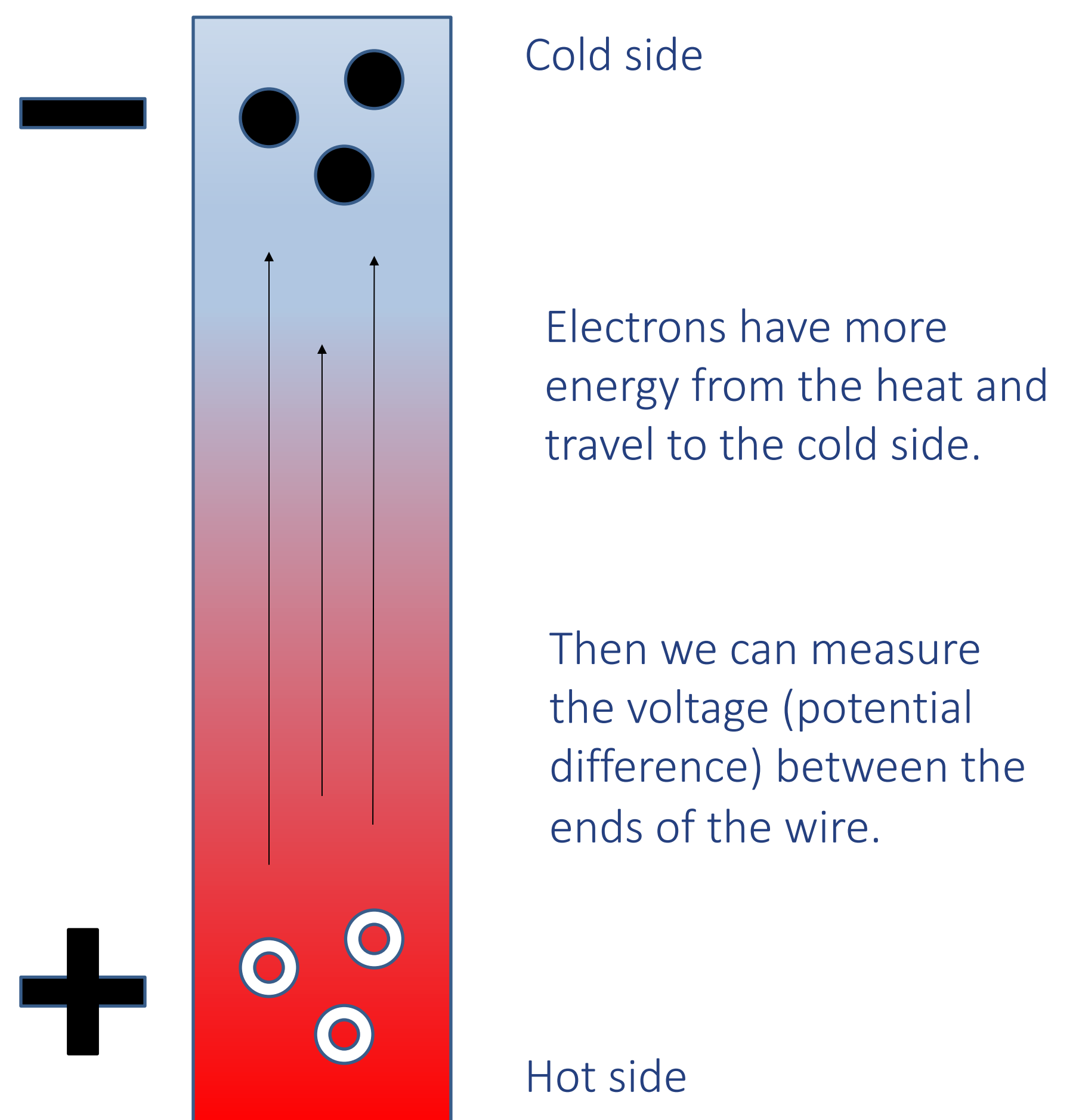
TECHNOLOGIES IN STEM EDUCATION

Libor Šmíd | University of West Bohemia; Faculty of Education | Pilsen | Czechia

Thermoelectric generator

The aim of the project was to design a thermoelectric generator and demonstrate the thermoelectric effect.

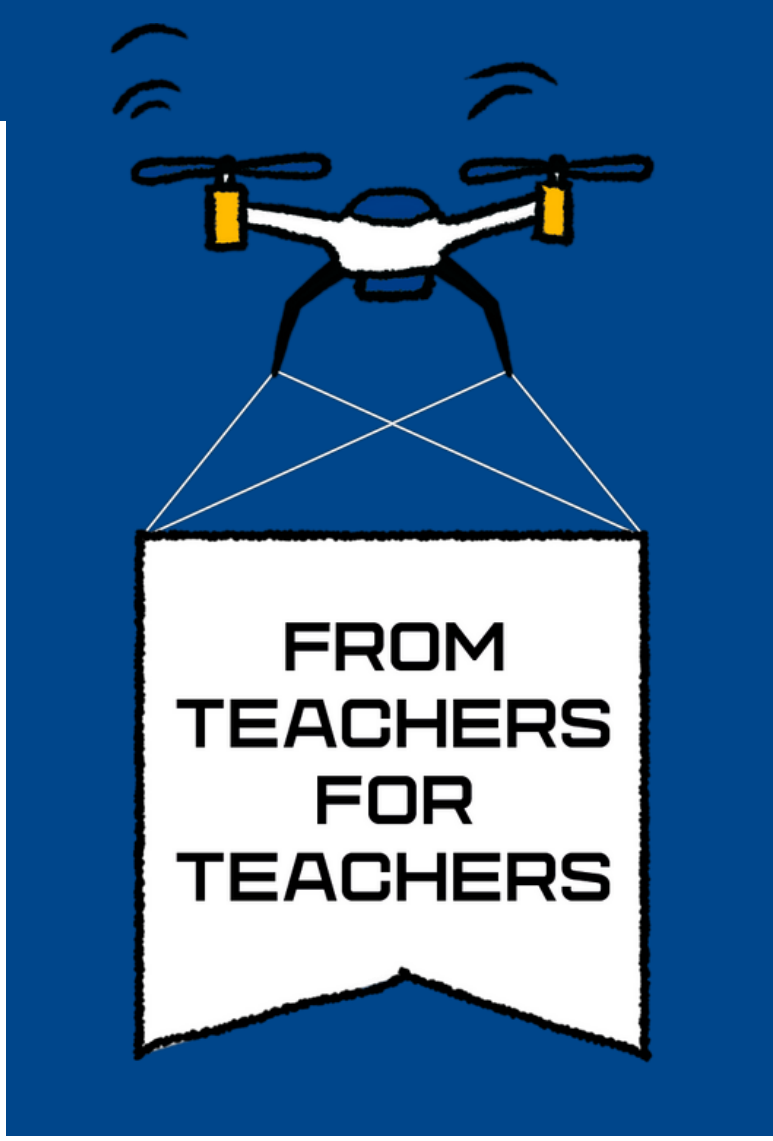
A thermoelectric generator is a device that allows the direct conversion of thermal energy into electrical energy. The thermoelectric generator is a reliable source of electrical energy without the use of any moving parts, thanks to which the whole device is almost inaudible, it does not require any special maintenance and it can theoretically work continuously for a long time. The thermoelectric generator is usually part of space probes, where it supplies stable electricity for decades. These generators use a radioactive element as a heat source, so they are called “RTG” (Radioisotope Thermoelectric Generator).



The principle is the same in semiconductors. Negatively charged electrons travel in N-type semiconductors, and positively charged holes travel in P-type semiconductors. As a result, semiconductor thermocouples can be connected in series.

My generator consist of ten Peltier TEG modules. The heat source is provided by tea candles and the cooling is provided by ice. With this setup, the generator is able to produce up to 2 Watts of electrical power. Peltier modules are connected to a USB module, through which we can charge any mobile device.

“Teachers who make physics boring are criminals.” – Walter Lewin



TECHNOLOGIES IN STEM EDUCATION

Václav Černík | Gymnázium Žďár nad Sázavou | Žďár nad Sázavou | Czech Republic

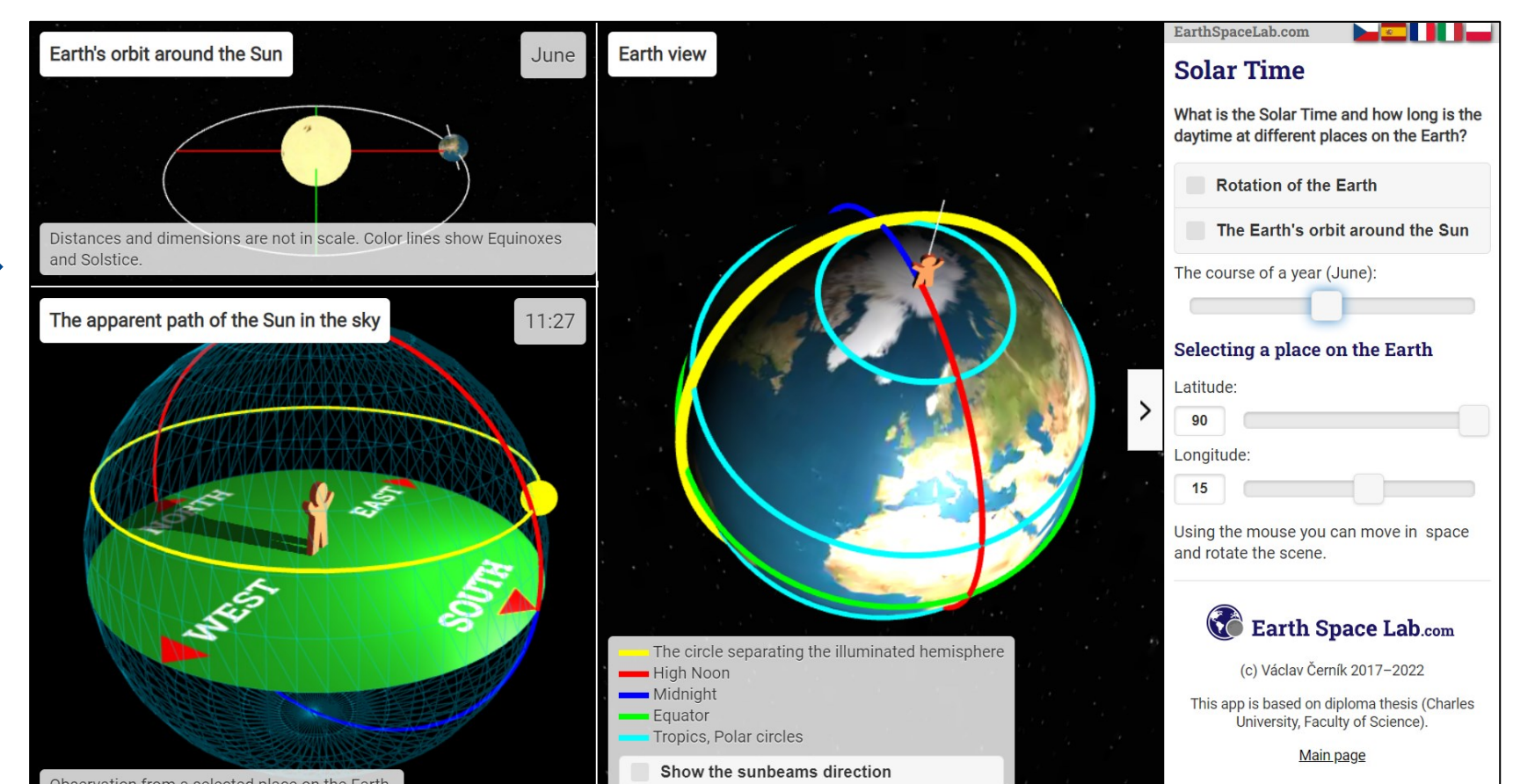
Earth Space Lab – an interactive learning app

The Earth Space Lab app is designed especially for learning **Physics** and **Geography** – it covers topics like the Earth's orbit around the Sun, the seasons, the solar time, the Moon phases, the eclipses, the tides, the distances in the Solar System. The app consists of individual learning objects – **interactive 3D animations** or an **interactive map**.

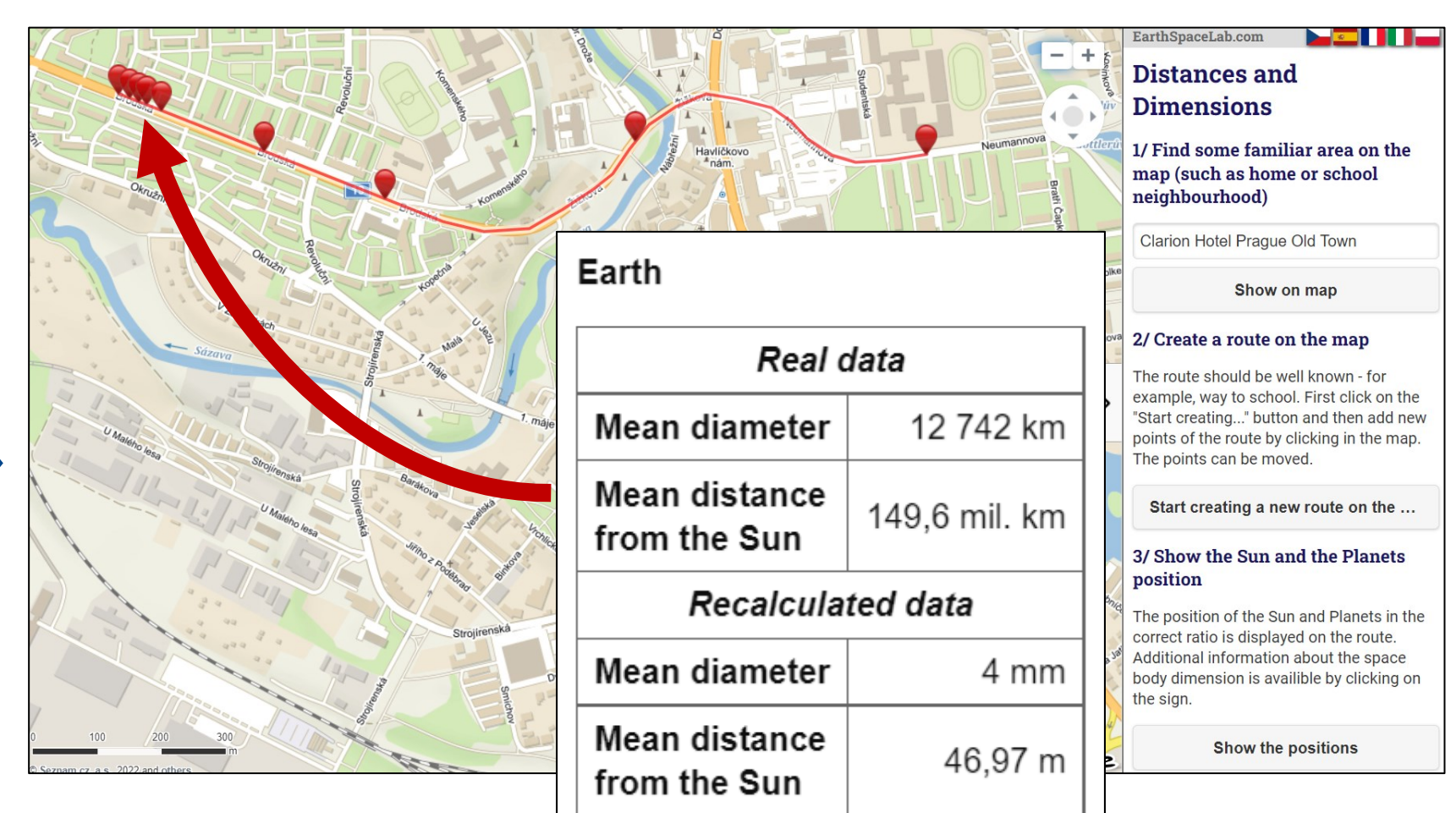


The user of the app is not just an observer, he or she can move the scene in various ways and set parameters – using and playing with the interactive app leads to a better understanding of the topic. Let's look at a couple of examples!

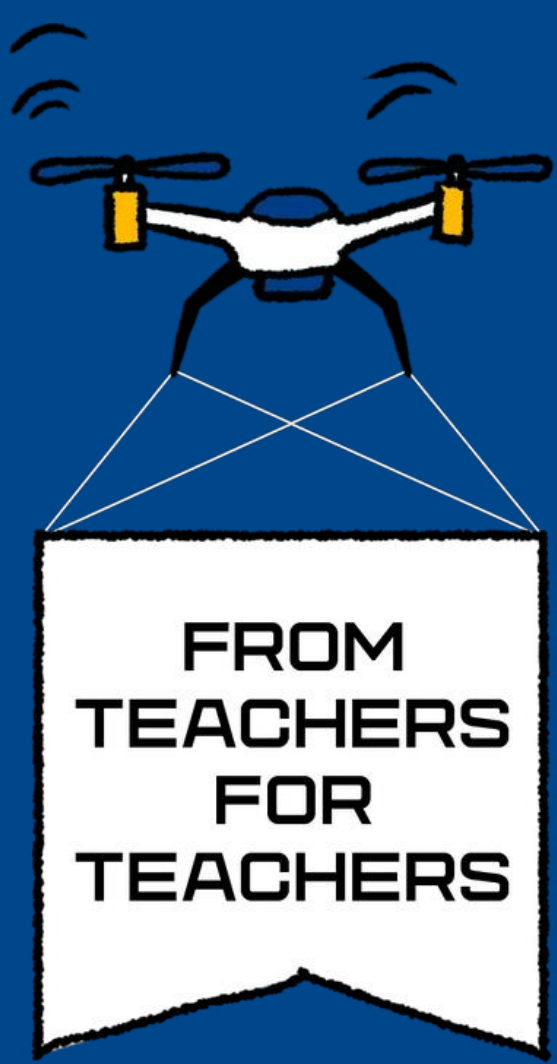
Solar Time: What is the solar time and how long is the daytime at different places on the Earth?



Distances and Dimensions: Explore this interactive map that presents enormous distances and dimensions in a familiar environment.



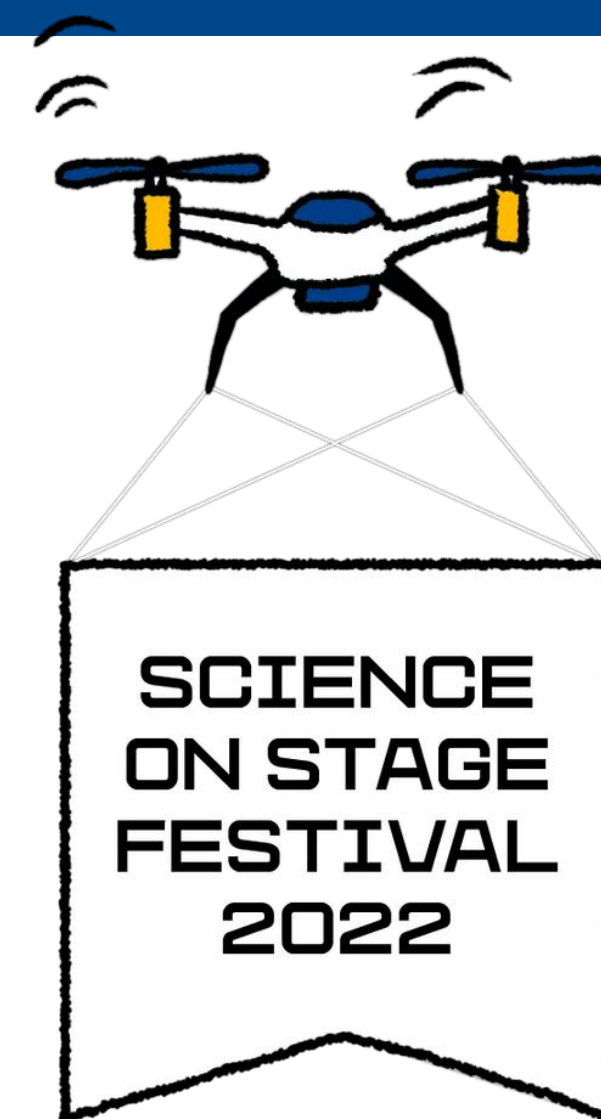
Visit the app www.EarthSpaceLab.com and enjoy exploring!



TECHNOLOGIES IN STEM EDUCATION



Georg-von-Langen-Schule
Berufsbildende Schulen Holzminden



Project team of the GVL-Schule

BG Technik

Topic: Energy-Harvesting



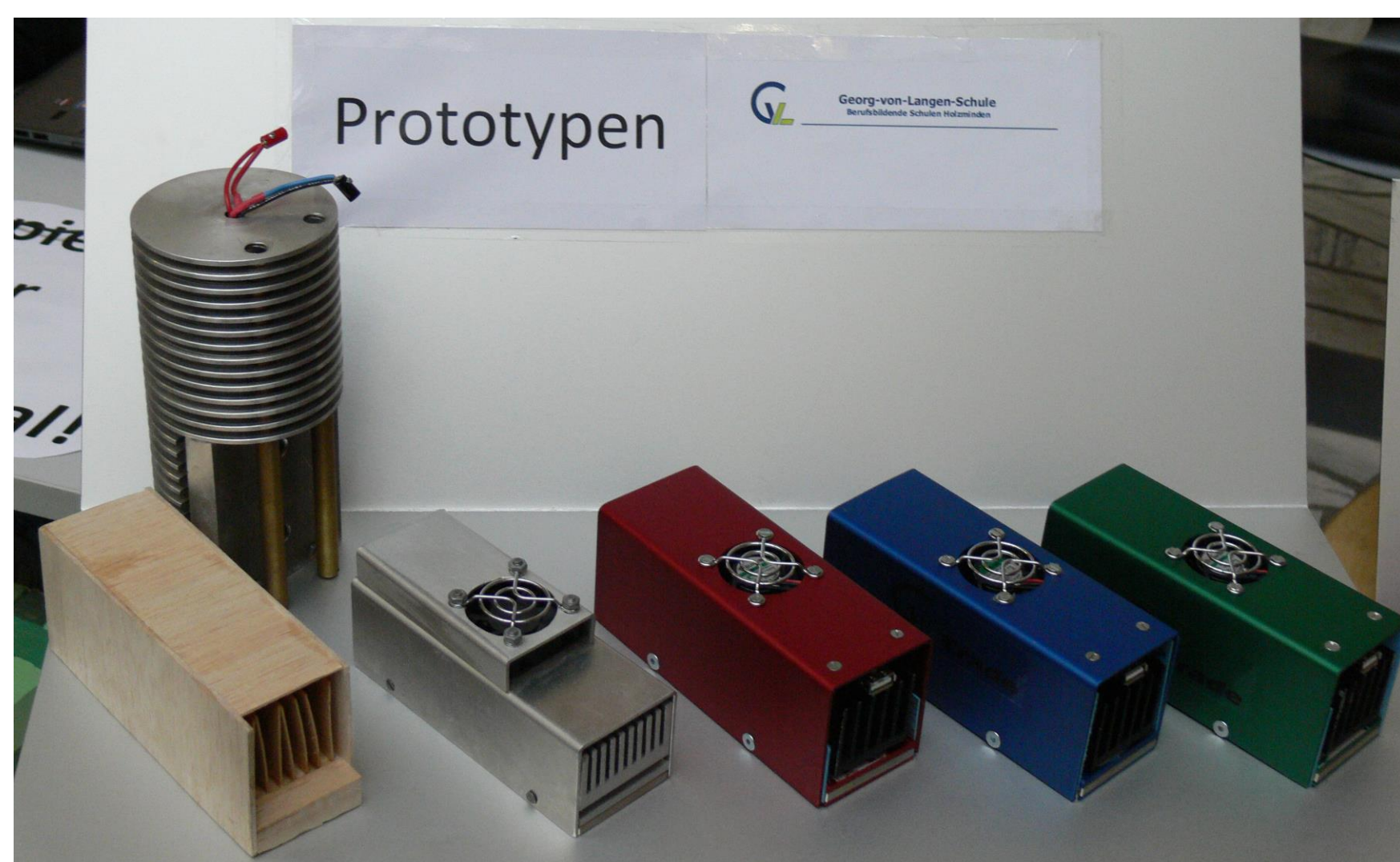
Energy-Floor



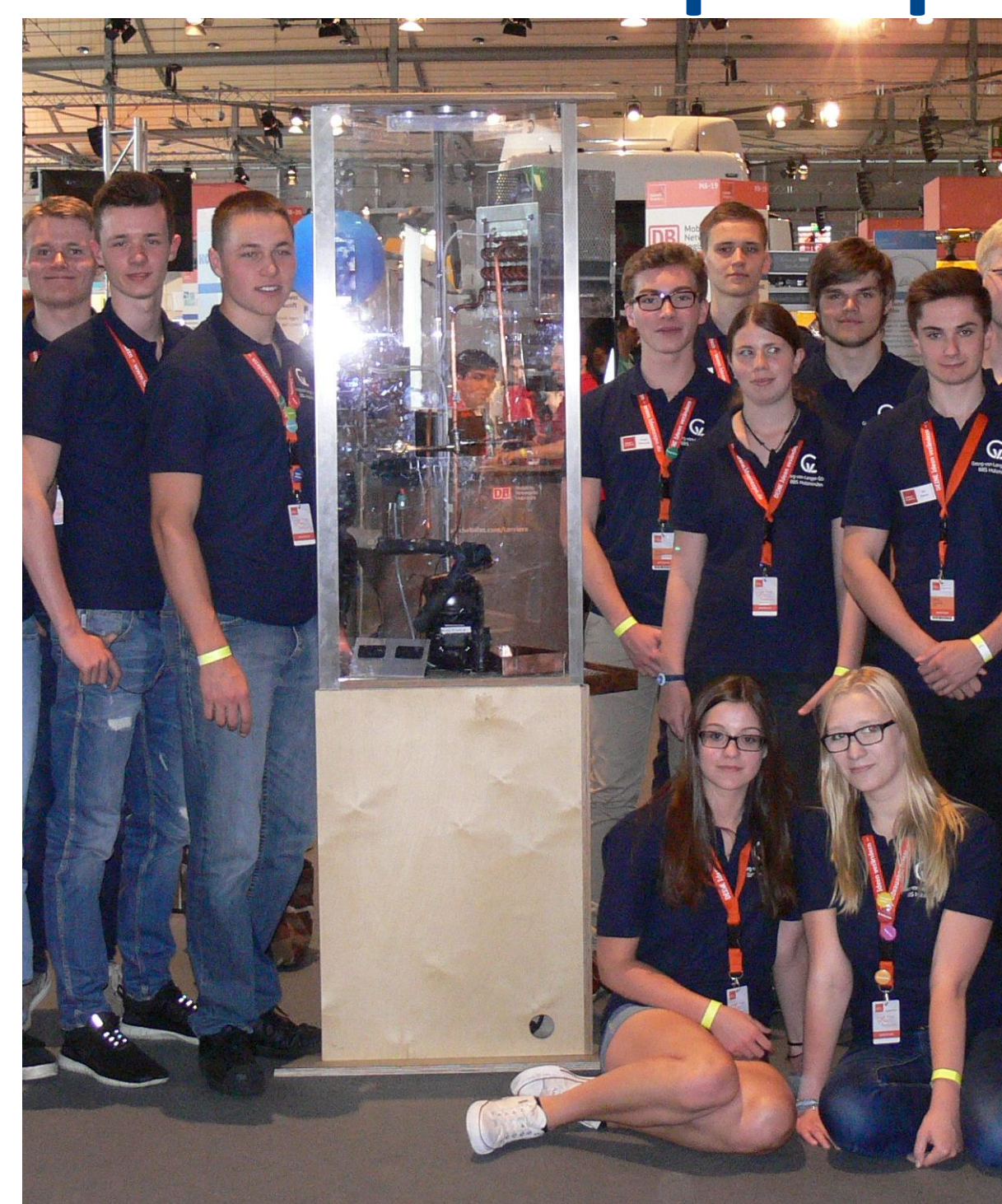
Wattamaran

A selection of successful
projects!

Thermogenerator



Wärmepumpe



The exhibits are created by the students themselves, and experiments are developed to illustrate how they work for other students.