Climate Change and STEM Education in Classrooms

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Lesson Plans

Climate Change and STEAM Education in Classrooms

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Climate Change and STEAM Education in Classrooms

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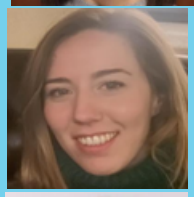

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Snježana Lovraković, Physical Education teacher advisor. School coordinator of the project 'Spin a healthy film' which is focused on the importance of a healthy life with an emphasis on a varied diet, the importance of physical activity, reduced food waste and environmental sustainability.

Engin KARAMANLI, Science and Technology teacher mentor. Mersin University Science and Technology master's degree graduate. Scientix STEM ambassador. Founder of Calibred Academy.

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E-book Staff

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Math’s and technology teacher in Arena Academy Stockholm. Mentor to Technology students. Coordinator & representative for three Erasmus + Projects. Climate change, Artificial intelligence & Green Technology. Member of Swedish Science & Technology AlbaNova University Center. Also, representative teacher for Technology & Science Museum of Stockholm for different Technology projects.

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Karin Westin Engström, is Head of the administrator for 5 years As an administrator. She has contact with every student and all the staff which is really nice. Since many years she worked as a project manager in other companies, her experience & involvement makes our school run in very professional way, basically she is core member of Arena top management.

Leen Siongers is science teacher in the secondary school "De Vesten", Herentals near Antwerp. Her students are from 12 till 16 years old who are in the 1st grade. A level and in the 2nd grade sports, electromechanics, business organization and society and welfare. Leen was the Erasmus-coordinator of this project. Leen has her bacheler degree in chemistry.

Liesbeth Leysen is a teacher in Dutch language for foreign students from 12 till 18 years old. She is extremely passionated about the 'A' in Ste(A)m. In her classes, she is the creative jack – of all trades and likes to work actively preferably with recycled materials. Liesbeth has her bachelor degree as teacher in Dutch language and history an her

Martine Verstappen is teacher Project General Subject in the secondary school "Daltonatheneum Het Leerlabo", Westerlo near Antwerp. The students there are from 15 till 20years old who study to go to the labour market (Hairdressers, metal constructions, vocationally oriented). Martine has her educational bachelor degree in finances, economy and trade.

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Isabel Bouwen Isabel Bouwen is mathematic teacher in the secondary school "Daltonatheneum Het Leerlabo", Westerlo near Antwerp. The students are from 15th till 18th years old who study to prepare themselves for higher education. Isabel has a masters degree in chemistry.

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Partners

Osnovna škola Petra Preradovića Zadar (Croatia)

Osnovna škola Petra Preradovića school is the oldest primary and lower secondary school in the city of Zadar. It has an integral role in the history of Zadar and Croatian education. The main school is attended by almost 600 students in 24 classes including a class for students with specific educational needs. In addition to the principal, the school has five professional assistants and almost 60 teachers, three of whom are teacher mentors, three are teacher counselors and one has achieved the highest level of professional development and holds the title of exemplary teacher counselor.

Beside its regular exceptional educational work, the school has realized notable results, won awards and recognitions in various fields related to extracurricular activities. The school has been awarded the STEM School Label Expert award, it is a Platon Research School and an eTwinning School. It is one of 10 schools in Croatia with an integrated Regional Education Hub.

For many years, Osnovna škola Petra Preradovića school has been a training laboratory for students of classroom teaching. Croatian language, foreign languages, geography, history and information sciences of the University of Zadar, who do the practical part of the methodology of the aforementioned subjects.

The school is also the professional exam centre for classroom teaching and school librarianship in cooperation with the Croatian Education Agency.

The school has been awarded the STEM School Label Expert level, it is a Platon Research School, an eTwinning School and a Regional Education Hub for the local community.

The school has most recently achieved the prestigious European Blue School label. Each Blue School promotes an interdisciplinary, inquiry, and project-based approach to teaching and learning about the ocean. Petra Preradović school integrates ocean knowledge into the classroom.

Lusófona University (Portugal)

Lusófona University is the largest non-public University in Portugal. The name of the university comes from the word “Lusofonia”, which encompasses all the Portuguese speaking countries and their shared linguistic and cultural background.

Lusófona University has a student body of more than 10,000 students and 1,500 teachers and is structured around 9 (nine) Schools that constitute the main institutional unit, offering 44 Bachelor’s Degrees, 45 Master’s Degrees, 11 PhD Degrees and 42 Specialisation Courses.

Partners

In addition to this, the university offers a large number of vocational and continuous training courses according to the life-learning development paradigm. All the university courses fulfil the European Higher Education requirements and comply with the European Credit Transfer systems (ECTS).

Het Leerlabo (Belgium)
Het Leerlabo is a Dalton-based school in Belgium that emphasizes self-directed learning, collaboration, and personal responsibility. Their approach integrates the principles of Dalton education, where students have the freedom to manage their own learning process at an individualized pace.
This fosters creativity, critical thinking, and a passion for lifelong learning. The school creates a dynamic and exploratory environment, encouraging curiosity and independence through project-based activities and collabora

Campus De Vesten Herentals (Belgium)
Traditional or Cognosco method education? Additional subjects such as STEM, Latin, cultural education, sports & health and cycling? Prepare yourself for higher education, a technical profession or a future as a professional? Or combine learning and working?
Secondary education De Vesten in Herentals offers you many possibilities, spread over three campuses.

Arena Academy (Sweden)
Arena Academy is a higher secondary school, students of age 17 to 19 years go in this school. Its location is in the heart of the city, and it is well connected with Swedish SL local traffic. It was founded in the year 2010. It has an integral role in the Swedish education system. The school has almost 400 students in 12 classes including four departments of Science, Technology, Social science & Ethete & media.
In addition to the principal, the school has four professional assistants and almost 30 teachers, most of the teacher are class mentors, and subject teachers and foreign language teachers.
We have a student council, a special needs teacher, a school nurse & a doctor to take care of special needs students in every class.
The school has achieved higher results, and our students have won awards and recognitions in various fields of science, medicine & technology.
Many of our teachers closely work with KTH & Stockholm University students.

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Arena Academy school was previously called the International IT School of Sweden, it is known for different IT courses like Programming, web designing, computer technology CAD-based project designing & 3D printers' workshops.
The school has three laboratories for students of classrooms teaching, Physics, Chemistry & Biology. School also provides mother language, and foreign languages like Japanese, Spanish, German & Chinese. The school is only the professional exam center for Cambridge Exams for different subjects A level exams. (Includes Physics, Chemistry, Biology, Mathematics & English language)
The school has a very spacious library with enormous resources & a full-time librarian.
The school also has an IT support department as every student has been provided with a personal Laptop.
The school in Gothenburg is located on Elof Lindälvsgatan 13 in the same building as the Deutschlandterminal. It moved there in the summer of 2007 after having been located in Gårda since the school was founded in 2004. The school in Stockholm is located on Hälsobrunnsgatan 6, earlier named Crafoords väg 20. Both school have the same student associations, like Skoluidrottsföreningen SIF (Athletics), Student Council, and the LAN-groups ILA (Gothenburg) and LUNI (Stockholm).

Yenişehir Anadolu İmam Hatip Lisesi (Turkey)
Yenişehir Anadolu İmam Hatip High School is a state school at secondary level for general education with the students aged between 11-18 and from 5th grades to 12th grades.
Students get education on sciences, mathematics, social sciences, foreign languages, art and music which already exist in the curriculum of all types of schools. Yenişehir Anadolu İmam Hatip Lisesi was founded in September 2016 and it has a new modern building with all kinds of facilities such as laboratories, conference hall, central heating and cooling, restaurant, a very big garden having too many playing fields and a luxurious pension to host the students etc.
There are 925 students and 85 teachers in the school. 5 administrators work in management as 1 principal and 4 manager assistants. We have students from 5th grade to 8th grade (called as secondary school students) and the students from 9th grade to 12th grade (called as high school students) attend different schools in our education system.

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The aim of this school is to donate students not only with academic subjects but also with religious and moral themes. The school aims to educate the students with European standards of teaching methods. The students are encouraged to attend the European projects. The more they have social integration with the rest of Europe the more they will be capable of integrating with the rest of Europe.

The students are interested in local and international social events. They are involved in sports events, youth and science projects. The teachers also have a variety of capabilities such as having better teaching skills, being sociable and experts in their professions to work at the school. The school has a high standard of technology. It gives great importance to extend the integration of itself, its city and its country with Europe because they think that as a candidate country to the European Union it is a must for them.

It has participated in many regional and national Works and competitions. Since our school was opened, we have given importance to technological issues. There is a big STEAM Lab in our school. Students have been learning STEAM for four years. So far, two Erasmus+ Projects have been carried out about STEAM and coding. In the strategic plan of the school, it is aimed to enable our teachers and students to acquire the skills of the 21st century.

That's why we would like to carry out activities to make all teachers and students of our school more aware of the importance of AI and to provide them adequate information about what we can do as normal people.

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Cooperation partnerships in school education

Erasmus plus KA220 SCH Project 2022-2024

Topic:

Air pollution by Snježana Lovraković

Aims:

Awareness raising: Educate students on what air pollution is and how harmful it is to living beings.

Understanding Air Pollution: Students should have a basic understanding of what constitutes air pollution, including direct and indirect sources.

Promoting Solutions: Encourage students to think and discuss possible solutions to combat air pollution.

Practical activities: Engage students with interactive content and strengthen their understanding of air pollution.

Encouraging critical thinking: To encourage students to think critically about the topic. Involve them in the discussion by asking various questions that will encourage them to think about air pollution and its harmfulness to life.

Encouraging Advocacy: Empower students to become advocates for reducing air pollution in their environment and among their friends. Inform them about how they can make a difference.

Connection with the curriculum: Integrate the workshop with the school curriculum, connecting it with the following subjects: geography, technical education and physical education.
This helps students demonstrate the real-world relevance of what they are learning.

Safety Awareness:
Educate participants about traffic rules and safety measures, raise awareness of the importance of safety, and encourage responsible behavior of participants as pedestrians and cyclists. The focus is on empowering the participants to become safe and responsible traffic participants, which would lead them to the decision to frequently use bicycles as a means of transportation.

Age Group:

10 - 14

Time:

2 x 45 minutes (two school lessons)

Materials:

Padlet, Flipchart, Canva, prepared worksheets, PC, smartphones. If it is not possible to comment or write in the above mentioned ICT tools, students can use paper and pencil.

Link to the worksheet to be used:

https://www.canva.com/design/DAF9oMDuDd4/znBucUa4B6Xzx-oOPrdT2g/edit?utm_content=DAF9oMDuDd4&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton

Introduction:

Researching the basics of air pollution, such as what it is, how it affects the environment, and why it is a problem, is the first step in raising awareness of this important issue.
Air pollution is a growing concern for the modern world and has a significant impact on our environment and the health of living beings. Sources of air pollution include smoke from burning fuel vehicles.

1. lesson

Introduction: Time: 5 minutes	Students are asked to complete a worksheet with the following questions: 1. What is the environment? 2. What are the different types of pollution? 3. Have you ever heard of air pollution? 5. Give at least one example of air pollution! 6. What is a sensor? The students' answers are discussed and recorded on the prepared class Padlet.
Task 1 Time: 10 minutes	Students are shown a video about air pollution. https://www.youtube.com/watch?v=sAKyhfxxr7s After watching the video, we discuss the possible impacts of air pollution on the environment, human health and wildlife. Students can watch other interesting videos in their free time or in the class if there is sufficient time: https://www.youtube.com/watch?v=e6rglsLy1Ys https://www.youtube.com/watch?v=fephtrPt6wk https://www.youtube.com/watch?v=8FSh6pIuRXo https://www.youtube.com/watch?v=8NUgB_xkIvU
Task 2 Time: 10 minutes	Task: how to prevent air pollution? The teacher facilitates a discussion in which the pupils propose their vision for solving this global problem. The pupils write their comments in a prepared class Padlet.

Task 3 Time: 5 minutes	Pupils look for the most polluted cities in the world in the following interactive map. https://waqi.info/hr/ After researching, they comment on why the air is the most polluted in those cities.
Task 4 Time: 10 minutes	Divided into groups, the pupils use their smartphones and laptops to find basic road signs. In groups, they add photos of basic traffic signs for cyclists in the Padlet. The pupils are given the task (depending on the possibilities) to make basic traffic signs during a lesson of technical education or at home. These signs will be used in the bicycle driving task which follows in the next lesson.
Task 5 Time: 5 minutes	After the pupils have a better understanding of the problematic situation, they discuss their personal contribution to reducing air pollution. https://www.youtube.com/watch?v=cXYbs7CRyiM

2. lesson

Introduction: Time: 5 minutes	https://www.youtube.com/watch?v=_Fh5pAiaTj4 https://www.youtube.com/watch?v=pBWKC7LKCiA The teacher facilitates a discussion with the pupils asking what they learned and concluded from the videos. Additional comments are added to the Padlet.

Task 1 Time: 5 minutes	The pupils are shown a video describing the various parts of a bicycle. https://www.youtube.com/watch?v=LnP-5GhS3N8 https://www.youtube.com/watch?v=VsuShNWghXk
Task 2 Time: 10 minutes	The pupils create basic traffic signs if they have not had the opportunity to do so in the technical education class or at home. This activity gives all pupils the opportunity to finish their road signs or help their peers make additional ones.
Task 3 Time: 20 minutes	During the workshop, children learn about road signs for cyclists, the rules of cycling and the importance of wearing protective equipment. Proper driving will be demonstrated on the training ground prepared by the pupils. After that, on the same training ground, students will have the opportunity to apply their cycling skills under the supervision of an appointed team leader. The workshop can be recorded, accompanied by pictures or video of the activity itself.
Task 4 Time: 5 minutes	Group competition - Who can correctly name the most bicycle parts. The pupils are divided into groups and shown individual parts of a bicycle. The team that names the most parts correctly by writing the answers on the Padlet or paper, is the winner.

Topic:

Carbon footprint by Jelena Marcelić

Aims:

Educating students about carbon story and footprint, and its importance in the problem of climate change.
Learning about basic terms like: environment, climate, atmosphere, biosphere, carbon cycle and carbon footprint.
Checking personal carbon footprint.
Raising awareness about the impact of an individual, organisation or product on the amount of the greenhouse gases in the environment.
Promoting solutions : each student must think about ways to reduce personal carbon footprint and understand the impact each one of us has on our environment.

Age Group:

10 -14

Time:

45 minutes (one school lesson)

Materials:

Blackboard, computer, presentation, videos, notebooks, smart phones.

Introduction: Climate change is a topic which cannot be ignored and all of us must do our part in understanding what it is and what can/must be done. Learning about carbon cycle and footprint is crucial for that achievement.

Introduction: Time: 5 minutes	After the short introduction from a teacher the pupils are reading about basic terms in the climate change topic, which are presented on the blackboard/or presentation: climate, environment, atmosphere, biosphere, greenhouse gases, carbon cycle and footprint.
Task 1 Time: 10 minutes	The pupils are watching 2 videos about climate change and the carbon cycle. What is climate change? IPCC Working Group III's Senior Scientist Alaa Al Khourdajie explains... (youtube.com) Fossil Fuels and CO2 | Our Climate Our Future, Chapter 3 (youtube.com) After watching the videos we discuss what is climate change, did they understand the carbon cycle and the impact it has on the environment.
Task 2 Time: 20 minutes	The teacher presents what is the carbon footprint (presentation) and explains the task to the pupils. The pupils use their smartphones and access the website for carbon calculator : United Nations online platform for voluntary cancellation of certified emission reductions (CERs) (climateneutralnow.org)

Task 3 Time: 10 minutes	The pupils discuss their results and the teacher encourages them to write possible solutions on how to reduce personal carbon footprint. They write their suggestions in notebooks.

Procedure:

Introduction

After a few sentences from the teacher the pupils read from the blackboard / or presentation about terms regarding climate change.

Climate: refers to the long - term panthers and averages of weather conditions in a specific region over a period of time, typically 30 years or more.

Environment: is everything that surrounds an individual or a group of organisms, the natural environment (air, soil, water, climate, living beings in total interaction), cultural heritage and other environments created by man.

Atmosphere: is the layer of gases that surrounds the Earth.

Biosphere: is the part of the Earth's surface and atmosphere where life exists.

Greenhouse gases: CO, CO2, SO2, SO3, NO3.

Carbon cycle: is the process by which carbon is exchanged between the atmosphere, land and oceans.

Carbon footprint: is the total amount of greenhouse gases , primarily carbon dioxide, emitted by an individual, organisation or product over its lifecycle.

Task 1

Video:

Show the pupils a video on climate change:
What is climate change? IPCC Working Group III's Senior Scientist Alaa Al Khourdajie explains... (youtube.com)

After watching the video, discuss with the pupils their understanding and the impacts of climate change on Earth and human life.

Show the pupils a second video about carbon cycle:

Fossil Fuels and CO2 | Our Climate Our Future, Chapter 3 (youtube.com)

After watching the video confirm that the pupils understand the carbon cycle in the environment.

Task 2

The teacher presents a part of the presentation about carbon footprint.

Carbon footprint is the total amount of greenhouse gases (CO, CO2, SO2, SO3, NO3), primarily carbon dioxide, emitted by an individual, organisation, or product over its lifecycle. It is a measure of the impact of human activities on the environment, particularly in terms of contributing to climate change. The carbon footprint includes emissions from activities such as burning fossil fuels for energy, transportation, manufacturing, and waste management. It is usually measured in units of carbon dioxide equivalent (CO2e) and can be reduced through various means, such as energy efficiency, transitioning to renewable energy sources, and adopting sustainable practices.

The teacher explains the task to the pupils: they will access the link on their smartphones/ or computers and calculate their carbon footprint.

United Nations online platform for voluntary cancellation of certified emission reductions (CERs) (climateneutralnow.org)

If necessary the teacher explains the parts of the calculator.

Task 3

The pupils discuss their results. In notebooks they write their suggestions on how to reduce personal carbon footprint. If they want they can write solutions for organisations also.

Topic:

The True Cost of Fast Fashion by Ivana Perić

Aims:

Raising awareness: Educate pupils about what fast fashion is, its environmental and social impact, consumer responsibility and sustainable fashion practices.

Understanding fast fashion and its impact on the environment: Ensure that pupils have a basic understanding of the concept of fast fashion and sustainable fashion practices.

Exploring the effects fast fashion has on resource depletion, pollution, waste generation, greenhouse gas emission, social and work injustices and the disruption of natural habitats.

Measuring the pollution caused by fast fashion - calculating an individual's fashion footprint.

Promoting solutions: Encourage pupils to think about and discuss potential solutions such as making more sustainable choices as consumers and future leaders, promoting sustainable fashion practices, advocating for ethical and environmentally responsible production.

Hands-on activities: Incorporate interactive activities to engage pupils and reinforce their understanding of fast fashion and its environmental and social impact. This can include an analysis of clothing labels, clothing recycling workshops (for example making a bag from jeans), clothing decoration, promoting sustainable fashion practices within their school or local community, supporting ethical fashion brands.

Fostering critical thinking: Encourage pupils to think critically about the topic. This could involve asking

questions like "Why is sustainable fashion important?" or "How can we balance a modern and “in” look

with the need to reduce fast fashion?"

” What can I do every day?”

Creative expression: Allow pupils to express their thoughts and feelings about fast fashion and sustainable practices through creative forms like drawings, clothes designing and redesigning, poems, or short stories. This can help reinforce their understanding and make the topic more relatable. Encouraging advocacy: Empower pupils to become advocates for slow fashion, sustainable practices and actions in their communities. Provide them with information on how they can make a difference. Connecting to the curriculum: Integrate the workshop with the school curriculum, linking it to subjects

like science, environmental studies, geography or with the school library programme of information and media literacy. This helps to show pupils the real-world relevance of what they're learning.

Age Group:

10 -14

Time:

90 minutes (two school lessons)

Materials:

Survey, prepared articles, presentations, smart phones, videos

The link of the worksheet which will be used:

Introduction:

Introduction:

Introduction: Time: 10 minutes	Discussion on favourite clothing and clothing brands. The pupils fill out the following survey (https://forms.gle/Cu8yhtmkDX9is5CX6). Through a group discussion, they are encouraged to start thinking about how today's clothing production (and then fast fashion) affect the well-being of our planet /how much does it cost our planet Earth.
Task 1 Time: 10 minutes	Watching the video of *A Life Cycle of a T-shirt* and the impact of fast fashion on the environment. https://www.youtube.com/watch?v=BiSYoeqb_VY Discussion of the impacts of fast fashion on the environment and our lives (presentation).
Task 3 Time: 20 minutes	Working in groups and using smartphones, pupils research and read different sources and articles to answer questions and draw conclusions about the impacts that fast fashion has on the environment and people. Group 1) research of infographics about environmental problems related to clothing; a summary of key facts about the impact of fashion on the environment. https://infographicjournal.com/fast-fashion-environmental-impact/ Group 2) research of articles and studies photos about the working conditions of workers in the textile industry (bad working conditions, low wages, exploitation of workers); https://earth.org/sweatshops/ Group 3) comparison of articles about the fast fashion industry and sustainable, slow fashion, explaining the advantages and disadvantages of each. https://earth.org/what-is-slow-fashion/ https://earth.org/statistics-about-fast-fashion-waste/ Group 4) investigation of alternative approaches to fashion as opportunities to reduce the environmental impact and promote sustainable fashion by reading articles on vintage fashion and DIY fashion. https://earth.org/sustainable-alternatives-to-fast-fashion/ A group representative proceeds to present the group findings to the class. All the observations are summarised and written on the Padlet, flipchart or blackboard and discussed.

Task 4 Time: 5 minutes	A homework assignment is given. Pupils are divided into two groups. Task 1: The impact of the most popular fast fashion brands (Padlet). Task 2: A sustainable fashion brand (Padlet).
Task 5 Time: 10 minutes	Discussion or quiz about their findings on the impact of the most popular fashion brands and their unfriendly environmental practices, and sustainable fashion brands and their environmental practices. Clothes labels. (presentation)
Task 6 Time: 10 minutes	Watching and discussing the following video: www.pbslearningmedia.org/resource/fast-fashion-costs-video/environmental-human-pbs-newshour/?student=true.
Task 7 Time: 15 minutes	Calculating the environmental footprint of their clothing choices: https://www.thredup.com/fashionfootprint/ and/or https://www.ethical-clothing.com/fashion-calculator/
Task 8 Time: 10 minutes	Discussing solutions: practical tips and suggestions: Applying Sustainable Fashion in Daily Life Conclusion (How to promote sustainability?)

Procedure:

Introduction

The pupils participate in discussion on their favourite clothing and clothing brands, why do they like them, how often do they buy new clothes etc.

They fill in the following survey (https://forms.gle/Cu8yhtmkDX9is5CX6).

This will lead to the questions:

Have you ever thought about where your clothes come from and how they are made?

How are clothes produced? What materials are most often used to produce clothes? Where are they usually made? Why do we need clothes and how often do we buy new clothes? Where do clothes end up and what happens to our old clothes?

Through a group discussion, pupils are encouraged to start thinking about how today's clothing production (and then fast fashion) affect the well-being of planet Earth /how much it costs planet Earth.

Task 1

After a discussion, they delve deeper into the topic by watching the video of *A Life Cycle of a T-shirt* and the impact of fast fashion on the environment. https://www.youtube.com/watch?v=BiSYoeqb_VY

Following this viewing we discuss the impacts of fast fashion on the environment, human health, human rights and social justice, the pupils answer questions about water consumption and the carbon footprint of the textile industry and raise awareness of how much an ordinary item of clothing actually costs the Earth (presentation).

A documentary film recommended for those who want to go deeper into the topic *The True Cost* (2015) by Andrew Morgan: https://www.youtube.com/watch?v=rwp0Bx0awoE.

Task 3

The pupils are divided into four groups, they use their smart phones or laptops to:
group 1) study infographics about **environmental problems related to clothing** and make a summary of key facts about the impact of fashion on the environment;
https://infographicjournal.com/fast-fashion-environmental-impact/

group 2) read articles and study photos about **the working conditions of workers** in the textile industry (bad working conditions, low wages, exploitation of workers);
https://earth.org/sweatshops/

group 3) read and compare articles about the **fast fashion industry and sustainable, slow fashion**, explaining the advantages and disadvantages of each;
https://earth.org/what-is-slow-fashion/
https://earth.org/statistics-about-fast-fashion-waste/

group 4) discover **alternative approaches to fashion** as opportunities to reduce environmental impact and promote sustainable fashion by reading articles on vintage fashion and DIY fashion.
https://earth.org/sustainable-alternatives-to-fast-fashion/.

They write down their findings and a group representative proceeds to present the group findings to the class. All the observations are summarised and written on the Padlet, flipchart or blackboard and discussed. Thanks to cooperation and knowledge sharing, each pupils will gain a broader picture of how much fashion costs the planet Earth

Task 4

A homework assignment is given. The pupils are divided into two groups.
One group has the following task:
Research an impact of the most popular fast fashion brands and write a paragraph explaining why their practices are not environmental friendly (Padlet).
The other one has the following task:
Research a sustainable fashion brand and write a paragraph explaining why their practices are more environmentally friendly compared to fast fashion brands. (Padlet)

Here are some online resources for students to research sustainable fashion options: Good on You, Fashion Revolution, Ethical Fashion Guide.

Task 5

A discussion or quiz about their findings on the impact of the most popular fashion brands and their unfriendly environmental practices, and sustainable fashion brands and their environmental practices. Clothes labels. Reading and interpreting labels on clothes as possible help when buying clothes (examples on a presentation).

Task 6

Watching and discussing a video: Journalist Iman Amrani joins Ali Rogin to discuss her investigation of Shein, one of the fastest-growing fast fashion brands in the world. Video:
www.pbslearningmedia.org/resource/fast-fashion-costs-video/environmental-human-pbs-newshour/?student=true
Answering the questions after watching:
https://www.canva.com/design/DAF-ByWgngM/wvxT855EUaHqTmyJg6Vs-w/edit?utm_content=DAF-ByWgngM&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton

Task 7

Introduce pupils to online tools or worksheets that calculate the environmental footprint of their clothing choices. Ask pupils to use these resources to assess the impact of their current fashion consumption habits. This activity can promote critical thinking about the environmental consequences of fast fashion.
Calculate your fashion footprint and impact:
https://www.thredup.com/fashionfootprint/
https://www.ethical-clothing.com/fashion-calculator/ .

Task 8

Discussing solutions: Once the pupils have a better understanding of the problem, they are encouraged to discuss possible solutions that can have an impact on the reduction of fast fashion pollution and become aware of their responsibility as consumer.
Applying Sustainable Fashion in Daily Life:
To help pupils apply the concept of sustainable fashion in their daily lives, here are some suggestions:
1.Second-Hand Shopping: Encourage pupils to explore second-hand shops for unique and sustainable clothing options. Discuss the benefits of extending the life cycle of clothing items.
2. Clothing Swaps: Organize a clothing swap event where pupils can exchange clothes they no longer wear. This promotes recycling and reduces the demand for new clothing production.
3. Capsule Wardrobe: Introduce the concept of a capsule wardrobe, which focuses on a minimalist collection of versatile, high-quality clothing items. Discuss how this approach can reduce waste and promote more mindful consumption.
4. DIY and Upcycling: Encourage pupils to get creative with DIY projects and upcycling old clothing items. This promotes a sustainable mindset and reduces the need for new purchases.
5. Eco-Friendly Brands: Provide pupils with resources to research and support eco-friendly and sustainable fashion brands. Encourage them to look for certifications like Fair Trade or organic materials when making purchasing decisions.
6. Care for Clothing: Teach pupils the importance of proper clothing care, including washing items in cold water, air-drying clothes, and mending garments instead of discarding them when damaged.
7. Educate Others: Encourage pupils to share their knowledge about sustainable fashion with friends and family. This can help spread awareness and inspire others to make more environmentally conscious choices.

Conclusion: How to promote sustainability?

You can promote sustainability by:

- Buying less clothing and opting for alternatives like renting and recycling.
- Only buying from certified sustainable brands.
- Always going for quality over quantity to reduce the demand for fast fashion.
- Buying second-hand will help lower the need to manufacture new clothes.
- Caring for your clothes to wear them for a longer time.

Annex
1. **Fast Fashion Consumption Survey. https://forms.gle/Cu8yhtmkDX9is5CX6**
2. **Journalist Iman Amrani joins Ali Rogin to discuss her investigation of Shein, one of the fastest-growing fast fashion brands in the world. Watch the video: www.pbslearningmedia.org/resource/fast-fashion-costs-video/environmental-human-pbs-newshour/?student=true**
3. **The life cycle of a T-shirt - Angel Chang - YouTube. YouTube. (2017, September 25). Retrieved April 20, 2022, from https://www.youtube.com/watch?v=BiSYoeqb_VY**
4. **Fashion footprint calculators:** **https://www.thredup.com/fashionfootprint/** **https://www.ethical-clothing.com/fashion-calculator/**

Topic:

Light pollution by Anita Šimac

Aims:

Raising awareness: Educate students about what light pollution is, why it's a problem, and its impact on the environment, wildlife, and human health.

Understanding light pollution: Ensure that students have a basic understanding of what constitutes light pollution, including both direct and indirect sources.

Exploring effects: Help students recognize the various negative effects of light pollution, such as disrupting natural habitats, affecting wildlife behaviour, and interfering with human sleep patterns.

Measuring pollution: Monitoring and measuring local light levels.

Promoting solutions: Encourage students to think about and discuss potential solutions to combat light pollution.

Hands-on activities: Incorporate interactive activities to engage students and reinforce their understanding of light pollution. This could involve experiments, simulations, or outdoor observations.

Fostering critical thinking: Encourage students to think critically about the topic. This could involve asking questions like "Why is reducing light pollution important?" or "How can we balance the need for outdoor lighting with the need to reduce light pollution?"

Creative expression: Allow students to express their thoughts and feelings about light pollution through creative means like drawings, poems, or short stories. This can help reinforce their understanding and make the topic more relatable.

Encouraging advocacy: Empower students to become advocates for reducing light pollution in their communities. Provide them with information on how they can make a difference.

Connecting to the curriculum: Integrate the workshop with the school curriculum, linking it to subjects like science, environmental studies, or geography. This helps show students the real-world relevance of what they're learning.

Safety awareness: Teach students about safe outdoor practices, especially at night, to ensure that they understand how to navigate in low light conditions without causing additional light pollution.

Age Group:

10 -14

Time:

90 minutes (two school lessons)

Materials:

Flipchart, prepared worksheets, light meters, smart phones and calculators.

The link of the worksheet which will be used:

Introduction:

Introduction:

Introduction: Time: 10 minutes	The pupils are asked to fill in a worksheet with the following questions: 1. What is the environment? 2. What are different types of pollution? 3. Have you ever heard of light pollution? Circle one: Yes No 4. Give at least one example of a light source: 5. What is a sensor? The pupil's answers are discussed and written on a prepared Padlet, flipchart or blackboard.
Task 1 Time: 10 minutes	The pupils are shown a video on light pollution and skyglow. https://youtu.be/TASWRxzGSJ0?si=rIOsRHXeZAvlH0Xm After watching the video, we discuss the possible impacts light pollution has on the environment, human health, and wildlife.
Task 2 Time: 20 minutes	In groups of four, the pupils use their smart phones or laptops to research the different sources of light pollution include streetlights, billboards, car headlights, buildings, and other human-made sources. They write down their findings and a group representative proceeds to present the group findings to the class. All the observations are written on the above mentioned Padlet, flipchart or blackboard and discussed.
Task 3 Time: 5 minutes	A homework assignment is given. The pupils are asked to take photos of various sources of light in their local community (streetlamps, shop windows, car light reflections etc.). This is preparation for the following lesson.

Task 4 Time: 10 minutes	A worksheet is handed to each student on which they are asked to draw examples of the variations of street lighting as per the following: https://nightsky.jpl.nasa.gov/download-view.cfm?Doc_ID=683 The drawings are displayed for the class to see and discuss. The photos the pupils took of examples of local sources of light are projected and also discussed.
Task 5 Time: 20 minutes	In pairs or small teams (depending on the materials available) the pupils proceed to measure light intensity in their school. Their measurements are documented on a provided worksheet. Once the data has been collected, the pupils analyse the data and interpret the results by using graphs and charts to show the level of light pollution in different areas.
Task 6 Time: 15 minutes	Discussing solutions and reflection: Once pupils have a better understanding of the problem and how to measure it, encourage them to discuss possible solutions to reduce light pollution. This can include ideas such as using energy-efficient lighting, turning off unnecessary lights, or creating lighting regulations in their local area. Ask them to reflect on what they have learned and then hand out a short questionnaire to test their knowledge.

Procedure:

Introduction

Icebreaker:

Prepare a short questionnaire (***Annex 1***) and ask your students to fill it in.

The aim is to get them thinking about the connection between the environment and pollution. This is an icebreaker activity which encourages open discussion. All the answers (unless repeated) are written on a flipchart, blackboard or a prepared Padlet which will serve as a collection of all materials compiled from the lesson.

Task 1

Video:

Show the pupils a video on light pollution such as:
https://youtu.be/TASWRxzGSJ0?si=rIOsRHXeZAvlH0Xm
After watching the video, discuss the possible impacts light pollution has on the environment, human health, and wildlife.

Write down all the pupils' suggestions on the flipchart or Padlet. Ensure all the following points are listed, if not then add them:

1) Environmental Effects:

- Disruption of Ecosystems: Excessive artificial light disrupts natural ecosystems. It can interfere with the behaviour, feeding patterns, and reproduction of nocturnal species.
- Altered Natural Processes: Light pollution can affect processes like migration, hibernation, and feeding cycles of various species.
- Changes in Plant Growth: Some plants rely on natural light cues for growth and reproduction. Artificial light can interfere with these processes.

2) Effects on Human Health:

- Sleep Disruption: Exposure to bright artificial light at night can disrupt circadian rhythms, leading to sleep disorders and associated health issues.
- Mood and Mental Health: Prolonged exposure to artificial light at night has been linked to mood disorders and mental health issues.
- Impaired Night Vision: Excessive lighting can reduce night vision, making it harder to see in dark conditions.

3) Impact on Wildlife:

- Disruption of Natural Behaviour: Many animals, especially nocturnal ones, rely on natural darkness for activities like foraging, mating, and predator avoidance. Light pollution can disrupt these behaviours.

- Navigational Confusion: Artificial light can disorient migratory birds and sea turtle hatchlings, leading to a higher risk of injury or death.
- Attraction to Light Sources: Insects, in particular, are drawn to artificial light, which can lead to reduced populations of insects and changes in food chains.

4) Astronomical Effects:

- Reduced Visibility of Stars: Light pollution obscures our view of the night sky, making it harder to see stars, planets, and other celestial objects.

5) Energy Consumption and Costs:

- Wastage of Energy: Much of the light produced by artificial sources is often directed upwards or into unwanted areas, resulting in wasted energy and increased carbon emissions.
- Economic Costs: The excessive use of outdoor lighting contributes to higher energy bills for cities and municipalities.

6) Social and Cultural Impact:

- Loss of Connection to Nature: Over-lit environments can disconnect people from the natural rhythms and beauty of the night sky.
- Loss of Astronomical Heritage: Light pollution reduces our ability to appreciate and learn from the night sky, impacting cultural and scientific traditions.

Task 2

Researching in groups

Divide the class in groups of four. Ask the pupils to use their smart phones or laptops to research the different sources of light pollution include streetlights, billboards, car headlights, buildings, and other human-made sources. After they write down their findings, a group representative proceeds to present the group findings to the class. All the observations are written on the above mentioned Padlet or flipchart and discussed.

Task 3

Homework:

The pupils are asked to take photos of various sources of light in their local community (streetlamps, shop windows, car light reflections etc.). This is preparation for the following lesson.

Task 4

Drawing street lighting:

A worksheet is handed to each student (***Annex 2***) on which they are asked to draw examples of the variations of street lighting as per the following:

https://nightsky.jpl.nasa.gov/download-view.cfm?Doc_ID=683

The drawings are displayed for the class to see and discuss. The photos the pupils took of examples of local sources of light are projected and discussed.

Task 5

Measuring light intensity:

In pairs or small teams (depending on the materials available) the pupils proceed to measure light intensity in their school. Their measurements are documented on a provided worksheet (***Annex 3***).

Once the data has been collected, the pupils analyse the data and interpret the results by using graphs and charts to show the level of light pollution in different areas.

Task 6

Discussing solutions:

Once pupils have a better understanding of the problem and how to measure it, encourage them to discuss possible solutions to reduce light pollution. This can include ideas such as using energy-efficient lighting, turning off unnecessary lights, or creating lighting regulations in their local area.

Hand out a short questionnaire to test their knowledge (Annex 4).

Annex

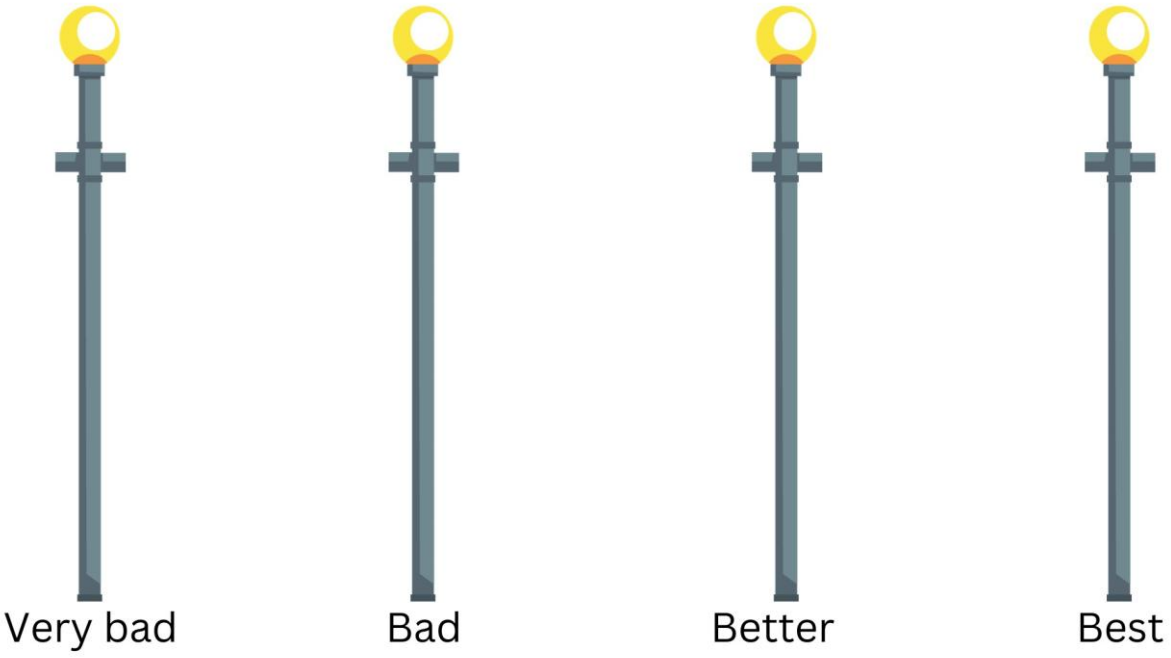
Annex 1.

1. What is the environment?
2. What are different types of pollution?
3. Have you ever heard of light pollution?

Circle one: Yes No

4. Give at least one example of a light source:
5. What is a sensor?

Annex 2.



Annex 3.

Date: _____

Your name:

_____

Time of measurements: _____

Room	Measurement (lux)	Recommended measurement (lux)	Difference
A classroom with one lit LED lamp		300	
A classroom with two lit LED lamps		300	
A classroom with three lit LED lamps		300	
A classroom where all the LED lights are on		300	
Entrance hall		200	
Staircase		150	
Library: bookshelves		200	
Library: reading zone		500	
Computer science classroom		300	
Hall		300	
School kitchen		500	
Headmistress's/headmaster's office		500	
Toilet		200	

Annex 4.

Question 1:

What is light pollution, and how does it affect our environment and wildlife?

Question 2:

Can you name three negative effects of light pollution on animals and plants in their natural habitats?

Question 3:

Explain how excessive outdoor lighting can impact human health and well-being. Provide at least two examples.

Topic:

Microplastics by Margarita Morić

Aims:

Raising awareness: Educate students about what microplastics is, why it's a problem, and its impact on the environment, wildlife, and human health.

Measuring microplastic pollution: Measuring local microplastic pollution.

Promoting solutions: Encourage students to think about and discuss potential solutions to microplastic pollution.

Hands-on activities: Filtration, working with microscope, production of a poster.

Fostering critical thinking: Encourage students to think critically about the topic. This could involve asking questions like "Why is reducing microplastic pollution important?" or "How can we balance the need for plastic usage with the need to reduce microplastic pollution?"

Creative expression: Poster production enables students to express ideas about microplastic in a creative way.

Encouraging advocacy: Empower students to become advocates for reducing microplastics production in their communities.

Connecting to the curriculum: Integrate the workshop with the school curriculum, linking it to subjects like science, environmental studies, or biology.

Age Group:

10 -14

Time:

90 minutes (two school lessons)

Materials:

Vacuum filtration equipment, water samples, microscopes, camera for microscope (optional), computer and projector, examples of microplastic (print outs or tablet/PC photos), multiple larger size papers (A2/A1), presentation

Introduction:

Microplastic pollution is a growing concern for the modern world, as its full impact on wildlife and human health is yet to be discovered. Microplastic is defined as extremely small pieces of plastic debris (less than 5 mm) in the environment resulting from the disposal and breakdown of consumer products and industrial waste.

Introduction: Time: 10 minutes	Students are asked to answer these two questions in their notebooks: 1. Have you ever heard of microplastics? (Yes/No) 2. How does microplastics occur in the environment? Students are then shown a video on microplastics, for example: https://www.youtube.com/watch?v=B_RBPAhx06w

Task 1: Time:10 minutes	Vacuum filtration apparatus is assembled and water samples are filtered. Pupils should be involved in assembly and filtration processes.
Task 2 Time: 20 minutes	Filtration paper is observed under the microscope, if available microscopic view is projected on the screen/projector. Printed photos of microplastics are handed to pupils divided in groups and used for microplastics recognition (alternatively tablet/PC can be used instead of print outs). Pupils in groups use given materials to compare particles found in samples with photos of microplastics. They write down their findings and a group representative proceeds to present the group findings to the class. All the observations are written in joint Padlet/on blackboard.
Task 3 Time: 5 minutes	Pupils are asked to clean their workspace and given homework. Homework: The pupils are asked to bring for the following lesson small pieces of plastic waste (e.g. chocolate wrapper) and newspaper cut outs or drawings of plastic items.
Task 4 Time: 10 minutes	In the beginning of a second school lesson, using the teacher's presentation, the origin of microplastics and possible impacts microplastic pollution has on human health and wildlife are discussed.

Task 5 Time: 20 minutes	The pupils are grouped again in teams up to four and each group gets blank paper A2 or A1 dimensions. Using materials that were brought as homework assignments each group produces a poster about plastic pollution, microplastics and ways it can be reduced.
Task 6 Time: 15 minutes	Using students' posters, solutions to microplastics pollution are discussed. Teacher encourages students to think about plastic consumption and ways they can advocate the implementation of the reduce-reuse-recycle rule in their households and local community.

Procedure:

Introduction

The pupils are asked to answer these two questions in their notebooks:

1. Have you ever heard of microplastics? (Yes/No)
2. How does microplastics occur in the environment?

Short verbal discussion is followed by viewing of a video on microplastics, for example:

https://www.youtube.com/watch?v=B_RBPAhx06w

Teacher explains that in this class microplastics will be extracted from waters in the school's vicinity (sea, lake, river) or if not applicable then samples should be taken from clothes washing or drying machine for example.

Task 1

Depending on the proximity of water bodies to the school, samples are collected during the school period or prior to it. Samples should be collected in larger quantities, at least 500ml. If there are no accessible water bodies near school, machine washer/drier water can be used for this exercise.

Vacuum filtration apparatus is assembled and water samples are filtered.

Note: Vacuum filtration apparatus can be assembled in different ways, professional equipment is not necessary (see the attachment on the end of lesson plan for an example where a syringe is used). Assembly process can be implemented as part of the teaching, so that pupils themselves try to come up with ideas on how to create a vacuum and engineer alternative solutions.

At least 500 ml of water should be filtered. Filtration paper should be moved with tweezers to a microscopic slide and observed under a microscope.

Task 2

Researching in groups

Divide the class in groups up to four. Depending on the available number of microscopes each group can be given their own filtration paper to observe, or a view from one microscope sample can be projected on screen/projector using a camera for microscope.

Teacher shows examples of microplastics and explains what should not be confused for microplastics (e.g. plankton or algae particles). Guides to microplastics recognition and identification can be easily found online, for example:

https://static1.squarespace.com/static/55b29de4e4b088f33db802c6/t/56faf38459827e51fccdfc2d/1459286952520/MERI_Guide+to+Microplastic+Identification.pdf

Printed photos of microplastics are handed to pupils and used for microplastics recognition (alternatively if available tablet/PC can be used instead of print outs). Pupils in groups use given materials to compare particles found in samples with photos of microplastics. They write down their findings and a group representative proceeds to present the group findings to the class. All the observations are compared as being written in joint Padlet/on blackboard.

Task 3

Pupils are asked to clean their workspace and given homework.

Homework: The pupils need to bring for the following lesson small pieces of plastic waste (e.g. chocolate wrapper) and newspaper cut outs or drawings of plastic items.

Task 4

In the beginning of a second school lesson using the teacher's presentation, the origin of microplastics and possible impacts microplastic pollution has on human health and wildlife are discussed. Since the research on health impacts are still being conducted, students are informed of the available discoveries.

Task 5

The pupils are grouped in teams up to four and each group gets blank paper A2 or A1 dimensions. Using materials that were brought as homework assignments each group produces poster about plastic pollution, microplastics and ways it can be reduced. Teacher encourages groups to think about these questions and incorporate answers to them in their posters:

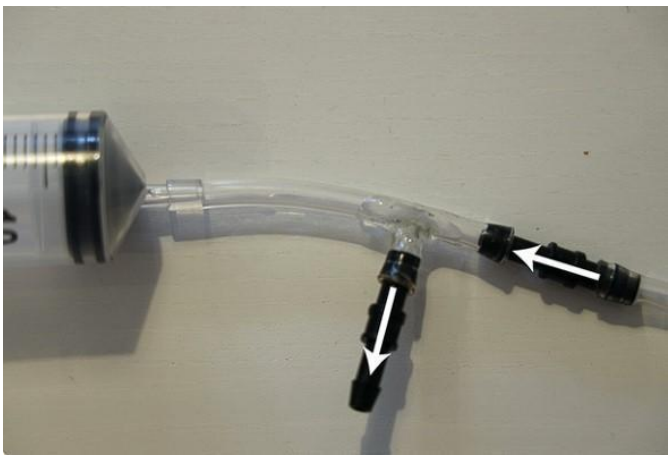
1. How are microplastics defined? 2. Where do microplastics come from? 3. Why are microplastics a larger environmental hazard than macroplastics? 4. What items are most

commonly discarded, contributing to plastic pollution? 5. How can we as individuals reduce microplastic pollution?

Task 6

Using students' posters, solutions to microplastics pollution are discussed. Teacher encourages students to think about plastic consumption and ways they can advocate the implementation of the reduce-reuse-recycle rule in their households and local community.

Anex: Example of adapted vacuum filtration system, using double sided valves and syringe.



Topic:

Renewable energy sources by Antea Žaja

Aims:

Understand Renewable Energy: Students will grasp the concept of renewable energy sources and how they differ from non-renewable sources.
Identify Types of Renewable Energy: Students will be able to recognize various types of renewable energy sources, such as solar, wind, hydroelectric, biomass, and geothermal.
Evaluate Benefits: Students will assess the advantages of using renewable energy, including environmental benefits and sustainability.
Engage in Hands-on Activities: Through scavenger hunts and discussions students will actively participate in learning about renewable energy.
Encourage Critical Thinking: The lesson plan aims to stimulate critical thinking skills by prompting students to consider the impacts of different energy sources on the environment and society.
Promote Awareness: By the end of the lesson, students should have an increased awareness of the importance of renewable energy for a sustainable future.

These aims guide the lesson plan to ensure that students not only learn about renewable energy sources but also engage with the material in a meaningful way, fostering curiosity and understanding about this vital topic.

Age Group:

12-14

Time:

90 minutes

Materials:

Visual Aids:
• Posters or images of solar panels, wind turbines, hydroelectric dams, biomass facilities, and geothermal plants
Handouts:
• Informational handouts about each type of renewable energy source
Manual Materials:
• A3 blank papers • Markers • Cardboard (cut into squares) • Aluminum foil • Black construction paper • Glue • Scissors
Technology:
• Computer or tablet for showing videos or virtual tours of renewable energy facilities • Internet access for research or virtual field trips

The link of the worksheet which will be used:

Introduction:

Procedure:

Introduction: Time: 15 minutes	Students will be shown informative video on renewable energy sources: https://www.youtube.com/watch?v=1kUE0BZtTRc After the video, students will be divided into groups. Each group must state new informations they have learned from this video that they did not know before and some informations about renewable energy sources they knew but were not mentioned in the video.
Task 1 Time: 30 minutes	Students will stay in their divided groups. Each group will get informational handouts about each type of renewable energy source. Then they will be given A3 papers with headlines – each group will get one renewable energy source. Their task will be to explain how certain source generate energy and explain benefits for environment. Then each group will present their poster to the rest of the class.
Task 2 Time: 15 minutes	Energy Scavenger Hunt: Each student will get a list of items related to energy use (annex 1) Students have to find and mark items in the classroom that use energy. Then it will be discussed which items could use renewable energy alternatives.
Task 3 Time: 30 minutes	DIY Solar Panel Model (annex 2) By now students have learnt what solar energy is and how it is used. For this workshop each student will be given materials needed to make solar panels. Then solar panels will be tested and finally a discussion will be developed on the importance and understanding of solar energy.

Annex

ENERGY SCAVANGER HUNT – LIST OF ITEMS:

Lights:

- Overhead lights
- Desk lamps

Electrical Outlets:

- Plugged-in devices (computers, chargers, projectors, etc.)

Appliances:

- Computer
- Printer
- Projector
- Fans
- Air conditioner/heater
- Refrigerator (if in a classroom or nearby staff room)

Electronic Devices:

- Tablets
- Smartboards
- Calculators
- Speakers

Window Blinds/Curtains:

- Used to control sunlight, affecting heating and cooling needs

Doors:

- Opening and closing affects heating and cooling

HVAC Vents:

- Heating, ventilation, and air conditioning system

Whiteboards/Chalkboards:

- Used for teaching but don't consume energy directly

Clocks:

- Electric clocks on the wall

Extension Cords and Power Strips:

- Used for plugging in multiple devices

Rechargeable Batteries:

- Used for devices that require batteries (remote controls, wireless mice)

Thermostat:

- Controls the heating and cooling system

Ceiling Fans:

- If present, they use electricity to operate

2. DIY: SOLAR PANEL MODEL

Materials needed:

- Cardboard (cut into squares)
- Aluminum foil
- Black construction paper
- Glue
- Scissors
- Markers
- Sunlight (for testing)

Workshop Steps:

1. Making the Solar Panel Model (15 minutes)

- Provide each student with a cardboard square (approx. 6x6 inches).
- Instruct them to cover one side of the cardboard with aluminum foil.
- Next, have them cut out small squares or rectangles from the black construction paper.
- Glue these black squares onto the aluminum foil-covered cardboard to represent solar cells.
- Optionally, they can draw "wires" connecting the cells together with markers.
- Encourage creativity and exploration as they design their solar panels.

2. Testing the Solar Panel (10 minutes)

- Take the students outside to a sunny area.
- Have them hold their solar panels facing the sun.
- Ask them to observe what happens to their solar panel model when exposed to sunlight.
- Discuss how the black cells absorb sunlight (represented by the aluminum foil) and how this creates energy.

3. Understanding Solar Energy (5 minutes)

- Gather the students back inside.
- Ask them questions:

- "What happened when we put our solar panels in the sun?"
- "What do you think we can use this solar energy for?"

- Explain how solar panels on roofs can power homes and schools with electricity.
- Emphasize the importance of sunlight as a renewable energy source.

Topic:

Waste menagement by Renata Cvetkoski

Aims:

1. Environmental protection: Waste management helps protect the environment. By learning how to properly dispose of waste, children become aware of the importance of recycling, reducing waste and reusing materials. This can reduce air, water and soil pollution and preserve natural habitats and biodiversity

2. Waste reduction: Learning about waste management encourages children to think about ways to reduce the amount of waste they produce. This includes being aware of packaging, avoiding the use of single-use products, repairing and donating things instead of disposing of them. Through such practices, children develop waste reduction habits that they can apply later in life.

3. Human health: Improper disposal of waste can have harmful effects on human health. Teaching children about proper waste disposal, separation of hazardous waste and keeping the environment free from pollution helps create a healthier environment for all of us.

4. Economic aspects: Efficient waste management can have a positive impact on the economy. Recycling and reuse of materials reduce the need to produce new raw materials, save resources and energy, and create opportunities for the development of green industries and new jobs.

5. Civic responsibility: Learning about waste management encourages children to understand the importance of their own role in preserving the environment. It empowers them to take responsibility for their actions and make informed decisions to contribute to a sustainable future.

Age Group:

10 -14

Time:

45 minutes (one school lesson)

Materials:

Clean paper, disposal boxes, pencils, cards with waste drawings

Introduction:

Introduction: Time: 10 minutes	Garbage or waste? Description of the activity: Prepare different objects or pictures that represent different types of waste and garbage, such as paper, plastic, metal, glass, and the like. Place two boxes in the classroom. Write "Garbage" on one and "Trash" on the other. Explain to the students that they will be tasked with sorting the objects or pictures into the appropriate bins according to their type.
Task 1 Time: 10 minutes	There are three basic elements of waste management: 1. Avoidance of waste generation 2. Evaluation of waste 3. Disposal of other waste Divide the students into small groups and assign two slips of paper to each group. Handout 1: Give examples of how you can reduce the amount of items you buy/consume. Handout 2: Give examples of how you can reuse objects. One representative from each group reads the answers. We discuss these ideas together.
Task 2 Time: 25 minutes	Recycling relay In their groups, students compete in a recycling relay.

Procedure:

Introduction

Icebreaker:

Garbage or waste?

Description of the activity:

Prepare different objects or pictures that represent different types of waste and garbage, such as paper, plastic, metal, glass, and the like.

Place two boxes in the classroom. Write "Garbage" on one and "Trash" on the other.

Explain to the students that they will be tasked with sorting the objects or pictures into the appropriate bins according to their type.

Divide the students into smaller groups and give each group a set of objects or pictures of waste to sort. Encourage them to collaborate and discuss within their groups to make decisions about proper waste sorting.

When they have finished sorting, review their work and check together that they have sorted the waste correctly.

Discuss the importance of proper waste sorting and recycling and how it helps to protect the environment.

This activity will help students visually identify different types of waste and understand the importance of sorting them correctly. It will also encourage teamwork and encourage conversation about recycling and environmental conservation.

Explain to them that waste is not a pile of useless substances. These are insufficiently discovered sources of raw materials and energy.
Unfortunately, waste is a problem of modern civilization and a central problem of environmental protection.

Task 1

Explain to students that there are three basic elements of waste management:
1. Avoidance of waste generation
2. Evaluation of waste
3. Disposal of other waste

Divide the students into small groups and assign two slips of paper to each group.
Handout 1: Give examples of how you can reduce the amount of items you buy/consume.
Handout 2: Give examples of how you can reuse objects.
One representative from each group reads the answers. We discuss these ideas together.
It is important for students to understand that there can be much less waste than there is in their households.

Task 2

Recycling relay

On one table of the classroom or in the yard in front of the school, there are four boxes in different colors of the recycling waste disposal site, and at the other end, about 10 meters away or more, there is a table with a waste box.

Divide the students into several teams. each team has four members. Each team has a recycling box available from the introductory part of the hour, the icebreaker.

The first member of the team takes a random card from the recycling box and runs with the card to the corresponding container and inserts the card.
After that, he runs back to the next member of his team who takes a new card from the recycling box.
A new team member runs with a card to the appropriate container, inserts the card and the whole process repeats until all the cards are gone.
After that, another team follows.

The winning team is the one that has achieved the largest number of correctly sorted cards into the appropriate containers.

Topic:

DOMESTIC SOLID WASTE SEGREGATION FACILITY

Aim:

- To enable students to gain awareness of waste management in the context of climate change and its effects.
- To enable students to produce solutions to the knowledge-based life problem, enabling them to realize learning in technology and design, mathematics and science.
- To enable students to develop a model on waste management using mathematical science and engineering processes.

Age Group:

12-13 years old

Time:

12 hours of teaching

Materials:

Computer, notebook, colored pencils, plastic, glass and metal waste, water, ruler, tape measure,

Introduction:

ENGINEERING DESIGN SKETCHBOOK
SESSION 1: Understand the problem.
SESSION 2: Set goals in line with the problem.
SESSION 3: Come up with simple visual design.

SESSION 4: Explore new skills and ideas.
SESSION 5: Discuss teamwork.

SESSION 6: Design the innovative model.
SESSION 7: Listen carefully to the ideas of other groups.
SESSION 8: Compete in a friendly way. Remember that learning is more important than winning.
SESSION 9: Make reviews and improvements.
SESSION 10: Plan the Presentation.

Procedure:

Introduction: Time:(3 x40 min)	Read news about the impact of household waste on climate change. Study of the effects of domestic waste on climate change. In the light of the findings obtained from the researches, determination of the problem situation and creation of research questions.
Task 1 Time: 2x40 min.	And explore what is inside the house. Research the efficiency percentages of current waste management methods. Research the working principle of the waste separation system to be designed and the method to be used Determine the working principle for the separation of different densities of substances and materials of the system to be designed Table graph of the data obtained for the system to be designed, etc. express with.
Task 2 Time:2x40 min.	Presentation of data on environmental issues and waste management Presentation of the data obtained for the separation of mixtures.
Task 3 Time: 3x40 min.	Creation of the efficiency of the designed waste management system and the functions of the profit loss relationship. Drawing of the prototype of the prepared design. Handling of the prepared design according to the principles of separating mixtures. Evaluation of the working principle of the prototype. Preparing the prepared design for presentation.
Task 4 Time:2x40min.	Banner, poster, etc. presentation with. Evaluation of the designs of different groups through the prepared rubric. Calculation of the efficiency percentages of the design of each group.

Title:

I AM DESIGNING A NEW GENERATION POWER PLANT

Objective:

*To make students aware of the importance of decreasing energy resources as a result of global warming and climate change
*To enable them to learn innovative applications of renewable energy in daily life and technologies
*To enable students to follow the design processes with the right techniques using appropriate tools, materials and materials

Age Group:

12-13

Time:

10 lesson hours

Ingredients:

Solar panel, servo motor, ruler, paper, scissors, cardboard, glue, Arduino sets and computer

Link to the worksheet to be used:

https://drive.google.com/file/d/1d_2m9DMo3jeZyBd_5AKvUjbkb5k3JLq2/view?usp=sharing

Procedure:

Introduction: Time:	*A scenario is projected to the students with a slide. There is a problem in this scenario. It is ensured that all students realise the problem so that they can produce solutions to this problem.
Task 1 Time:	*They are provided to do research on the subject in order to produce a solution proposal for the problem. *Examination of case studies on energy production types and renewable energy is provided.
Task 2 Time:	*The best solution proposal is determined by brainstorming between the groups established among the solution proposals produced, and drawings and calculations are requested for the system to be built. *The drawn design is asked to pay attention to its conformity to the rules of science, engineering, technology, mathematics (STEM) and to reach the importance of the unity of different disciplines.
Task 3 Time:	*The construction phase of the drawn system is started and the students are enabled to realise the design with the instructions. *It is investigated how the system of conversion of solar energy into electrical energy is realised. *It is ensured that trials are made to place the panel in a way that will provide the highest efficiency from solar energy. *A simple circuit is designed with Arduino so that solar panels can obtain maximum efficiency from the sun. The photosensitive system follows the movement of the sun and the solar panels are rotated towards the light with the help of servo motors.
Task 4 Time:	*The model solar panel is designed and placed on the roof of a model house and the operation of the system is monitored. *It is ensured that the obtained energy production is tabulated with data. *Presentation is prepared for the package solar power plant and the products are evaluated.

Title:

INTELLIGENT IRRIGATION SYSTEM DESIGN

Purpose:

* To ensure that proposals for solutions to the water problem, which is one of the consequences of increasing climate change, are discussed.
* To draw attention to the importance of water saving and raise awareness of the water-related problems we will face in the future.
* Demonstrate that you can solve problems in daily life with STEM activities.

Age Group:

11-13

Time:

10 hours of teaching

Materials:

Computer, notebook, paper, cardboard, stretch film, textile twine, plate, cup, double-sided tape

Link to the worksheet to be used:

https://tryengineering.org/what-kind-of-engineer-are-you/

Procedure:

Input: Time:	* Classes are divided into groups. Ask them to gather information about the importance of water. Attention is drawn to the concept of water scarcity, which expresses the reduction of water to the extent that it is not sufficient for the needs of all living things. * Water is one of the risk factors that threaten the world. * They are asked to develop solutions with brainstorming to solve this problem.
Task 1 time:	* Students are asked to develop a watering system that will save water. * In the design process, engineers are investigated how they previously developed the irrigation system. * It is ensured that they provide the materials to create the designs they develop and install the necessary equipment and systems.
Task 2 time:	* Model systems made using engineering and design knowledge are tested with a few trials. * The irrigation system is ensured to show the expected effect and the difference between it and wild irrigation is revealed. * The results obtained are shown with tables and graphs.
Task 3 time:	* Because this system data is more efficient than wild irrigation, intelligent irrigation designs are evaluated with all the details.

Topic:

Is thermal insulation profit or loss?

Aim:

- To enable students to understand the importance of thermal insulation and energy savings.
- To enable students to gain awareness about thermal insulation energy savings.
- To enable students to make calculations that are appropriate for everyday life problems using the concepts of profit loss and cost.

Age Group:

12-13 years old

Time:

10 hours of teaching

Materials:

Computer, activity sketches

Procedure:

Introduction: Time: 2x40 dk.	• Students are asked to do research on thermal insulation after separation. • What are the materials used in thermal insulation? , • Where should the heat insulation be used? • In which cities is it necessary to build thermal insulated houses in our country? • Is heat insulation only used in cold weather?

	• Students are asked to do research to find answers to these questions.
Task 1 Time: 2x40 dk.	• The groups present their knowledge of thermal insulation in the classroom by presenting it in presentations and posters, in other groups.
Task 2 Time: 2x40 dk.	• For example, research on how the thermal insulation should be for two houses with the same characteristics. • Determination of materials to be used as thermal insulation and investigation of thermal insulation coefficients. • According to the researches obtained, the insulation materials to be used for both houses are determined. • Determination of the prices of specified insulation materials. • Researching the labor price for thermal insulation.
Task 3 Time: 2x40 dk.	• Students are asked to prepare a thermal insulation plan for two houses Turkiye in Erzurum and Muğla, in the light of the data obtained in the previous stage. • According to the prepared plan, the cost for thermal insulation materials is determined. • The cost of the energy savings to be made if the thermal insulation is done is calculated. • The amortization period is determined by taking into account the cost of thermal insulation and the savings to be obtained from thermal insulation on an annual basis.
Task 4 Time: 2x40 dk.	• After all the work, the groups are asked to prepare a report for thermal insulation. • The report should include all the details of an insulation proposal for Erzurum and Muğla. • After students have watched the presentation of each group, a peer assessment will be conducted. • Students will prepare recommendations for thermal insulation according to regions and climatic conditions for the whole of our country. The course will end with the determination of these suggestions with the participation of the entire class in the classroom environment.

Topic:

MY CARBON FOOTPRINT IS SHRINKING

Aim:

- To enable secondary school students to gain awareness of their individual carbon footprint and climate change.
- To enable students to produce solutions to the knowledge-based life problem, enabling them to realize learning in technology and design, mathematics and science.
- Develop students' problem-solving skills.
- To enable students to develop a life model aimed at reducing their individual carbon footprint.

Age Group:

12-13 years old

Time:

12 hours of teaching.

Materials:

Each group has a computer, sketches, carbon footprint information test, carbon footprint measurement test.

The link of the worksheet which will be used:

- https://www.carbonfootprint.com/calculator.aspx
- these web pages can be used with the translation tool.

Procedure:

Introduction: Time: 2x40dk.	• The classroom is informed by digital media coverage on the students' carbon footprint and global climate change. • The news is read in the classroom, allowing students to show curiosity about their carbon footprint. • Students are provided with knowledge of the carbon footprint, the situations that reveal the carbon footprint, and the carbon footprint to address global climate change. • The current situation of the students is determined by applying the carbon footprint information test to the students.
Task 1 Time: 3x40dk.	• Students are allowed to form teams by dividing them into groups. • Each group is given a carbon footprint calculation test, allowing students to calculate their current carbon footprint. • The aim of this task is to enable students to learn about the factors that make up their carbon footprint. • Students are expected to do their carbon footprint calculations with the test they found as a result of their research. • Each group is asked to show the data for a human's carbon footprint with a circle graph.
Task 2 Time:	• After each group completes their calculations with their own carbon footprint calculation tests, they are asked to do research on different

2x40dk.	calculation engines and compare the results. • Students are allowed to note the results they have received from different tests and express the data with tables and graphs.
Task 3 Time: 2 x40min	• Each group of students is asked to present the data they have obtained in the classroom. • Groups are asked to discuss the data they have reached as a result of their research in the classroom.
Task 4 Time: 3x40dk.	• As a result of their calculations and presentations, students are asked to propose a life model for reducing their carbon footprint. • In the model, students are expected to create a chain of recommendations for what to consider in a person's daily life cycle and what to do to reduce their carbon footprint to zero. • The carbon footprint of the developed life model is calculated. • Reductions to the newly modelled carbon footprint are calculated as a percentage. • Finally, what behaviors the students have created with the new model of carbon footprint (tree planting, etc.) calculations that can be eliminated. • The developed life model and the information obtained are requested to be prepared and presented as posters in canva software. • The activity ends when groups evaluate each other's models.

Title:

OIL SPILLS ARE NO PROBLEM

Purpose:

Designing a product necessary for cleaning up oil residues and spills, which is one of the most important causes of environmental pollution.
He will realize how dangerous oil is for the natural environment.
With STEM activities, a stop solution proposal that damages the natural environment will be developed.

Age Group:

12-13

Time:

10 hours of teaching

Materials:

Small plastic bowls and aluminium containers, water, oil and products, plastic tape, paper towels, toothpicks, cotton containers plastic packaging, balloon, spoon.

Link to the worksheet to be used:

https://www.youtube.com/watch?v=0YVGm8cOSdA

Input: Time:	The class is divided into groups of 5.6 and the class is presented with a presentation about the effects of fossil fuels on the natural environment. Every group should be aware of this. In addition, a scientific report on the oil spills and their effects is created.each group is investigated in the light of this information what the cleaning operations are in the event of a real leak.the videos about the studies are watched.
Task 1 time:	Each group is asked to design a product to clean up the pollution caused by an oil spill based on this information.
Task 2 time:	Engineering design processes design difficulty and criteria, difficulty and criteria of limitations to be compared, constraints to be compared are reviewed. The brainstorming method outlines the cleaning stages and what materials they will use. The groups are explained that they must develop a system that clears the spilled oil from the system that contains an oil spill. it is said to remove as much residue as possible without spilling.
Task 3 time:	Students come together for restraint and cleaning systems and develop a plan. They understand the materials they need, they plan. They develop their designs and express them with drawing. They then create the systems they design using materials.
Task 4 time:	Each group first shows how to control spilled oil using containers and water. They then show how their system cleans the spilled oil, and finally, how much the system cleans the spilled oil is evaluated using scale and the results are compared in class.

Topic:

Biowaste - Circular Bioeconomy

Aim:

The main aims are:

- Understand the impact of organic wastes in environment and climate change.
- Raising awareness about the methods used to re-use and transform orange waste into new value bioactive compounds
- Know the maintechnology used for extraction of essential oilsto valorize organic waste before going to landfills
- Learn which are the possible uses of the recovered essential oils from orange waste
- Acquire knowledge about circular bioeconomy concepts
- Hands-on-activities with an experimental lab experience
- Encourage students to think and discuss about solutions to solve and minimize the production of organic wastes with a critical thinking.

Students will gain the following skills through this activity:

- Practical experience and knowledge how technology can minimize the problem
- Understand several concepts and definitions link to the circular bioeconomy.
- Understand how an irresponsible production and consumption affects us and the environment
- Able to identify the main strategies of circularity
- Understand the role of chemistry and concepts before starting the practical experiment

Age Group:

15-18

Time:

90 minutes (the lesson is divided in two periods: Part I (20 minutes to learn about the topic)- Part II (70 minutes for a practical experiment)

Materials:

Part I: 20 minutes
Computer**/**internet
Part II: 70 minutes
Reagents: Organic waste (3 oranges peel recovered from the canteen or house);ice; 150 mL of distilled water;

Equipment: Eye protection; Universal support and 2 claws;250 mL round-bottomed flask; Heating mantle; Thermometerup to 110°C; Strainer; Distillation head; condenser; elevator; plastic funnel; Squirt bottle with distilled water; Pasteur pipette; 100 mL separating funnel; 150 mL beaker; Spatula; 10 mL vial.

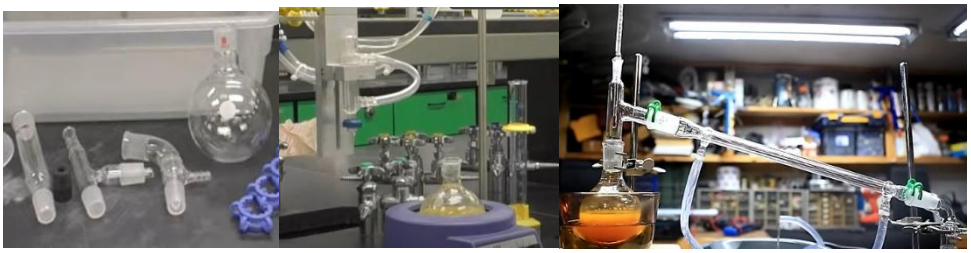
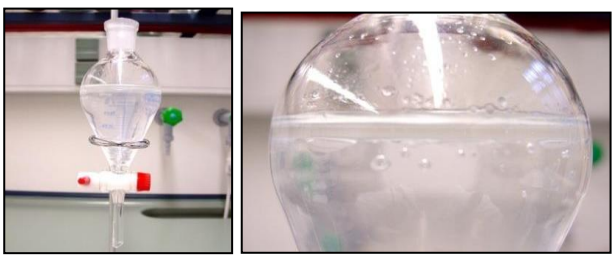
The link of the worksheet which will be used:

Introduction:

According to the European Environment Agency, the large amount of food waste is a serious problem in the European Union. More than 89 million tonnes of waste is produced every year in Europe without any kind of recovery or recycling, causing serious environmental pollution problems. Oranges are the second most important species in fresh fruit production, accounting for 24% of the total volume of citrus fruit, with a contribution of 355,000 tonnes/yearresulting in large quantities of orange peel waste. This problem is particularly acute in school canteens, restaurants and other shops specialised in fresh fruits and drinks, where large quantities of orange waste are generated, without any reuse or recycling.

Procedure:

Part I Introduction: Time: 10 minutes	The first period will be theoretical exploration.The teacher will introduce and explain the topic of circular bioeconomy, organic wastes and their impact in environment and climate change.The teacher engages the students to discuss, in a few words, what they know and understand about organic waste, circular economy and circular bioeconomy
Time:10mi nutes	Studentswill watch the video link given to them by the teacher to enhance their knowledge, complete and explore the topic. Link video 1: https://www.youtube.com/watch?v=ishA6kry8nc Link video 2:https://www.youtube.com/watch?v=hx-jZmE-2_U Based on the videos the students are asked twoquestions to discuss, giving to the student a better understanding of the impact of biowaste in climate change. *What is the relationship between waste and climate change?* *How much does waste contribute to climate change?*
Part II Task 1 Time: 15 minutes	In the second period the class will be split up into teams consisting of three to four students. They will work within their teams to complete the practical activity. In order to understand the complete experimental procedures, they will watch the video 3 with the link https://www.youtube.com/watch?v=xswsgkQXPqMand video 4 https://www.youtube.com/watch?v=o4CBXkfVHDc **Preparation of the sample:** 1-Wash the oranges waste recovered from the organic waste at home or at the canteen 2-Grate 3 oranges wasteandput it into a beaker with 150 mL of distilled water. 3-Pour the mixture into a round-bottomed flask using a funnel.

	1  2  3 
Task 2 Time: 40 minutes	4-Assemblythe steam distillation apparatus following the procedure **video 3**in task1 5-Put a plastic water inlet pipe at the bottom of the condenser and a water outlet pipe at the top of the condenser for the circulation of cold water. 6-Put on the heating mantle and open the circulation of cold water 7-Put a beaker containing distilled water at the end of the extension of the condenserwhich should be immersed in an ice bath. 8- Perform hydro distillation at a ratio of 1:3 (weight oranges/volume water) for 3 hours at boiling temperature (the peel of oranges is boiled in water and the oil produced (limonene) distilled in steam at a temperature just below 100°C) 9-Switch on the heating mantle and open the water inlet. 
Task 3Time:15 minutes	10-Collect de essential oil and water from the beaker and put it into the separating funnel for decantation and separation of the two layers. 11-Collect the essential oil (organic layer on the top of the separating funnel) in a flask.  At the end of the experiment, each group will carry out a presentation to justify their conclusions.Students will research real life applications of what they have learned.

Topic:

Exploring the Greenhouse Effect and Its Impact on Earth Temperature

Aim:

1.- To understand the mechanism of the greenhouse effect and its role in regulating Earth's temperature.
2.- To observe the effect of increased greenhouse gas concentration on temperature.
3.- To explore how human activities contribute to the intensification of the greenhouse effect.
4.- To reflect on the environmental consequences of an enhanced greenhouse effect and discuss potential mitigation strategies.

Age Group:

15– 18 years

Time:

90minutes

Materials:

THEORETICAL PART:
Computer and projector

PRACTICAL PART:
Specified in each of the experiments.

The link of the worksheet which will be used:

Procedure:

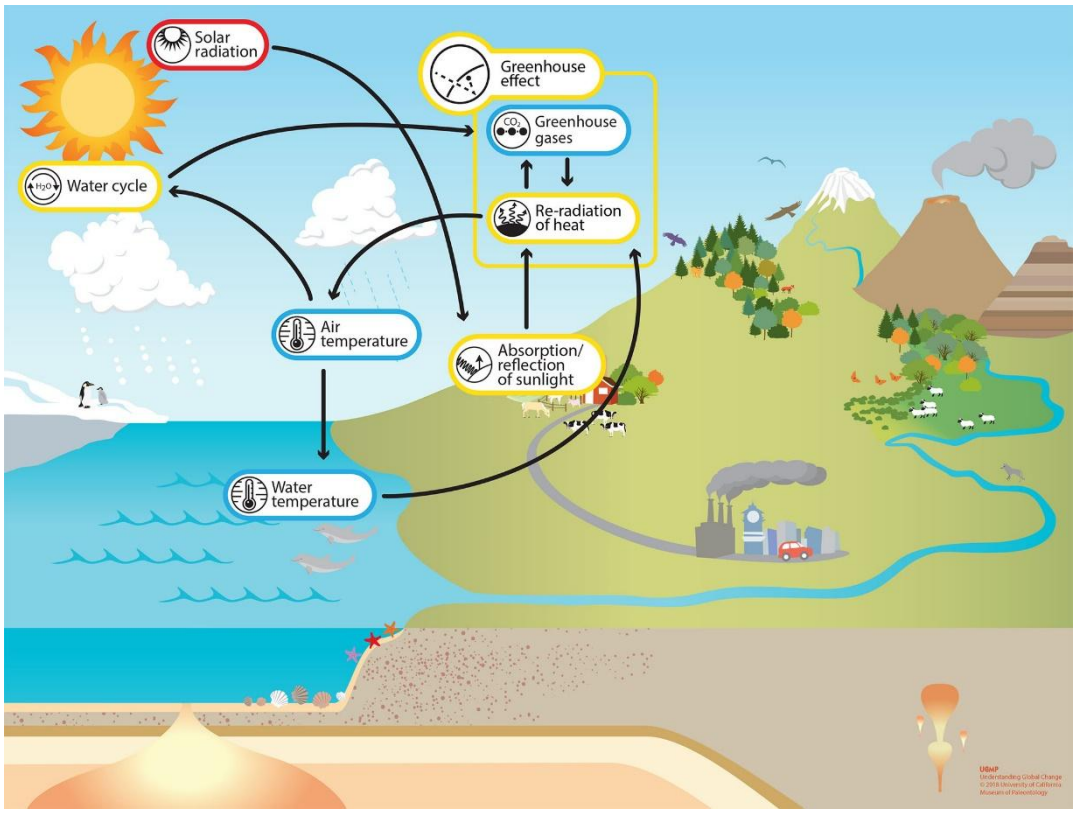
Introduction: Time: 10 minutes	**1.-**The greenhouse effect is a fundamental mechanism that regulates Earth's climate, but its intensification due to human activities has led to profound implications for global climate change. To grasp the complexities of this phenomenon, let's delve into a conceptual analogy that parallels the greenhouse effect with the carbon cycle, shedding light on its intricate dynamics and environmental consequences. The Greenhouse Effect Explained (youtube.com)and/or The Greenhouse Effect (youtube.com)
Task 1 Time: 20 minutes	**2. –**In the context of climate change, the greenhouse effect acts as a crucial regulator of Earth's temperature, analogous to the carbon cycle's role in maintaining atmospheric carbon dioxide (CO_2) levels. Just as CO_2 serves as a key player in the carbon cycle, facilitating the exchange of carbon between various reservoirs, the greenhouse effect governs the exchange of thermal energy between Earth's surface and its atmosphere. Initially, solar radiation penetrates Earth's atmosphere, warming its surface and triggering the emission of infrared radiation. Similarly, carbon compounds circulate through the carbon cycle, transitioning between atmospheric, terrestrial, and aquatic reservoirs through processes like photosynthesis, respiration, and decomposition. As infrared radiation attempts to escape into space, greenhouse gases, such as CO_2, methane (CH_4), and water vapor (H_2O), intercept and absorb this energy, effectively trapping heat within the atmosphere. Analogously, carbon compounds in the carbon cycle undergo transformations, with CO_2 acting as a primary greenhouse gas responsible for regulating Earth's energy balance. In this dynamic interplay, human activities, such as fossil fuel combustion and deforestation, have perturbed the delicate balance of the greenhouse effect, akin to disruptions in the carbon cycle caused by anthropogenic emissions. The increased concentration of greenhouse gases in the atmosphere amplifies the greenhouse effect, leading to global warming, altered weather patterns, and other manifestations of climate change. Like the intricate feedback loops within the carbon cycle, the greenhouse effect engenders a complex web of interactions that transcend geographic and temporal boundaries, profoundly influencing Earth's climate system. Understanding these parallels between the greenhouse effect and the carbon cycle is essential for elucidating the drivers of climate change and devising strategies to mitigate its impacts on ecosystems, societies, and future

	generations.
Task 2 Time: 30minutes	Experience 1: **Investigating Carbon Dioxide Levels** (This experience can be carried out in any space; no special conditions are required) AIM To investigate the relationship between carbon dioxide levels and temperature by observing the effects of photosynthesis on atmospheric carbon dioxide concentration. FRAMEWORK Carbon dioxide (CO_2) is a greenhouse gas that plays a crucial role in regulating Earth's temperature. Through the process of photosynthesis, plants absorb CO_2 from the atmosphere, converting it into oxygen and organic compounds. By monitoring temperature changes in the presence of plants, we can explore how photosynthesis influences CO_2levels and atmospheric heat retention. MATERIAL Potted plant or container with soil. Lamp or light source. Thermometer. Watering can. Stopwatch or timer. Notebook and pen PROCEDURE Select a potted plant or prepare a container with soil suitable for growing plants. Place the plant or container in a well-lit area where it can receive sunlight or artificial light from a lamp. Measure the initial temperature of the environment surrounding the plant using a thermometer. If using artificial light, position the lamp above the plant to simulate sunlight exposure. Water the plant as needed to ensure it remains healthy and hydrated throughout the experiment. Use the stopwatch or timer to monitor the duration of the experiment.

	Periodically record the temperature of the environment surrounding the plant at regular intervals (e.g., every hour) throughout the experiment. Observe any changes in temperature over time and note any patterns or trends. After a sufficient duration has passed (e.g., several hours or days), conclude the experiment and record the final temperature reading. Analyse the data collected to determine if there is a correlation between photosynthesis, carbon dioxide absorption, and temperature changes. Consider additional factors that may influence temperature fluctuations, such as ambient conditions and plant metabolism. Reflect on the significance of plants in regulating atmospheric CO_2 levels and their role in mitigating climate change. Discuss potential implications of the experiment's findings and explore avenues for further research or action.
Task 3 Time: 40 minutes	Experience 2: Measuring the Heat Absorption of Different Surfaces Begin by preparing three identical small boxes or containers. Paint the inside of one box white to represent a high-albedo surface, the inside of another box black to represent a low-albedo surface and line the inside of the third box with aluminium foil to represent a reflective surface. Place a thermometer inside each box. Measure and record the initial temperature inside each box before starting the experiment. Position all three boxes under a lamp or in a sunny area where they can receive consistent light exposure. Ensure the lamp is at an equal distance from all boxes to guarantee uniform light exposure. Using a stopwatch or timer, record the temperature inside each box at regular intervals (e.g., every 10 minutes) over a set period. Carefully note all temperature readings in a notebook, including the time and the temperature in each box. After completing the observations, compare the temperature changes in the white-painted box, the black-painted box, and the aluminium foil-lined box. Analyse the data to understand how different surfaces absorb and retain heat. Reflect on the results and discuss how surface colour and material affect heat absorption and retention. Relate the findings to real-world scenarios, such as urban heat islands, where dark surfaces like asphalt increase local temperatures. Discuss the implications of the albedo effect on global warming and climate

	change, emphasizing the importance of reflective surfaces in reducing heat absorption. Summarize the findings and relate them to the broader context of the greenhouse effect and climate change. Encourage students to think about practical applications, such as using light-coloured roofing materials or reflective surfaces to mitigate heat absorption. For further exploration, experiment with additional surface materials, such as grass or sand, to observe their impact on temperature changes. Investigate the effects of different light intensities or durations on temperature changes and explore the role of surface texture in heat absorption and retention.
Task 4 Time: 20 minutes	Time for conclusions; create debate among students, focusing on possible (effective mitigation) measures.

Annexe


Solar radiation
Greenhouse effect
Greenhouse gases
Water cycle
Re-radiation of heat
Air temperature
Absorption/ reflection of sunlight
Water temperature

Topic:

Ocean acidification

Aim:

1.- Understand the interaction between the atmosphere and the ocean as a transfer of energy and mass. 2.- Explain the reactions that exist in aqueous medium (chemistry of aqueous solutions), the transformation of substances and their abiotic and biotic consequences. 3.- Implications of small variations in ocean pH 4.- Introduce the adaptive processes of species and the importance of disturbing organisms that are at the base of the food chain.

Age Group:

15-18 years

Time:

90 minutes

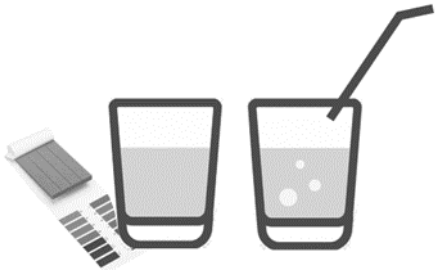
Materials:

THEORETICAL PART: Computer and projector PRACTICAL PART: Specified in each of the experiments.

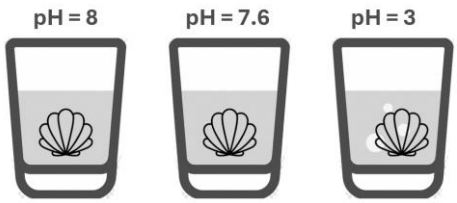
The link of the worksheet which will be used:

Procedure:

Introduction: Time: 10 minutes	**1.-**Introduce the topic with the anthropogenic export of CO_2 to the atmosphere. Converging towards the exchange of gases between the atmosphere and the ocean. https://www.youtube.com/watch?v=L2bxwnm7JG4
Task 1 Time: 20 minutes	**2.-**Explain how a CO_2 molecule reacts with an H_2O molecule, recalling the chemistry of aqueous solutions and the balance of the chemical equation by the law of conservation of mass. Introducing the carbonated system: CO_2 (g) ⇆ CO_2 (aq) CO_2 (aq) + H_2O ⇆ H_2CO_3 H_2CO_3⇆ H^+ + HCO_3^- HCO_3^-⇆ H^+ + CO_3^{2-} Ca^{2+} + CO_3^{2-}⇆ $CaCO_3$ The marine carbonate system involves the atmosphere, the ocean water column, and the marine sediment. The interaction of gases present in the atmosphere with the ocean surface allows carbon dioxide (CO_2) to be transferred to the marine water column, as characterized by the first reaction in the carbonate system. The dissolved carbon dioxide reacts with the water molecule to form carbonic acid (H_2CO_3). As this is a weak acid, it will look for a more stable form. As such, the molecule dissociates to produce a hydrogen cation (H^+) and a bicarbonate anion (HCO_3^-). This can lose a further H^+ cation to form the carbonate anion (CO_3^{2-}). Finally, it can react with seawater's calcium ion (Ca2+) to form calcium carbonate ($CaCO_3$). The last reaction in this system is fundamental for the maintenance of various calcareous organisms present in the ocean, i.e. those that present calcium carbonate structures. Examples of these structures in the ocean are mollusc shells and coral reefs. https://www.youtube.com/watch?v=IPuDEMnG4RA

Task 2 Time: 20minutes	Experience 1: **Variation of pH (acidity) with CO_2** (This experience can be carried out in any space; no special conditions are required) AIM *Visualize the action of CO_2concerning the acidification of the aquatic environment (ocean) and relate this effect to the increase in atmospheric CO_2 concentration.* FRAMEWORK *Atmospheric CO_2 is absorbed by the aquatic environment in large quantities, making seas and oceans an important sink in the fight against climate change. However, this process causes an acidification of this medium due to the above view (in the theoretical part).* MATERIAL A few glasses, straws, water, and material to measure the pH. PROCEDURE Place two glasses halfway filled with water. For those measure the pH with a measuring system (litmus paper, pH meter…) and register the values. Then, with the help of 2 or 3 straws (one per participating student), air is blown intothe water in one of the glasses, bubbling the water for a few minutes (3-4). Once this time has passed and having injected air and therefore also CO_2 from breathing, into the water, measure the pH of both glasses of water again. The two results obtained are compared. 

Task 3 Time: 20 minutes	Experience 2: **Impacts of ocean acidification on organisms with calcium carbonate structural systems** (This experience can be carried out in any space; no special conditions are required) AIM: • *Perceive the effect caused by the acidification of the aquatic environment on living organisms that have to incorporate calcium carbonate ($CaCO_3$) in their structural system.* • *Relate this effect to alterations in ecosystems, biological communities, and food chains.* FRAMEWORK The acidification process causes in aquatic organisms that present calcareous structural systems (shells, shells, cuticles...), fragility in these structures. These alterations cause the reduction of specimens or make them more sensitive to other alterations. This means that the biological communities and the food chains where these organisms are found are also altered, affecting the ecosystem as a whole. MATERIAL Shells (or eggshells), glass containers, vinegar (if possible colourless), water, salt (optional), material to measure the pH, precision scales (if you want to calculate the difference in mass of the shells) PROCEDURE Weigh the shells/eggshells (dried). Identify the three glasses and insert an eggshell into each of them. In the glass 1, cover the shell with water. In glass 2, cover the shell with the slightly more acidic solution (pH = 7.6). In glass 3, cover the shell with the vinegar. Leave into the solutions. It can observe the immediate effects ofleaving the shells submerged in the solutions for a week and thus observe the exposure to the solutions for a longer period. NOTE 1: If it is intended to calculate the difference in weight of the shells before and after exposure, allow them to dry before weighing. NOTE 2: The ocean will never have the acidity of vinegar. The point of this experience is to increase the problem to see the immediate effects.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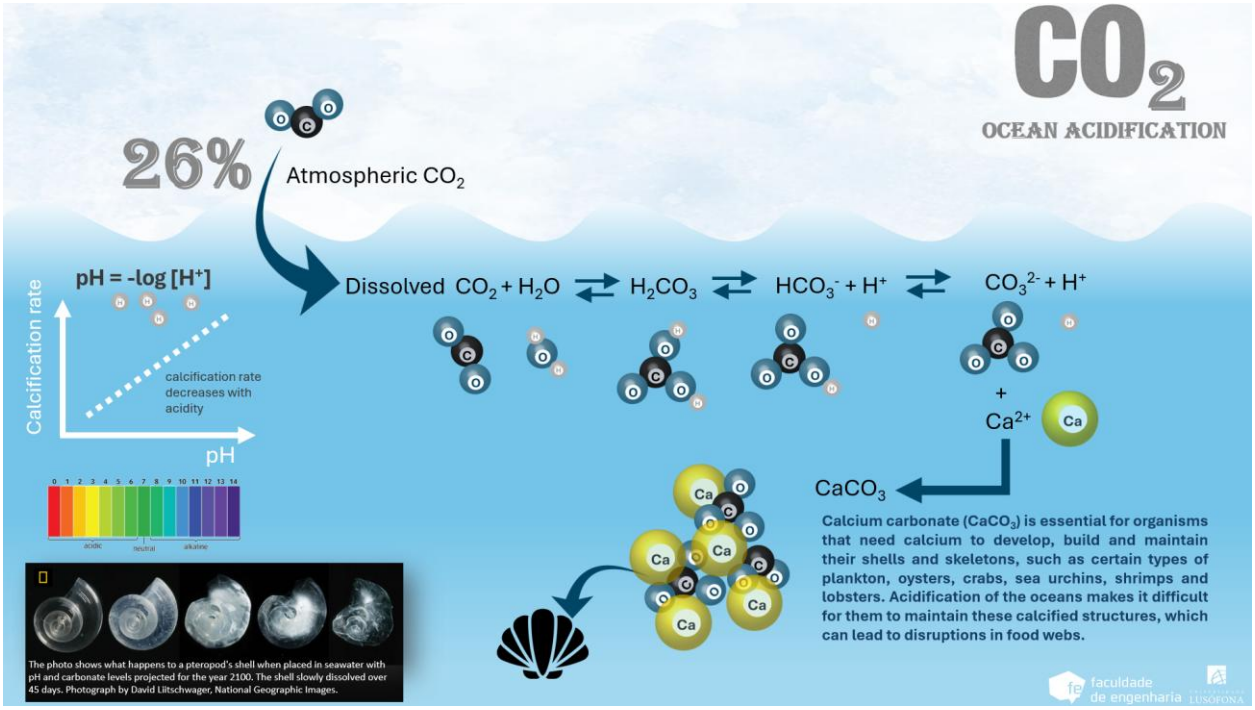
Annexe



Topic:

Global warming and rising sea levels. Consequences of the dynamics of melting and solidification of large ice sheets and icebergs on the mean sea level.

Aim:

1. Discuss with students the relation between global warming of the atmosphere/ocean water and the rising sea levels. Analise some local evidence of rising sea levels.
2. Study the heat transfer mechanisms between a system and its neighborhood.
3. Study fusion, melting, and vaporization processes.
4. Relate global warming and rising sea levels with the heat transfer mechanisms studied.
5. Discuss with students the impactthat melting and solidification dynamics of large ice sheets and icebergs can have on the sea level over time. This is an important topic to explore as it can have significant consequences for our planet's ecosystems and the communities that depend on them. By delving into the various factors that influence this process, students can better understand the complex relationship between climate change and sea level rise.

Age Group:

15-18 years old

Time:

120 minutes

Materials:

- Computer and data show to visualize videos and graphs;
- 3 identical glass jars os around 500ml (at least 1 of the jars must have a lid);
- Coloured marker to write on the glass (use preferably a non-aqueous marker);
- Freezer or chest freezer;
- Volume measuring beaker;
- Dry cloth or absorbent paper.

The link of the worksheet which will be used:

Procedure:

Introduction: Time: 15min	Sea level rise refers to the average increase in the water level of the Earth's oceans. Average increase means that in some parts the water level may decrease, but the main trend is an increase of sea water level. Global sea levels are rising as a result of human-caused global warming. Sea level rise is caused primarily by two factors related to global warming: the added water from melting ice sheets and glaciers on land, and the expansion of seawater as it warms. The following graph shows the change in global sea level from 1993 till the present (Credit: NASA's Goddard Space Flight Center).

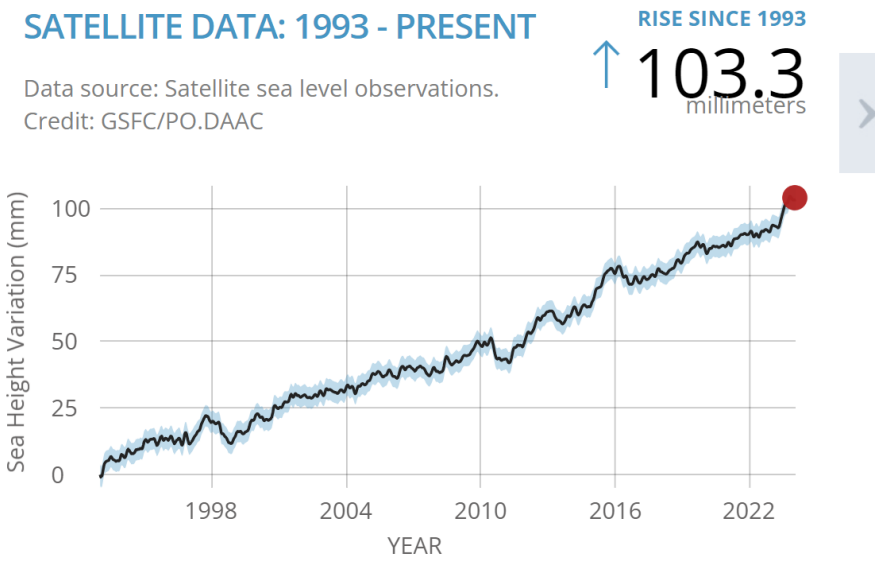


Figure: Change in global sea level since 1993 till the present (Credit: NASA's Goddard Space Flight Center).

Watch the following video:

Student Video: NASA's Earth Minute: Sea Level Rise | NASA/JPL Edu

Understanding the increase of sea level

Warming increases the sea level,mainly in two ways:

(1) Increasing average global temperatures (especiallyat the poles) causes glaciers and ice sheets on land to melt, which increases the amount of water in the oceans, thus increasing sea level;
(2) In general, volume of systems usually increases with the increase of temperature, and ocean water is no exception, so it is expanding as it absorbs heat from the warming atmosphere, leading to sea level rise. This phenomenon is called thermal expansion.

Figure: Melt streams on the Greenland Ice Sheet on July 19, 2015. Ice loss from the Greenland and Antarctic Ice Sheets and alpine glaciers has accelerated in recent decades. NASA photo by Maria-José Viñas.

But we can find other important interactions between sea water, ice, and air (and the increase of greenhouse gases in the atmosphere) that can contribute to water level rising. “Sea ice acts like a buffer between the ocean and the atmosphere,” said ice scientist Linette Boisvert of NASA’s Goddard Space Flight Center in Greenbelt, Maryland. “Sea ice prevents much of the exchange of heat and moisture from the relatively warm ocean to the atmosphere above it.”

	 Figure: Image from NOAA National Environmental Satellite, Data and Information Service (https://www.nesdis.noaa.gov/our-environment/ice-snow) Less ice coverage allows the ocean to warm the atmosphere over the poles, leading to more ice melting in a vicious cycle of rising temperatures.

Task 1
Time:
15min
	Watch a Video and allow students to present and discuss their opinions.
	(1) Visualize the following video
	`Nasa Vídeo about climate changes`
	`Rising tides: Understanding Sea level rise`
	
	Nasa Climate Changes Vídeo. Rising Tides: Understanding Sea Level Rise - YouTube
	
	(2) Teacher can propose two or three generic questions about the topic, like e.g.: "What kind of ice structures contribute to the water level rising?" or "Which factors contribute the most to the water level rising?" and "Which factors have a less significant contribution to the observed global increase on water sea level?";
	(3) Students present their points of view and answers that are registered for further analysis.

Task 2 Time: 90min (90 minuts Excluds time for the preparation stage that should be developed at least 3hours before the start of laboratory stage)	Development of a "hands-on" practical activity with students: study of the water level rising by melting of a well-known mass of ice. Comparative analysis of three different ice structures melting in contact with water and air. All studied scenarios include structures with equal mass of ice. (Preparation Stage – 15 min+3hours to freeze the water) This preparation stage must be developed at least 3hours before the start of the activity and is not included on the "Task 2 Time" defined. • Use 3 glasses jars of about 500ml of capacity (at least one glass should have a lid to prevent water flow). Identify each glass (e.g. Glasses A, B and C). • Add 100 ml or 150 ml of water to each glass. • Put glass A in the freezer in a vertical position, lid the glass B and put it in the freezer in a horizontal position, as indicated in figure 1. • Pour all the water of glass C into a small plastic bag, close the bag, and put it in the freezer (figure 1). • Wait at least 3hours to be sure that all the water is completely frozen.  FIGURE 1 – Freeze 100ml - 150ml of water in a horizontal glass; in a vertical glass and in a plastic bag.

(Laboratory Stage – 30 min+ time to melt the ice)

- Take the glasses and bag out of the freezer and clean the glasses with a dry cloth or absorbent paper.
- Witha marker and a ruler,measure, and mark around 6cm from the bottom of the three glasses as shown in the figure 2.

FIGURE 2 – Mark 6cm from the bottom of the three glasses

- Put the ice from the plastic bag intothe glass C (figure 2).
- Add water at 22ºC or more to each of the three glasses until you reach the mark. This mark is the water level before the ice melting (figure 3).

FIGURE 3 – Add water until you reach the mark

- Waituntil all the ice in the glasses is melted (time to melt the ice depends on the water temperature. To decrease this period, can be used water with temperature above 22ºC).
- During the waiting period teacher can ask students what they expect to happen in each glass. Students can discuss and justify their opinions.
- During this waiting period,the teacher and students can also develop task 3 and/or task 4.
- When all the ice is melted in the three glasses, students should mark with a distinct color the water level after ice melting (figure 4).

	 FIGURE 4 –Mark the water level after ice melts. • Discuss results for the three glasses and compare the water level before and after ice melts. • Explain results.
Task 3 Time: 15 min	Use the ice example to explain the ice melting when receiving heat from the atmosphere or water.The teacher can also discuss the water freezing that occurs in the freezer. Connect phase transformations with sea ice formation (for more information https://www.nesdis.noaa.gov/our-environment/ice-snow/sea-ice)
Task 4 Time: 20 min	Discuss the mechanisms of heat transfer, conduction, convection and radiation, and relate these mechanisms to the transfer of heat between ice and atmospheric air and/or ocean water, resulting in a decrease or increase in the mass of ice formed. Use the example of ice structures formed on poles to discuss with students if all heat transfer mechanisms are equally important for the ice melting and water level rising. Additionally, and depending on the students' backgrounds, in this task the teacher can revisit in more detail the three different heat transfer mechanisms responsible for the increase/decrease of temperature or for the phase changes, like melting/freezing, or can keep the discussion with the students more qualitative. Go deeper:

	Heat rate $d\dot{H}_{cond}$ by Conduction through a wall: $$\dot{H}_{cond} = kA\frac{\Delta T}{\Delta x}$$ A is the local area of the wall surfaces, k is the thermal conductivity of material and $\frac{\Delta T}{\Delta x}$is the temperature gradient along the wall thickness; Heat rate $d\dot{H}_{conv}$ by Convection: $$\dot{H}_{conv} = h\ A\ \Delta T$$ A is the local area of the surface of the system in contact with the fluid (e.g. air or water), h is the convection coefficient of material, and dT is the difference of temperature between the system and the fluid; Net Heat rate $d\dot{H}_{net,rad}$ by Radiation: $$\dot{H}_{Net,Rad} = \sigma\epsilon A\left({T_2}^4 - {T_1}^4\right)$$ Net rate of heat transfer by radiation (absorption minus emission) depends on both temperatures of the system (T_1 - emission) and the temperature of its surroundings (T_2 - absorption), A is the area, $\sigma = 5.67 \times 10{-}8$ J/s · m^2 · K^4 is the Stefan-Boltzmann constant andε is the emissivity of the system.

Annex

1. **References:**
   - **Sea Ice – NSIDC National Snow and Ice Data Center (https://nsidc.org/learn/parts-cryosphere/sea-ice/science-sea-ice)**
   - **Global Mean Sea Level – NASA (https://sealevel.nasa.gov/understanding-sea-level/key-indicators/global-mean-sea-level)**
   - **Ice and Snow – NOAA National Environmental Satellite Data, and Information Service (https://www.nesdis.noaa.gov/our-environment/ice-snow)**

Topic:

The rise in the average sea level and the consequences for coastal areas

Aims:

Introduction:

- Be aware of the consequences of rising sea levels in coastal areas;
- understand that there are different mechanisms responsible for sea level variation (global versus local variations)
- understand that the melting of mountain glaciers and thermal expansion are the main causes of global sea level rise

Hands-on activities:

- Understand that the melting of icebergs (ice in water) is not responsible for rising sea levels, but the melting of mountain glaciers (ice on top of continents) is;
- understand the risk of flooding in coastal areas;
- observe coastal zones of different morphologies and understand that sea level rise will have different impacts on coastal zones of different morphologies;
- assess the impact of sea level rise on various coastlines around the world using mathematical modeling tools.

Creative reflection:

- Promote the production of a poster showing the differences in sea level rise on coastlines of different characteristics, using simulations using the digital tools explored.

Age Group:

15 - 18 years

Time:

90 + 90 minutes

Materials:

THEORETICAL PART:

Computer, video projector, internet access.

PRACTICAL PART:

Experiment: 2 glasses, water, ice cubes, small float smaller than the diameter of the glass.

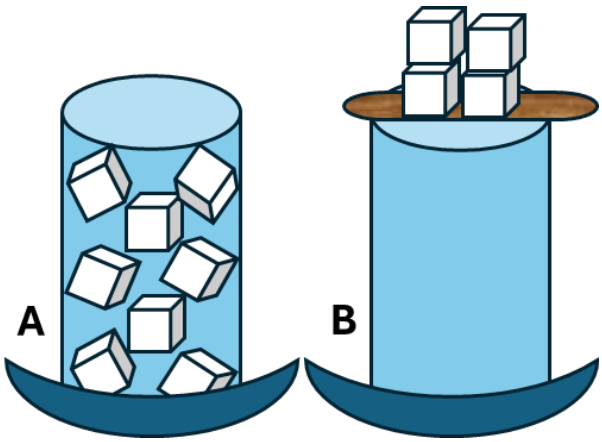
Individual computer, internet access.

Introduction:

Sea levels have fluctuated over time, with global and regional/local forcing factors.
Global factors include:
1. thermal expansion of the oceans;
2. Increase/decrease in mountain glaciers and/or polar ice caps;
3. Oscillations of the geoid;
4. Plate tectonics (divergence/convergence, changes in the elevation of the middle ocean ridges).
Regional/local factors include:
1. isostatic movements, which can lead to subsidence/uplift phenomena as a result of

variations on the continent or in the coastal zone of:
- Volume of ice (glacio-isostatic);
- Volume of water (hydro-isostatic);
- Volume of lithosphere, thermal oscillations/density (thermo-isostatic);
- Deposition/erosion of rocks and/or sediments (sediment-isostatic);
2. Compaction phenomena;
3. Tectonic movements (tectonics/volcanism);
4. Changes in terrigenous sedimentary flow;
5. Local/regional changes in atmospheric wind patterns and ocean currents.

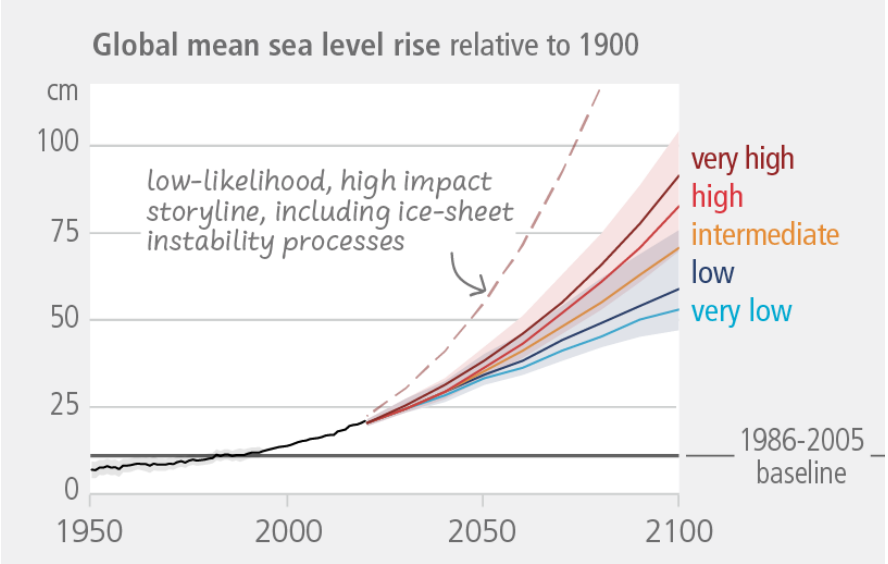
Introduction: Time: 15 minutes	After the teacher has presented the main global and regional forcing factors responsible for sea level rise (see Introduction), students should be asked what the two main global factors are (Answer: thermal expansion of the oceans and Increase/decrease in mountain glaciers and/or polar ice caps). Students should watch the following movie (1:38'):*Why is Sea Level Rising? We Asked a NASA Scientist* (https://www.youtube.com/watch?v=WadD54Ywvz4)
Task 1: Time:15 minutes	Objective: Understand that the melting of icebergs is not responsible for the rise in sea level and that it is the melting of the ice that is found on top of continents (mountain glaciers and others) that when it melts flows into the oceans and this is responsible for the increase in the volume of water stored in the ocean basins and consequently produces the rise in sea level. Prepare two glass beakers as follows (see diagram):

	- Glass A (represents ice melting into water - icebergs) - fill the glass with several ice cubes so that none are above the top of the glass. Fill the glass to the edge with water without it spilling over. - Glass B (represents the melting of mountain glaciers) - fill the glass with water up to the rim, without spilling it, and place a wooden spatula on top of the glass where you can put one or two ice cubes (see diagram). Place each glass on a different plate and let it melt. Note that in glass A the water doesn't overflow the glass (the sea level isn't affected) while in glass B the water from the ice cubes adds to the pre-existing volume in the glass and causes the water to overflow (the sea level rises). After all the ice has melted, reflect with the students on the contribution of melting icebergs and mountain glaciers to sea level rise. 
Task 2 Time: 15 minutes	Objective: - understand the risk of flooding in coastal areas; According with the AR6 Synthesis Report: Climate Change 2023The IPCC finalized the Synthesis Report for the Sixth Assessment Report during the Panel's 58th Session held in Interlaken, Switzerland from 13 - 19 March 2023 (https://www.ipcc.ch/report/sixth-assessment-report-cycle/) the sea level relative to 1995-2014:

- the likely global mean sea level rise under the SSP1-1.9 GHG emissions scenario is 0.15-0.23 m by 2050 and 0.28-**0.55 m by 2100**;

- while in the SSP5-8.5 GHG emissions scenario it is 0.20-0.29 m by 2050 and 0.63-**1.01 m by 2100** (medium confidence).

Over the next 2000 years, global mean sea level will rise by around 2-3 m if warming is limited to 1.5°C and 2-6 m if it is limited to 2°C (see figure bellow – from page 17 of https://www.ipcc.ch/report/sixth-assessment-report-cycle/).



The 2023 IPCC Report predicts a worst-case sea level rise of 1.01 m by 2100. It also states that over the next 2000 years, the global average sea level will rise by around 2 - 3 m if warming is limited to 1.5°C and 2 - 6 m if it is limited to 2°C.

What would happen in coastal areas if all the ice on top of the continents melted? How would coastlines all over the world be affected? Would they

	be affected in the same way? Movie (6:33'): *How Will Earth Change If All the Ice Melts?* (https://www.youtube.com/watch?v=pIxRVfCpA64) Movie (2:44'): *How Earth Would Look If All The Ice Melted | Science Insider* (https://www.youtube.com/watch?v=VbiRNT_gWUQ&t=77s)
Task 3 Time: 45 minutes	Objective: - observe coastal zones of different morphologies and understand that sea level rise will have different impacts on coastal zones of different morphologies; The transition zone between the continent and the ocean can have very different morphologies and can be divided into two main types: A) Rocky coasts - these coastal segments (of high and low altitude) result from the presence of geological lithologies resistant to erosive factors (sea, rain, wind) often in a high-energy environment; B) Coastal plains - these are low-lying areas where sandy coasts (sandbanks, dunes, barrier islands) and wetlands (estuaries, lagoons, deltas) form as a result of the supply of sediment from direct land and sea sources, often in a low-energy environment. Movie (4:18'): Predicting the Impacts of Rising Sea Levels on Sandy Coasts (https://www.youtube.com/watch?v=WuRRiFWEYWo)

	Movie (20:11'):Lands That Could FLOOD in Our Lifetime (https://www.youtube.com/watch?v=CurmnLKikyI) The computers should have Google Earth Pro installed (free version) which the students should use to search for coastal areas with different morphologies (rocky versus sandy coastlines), referred on the movie. Homework: After watching the movie in class, the students should search independently at home, using Google Earth, for coastal areas in the country where they live with characteristics of rocky and sandy coastlines for reflection in the next lesson.
Task 4 Time: 60 minutes	Objective: - assess the impact of sea level rise on various coastlines around the world using mathematical modeling tools. There are simulations for various parts of the world that show the evolution of flooding because of the rise in mean sea level. However, some are very exaggerated and show variations simulating up to 60 m of sea level rise. On this platform you can see/choose some locations, such as: **VENEZIA - SEA LEVEL RISE:** (https://www.youtube.com/watch?v=mAAW2tbaP_U&list=PL9F055E718DF56DE8&index=31) **ABU DHABI - SEA LEVEL RISE:**

https://www.youtube.com/watch?v=5soQ___Tbdg&list=PL9F055E718DF56DE8&index=4

STOCKHOLM - SEA LEVEL RISE:

https://www.youtube.com/watch?v=7P-2gTxHqvM&list=PL9F055E718DF56DE8&index=33

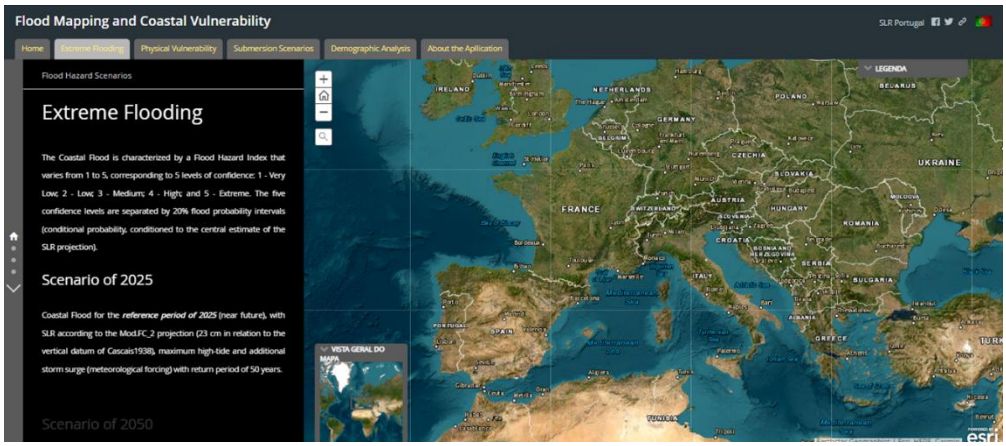
LISBOA - SEA LEVEL RISE:

https://www.youtube.com/watch?v=vyku69avZmE&list=PL9F055E718DF56DE8&index=23

Using simulation platforms that use mathematical modeling, the students are asked to choose various places in the world and different sea level rise scenarios and check the consequences of flooding (transgression) in each region.

Two of these simulation platforms:

1) https://flood.firetree.net/ - for coastal zones around the world

	2) http://www.snmportugal.pt/ - SEA LEVEL RISE FOR PORTUGAL - In accordance with European Directive 2007/60/EC - National Scale Study (In this site Go to “Viewer” and and choose the scenarios you want).  Navigate using these platforms to see the different flooding scenarios in rocky and sandy coastal floodplain areas. What actions could be taken to reduce the extent of the affected areas on sandy low-lying coastlines? Look for/investigate some projects or solutions that some countries have developed.
Task 5 Time: 15 minutes	- Promote the production of a poster showing the differences in sea level rise on coastlines of different characteristics, using simulations using the digital tools explored.

	The students are grouped again in teams up to four and each group produces a poster about the topic explored: - Sea level rise (causes and effects); - Littoral zones (differences and examples); - Comparison between two coastal regions of different morphology (rocky and sandy) with predicted inundation in 2100 (1m above current sea level). - The main impacts of this land alteration on the two chosen sites.
Task 6 Time: 15 minutes	- Discussion of the results expressed in the posters. - Using students' posters the teacher encourages students to present the main impacts of this land alteration on the two chosen sites and think about plans to mitigate those impacts (economic, social, environmental).

Topic:

On the importance of thermal insulation for buildings and its impact on climate change

Aim:

1. To learn how the advancesinconstruction techniques, in order to improve building's thermal insulation, play a centre role in embodying the two key factors of climate change in construction: (i) Mitigation; (ii) Adaptation;

2. Establishing a connection between the materials used in construction (namely their thermal conduction capabilities), and their effect on climate change, allows the studentsto understand the importance of building insulation and its impact on climate change.

3. Regarding mitigation: Increasing a building's thermal insulation increases its response time to external thermal variations, i.e., the time it takes for the temperatures in the interior environment to change, in reaction to the change of external temperatures. Therefore, the need for active heating or cooling is reduced, along with the energy consumption of the building, thereby mitigating its impact on climate change.

4. Regarding Adaptation: Increasing a building's thermal insulation (with its response time to external thermal variations), also improves the building's adaptation to climate change: as external temperatures increase, the building will be able to maintain comfortable interior temperatures for a longer period of time, without resorting to active heating and cooling solutions.

Age Group:

15-18 years

Time:

60 minutes

Materials:

- A slab of cork with a minimum thickness of 2cm.
- A solid clay brick, with a thickness of around 3 cm (note that, the thicker, the longer the experiment takes).
- Asmall heating plate with controlled temperature (a portable electric heating plate can be used, provided that the contact surface is flat, and the minimum operating temperature is around 50/60 ºC).
- A set of three digital thermometers with external probes.
- Aluminium duct tape.
- A craft knife.
- A hammer.
- A watch (or phone with a clock application).

The link of the worksheet which will be used:

Procedure:

Introduction: Time: 5 minutes	Present the goals of the lesson, and the motivation for learning the concepts, as stated in the aims section;
Task 1 Time: 15 minutes	Present the Fourier law of heat conduction, then apply it to the simple case of a solid structure with an infinite surface area, constituted by an homogeneous medium. Then, apply this approximation to the case of the three samples: (i) Solid ceramic brick (e.g., consider a thermal conductivity of $k = 0.6$ W/mK); (ii) Small cork slab (e.g., consider a thermal conductivity of $k = 0.04$ W/mK). Discuss, based on the equation and the thermal resistance of each material, which of the materials should be faster to transmit heat from one face to the other. Consider the simplified Fourier Law: $$\frac{Q}{\Delta t} = -kS\frac{\Delta T}{\Delta x}$$ where Q is the amount of heat transferred over timeΔt, k is the material conductivity, S is the surface through which the heat is flowing, ΔT is the temperature difference between the facesof the sample and Δx is the distance between the faces (i.e., thickness). Moreover, defining the thermal resistance as $$R = \frac{1}{k}\frac{\Delta x}{S}$$ one can still write $$\frac{Q}{\Delta t} = -\frac{\Delta T}{R},$$ or, to clarify the relation between the transference time and thermal resistance, $$\Delta t = -R\frac{Q}{\Delta T},$$ i.e., the greater the thermal resistance, the longer it takes to transfer the same amount of heat (for the same temperature difference between faces), from one face to the other.

Task 2
Time: 10 minutes

Build the experiment apparatus, as illustratedinFigure 1.

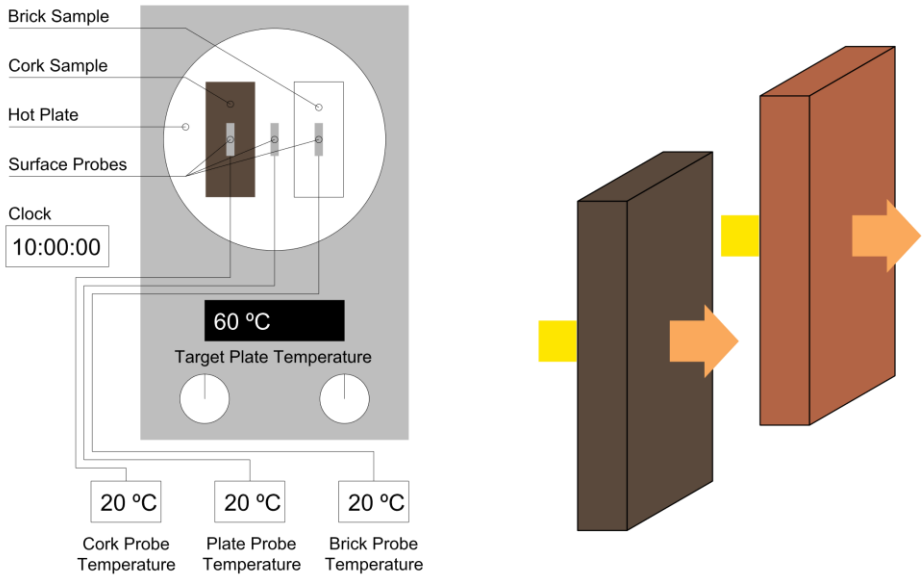


Figure 1. Schematic representation of the experiment.

The set-up procedure can be described by the following steps:

1. Cut off a small rectangular piece of cork, using a craft knife, and try to break of a similar piece of the solid brick using a hammer. Note that, the size of the samples must be comparable, and they both must fit on the heating plate, at the same time, while leaving room for the heating plate probe (see Figure 1).

2. Attach the probes of the thermometers, one for each sample and one for the hot plate, as show in Figure 1, using the aluminium duct tape.

3. To make sure the samples are properly contacting the surface of the hot plate, a set of small weights can be placed on top of the samples, but not touching the probes.

4. Wait until both samples and the hot plate are all at the same temperature before starting the experiment.

Task 3 Time: 15 minutes	Turn on the hot plate and set the target temperature to 60ºC. Write down the temperature displayed in the thermometers at every 30 seconds or at an interval of your choosing. For this part, if there is any difficulty in assembling the apparatus or obtaining the values, you can consider showing the following video that illustrates and example of this experiment: https://www.youtube.com/watch?v=XaRvosSVHoM, and using the set of results provided with this lesson.
Task 5 Time: 15 minutes	Plot the charts of the temperature variation (through time) for all samples and the hot plate and discuss the results.

Annex
1. Excel sheet with pre-prepared tables, example results and a chart.
2. YouTube video of an example experiment: https://www.youtube.com/watch?v=XaRvosSVHoM

Topic:

Waste Management Humanoid Robot.

Aim:

Creating a Waste Management humanoid robot model using a micro: bit.

Age Group:

17 to 19

Time:

300 minutes

Materials:

Micro: bits v2 with USB cable, Cardboard or lightweight materials for the robot body, Small container for bin for waste collection, wires, pipe, power source.

The link of the worksheet which will be used:

Introduction:

Procedure:

Introduction: Time: 30 minutes	Introduction climate & technology Introduction of Robots, Humanoid Robot, programming them using Micro: bit Introduction to Fusion 360 Autodesk CAD modelling program.
Task 1 Time: 30 minutes	Rough sketch & final sketch on A3 mm includes scale, measurement & materials
Task 2 Time: 60 minutes	Practical workshop: Designing 3D model in Fusion 360
Task 3 Time: 120 minutes	Practical workshop: Creating the body & other part of your Waste Management robot model
Task 4 Time: 30 minutes Task 5 Time: 30 minutes	Practical workshop: Programming with micro: bit. Presentation & evaluation

Annex Students Work in progress examples
1. https://docs.google.com/document/d/17lKuwSRoILAnStoWKgzRNDknMRwB4tsb/edit?usp=drive_link&ouid=100645313696182979641&rtpof=true&sd=true
2. https://docs.google.com/document/d/1roSZI16xUaKQ2ZyYFxmvANE_sOO-FdmZ/edit?usp=drive_link&ouid=100645313696182979641&rtpof=true&sd=true
3. https://docs.google.com/document/d/1qII9w1FktPdsAh8-Jm181lln9GhjZ7UH/edit?usp=drive_link&ouid=100645313696182979641&rtpof=true&sd=true 4.

Topic:

Humanoid Robot for Irrigation system

Aim:

Creating a smart Irrigation humanoid robot model using a micro: bit.

Age Group:

17 to 19

Time:

300 minutes

Materials:

Micro: bits v2 with USB cable, Cardboard or lightweight materials for the robot body, Small tubes connected to water source, switches, wires, pipe & power source.

The link of the worksheet which will be used:

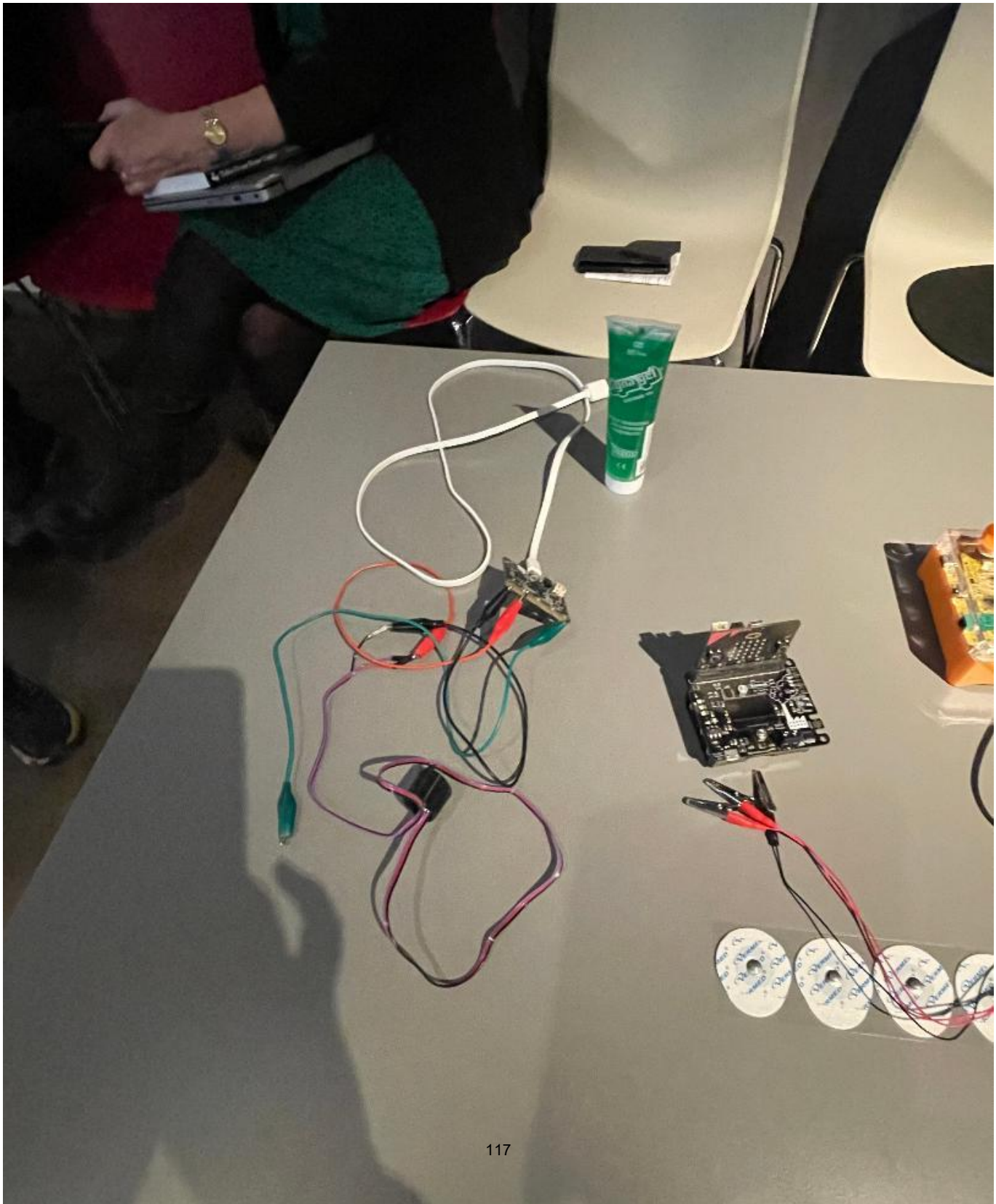
Introduction:

Procedure:

Introduction: Time: 30 minutes	Introduction climate & technology Introduction of programming using Micro: bit Introduction to Fusion 360 Autodesk CAD modelling program
Task 1 Time: 30 minutes	Rough sketch & final sketch on A3 mm includes scale, measurement & materials
Task 2 Time: 60 minutes	Practical workshop: Designing 3D model in Fusion 360
Task 3 Time: 120 minutes	Practical workshop: Creating the body & other part of your smart Irrigation robot model.
Task 4 Time: 30 minutes.	Practical workshop: Programming with micro: bit.
Task 5 Time: 30 minutes	Presentation & evaluation

Annex

1. https://docs.google.com/document/d/1G60XPGwGAoKtgfk2bAN7ZnOGNItRktJT/edit?usp=drive_link&ouid=100645313696182979641&rtpof=true&sd=true
2. https://docs.google.com/document/d/1kni6wt9csgo6ipwVt0fh7xGyb0Z9l1vc/edit?usp=drive_link&ouid=100645313696182979641&rtpof=true&sd=true
3. https://docs.google.com/document/d/1m0SkiWy6hIJC9r2z-Bw6vB-EwgzyP033/edit?usp=drive_link&ouid=100645313696182979641&rtpof=true&sd=true
4.



Topic:

Use of Smart Material in manufacturing of Robotic components.

Aim:

Educating students about material science will encourage them to understand how engineers select smart materials based on the specific requirements in a robot. Students will learn how researchers in material science explore properties in smart materials (nanomaterials, carbon fibres, titanium etc) which can be integrated into Robotics systems, for creation of complex & customised robot parts. Nanomaterials can be utilised in manufacturing of miniaturised components in a robot. Topic will be integrated with a study visit in Material Science lab.

Age Group:

17 to 19

Time:

100 minutes

Materials:

Computer, internet access for research work. Samples of various material used in robotics (different types of metal, plastics, rubber etc) Projector for presentation. Material Science lab.

The link of the worksheet which will be used:

Introduction:

Procedure:

Introduction:	Students will understand the fundamental concepts of material science & its application in Robotics, selection of material is based on properties, performance & functionality of Robots.
Task 1 Time: 20 minutes	Present the basic principles of material science, properties & applications. Talk in detail about physical properties like strength, flexibility, conductivity& their alloys.

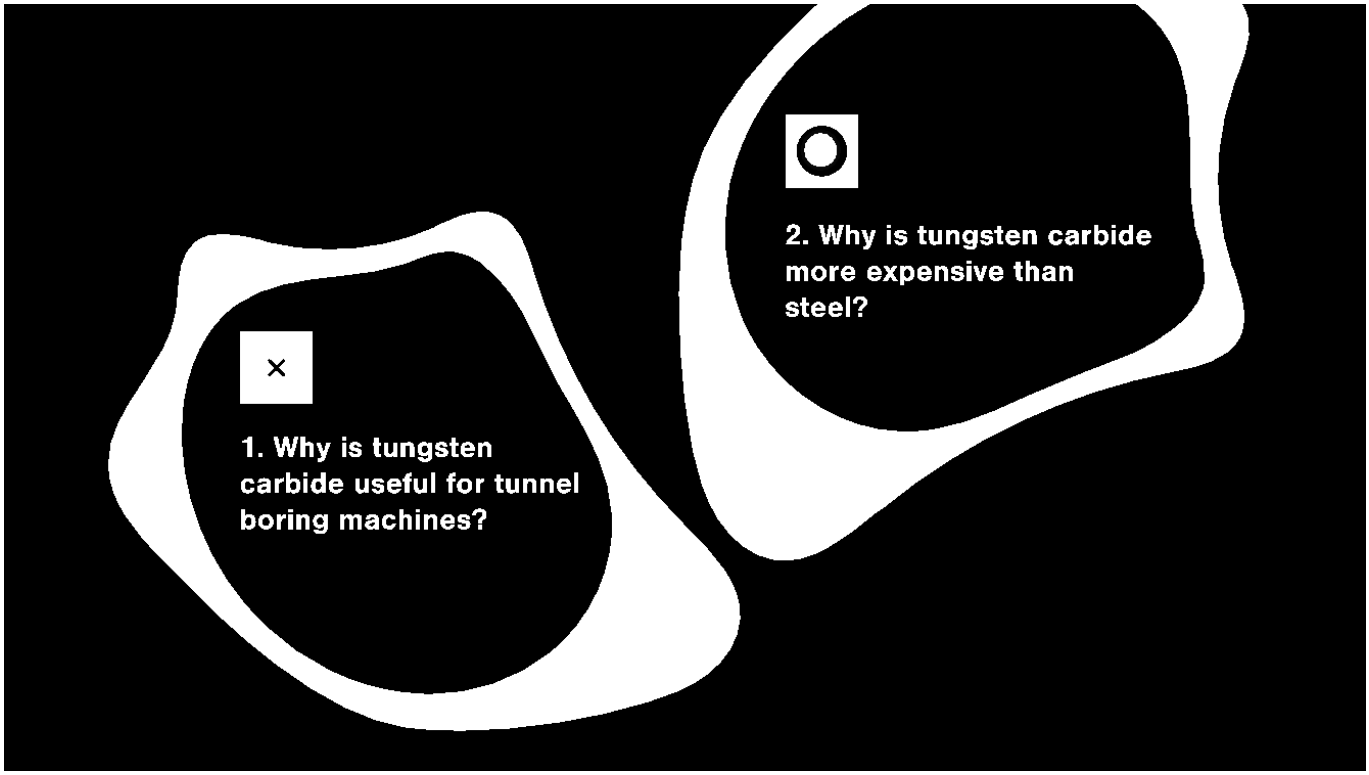
Task 2 Time: 20 minutes	Introduction using PowerPoint presentation: ● Importance of material. ● Introduce concept of robotics & its application in various fields ● Role of material science in enhancing performance of robots.
Task 3 Time: 20 minutes	Practical workshop: Divide students in small groups. Show samples of the different materials used in robotics, provide them with a hypothetical scenario where they need to design a robot for a specific task. Material Science lab to demonstrate the properties of material and its use.
Task 3 Time: 30 minutes	Individual assignment: Each Student will do research on your own presentation topics (research + creating PowerPoint presentation of the material chosen & presenting to their class).
Task 4 Time: 30 minutes	Assessment: Class participation, project presentation ,improved understanding of material science & robotics.

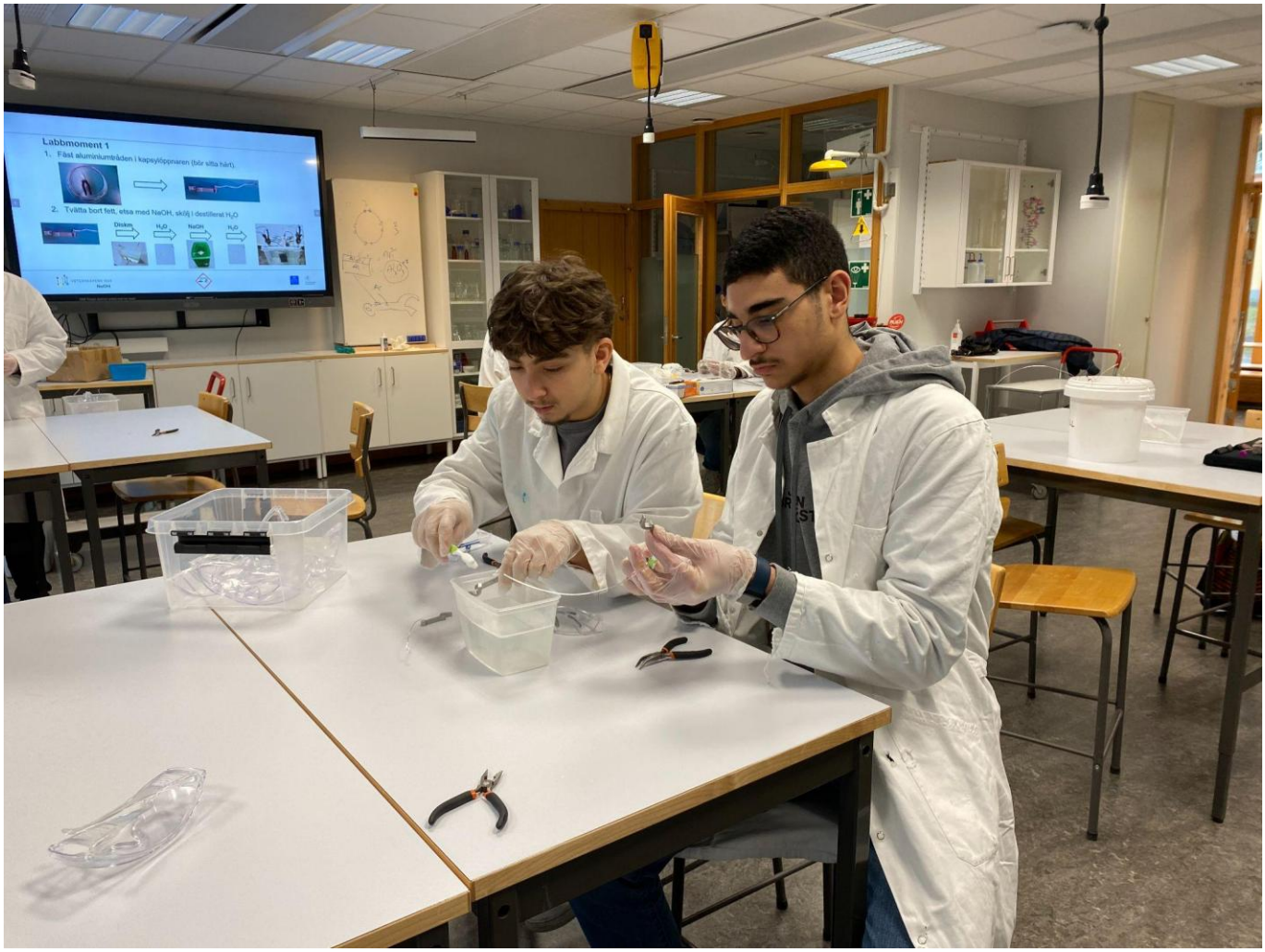
Annex
1. https://drive.google.com/drive/u/1/folders/1AIQNfo3LPpiQ7lMfIRDYImDU7xk81QHv 2. https://sms.schoolsoft.se/arenaacademy/jsp/teacher/right_teacher_test.jsp?menu=test_new#/myplannings 3.

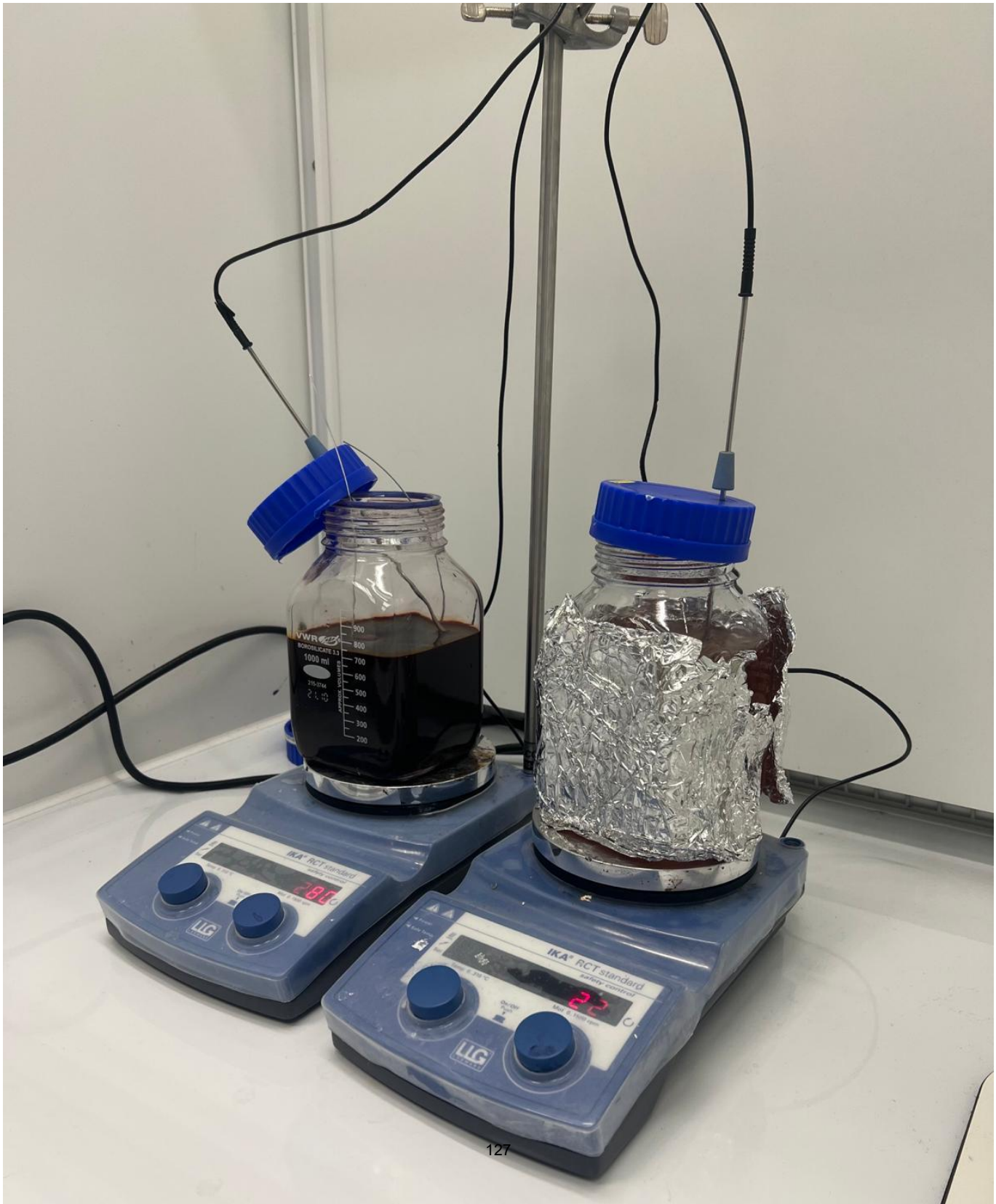

TUNGSTEN CARBIDE
One of the hardest materials known.
By Kuzey Kirbas


TUNGSTEN CARBIDE AND ITS HISTORY
1:1 ratio between tungsten and carbon.
Discovered in the 19th century.
Used as a cutting tool material.
Combining with titanium, tantalum and cobalt.
https://www.linkedin.com/pulse/background-tungsten-carbide-shijin-lei
https://www.linkedin.com/pulse/history-tungsten-carbide-shijin-lei?trk=pulse-article
https://en.wikipedia.org/wiki/Cemented_carbide
https://edu.rsc.org/magnificent-molecules/tungsten-carbide/3008556.article


ENVIRONMENT
5,000 ton CO_2/year
TUNGSTEN MINING
Can involve deforestation and release of pollutants.
6.85 * 10^4kg CO_2
POWDER PRODUCTION
Energy intensive processes.
3.00 * 10^{-4} kg CTUh
TOXIC PRODUCTION
Carcinogen release in production mills.


×
1. Why is tungsten carbide useful for tunnel boring machines?
O
2. Why is tungsten carbide more expensive than steel?


Labbmoment 1
1. Fäst aluminiumtråden i kapselöppnaren (bör sitta hårt).
2. Tvätta bort fett, etsa med NaOH, skölj i destillerat H_2O
Diskm.
H_2O
NaOH
H_2O


VWR
1000 ml
IKA RCT standard
IKA RCT standard
LLG


Gips
Kalcit
Fluorit
Apatit
FÄLTSPAT
Kvarts
Topas
Korund
Diamant

Topic:

Smart Wind turbine with robotics

Aim:

Combining Wind Turbine with Robotics can enhance the efficiency, maintenance & overall performance of wind Energy system.

Age Group:

17 to 19

Time:

140 minutes

Materials:

Small scale wind turbine model, Generator, Integrated sensors, fan to blow air, central control system

The link of the worksheet which will be used:

Introduction:

Procedure:

Introduction: Time:	PowerPoint: 30 min
Task 1 Time:	Build a prototype of wind turbine: 60 min
Task 2 Time:	Integrate sensors & a control system: 30 min
Task 3 Time:	Perform field testing using a fan: 20 min
Task 4 Time: Optional	The model can be tailored to code for specific parameters, wind speed, Blade length, angle of the blade, aerodynamics principle, Gear assembly, sensors in the maintenance robot.

Annex
1. Student_Project Report_ wind turbine.docx 2. Windmill (1).pdf

Climate Change & STEM Education in Classrooms

Climate Change and STEM Education in Classrooms

Cooperation partnerships in school education

Erasmus plus KA220 SCH Project 2022-2024

Topic:

Wind Turbine

Aim:

Building a wind turbine in Tinker CAD online Autodesk program

Age Group:

17 to 19

Time:

150 minutes

Materials:

Computer lab with internet access Tinker Cad account for each student. Projector or smartboard for demonstration of their design

The link of the worksheet which will be used:

https://www.vetenskapenshus.se/

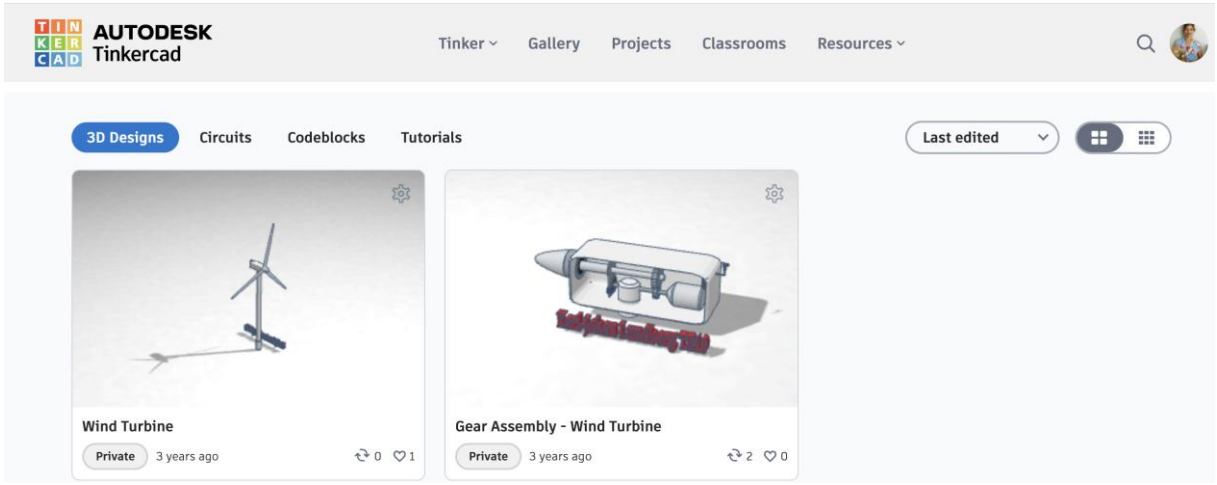
Procedure:

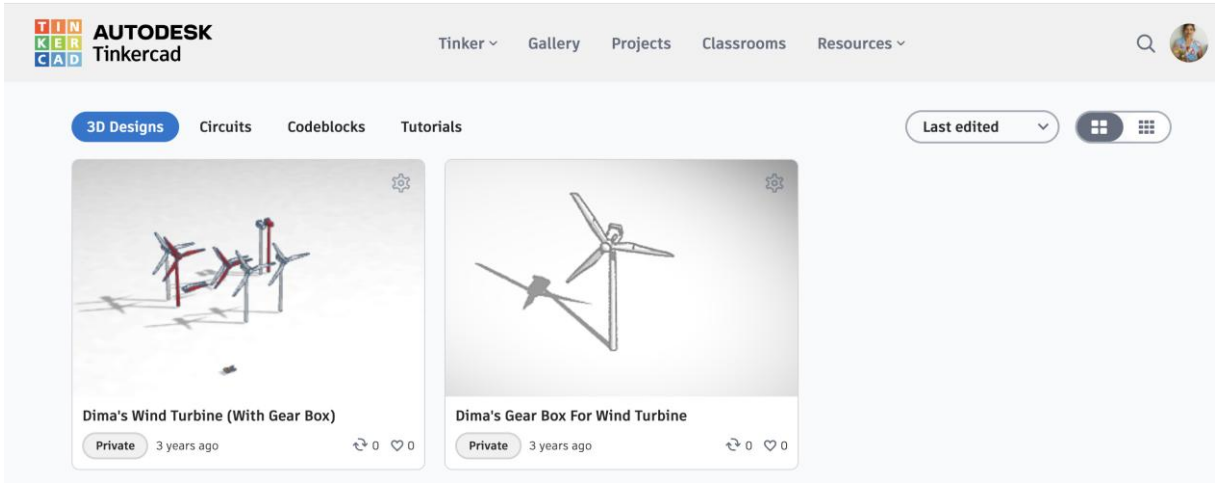
Introduction: Time: 70 minutes	Half day visit to House of science (Vetenskapens Hus) KTH Campus. Teacher has taken students to KTH University campus where the professional helps students to learns basic navigation, tools & features in tinker Cad. Later use these learningto develop from Idea to a physical product by using computer program to design their own object, which they can print in 3D printers.
Task 1 Time: 15 minutes	Basics: Importance of Renewable energy & concept of wind energy. Explain how wind turbine convert wind energy into electricity.
Task 2 Time: 30 minutes	Design: Each student will design a wind Turbine, they will focus on key components (Blades, Rotor, Generator, Tower)
Task 3 Time:30 minutes	Presentation: Each students show their design to the class using Tinker Cad program.
Task 3 Time: 15 minutes	Assessment criteria: • Creativity, • Attention on key components, • Use of Tinker cad tools, • Presentation.
Task 4 Optional	Students can upload their design on school based digital platform. Schoosoft

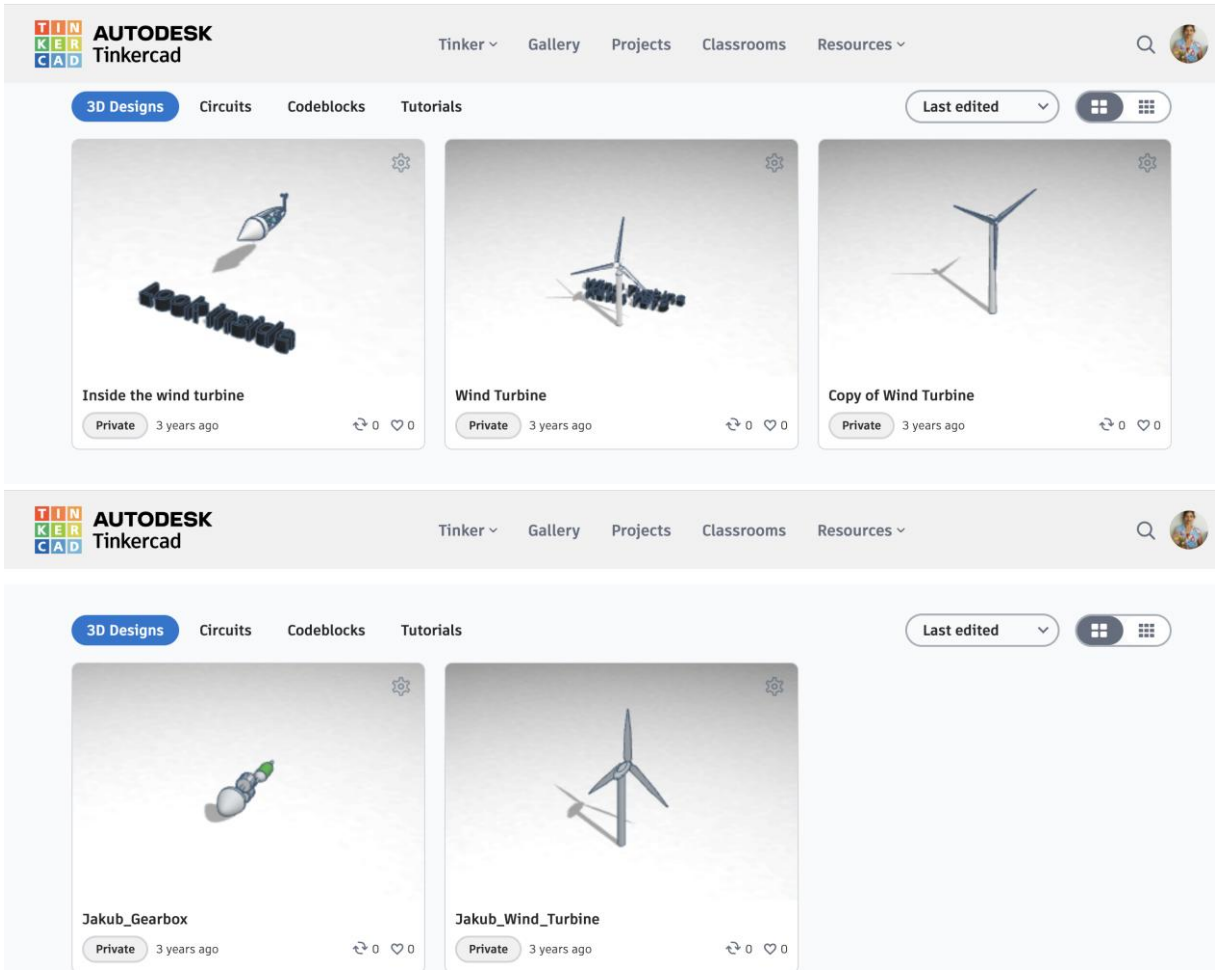
Annex

1. https://www.tinkercad.com/dashboard
2. https://sms.schoolsoft.se/arenaacademy/jsp/teacher/right_teacher_test.jsp?menu=test_new#/myplannings

Examples of students work is shown below






AUTODESK Tinkercad
Tinker
Gallery
Projects
Classrooms
Resources
3D Designs
Circuits
Codeblocks
Tutorials
Last edited
Inside the wind turbine
Private
3 years ago
Wind Turbine
Private
3 years ago
Copy of Wind Turbine
Private
3 years ago
AUTODESK Tinkercad
Tinker
Gallery
Projects
Classrooms
Resources
3D Designs
Circuits
Codeblocks
Tutorials
Last edited
Jakub_Gearbox
Private
3 years ago
Jakub_Wind_Turbine
Private
3 years ago

Topic:

Urban Planning project

Aim:

Objective: The purpose of this project was to get an idea, design, plan & implementation the concept of a smart city. Students have combined the Urban planning concept with coding, AI & Robotics, which can lead to innovations & efficient solutions for modern cities. Identify key areas: 1) Traffic management 2) Waste management. 3) Maintenance of Green space 4) Energy efficient LED lamps which are sensor based. 5) Drones for public safety & package delivery drones (Food medicine, postal, parcel etc) 6) Smart parking 7) Sustainable Energy source: offshore wind farm, Hydro power, geothermal, Solar energy. Activities: Making models for Urban planning in group, using recycle material, woodcraft sticks, cardboards, coloured paper, 3D printer. Research & inspiration: idea about what a sustainable city should have, awareness about energy, transportation system, recycling in a closed loop.

Age Group:

17 to 19 years

Time:

180 minutes (90 minutes each / 3 lessons)

Materials:

Materials: -A4 & A3 papers for rough & final idea sketch, cardboard boxes from school library & coping room, woodcraft sticks, coloured paper, Glue gun, scissor, knife, small saw, hand drill machine, clamp. Technology: -School Laptop provided to them, Access to computer lab for CAD program, Access to 3D printers.

The link of the worksheet which will be used:

Introduction:

Procedure:

Introduction: Time: 15 minutes	Students will be showed the PowerPoint presentation with details information. The PowerPoint previously shared in Google drive. After the ppt. students are divided in group (two or three students in each group)
Task 1 Time:30 minutes	Plan: students in group will do plan & research on what they are planning to include in their design / Model of the city. 1. Important buildings (For example: Business hubs, Industries, Residential building Communities centres, Sport facilities, Governmental budlings, Roads & highways, Electricity grid & transportation system) 2. Energy source 3. Traffic management 4. Waste management. 5. Maintenance of Green space 6. Energy efficient LED lamps which are sensor based. 7. Drones for public safety & package delivery drones (Food medicine, postal, parcel etc) 8. Smart parking
Task 2 Time: 30 minutes	A4 mind map, idea A3 mm paper final sketch
Task 3 Time: 40 minutes	Join teachers account for Tinker Cad, design prototype of house, tree. (optional) Or make model house, tree, road, bridges using cardboard paper, craft wood and other material provided.

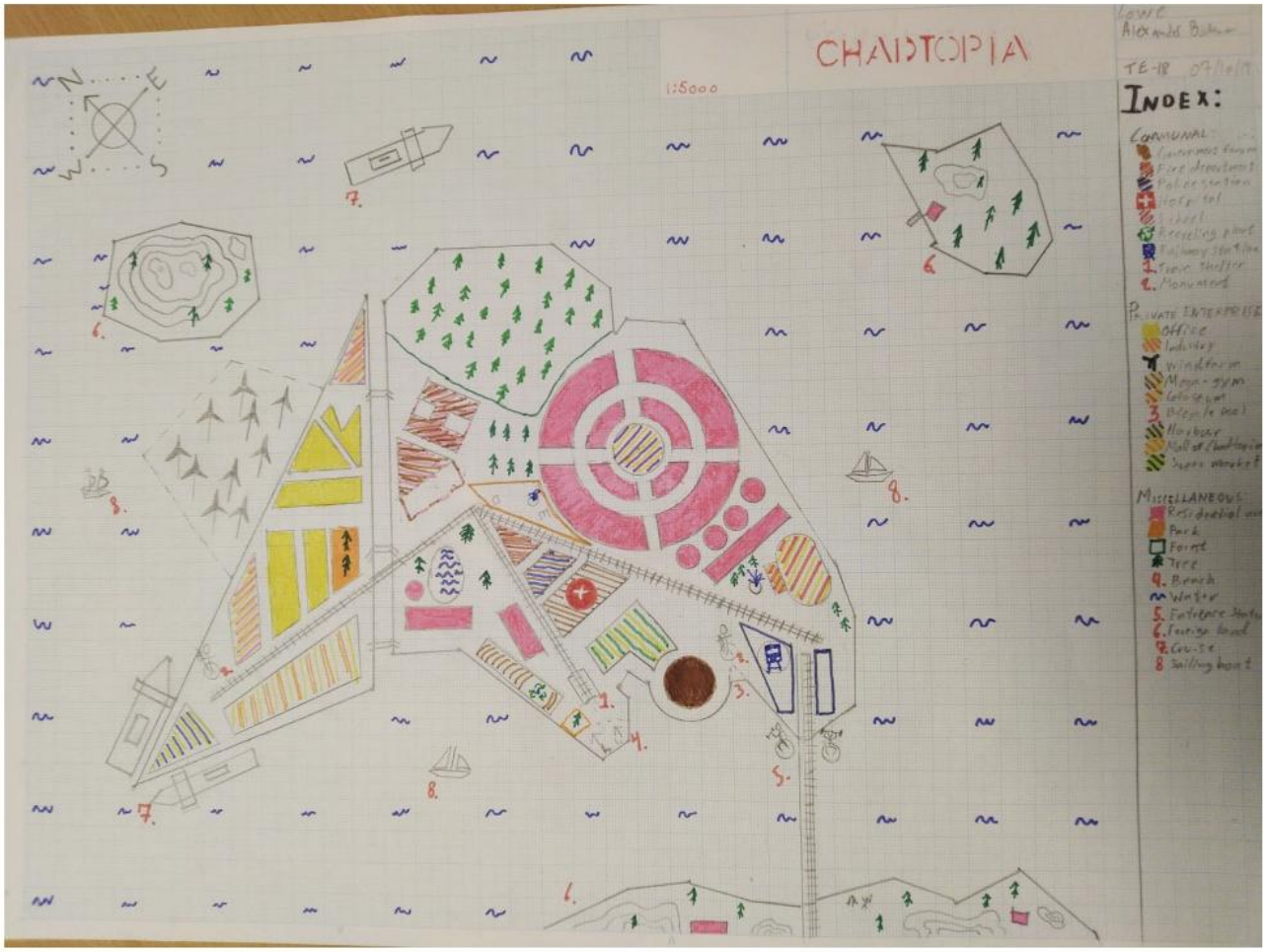
Task 4 Time: 20 minutes	Collect material for model construction. Also look around for the tool you might need from the tool stations / workbenches created by your teacher. List of the items: woodcraft sticks with different dimensions. Cardboards, coloured papers & recycle boxes. Thread, metal wires. Glue gun& paper glue. Tool arranged on tool benches. (Clamp, holders, Hand drill, scissors, paper knife, hand saw)

Task 5 Time: 75 minutes	Workshop: - 1. Posters are put on workbenches with safety& usage instructions, for easy excess. 2. Model templates are provided for house, trees, road & wind turbines for quick skill learning. 3. Each group will be involved in interactive presentation, as it always been the goal in Swedish education system. Questions and answers are a great way to get the whole class involved. 4. In presentation groups will focus on the choices they have made in designing the city planning which includes. Traffic management: a) Development of smart traffic light using sensors, cameras, Algorithms to optimize traffic flow. b) Adjust signal timings based on coding. Automated waste management: a) Integrate Robotics into waste collection system. b) Develop Pneumatics vacuum waste collection system (AVAC) it can transport the waste with high speed through underground Pneumatics tubes to a sealed collection station. Maintenance of Green spaces which includes automatic grass cutters for public part and facilities. Energy efficient lights, smart LED lamps with sensors & coding to adjust streetlights, brightness is based on pedestrian & vehicle movement. Floating offshore wind turbines Public safety & package delivery by Drones, In dark & cold weather integrating AI in Drones for public surveillance can be very important. Also for food, postal, medicine delivery on unreachable places.

Annex

1. https://www.tinkercad.com/dashboard
2. https://drive.google.com/drive/u/1/folders/19aFdjiMLo668QKuBLDxIZLok6VGa63Ep
3. https://docs.google.com/document/d/13dK_Fsl1ZVovCyUsKBhjhU0pP8lp2ObA/edit
4.

The Smart-City



Final sketch

Supervisor: Seema Pal

Smart-City

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Erasmus plus KA220 SCH Project 2022-2024

Topic:

Activating lesson about the climate (change) on the Kleine Nete between Herentals and Grobbendonk (canoing, litter picking, learning about fauna and flora around the Kleine Nete.

Aim:

Discover the fauna and flora around the river the Kleine Nete between Herentals and Grobbendonk.
Sport activity: canoing.
Awareness of climate change: litter picking on and around the river

Age Group:

Adults (12 – 18 years)

Time:

Half a day (activity itself) + discussion in classroom the next lesson.

Materials:

We cooperated with these organisations, specialised in these kind of activities.
https://www.dewaterral.be/
https://www.natuurpunt.be/afdelingen/natuurpunt-turnhoutse-kempen

Example of procedure:

Introduction	Before leaving, we make good appointments with the pupils. People from the Waterral tell them about the do's and don't's on the river, about how the traject looks like, ….
Canoing	Pupils canoe the 9 km from Herentals to Grobbendonk.
Litter picking	In between, we have all the materials to pick up the litter on and around the water.
Fauna and flora	We study the fauna and flora on, in and around the river.
Evaluation	Afterwards, we summarize what we have seen and studied. What were the opportunities,

Extra possibilities:

1 Lessons in determination of the fauna and flora we 've seen.

2 Analysation of the litter we found on and around the river.

Extra:

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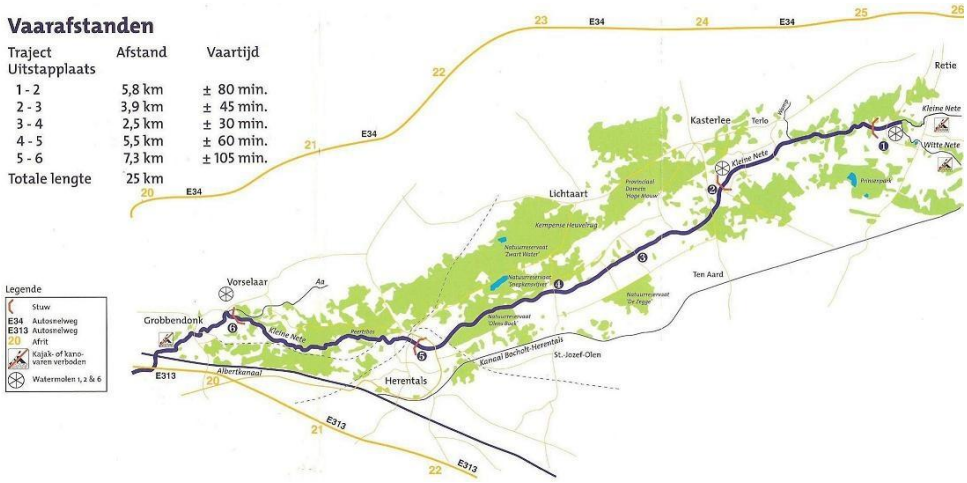
1 Map of the traject: [1]



Extra 2: QR code with all the information you need about the trip.

[1] We choose the traject between Herentals and Grobbendonk. There are also other possibilities available.

Extra 3: Explanation about how to use the paddles.

Extra 4: On the water in the middle of the fauna and flora.

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Topic:

Climate & technology

Aim:

How technology can be used to limit climate change

Age Group:

adults

Time:

90 minutes

Materials:

Arduino, electronic components (leds, buzzer, resistor, photo resistor,..), laptop

The link of the worksheet which will be used:

Introduction:

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Erasmus plus KA220 SCH Project 2022-2024

Procedure:

Introduction: Time: 30 minutes	Powerpoint: 20 min
Task 1 Time: 15 minutes	Practical workshop part 1 : blinking led
Task 2 Time: 15 minutes	Practical workshop part 2 : Led & Button
Task 3 Time: 15 minutes	Practical workshop part 3 : Led & lightsensor (photoresistor)
Task 3 Time: 15 minutes	Practical workshop part 4 : Buzzer

Annex
1. Powerpoint introduction
2. Documents for the practical workshops (schemes and programs)

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Topic:

The green saloon

Aim:

How student help realising a better climate

Age Group:

adults

Time:

90 minutes

Materials:

The students green Hair Saloon, computer

The link of the worksheet which will be used:

Introduction:

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Procedure:

Introduction: Time: 15 minutes	Student welcome the partners of the project in their green saloon
Part 1 Time: 15 minutes	Student explains the climate friendly products they use in the saloon
Part 2 Time: 15 minutes	Student explains the limitation of water use in the saloon by the use of climate friendly taps which produces 30 % less water
Part 3 Time: 15 minutes	Student explains how they sort the waste by dividing aluminium, plastic, paper and hair. Student explains and shows how those products are recycled.
Part 4 Time: 15 minutes	Student explains how they organise projects to support the social sustainability. en the economic sustainability
Part 5 Time:15 minutes	Students answer questions about the green saloon asked by the participants.

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Realisation of the green saloon

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Topic:

The adaptions of the valley of the KleineNete

Aim:

Discover how drought can be handled by the adaptation and re meandering from the river KleineNete.

Age Group:

Adults (12 – 18 years)

Time:

At least two hours – a full day (excursion, depends on the length of the hike).

Materials:

Proper shoes when there has been a lot of rain.
Paper / pen / writing board when the pupils have to fill in a course.

Example of the course pupils have to fill in:

See annex

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Example of procedure:

Introduction	Make appointments with the pupils.
Map exercise	Pupils find out the route and the stops and make the exercises.
Observations	At eacht point, pupils have to complete their observation of the landscape.
Post processing	Pupils learn about the Blue Deal and explain how the meandering of the KleineNete fits in it.
Extra	Pupils compare the situation in Herentals with the situation in Brazil.

Annex
Example of Lesson Plan, with the solutions

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Topic:

The Vlinder Project: a citizen science project to monitor weather and climate phenomena

Aim:

Learn about climate change from weather perceptions

Age Group:

Adults (12 – 18 years)

Time:

60 minutes (only classroom) – half a day (visit weather station)

Materials:

Laptop / beamer or smartboard, devices (quiz)

The link of the worksheet which will be used:

Introduction:

Procedure:

Introduction: Time: 30 minutes	Powerpoint: 20 min
Quiz	Quiz: 20 min
Evalution	Evaluation of the quiz: 10 min
Visit of the weather station	Optional: visit of the weather station (half day)

Annex
Link to the quiz: https://b.socrative.com/teacher/#import-quiz/65106933 (First you have to make an account as 'teacher' on Socrative)

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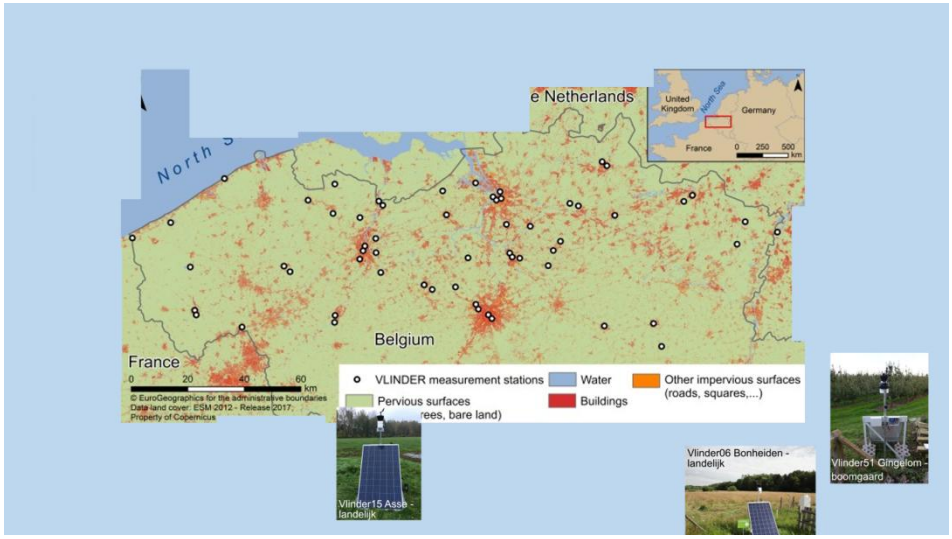
What is the Vlinder-project?

- Citizen science
- Weather stations in diverse environments
- Schools as pillars
- Start 2019



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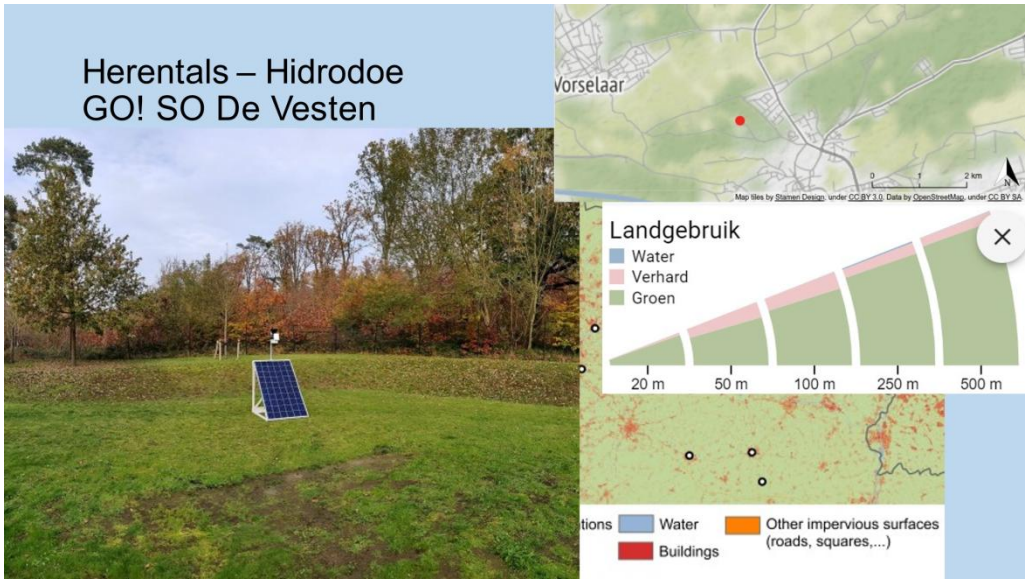

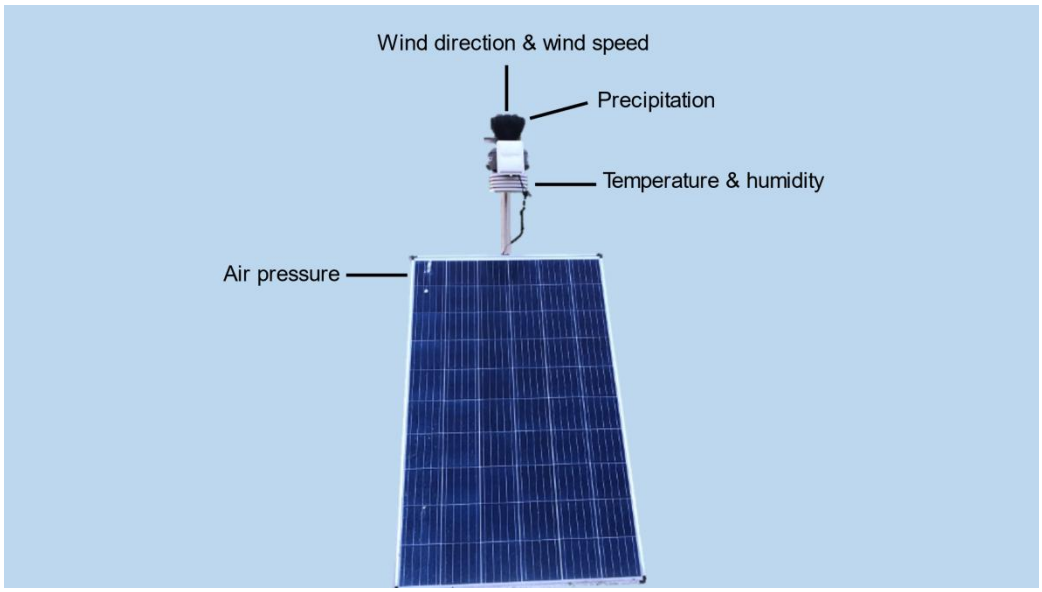

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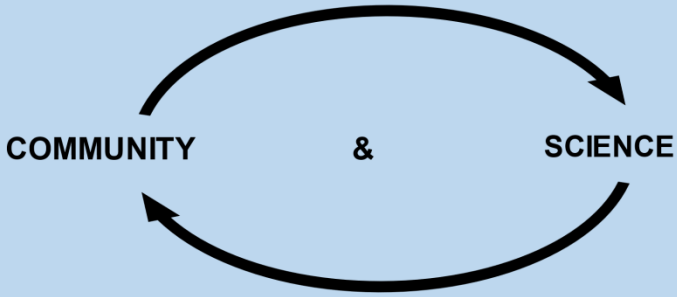
Importance of the Vlinder-project



COMMUNITY

- Expertise schools:
  - Find location, build & maintain weather station
    → STEM
  - Teach the teacher

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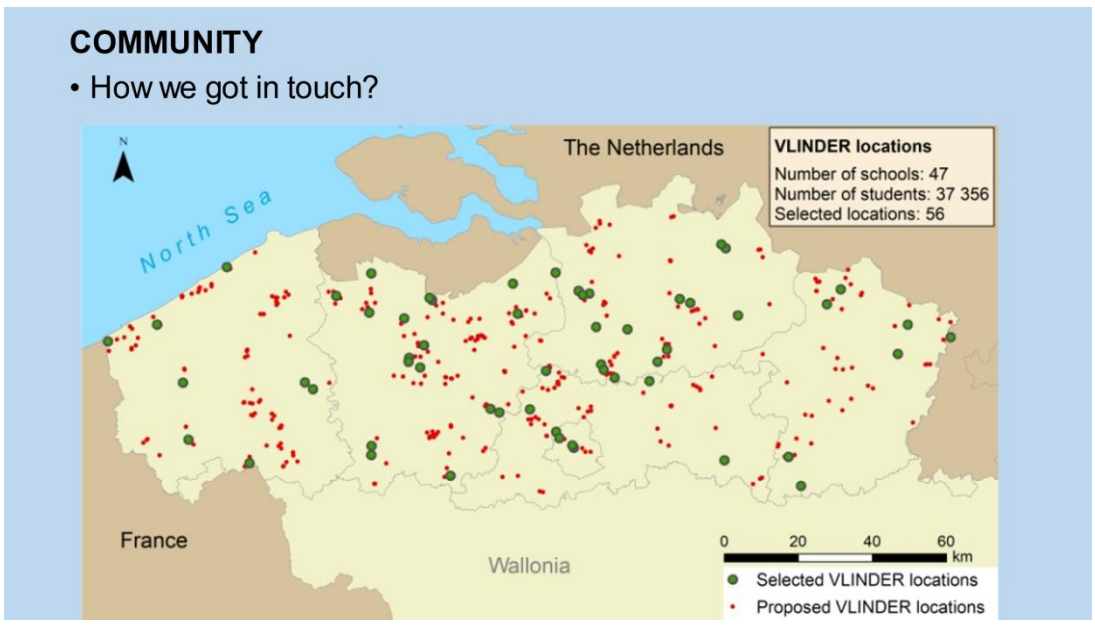

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COMMUNITY

- Rewarding schools:
  - Online classes: sites.google.com/view/vlinder-leerpaden/startpagina
  - Using open data in class
  - Workshops for students by students: result info panel

The broader COMMUNITY

- Info for broad public:
  - Info panels
  - Public lectures
  - Website: www.vlinder.ugent.be
  - Twitter: @VLINDER_project
  - Online news letter

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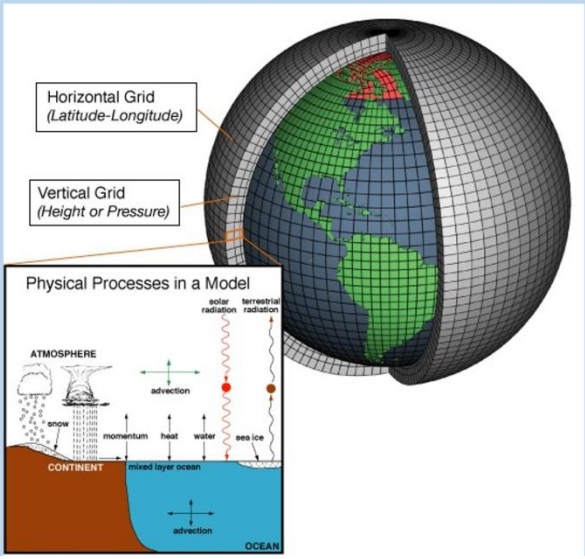
SCIENCE

- Which new scientific insights could such a network provide?
  - Studying regional/local differences in weather and climate
  - Optimise weather & climate models
  - Data for other scientists their applications



https://celebrating200years.noaa.gov/breakthroughs/climate_model/modeling_schematic.html

Climate Change & STEM Education in Classrooms

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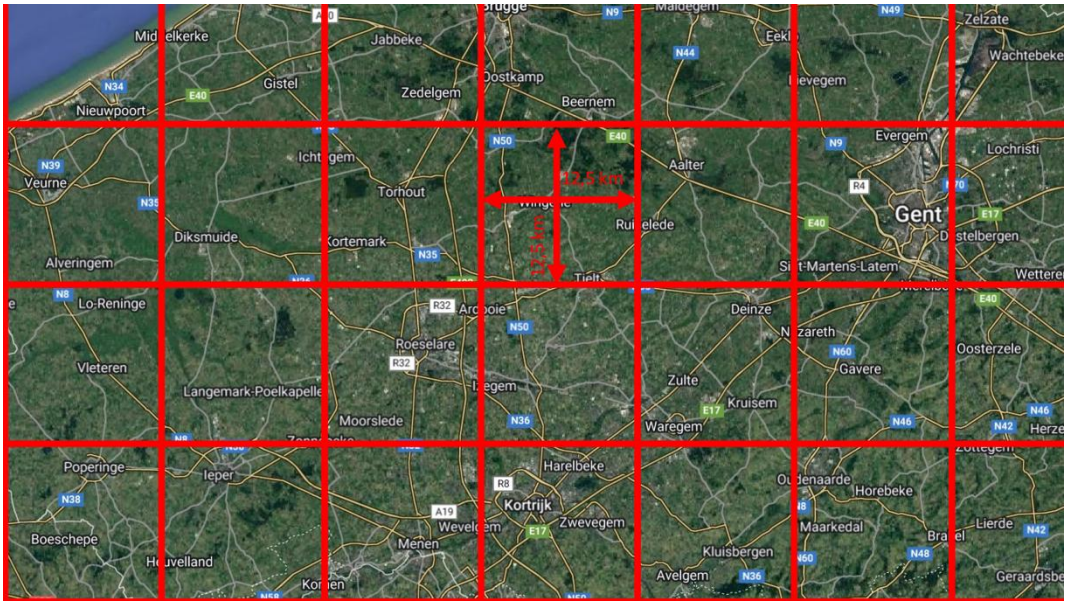

Climate Change & STEM Education in Classrooms
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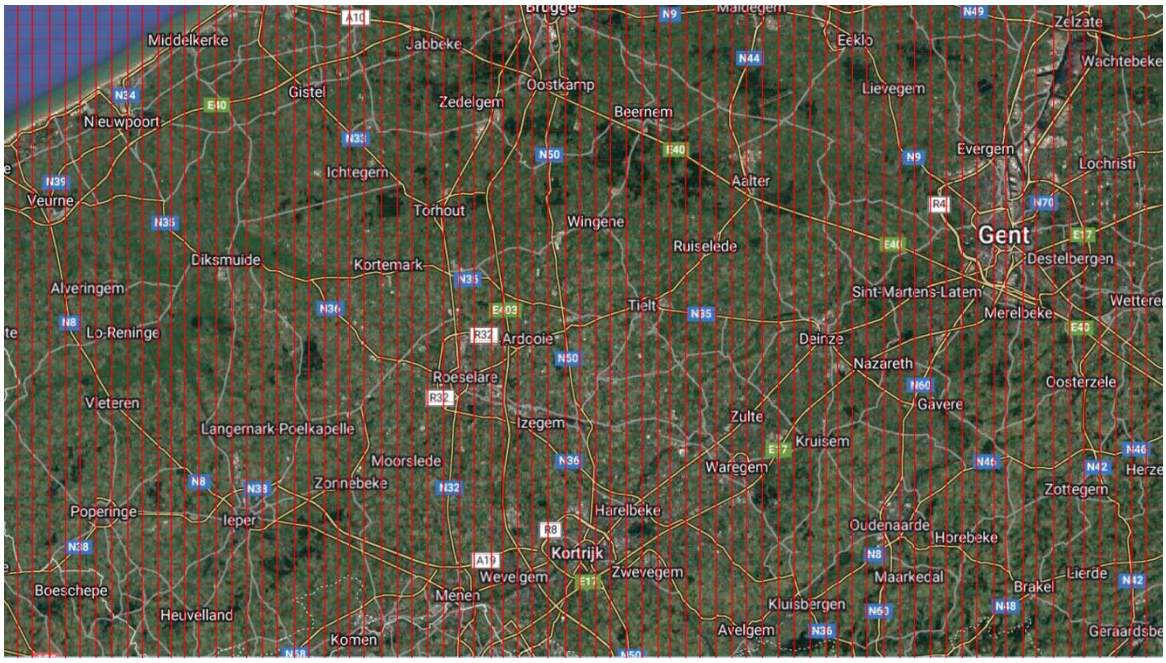

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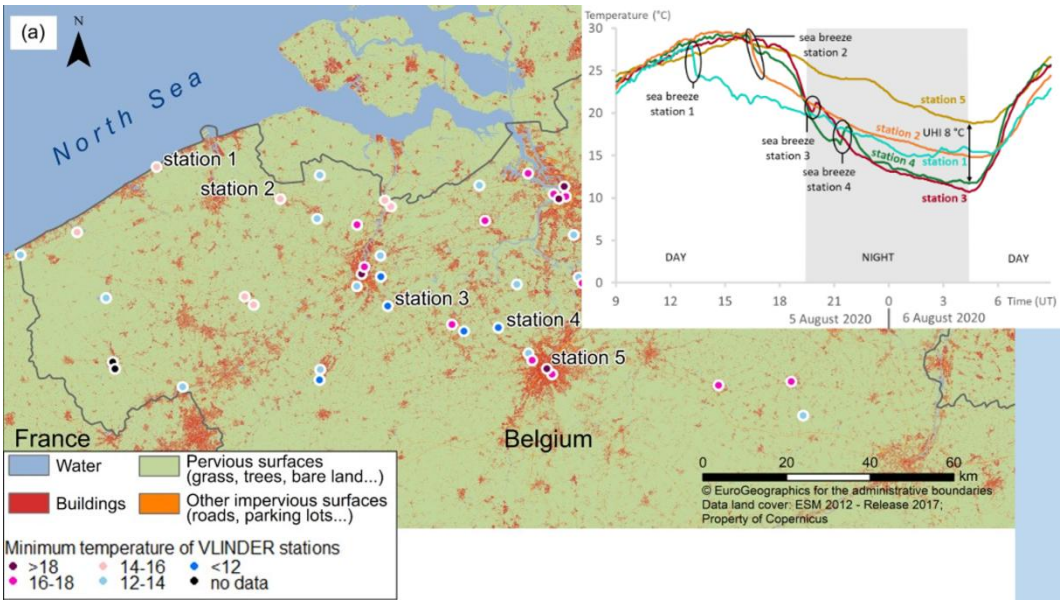
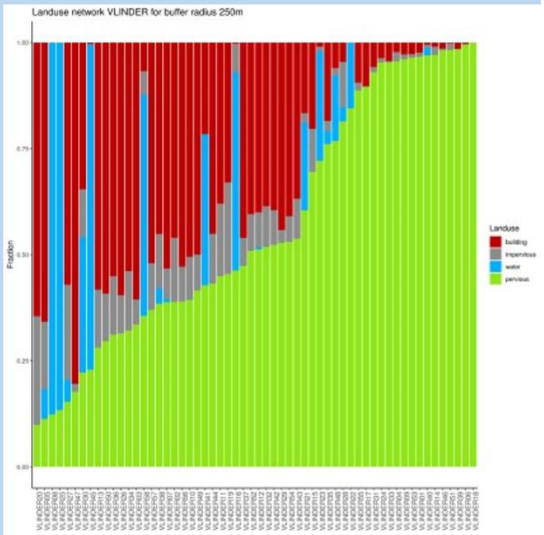


SCIENCE

- Unique & durable measurement network (2019 – now)
- Uni students test new sensors
- Students are future scientists?



Climate Change & STEM Education in Classrooms

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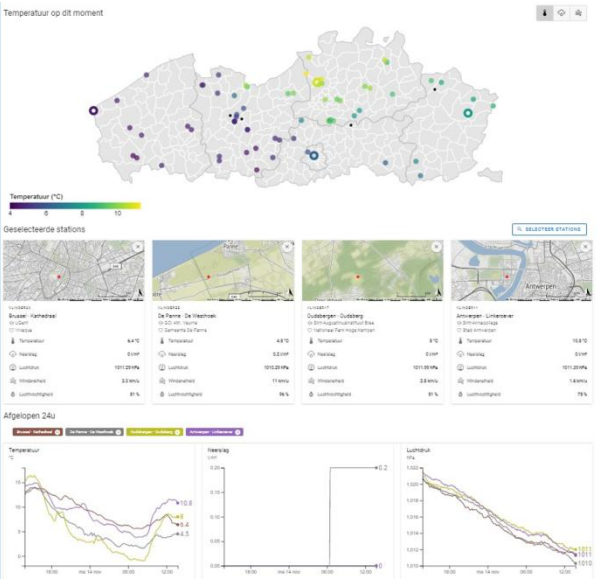
Innovation made this possible

- Automatic weather stations
- Data send by IoT
- Dashboard & API

https://vlinder.ugent.be/dashboard/



How were we able to run this project?

- Need for meteorological observations in diverse landscapes
- Citizen science call departement EWI 2017 – selectie 2018
  → financing for 1 year

DEPARTEMENT ECONOMIE WETENSCHAP & INNOVATIE — Vlaamse overheid

- Additional local partners (municipalities, companies, agencies,…)
  Scientists & university students

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Educational material

QUIZ TIME!

Educational material

- Online material sites.google.com/view/vlinder-leerpaden/startpagina
  - Teachers
  - Students
- Workshops

Cooperation partnerships in school education
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Contact:

vlinder@ugent.be

Steven.Caluwaerts@ugent.be
Sara.Top@ugent.be

Cooperation partnerships in school education
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Topic:

We learn about butterflies and how their behaviour is an indicator for climate change.

Aim:

Children can tell us how butterflies tell us something about climate change and how we can adapt our environment to this climate change.

Age Group:

Young adults (10 – 14 years old)

Time:

One lesson (50 minutes)

Materials:

Worksheet (The teacher can make a powerpoint or look for some videos (Youtube or platforms with educational videos) in your own language.

Climate Change & STEM Education in Classrooms
Cooperation partnerships in school education
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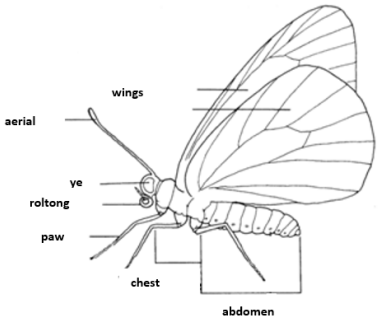
Example of procedure:

Introduction	Start with a good introduction video about the behaviour of butterflies. https://www.youtube.com/watch?v=COtpTt-ICwk&t=218s
Theory	The teacher teaches the theory about butterflies: **Insects** Butterflies belong to the insects. Insects form a very large animal group. Insects all have roughly the same build. The body consists of a head, a thorax and an abdomen. Butterflies have a head with two large eyes and two feelers, also called the antennae. With the antennae, they can smell. They have a long hollow rolling tongue: they can unroll it and stick it into a flower to drink nectar. When they are not drinking, the tongue is rolled up under the head. Butterflies use their legs, for example, to taste which plant they are sitting on (not their tongue!). The four wings and six legs are attached to the thorax. Strong muscles are attached to these. Some butterflies can fly very well thanks to their muscles.  Butterflies are cold-blooded animals. This means they do not, like us, always have 37°c. Their temperature depends on the temperature of the environment. They need the warmth of the sun to fly. Only when it is warm do they become active.

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Wings

A butterfly's wings are made up of all these tiny scales. The scales have a certain colour. If a butterfly is grabbed, a few scales can easily be rubbed off and the wings can be damaged. So it is best not to pick up butterflies.

Camouflage

Some butterflies have a beautiful colour at the top and not at the bottom. When they want to hide from their enemies, they close their wings. This way, it shows off the underside of its wings and stands out less in its surroundings.

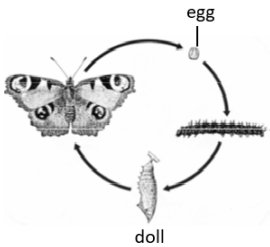
Food and eating habits

Most butterflies live on nectar. It is syrupy liquid in flowers. It contains sugar, small amounts of protein and vitamins. Butterflies suck up the nectar with their long tongues. It is coiled under their head. Apart from nectar from flowers, some butterflies eat other food such as rotting fruit, liquid from dung or from dead animals.

Day and night butterflies

Over 2,000 species of butterflies are found in our country. There are 54 species of diurnal butterflies. The others are moths. The moths have less beautiful colours than the day butterflies.

Metamorphosis



Butterflies have a complete metamorphosis. They change four times in their lifetime.

1. The butterfly lays eggs.
2. From the egg comes the caterpillar.
3. The caterpillar turns into a chrysalis.
4. From this, the butterfly emerges: then the creature is an adult.

Exercises	Children make exercises about what the teacher explained.

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Pick the right word and fill in:
(*male, eggs, shape, transparent, small, plants or herbs, inside, butterfly, pupa, female, sleeping, outside*)

Eggs
The eggs of butterflies are very small and have different shapes.

Caterpillar
Caterpillars eat a lot of plants or herbs and usually grow quickly.
When the caterpillar is fully grown, it turns into a pupa. Before that happens, the caterpillar stops eating and looks for a special place. Some will hang from a branch or a leaf. Others just lie on the ground.

From pupa to butterfly
The pupa seems to be sleeping. It is not eating. It cannot walk and on the outside, nothing changes. Inside, however, everything is happening! After all, the caterpillar changes into a butterfly. Even on the outside, you can see that it is alive and awake. Many pupae can move their abdomen or even make a rattling sound. They do this when they are threatened.
A few days before the butterfly hatches, the pupa becomes transparent. You can already see the colour of the wings. Then the chrysalis bursts open and the butterfly crawls out.

Butterfly
As with most animals, there are males and females. In some species, you can easily tell th because they have slightly different markings on their wings. Usually the female is larger t male, but the differences are sometimes very small. Butterflies recognise each other by th and by their smell. When a male and a female have mated, the female starts looking for a plant to lay eggs on. So it starts all over again....

	egg	caterpillar	doll
Can he fly?	no	no	no
Can he walk	no	yes	no
Can he eat/drink?	no	yes	no
Is he alive?	yes	yes	yes

Evaluation	Children learn the theory and the exercises at home. They make a test in class.
Succession	The teacher offers the children extra opportunities to learn more about the fascinating life of butterflies.

1 We found our inspiration in the lecture of prof. Dr. Hans Van Dyck. The lesson was internationally streamed. In the link below, you can find his international publications:

https://www.researchgate.net/profile/Hans-Van-Dyck

2 Very accessible voor laymen is his book about the butterfly “bosnimf”:

Van Dyck, Hans, *Het orakel van de bosnimf, Van vlindersenmensen, Wat frivolefladderaars je vertellenover het leven op onzeplaneet*, Lannoo, Tielt, 2021.

3 Last but nog least: some pictures from Hans van Dyck’s memorable lecture on 7 june 2024.

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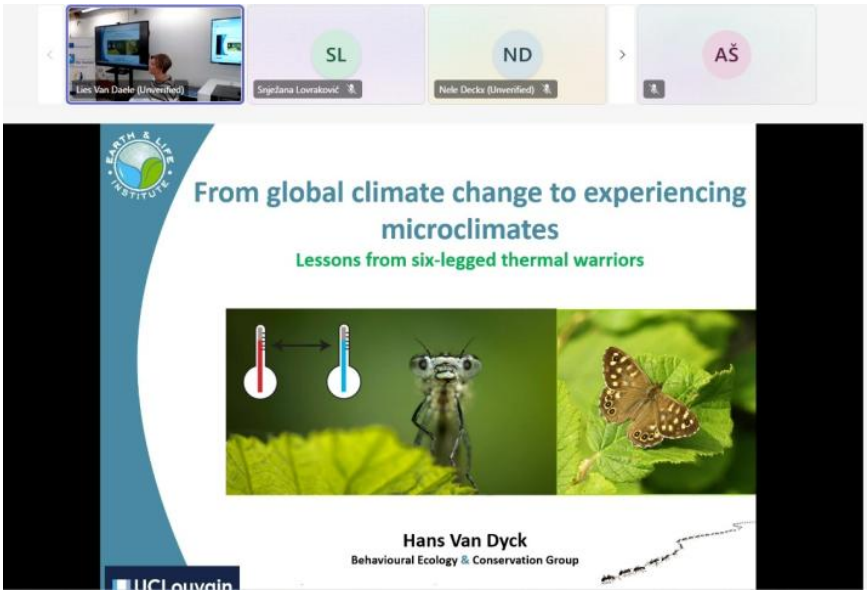

Topic:

Bioplastic is the best way to avoid plastic pollution

Aim:

To raise awareness about plastic pollution and to use bioplastics if necessary.

Age Group:

10-14

Time:

90

Materials:

The students purchase the following items and bring them to class on the day of the experiment; school glue (enough for 4 cps), 20 Mule Team borax (enough for 8 tsp), water (enough for 8 cps), and food coloring (optional).

The link of the worksheet which will be used:

- http://www.engineeringessentials.com/doeexperiments/bioplastic.html#:~:text=.hobbylobby.com%20)-,Student%20supply%20list,and%20food%20coloring%20(optional).
- https://theoceancleanup.com/ocean-plastic/

Procedure:

Introduction: Time: 15 minutes	There has been a great deal of coverage in the news recently about plastic pollution, particularly since David Attenborough's moving Blue Planet 2 documentary on the impacts of plastic pollution (2017). How much do students know about what is being done to address the problem? Have they noticed changes in their local supermarkets or coffee shops? Have they heard about it on the news? A possible homework task could be to make a list of actions that are being taken to reduce our use of plastic.
Task 1 Time:	A number of plastic alternatives have been developed e.g., corn-based plastic, PHA polyesters, chicken feather plastic and starch as an additive. But how many problems do they actually solve? https://www.youtube.com/watch?v=901aQFR6Ft0
Task 2 Time:	This can biodegrade within 47 days in an industrial composter. It doesn't emit fumes when burned and uses up to 50% less fossil fuels than making petroleum based plastic. BUT it won't degrade in the environment or in landfill. It's also brittle and doesn't stand up to heat well. Another key issue is that it uses up corn or other crops that could otherwise be used to feed people.
Task 3 Time:	The first Lego pieces made from plant-based plastic sourced from sugar cane is due to come on sale later this year (2018). They will be made from polyethylene – a soft, durable and flexible plastic that can now be made with ethanolextracted from sugar cane material. As a bioplastic, it can be recycled many times,though it is unlikely to be 100% biodegradable. This is Lego's first step in itscommitment to make all Lego bricks using sustainable materials.

Task 3 Time:	Standard Recipie The standard Flubber recipe is; 1/3 cp Elmer's glue, 1/2 cp warm water, 1/2 tsp 20 Mule Team borax, and 1/4 cp warm water. Ingredient Levels The ingredient levels for Flubber are; Bowl#1 - Elmer's glue (Low = 1/3, High = 1/2 cp), 1/2 cp water (Low = cold, High = warm (1 min in the microwave)), Bowl #2 - 20 Mule Team borax (Low = 1/2 tsp, High = 1 tsp.), and 1/4 cp water (Low = cold, High = warm (1/2 min. in the microwave)). Note that the microwave cooking times are microwave dependent. The microwave used in this experiment was very low wattage. Procedure In Bowl #1 add the desired amount of water and heat if necessary. Add the desired amount of glue. Mix until uniform. Add food coloring. In Bowl #2 add the desired amount of water and heat if necessary. Add the desired amount of Borax. Mix until uniform. Add the Borax mixture to the Glue mixture and stir until it becomes a uniform glob. Place the flubber on the aluminum foil, measure its diameter and note this on the data sheet. Wait one minute, measure the diameter again and note this on the data sheet. The ratio of these two diameters will be defined as the Spread. Characterize the Flubberness of your sample and note this on the data sheet. Place the samples aside for 48 hours. Measure the Spread and Flubberness of each sample.

Topic:

Clean Water and Sanitation For All

Aim:

-Intellectual skills: The learner will understand concepts
-Cognitive skills development:The learner uses personal strategies to think,organize,learn and behave
-Individual`s personal growth
-Affective-attitudes,behaviours and values related to a discipline

Age Group:

14-15

Time:

100 min.

Materials:

-Windows 10 4GB ram
-Worksheets
-Videos
-Plants
-Online quizzes

The link of the worksheet which will be used:

We make the students watch a video for raising their awareness about water scarcity
https://youtu.be/LCKsU4bPFOQ?si=bu918MwpH1nnZQtF

Procedure:

Introduction: Time: 20 min.	To get information about water scarcity and sanitation for all and the reasons of water scarcity. Forexample,you are a water resources engineer working in a water science company.you were assigned to investigate the reasons for the formation of potholes in some areas.You are responsible for finding solutions to water scarcity and the effects of it. -Water scarcity -Water sanitation -Clean water -Ecosystem health Engage: Teacher asks key questions about what they already know about water scarcity and ecosystem health. Students try to answer the key questions,watch a video to raise awareness about the concepts of water scarcity and ecosystem health.And then they talk about the video,the concepts they have learned.
Task 1 Time: 30 min.	Explore: Teacher makes the students explore the new concept through concrete learning experience. And makes them communicate with their peers to make observation. He/she brings two plants.One of them is watered and the other one is not. Students observe and compare these two plants and tell the differences between them.
Task 2 Time: 30 min.	Explain: Students make some research for collecting information to use it in discussion part.They discuss the issues about what they defend for reducing water scarcity. Teacher answers student`s questions about the topic. At the end of the discussion part, he wants students to talk about what they learned.
Task 3 Time: 10 min.	Elaborate: Teacher asks students to create presentations or conduct additional investigations to rain force new skills.Students will have space to apply what they have learned.So, this helps them to develop a deeper understanding.And they can cement their knowledge before evaluation.
Task 4 Time: 10 min.	Evaluate: Teacher observes their students and see whether they have a complete grasp of the core concepts.And they note that whether students approach problems in a different way based on what they learned.Students watch the video links given to them.They answer post class questions.They work in groups to prepare presentations and to present them to their class.

Topic:

Climate Change

Aim:

Students will be able to understand and use vocabulary related to climate change, including terms like "greenhouse effect," "carbon footprint," and "global warming." They will also be able to use the present perfect tense to talk about past actions with present results, as well as make predictions using future tense.

Age Group:

13-16

Time:

80 min.

Materials:

A short video on climate change, vocabulary worksheets, group discussion prompts, and an infographic on carbon emissions.

Procedure:

Introduction: Time: 10 min.	Warm-up Activity: Brainstorm a list of environmental problems in the city you live and talk about solutions.
Task 1 Time: 20 min.	Vocabulary Activity: Complete a worksheet on climate change-related vocabulary. Video Analysis: Watch a short video on climate change and answer comprehension questions.

Task 2 Time: 20 min.	Group Discussion: Discuss in groups what people can do to reduce their carbon footprint.Infographic Analysis: Analyse an infographic on carbon emissions and answer questions.
Task 3 Time: 10 min.	Presentation: Prepare and present a short presentation on predictions for the future of the planet. Infographic on carbon emissions.
Task 4 Time: 20 min.	Group discussion and presentation.Quiz on vocabulary and comprehension questions, as well as evaluation of the group presentation.Reflect on student feedback and identify areas for improvement, such as incorporating more interactive activities and incorporating more opportunities for speaking practice.: Incorporate more interactive activities in future lessons.

Topic:

Environment in English

Aim:

- Improving vocabulary related to environmental topics in English
- Learning to discuss and debate environmental topics in English
- Learning to summarise and present text in English
- Improving knowledge of environmental topics in general

Learning to communicate in English in team work setting

Age Group:

14-16

Time:

2 hours

Materials:

- A data projector

Each student should have a laptop / tablet device / mobile phone

The link of the worksheet which will be used:

Environmental issues are very important in the current state of the world, and it is essential for students to learn to use environmental vocabulary and to discuss related matters in English. The lesson materials are content-based but a language teaching element is also present in each step. The lesson includes introducing both vocabulary and texts, games and video material to make the lesson varied.

Procedure:

Introduction: Time: 10 minute	The teacher will introduce the topic of the lesson briefly (environment and conservation of nature) and why it is important to discuss the topic. They can introduce the topic by listing some of the biggest environmental issues and asking students to describe the problem with a few words. These issues can be taken e.g. from the list of *12 Biggest Environmental Problems Of 2022* on earth.org website. 1. Global Warming From Fossil Fuels 2. Poor Governance 3. Food Waste 4. Biodiversity Loss 5. Plastic Pollution 6. Deforestation 7. Air Pollution 8. Melting Ice Caps and Sea Level Rise 9. Ocean Acidification 10. Agriculture 11. Food and Water Insecurity 12. Fast Fashion and Textile Waste
Task 1 Time: 20 minute	Vocabulary The teacher will introduce some basic environmental vocabulary (Worksheet 1). The students will practice the vocabulary with a matching exercise (Worksheet 2) by matching each word and its definition, which means they will have to think about the definitions carefully.

Task 2 Time: 20 minute	Kahoot game The teacher will divide the students in teams and conduct a Kahoot quiz using ready-made quiz Let's celebrate Earth Day!
Task 3 Time: 40 minute	Reading exercise The students are divided into pairs or small groups (depending on the size of the class). Each pair is assigned 1-2 of the environmental problems listed in the article *12 Biggest Environmental Problems Of 2022* (Worksheet 3). Each pair will read and discuss the text and summarise the content of the text in writing in 4-5 sentences. Then each pair will verbally introduce the problem to the rest of the class.
Task 4Time: 30 minute	Discussion The students are divided into teams. Each team is given a discussion topic, such as: *What daily activities can you do in order to protect the environment?* *Do you recycle? What are the benefits of recycling?* *What are the best methods for reducing pollution?* *What are the worst pollutants for water and air?* *Do you drive or fly a lot? Why is driving so bad for the environment?* *What is the greenest form of transport?* They discuss the topic for 15 minutes, one student writes down the conclusions. Then each team presents their conclusions to the class verbally in a few sentences.
Conclusion/Revision	The students will write down the main things that they learned about the environment during the lesson.

Annex
1. https://earth.org/the-biggest-environmental-problems-of-our-lifetime/
2. https://docs.google.com/document/d/1HlY05D6uLk3VMCDiJOOxC6ZjF_-rrrhF/edit?usp=sharing&ouid=104626795198941911901&rtpof=true&sd=true

Topic:

Environmental Science, Water Resources Management

Aim:

In this project, students will explore the importance of water quality assessment in environmental management. They will learn about key parameters and indicators for assessing water quality and become familiar with national and international regulations and standards. Through engaging discussions, exploration of case studies, interactive activities, and practical laboratory techniques, students will develop a strong foundation in water quality assessment and its significance for sustainable water resource management.

Age Group:

17-19

Time:

280 min.

Materials:

Presentation slides or visual aids.
- Handouts or digital resources on water quality parameters and regulations.
- Case studies or real-world scenarios related to water quality assessment.
- Water samples for the practical laboratory session.
- Laboratory equipment and instrumentation for water quality assessment. (Although not specifically specified each educational institution will have the required equipment to carry out experiments to determine the following: pH, dissolved

oxygen, nitrates, phosphates. See appendix one for some common laboratory techniques.)

● Assessment materials (quizzes, assignments).

The link of the worksheet which will be used:

https://docs.google.com/document/d/1HlY05D6uLk3VMCDiJOOxC6ZjF_-rrrhF/edit?usp=sharing&ouid=104626795198941911901&rtpof=true&sd=true

Procedure:

Introduction: Time: 40 min.	Engage (5 minutes): Present a real-life scenario highlighting the consequences of poor water quality. Ask students to discuss potential impacts and why water quality assessment is crucial. ● Explore (15 minutes): Conduct a class brainstorming session on the reasons why water quality assessment is essential. Encourage students to share their ideas and experiences related to water pollution. ● Explain (25 minutes): Introduce the module's objectives and provide an overview of the topics to be covered. Present key concepts, such as the significance of water quality for ecosystem health and human well-being.

Task 1 Time: 60 min.	Engage (10 minutes): Display visual representations of different water quality parameters (e.g., pH, dissolved oxygen, nitrates, phosphates). Ask students to identify and briefly explain each parameter. ● Explore (20 minutes): Provide handouts or digital resources with information on common water quality parameters and their significance. In small groups, students discuss and summarize the key points related to each parameter. ● Explain (30 minutes): Facilitate a class discussion, highlighting the importance of each parameter in assessing water quality. Discuss the acceptable ranges, potential sources of pollution, and the ecological and human health implications of deviations.
Task 2 Time: 60 min.	Engage (10 minutes): Share examples of national and international regulations and standards for water quality. Discuss their purpose and influence on environmental management. ● Explore (20 minutes): Divide students into small groups and assign them different regulations or standards. In their groups, they research and summarize the key requirements, goals, and implications of their assigned regulation or standard. ● Explain (30 minutes): Each group presents their findings, providing an overview of the assigned regulation or standard. Lead a class discussion to compare and contrast the different guidelines and address any questions or concerns raised by the students.
Task 3 Time: 60 min.	Engage (10 minutes): Introduce the importance of practical laboratory techniques in water quality assessment. Discuss the significance of accurate measurements and precise data collection. ● Explore (20 minutes): Demonstrate and explain various laboratory techniques for water quality assessment, such as sample collection, chemical analysis, and use of instrumentation. Students observe and take notes on the procedures. ● Explain (30 minutes): Divide students into small groups and provide them with water samples. In the laboratory, they perform water quality assessments using the techniques given out by your lecturer. Students record and interpret the results,

	identifying potential pollution sources.
Task 4 Time: 60 min.	Engage (10 minutes): Conduct a class review game or quiz, using the water quality parameters, regulations, and standards covered in the previous sessions. This will help reinforce the students' understanding and retention. ● Explore (20 minutes): Assign individual or group activities that involve analysing case studies or real-world scenarios related to water quality assessment and regulations. Students should apply their knowledge and critical thinking skills to assess the given situations. ● Explain (30 minutes): Facilitate a class discussion to review the answers and discuss the outcomes of the case studies or scenarios. Summarize the key takeaways from the module, including both theoretical knowledge and practical laboratory techniques, and address any remaining questions or concerns.

Title:

POLLUTION PATROL

Objective:

To raise awareness of air pollution caused by climate change, which has a negative impact on human health and ecosystems.
To draw attention to the substances that cause air pollution and to ensure the development of methods to eliminate pollutants.
To determine the effect of STEM activities on problem solving skills of secondary school students based on daily life.

Age Group:

11-13

Time:

16 Lesson hours

Ingredients:

Ardunio uno board, Air quality measurement sensor, Computer, Jumper cable, Bord, Cardboard, Glue, Paper

Link to the worksheet to be used:

https://tryengineering.org/

Procedure:

Introduction: Time 2 Lessons	A video on air pollution and its effects is shown to the class. Students are given the task of designing a system to solve this problem and to determine the approximate amounts of polluted gases in the air.
Task 1 Time: 2 Lesson	The class is divided into groups and then each group is given a sheet of paper to design. They are asked to discuss how engineers design instruments that detect the presence of different types of pollutants in the air.
Task 2 Time: 2 Lessons	Materials are distributed to each team. They are asked to make a device to measure air quality using these materials. Students are given two class hours. They are expected to create the device they designed using sensor, Ardunio card and computer.
Task 3 Time: 8 Lessons	Students are allowed to make regular air quality measurements by placing the devices they have created at different points. Measurements are taken for a month and tables are created. The data in the tables are converted into graphs and the dimensions of pollution are discussed. The graphs obtained are presented in the classroom environment.
Task 4 Time: 2 Lesson	The results of the measurements made in previous years in the same region are taken from the literature. Students compare their own results with the results of measurements made in previous years. If there is an increase in air pollution, the reasons for this are discussed. By discussing the negative effects of air pollution on human health, it is ensured that guidelines are created to improve air quality.

APPENDICES
1. https://www.youtube.com/watch?v=6IKaUTYWtvg
2.