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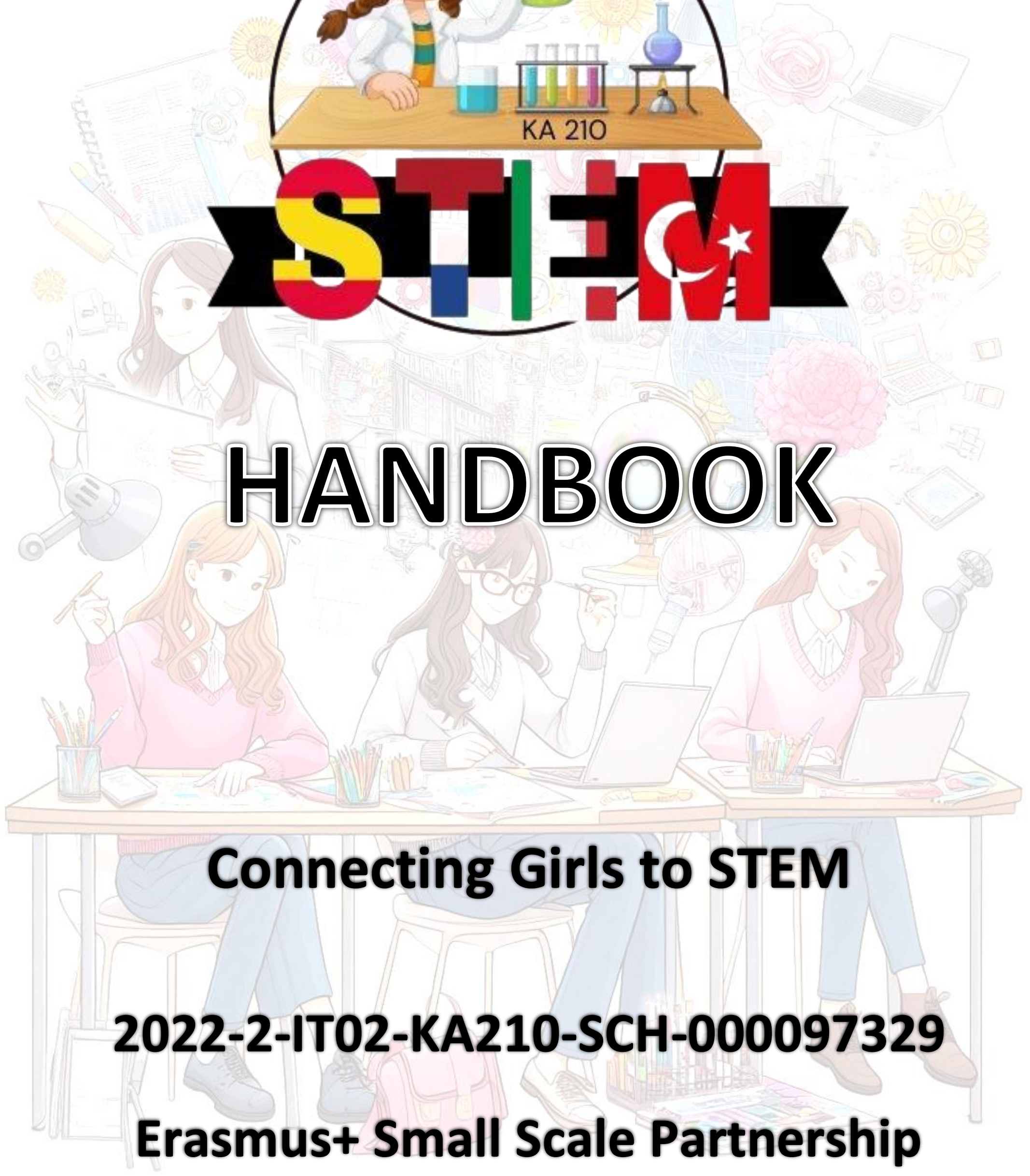


HANDBOOK

Connecting Girls to STEM

2022-2-IT02-KA210-SCH-000097329

Erasmus+ Small Scale Partnership

INTRODUCTION

The partnership structure of the "Connecting Girls to STEM" project, developed within the scope of Erasmus+ program small-scale collaborations in the field of school education, consists of 4 organizations from 4 different countries: Istituto Tecnico Tecnologico “G. Giorgi” Brindisi, Italy (Project Coordinator); (project partners) Hadiye Kuradacı Bilim Ve Sanat Merkezi, Türkiye**,** INSTITUTO DE ENSEÑANZA SECUNDARIA SANTA LUCÍA, Spain**,** INTERNATIONALE ARBEIDSVERENIGING, Netherlands.

The main aim of the project is to increase the interest of female students in STEM approach / education in order to encourage them to make effective career choices in STEM area and to contribute to the reduction of skill gaps about STEM from an early age and to achieve better scientific learning outcomes.

In line with this overall objective, Project partners has focused on the following goals for 18 months:

1- To ensure the transfer of experiences between 2 LTTAs and 24 education professionals on digital technologies and interdisciplinary learning methodologies and methods that provide better scientific learning outcomes in STEM education for girls and encourage girls' interest in STEM;

2- Developing 1 handbook containing activities in a variety of modern interdisciplinary learning models and methods which will increase female students' interest, participation and motivation to learn in the STEM field.

3- Developing 15 female students' key STEM-related skills (Eco-skills, digital skills, entrepreneurial skills, etc. cross-skills) with an LTT activity.

This handbook has been prepared within the scope of project objective-2. In this context, in 4 different learning models; Different STEM course activities have been designed in project-based learning, problem-based learning, engineering design process and inquiry-based learning models. Care was taken to use different digital tools in the design of STEM activities planned in the context of sustainable development goals. In particular, it is open to professionals from different disciplines who want to increase the interest and participation of girls in STEM.

Engineering Design Process

Activity_1	
Age Group	14-17 ages
Subject - Topic	Fire Warning Automation
Time required	2-3 weeks / 8 hours
Learning objectives and STEM disciplines	In this section, you can write the disciplines that the subject is related to. It could offer preventative ideas for fires that encourage climate change. Can calculate the resistance values of materials. Can design and program the fire warning system using various electronic materials and digital tools. Can develop designs that provide solutions to current climate problems. …etc
Resources Needed and materials	Arduino Uno, breadboard, 9 Male-Male Jumper Cables, LM35 temperature sensor, 5mm Red LED, Buzzer, 2 Pieces 330 Ohm (Orange-Orange-Brown) resistors, Computer
Safety notes	Be carefull using electric
Group	Create groups insluding 3-4 students
Problem scenario	In this step, the teacher should write a few problem sentences. For example, question statements could be: • What is the relationship between climate change and carbon emissions? • What can be done to minimize carbon emissions? • How do fires affect carbon emissions? • Is it possible to prevent fires? • Is it possible to have a simple fire warning system that can be used in our home or workplace? • If possible, how can we do this with materials like Arduino?
Ask	The teacher direct students to identify and define the problem ans to do so, ask critical questions: • What is the problem to solve? • What do we want to design? • Who is it for? • What do we want to accomplish? • What are the project requirements? • What are the limitations? What is our goal? • Who does the problem affect? • What needs to be accomplished? • What is the overall goal of the project? The teacher also identify the criteria and constraints of the problem.
Research	

the problem

In this step the teacher direct students to use K-W-L chart form to assess what they know about a particular topic before and after they have engaged the design process.

What do you **K**now about the topic?	What do you **W**ant to know?	What did you **L**earn?
For example; - Temperature can be detected with fire sensors. - Fire warning systems can prevent large fires. - …etc	For example; - I want to develop a fire warning system with digital tools. - I want to make a simple fire prevention design that provides early warning. - …etc	**It should be written after the activity.**

Teacher should;
direct students fill the form before searching the problem and make students work in groups to search the problem.

Teachers direct students

- ➢ to learn everything they can about the problem.
- ➢ to talk to experts and/or research what products or solutions already exist.
- ➢ to examine the current state of the issue and current solutions.
- ➢ to explore the other options via internet, library, interviews, etc..

At this stage, research on the fire warning system can be done from various sources. Various simple models are examined and students are provided with inspiration.

Recommended resources for research;
https://sensorkit.arduino.cc/sensorkit/module/lessons/lesson/08-the-temperature-sensor

https://maker.robotistan.com/arduino-ile-lm35-sicaklik-sensoru-kullanimi/

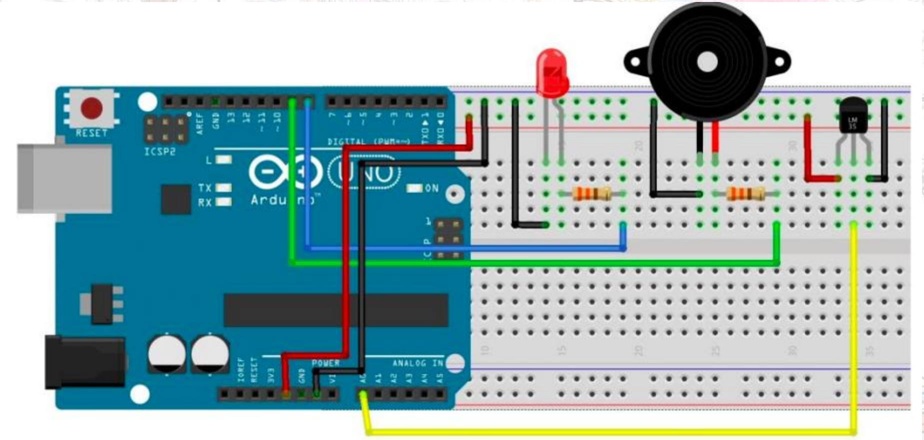
https://www.electronicwings.com/arduino/lm35-interfacing-with-arduino-uno

Imagine: develop possible solutions

In this step the teacher encourage teamwork and building on ideas.

The teacher direct teams;

- ➢ To brainstorm ideas and develop as many solutions as possible
- ➢ To think of many different ideas that might be possible solutions to the

	problem statement ➢ To brainstorm ideas and come up with as many solutions as possible. ➢ To develop possible solutions ➢ To draw on mathematics, technology, enginering, and science ➢ To articulate possible solutions in two or three dimensions ➢ To sketch ideas with labels and arrows to identify parts and function
Plan: select a promising solution	In this step, the teacher direct students; ➢ To consider the pros and cons of all possible solutions, keeping in mind the criteria and constraints. ➢ To compare the different design solutions ➢ To select the best design ➢ To make a plan to move forward with it. ➢ To draw the prototype
Create: build a prototype	In this step, the teacher direct students; ➢ To create (build) their designed product (It is important to make a model or prototype of the design to make sure it works) *Note for the teacher: A prototype is the first product that is made from the design, which the teacher use to analyze whether or not it addresses the problem adequately The fritzing program can be used to draw the prototype model. An example circuit design / prototype; 
Test and evaluate prototype	In this step, the teacher ask to the students test out the solution to see how well it Works considering the question given below. • Does it work? • Does it solve the need? • Does it meet all the criteria and solve the need? • Does it stay within the constraints? The teacher direct students to talk about what worked during testing and what didn't work., communicate the results and get feedback.
Improve: redesign as needed	In this step, the taacher : ➢ ask to the students review and decide if their design is the best one possible and optimize the solution. ➢ direct them If they have not an excellent solution to a problem, go back to step one, redesign parts that didn't work, and test again.

Activity_2	
Age Group	**15-17 years old**.
Subject - Topic	**Engineering and Technology**, focusing on the topic of **Renewable Energy**, specifically the design and construction of a wind turbine prototype.
Time required	**4 sessions** of 2 hours each
Learning objectives and STEM disciplines	• **Physics and environmental science**: Understand aerodynamics and energy conversion by exploring the principles of wind energy. Develop problem-solving skills by optimising wind turbine designs based on scientific principles. • **Technology**: Use tools and technology to build and test wind turbine prototypes, improving technical skills and developing critical thinking through technology-driven improvements. • **Engineering**: Engage in the engineering design process to iteratively design, build, test and refine wind turbines. Improve problem-solving and teamwork skills by tackling real-world engineering challenges. • **Mathematics**: Use measurements and calculations to determine blade angles and dimensions and analyse turbine efficiency, demonstrating the application of mathematical principles to engineering and technology projects.
Resources Needed and materials	• Small DC motor (acts as the generator) • LED light bulb or small buzzer (to test electricity generation) • Multimeter (to measure voltage and current) • Blade materials (cardboard, plastic, balsa wood) • Turbine tower materials (PVC pipes, wooden dowels, or sturdy cardboard) • Glue, tape, and fasteners • Fan (to simulate wind)
Safety notes	Ensure that students wear safety goggles during construction to protect their eyes from potential hazards. Supervise the use of sharp tools such as scissors or craft knives. Care should be taken when testing the wind turbines near moving parts, such as the fan, to prevent accidents.
Group	Create groups including 3-4 students
Problem scenario	Design and construct a prototype wind turbine that is capable of generating electricity efficiently using the materials provided and within the given time frame. The turbine should be able to power a small LED light bulb or buzzer and meet specific performance criteria, taking into account factors such as blade design, tower stability and overall cost effectiveness.
Ask	Students will be guided to ask critical questions about the challenge: • What problem do we want to solve with our wind turbine prototype? • What specific design features are we considering for our turbine? • Who will benefit from the successful implementation of our wind turbine? • What are the main objectives we want to achieve with our project? • What are the essential requirements that our wind turbine must meet? • What constraints do we need to consider when designing our turbine? • What tasks do we need to perform to achieve our project goals?

Research the problem	Students use a K-W-L chart to document: • **Know**: List existing knowledge about wind turbines, including how they work and their applications in renewable energy. • **Want to know**: Identify specific questions or areas of interest regarding the design, construction and performance of wind turbines. • **Learn**: Reflect on new insights gained throughout the design process, including discoveries, challenges and solutions.
Imagine: develop possible solutions	Teacher will encourage students to brainstorm and develop multiple solutions to generate electricity efficiently. Foster a creative environment where they can explore different ideas and integrate principles of maths, science and engineering. Encourage articulation of proposed solutions through visual sketches and provide clarity through labels and annotations that represent key components and functions in their wind turbine designs.
Plan: select a promising solution	Students consider the pros and cons of all possible solutions, taking into account the criteria and constraints given. They compare the different design solutions and choose the best one. They draw up a plan to take their chosen design forward. Finally, they draw the prototype based on the selected design, ensuring that it reflects their collective vision and effectively addresses the problem statement.
Create: build a prototype	Students are tasked with building physical prototypes of their conceptual designs. By building prototypes, students are able to identify what needs to be improved, leading to a better design before final implementation. This hands-on approach promotes practical problem-solving skills and reinforces the importance of the engineering design process in achieving successful outcomes.
Test and evaluate prototype	After building their prototypes, students are asked to test their solutions to evaluate their effectiveness. They assess whether the prototypes work as intended. The teacher guides the students to reflect on their testing experience, discussing which aspects were successful and which weren't. By effectively communicating results and seeking feedback, students gain valuable insights to further refine and improve their designs.
Improve: redesign as needed	Students evaluate the effectiveness of their designs and optimise them. The teacher encourages critical review to ensure the best solutions. If designs fall short, students return to previous steps, redesigning and retesting until optimal results are achieved. This iterative process cultivates resilience and innovation, and promotes continuous improvement in students' problem-solving and design skills.

Activity_3	
Age Group	**12-15 years old** - This age group is ideal as students have sufficient foundational knowledge in STEM subjects and can engage in more complex project-based learning.
Subject - Topic	**STEM - Engineering and Biology** - The main focus is on engineering a sustainable environment for plant growth under lunar conditions, integrating biological science for understanding plant life support systems.
Time required	**12 sessions over 6 weeks**, with each session lasting 2 hours. This schedule allows adequate time for in-depth exploration, design, building, and testing of prototypes.
Learning objectives and STEM disciplines	• **Science:** Learn about plant life cycles, photosynthesis, and adaptations necessary for growth in lunar-like environments. • **Mathematics:** Calculate resource needs (water, light, nutrients) and constraints (space, weight). • **Technology:** Utilize digital tools for design (CAD software), and data collection (sensors for temperature, humidity, and light). • **Engineering:** Apply the engineering design process to create a prototype that simulates lunar conditions for plant growth.
Resources Needed and materials	• LEGO Mindstorms EV3 kits: For building mechanical parts of the growth chamber. • Computer lab with CAD software: For designing the chamber and planning layouts. • Internet access: For research purposes. • Gardening supplies: Soil, seeds, small plants for testing. • Sensors: To monitor environmental conditions within the prototype. • Miscellaneous: LEDs for lighting, wires, batteries.
Safety notes	• Electrical safety: Handle batteries and wiring carefully. • Tool safety: Supervise the use of any sharp tools or mechanical components. • Chemical safety: Proper handling and disposal of any plant nutrients or growth substances.
Group	Form groups of 3-4 students, encouraging collaboration and ensuring each student takes on various roles throughout the project to foster a comprehensive learning experience.
Problem scenario	Humanity is preparing for future lunar missions where astronauts will need to grow their own food. Design a plant growth chamber that can operate under lunar conditions, considering limited resources and harsh environmental factors.
Ask	Students are guided to ask critical questions about the challenge:

	• What types of plants are most suitable for lunar conditions? • What are the critical environmental factors to consider (e.g., no atmosphere, extreme temperatures)? • What resources are limited on the moon (e.g., water, organic soil)? • How can we simulate lunar gravity and radiation?
Research the problem	Students use a K-W-L chart to document: • **Know:** Basic plant biology, what plants need to grow. • **Want to know:** Specific adaptations plants need for lunar environments, existing technologies for growing plants in space. • **Learned:** Insights from research, expert interviews, and studying existing space agriculture projects.
Imagine: develop possible solutions	Students brainstorm and propose multiple design solutions. They consider innovative materials, recycling water and air, using artificial light sources, and automating care processes.
Plan: select a promising solution	Groups evaluate their brainstormed ideas against the project criteria and constraints, select the most feasible solution, and begin detailed planning for their prototype.
Create: build a prototype	Using LEGO Mindstorms for structural components and integrating sensors and control systems, students build a working model of their design.
Test and evaluate prototype	The prototype is tested to see how well it supports plant growth, maintaining required environmental conditions. Students collect data and observe plant health and growth rates.
Improve: redesign as needed	Based on testing outcomes, students identify any shortcomings in their designs and make necessary adjustments to optimize the system, followed by further testing and evaluation.
Integration with Digital Tools	Throughout the project, digital tools enhance learning and engagement: • **CAD software:** For design visualization and modifications. • **Online platforms like eTwinning:** To document progress, share ideas, and collaborate with peers. • **Data logging software:** To monitor and analyze environmental data from sensors.
Addressing Sustainable Development Goals	This activity promotes SDG 12 (Responsible Consumption and Production) by designing efficient use of resources and SDG 15 (Life on Land) by exploring sustainable agricultural practices. This comprehensive setup ensures that the project is not only educational but also engaging, fostering creativity, critical thinking, and a deeper understanding of interdisciplinary applications in STEM.

Activity_4	
Age Group	**15-17 years old** - This age group is ideal as students have sufficient foundational knowledge in STEM subjects and can engage in more complex project-based learning.
Subject - Topic	**STEM - Engineering and Computer Science** - The main focus is on engineering a creative and innovative "app intelligent" that simulates separate waste collection solutions and classify the different types of waste.
Time required	**12 sessions over 6 weeks**, with each session lasting 2 hours. This schedule allows adequate time for in-depth exploration, design, building, and testing of app prototypes.
Learning objectives and STEM disciplines	• **Computer Science:** Learn about the basics of **image classification** and of **machine learning.** Apply the engineering design process to create an app prototype. • **Citizenship/Social Studies:** Raising awareness of the objectives of the 2030 agenda and sustainable cities.
Resources Needed and materials	• Google Teachablemachine • App Inventor • Computer lab • Internet access: For research purposes and traing of the machine learning. • Camera o smartphone: to take image of waste for testing. • Miscellaneous: different type of waste (plastic o glass bottles for example).
Safety notes	• Tool safety: Supervise the use of any type of waste (glass)
Group	Form groups of 3-4 students, encouraging collaboration and ensuring each student takes on various roles throughout the project to foster a comprehensive learning experience.
Problem scenario	We guide reflection and promote behaviors aimed at reducing consumption, especially of disposable plastic products, we educate recycling and even creative reuse. Design a machine intelligent" that simulates separate waste collection solutions and classify the different types of waste.
Ask	Students are guided to ask critical questions about the challenge: • Can artificial intelligence help us care for the environment? • What type of waste is more critical for the environmental? • How many images we need for train the machine learning model?
Research the problem	Students use a K-W-L chart to document: • **Know:** Student know to take photos • **Want to know:** Students learn about the basics of image classification and of machine learning • **Learned:** Students learned to use App Inventor
Imagine: develop possible solutions	Students brainstorm and propose multiple design solutions. They consider different type of waste and then take photo or download data set from Kaggle.
Plan: select a	Groups evaluate their brainstormed ideas against the project criteria and

promising solution	constraints, select the most feasible solution, and begin detailed planning for their prototype.
Create: build a prototype	Using Teachablemachine and App Inventor students build a working model of their design.
Test and evaluate prototype	Students test the app on classifying various objects. What types of objects is it good at classifying? Students collect data and observe how classification works.
Improve: redesign as needed	Based on testing outcomes, students identify any shortcomings in their designs and make necessary adjustments to optimize the system, followed by further testing and evaluation.
Integration with Digital Tools	Throughout the project, digital tools enhance learning and engagement: • **Machine learning tool:** For training a machine learning model • **App Inventor platform**: to create a mobile app to use for image classification • **Online platforms like eTwinning:** To document progress, share ideas, and collaborate with peers. • **Data science community:** to download data set to training the model (instead to take images manually)
Addressing Sustainable Development Goals	This activity promotes SDG 12 (Responsible Consumption and Production) by designing efficient use of resources. How can I help as a consumer? This comprehensive setup ensures that the project is not only educational but also engaging, fostering creativity, critical thinking, and a deeper understanding of interdisciplinary applications in STEM.

Project Based Learning

Activity_5	
Age Group	15-17 ages
Activity Tittle	Sustainable Building
Subject - Topic	Climate change,
Learning objectives and STEM disciplines	Related with science, enginering, math
Key Vocabulary	Determine the key vocabulary words and terms you need to teach based on your focus content and the prior knowledge and needs of your students., energy 3d software, climate change,
Keys Skills	Problem solving, analitic thinking, creatieve thinking,
Safety concerns	Are there any safety concerns that you and your students should be aware of while working on this lesson?
Time	Approximate time needed to complete activity,
Resources needed and materials	Energ3d program (https://energy.concord.org/energy3d/) , computer,
Implementation process	
Group working	Create groups consisted of 2-3 students
Challenging Problem/Essential Question	How much electricity bill do you pay annually in your city and in your home? How much is your city's annual/monthly or daily electricity consumption? How much is your home's annual/monthly or daily electricity consumption? So, do you think that you increase global warming as a result of the electricity you consume? Is it possible to use electrical energy in more ecological ways? If possible, in what ways can we do this? Also, are there environmental ways to reduce the cost of electricity? Students are mentored on how to benefit from solar energy and how to benefit from it. Students are expected to state that electrical energy can be produced from solar energy. In this activity, it is emphasized that the most ideal energy-saving design for our home will be made by using the Energy 3D program.
Create a Schedule	At this stage, it is decided together with the students / groups how much time will be allocated for the project. Emphasize students to consider possible changes when creating the project timeline. Specify the project timeline and cost calculations at the design stage of the house model to be designed in the Energy 3D program. Tell them to design sustainable house models at the most ideal cost and to make a cost table appropriate to this model.

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For example schedule:
<table>
<tr><td>Tasks</td><td>Deadline</td><td>Responsible</td></tr>
<tr><td>Exploring the Energy 3d program</td><td>1 week</td><td>As group</td></tr>
<tr><td>Calculating your home's annual energy consumption</td><td>3 days</td><td>As group</td></tr>
<tr><td>Designing the most cost-effective home and calculating the cost of solar panels</td><td>1 week</td><td>As group</td></tr>
<tr><td>Calculating the amount of energy required to determine the solar panels to be used in the designed house</td><td>2 days</td><td>As group</td></tr>
</table>
Students are recommended to review inspiring examples for the placement of houses and solar panels at the following link:
https://energy.concord.org/energy3d/models.html
https://energy.concord.org/energy3d/styles.html
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<tr>
<td>Inquiry</td>
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At this stage, they are asked to search for previously designed environmentally friendly house, workplace or building models on the internet. Students are expected to discuss as a group different environmental models discovered on the internet.

Additionally, experts such as solar energy engineers, civil engineers and academics may be asked to gather information on sustainable home models. Thus, they will gain deeper knowledge.

To deepen the subject, they are asked to list the electrical devices in their homes. In addition, they are asked to add their daily consumption amounts and electricity costs to this list.
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<td>Monitor the Students and the Progress of the Project</td>
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At this stage, the work of each group is monitored. Situations requiring guidance and mentoring are noted. Follow-up meetings are held with groups through various methods such as round table meetings. Deficiencies, improvement suggestions, emerging problems and group performances are discussed. Monitoring forms that provide qualitative and quantitative data for each group are created by the teacher.

As basic lines for monitoring the process;
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	• Monitor group dynamics and compliance with rules. • Are group members performing their roles? • How well are members involved in the project process? What is the performance of each group member? • Is the group progressing in accordance with the project purpose? Is the process as expected? • Are the resources, references and guidance available sufficient?
Presentation	Teachers ask students to present sustainable house models in different ways. (Web 2 tools, posters, infographics, tables, graphs, photographs and 3D designs can be used for presentation purposes.)
Assess the Outcome	At this stage, students' projects are evaluated according to the project evaluation rubric. Additionally, focus group discussions are conducted with groups to collect qualitative data. The teacher conducts evidence-based assessment with qualitative and quantitative data and provides feedback to groups.

Activity_6	
Age Group	15-17 years old
Subject - Topic	Environmental Science and Engineering - Design and Testing of Water Filtration Systems
Learning objectives and STEM disciplines	Learning objectives: • Identify common water contaminants. • Carry out water quality tests. • Design and construct a water filtration system. • Work together and develop communication skills. STEM disciplines: Environmental Science, Chemistry, Engineering, Mathematics
Key Vocabulary	A filtration system will be useful to remove contaminants from the water. Some characteristics such as pH, turbidity, microbial content and concentration of chemical contaminants need to be taken into account to determine if the water is ready for use or reuse. Using activated carbon, students will build and refine their prototypes and present their findings to improve water safety and sustainability.
Keys Skills	Problem solving, analitic thinking, creatieve thinking,
Safety concerns	Ensure proper handling of water samples to avoid contamination, wear gloves and goggles when testing for microbial content and chemical contaminats, and follow safety guidelines when using activated charcoal and other filtration materials.
Time	6 sessions

Resources needed and materials	• Water testing kits (for pH, turbidity, microbial content, chemicals) • Activated charcoal • Sand and gravel • Water collection containers • Plastic bottles or containers for filtration systems • Gloves and goggles • Data recording sheets or lab notebooks • Computers for data analysis and presentation preparation
Implementation process	
Group working	Create groups consisted of 2-3 students
Challenging Problem/Essential Question	The teacher will introduce the activity with the following challenge problem: **How can we ensure access to clean and safe water for all, especially in regions with limited resources?** Students are given additional questions: • What are the main contaminants found in water and how do they affect human health and the environment? • What are the main factors contributing to poor water quality? • What are the principles of effective water filtration systems, and how can we design and optimise them? • How can we promote sustainability and equity in the global management of water resources?
Create a Schedule	Session 1: Introduction to water quality issues. Explore common contaminants and filtration methods. Discuss the importance of clean water. Session 2: Form teams and finalise design proposals. Gather materials. Brainstorm and sketch prototype designs. Session 3: Build prototype filtration systems. Test basic functionality. Continue to collect materials and refine prototypes. Session 4: Conduct initial water quality tests. Collect data on pH, turbidity and microbial content. Discuss the significance of the data. Session 5: Analyse pre and post filtration data. Evaluate system effectiveness. Identify areas for improvement and refine prototypes. Session 6: Prepare and practice presentations. Present findings and reflect on the implications of the project. Discuss real-world solutions.
Inquiry	In the inquiry phase, students explore water quality and filtration methods through questioning and investigation. Teachers guide the process by providing resources and asking key questions. Students use different sources of information, such as books or the Internet to learn new concepts. Teacher encourage students to ask deeper questions and to think critically. The inquiry phase continues iteratively until students

	develop satisfactory solutions or answers, refining their understanding and developing essential skills in the process.
Monitor the Students and the Progress of the Project	Throughout the water filtration project, the teacher will monitor students and their progress to ensure that they are working effectively. The teacher will guide students in working as a team, encouraging members to choose specific roles while remaining responsible for all tasks involved in designing, building and testing the filtration systems. In addition, the teacher will evaluate the process using rubrics to assess the effectiveness of the filtration systems and individual participation. Basic guidelines for monitoring the process: • Ensure that students understand and practice collaborative techniques. • Identify and confirm fluid roles for group members. • Remind students of their shared responsibility for all tasks. • Provide resources and guidance on test kits, materials and data analysis. • Use rubrics to assess the effectiveness of the filtration system and individual participation.
Presentation	Teachers ask to the students present their findings in different ways (Tables, graphics, photos, models can be used for presentation)
Assess the Outcome	Students will be assessed through continuous evaluation and will receive feedback on their performance. In the beginning, the teacher will check the initial designs to avoid big mistakes. In addition, students will be quizzed on water quality concepts and filtration mechanisms by the teacher, who will check that they fully understand what they are learning.

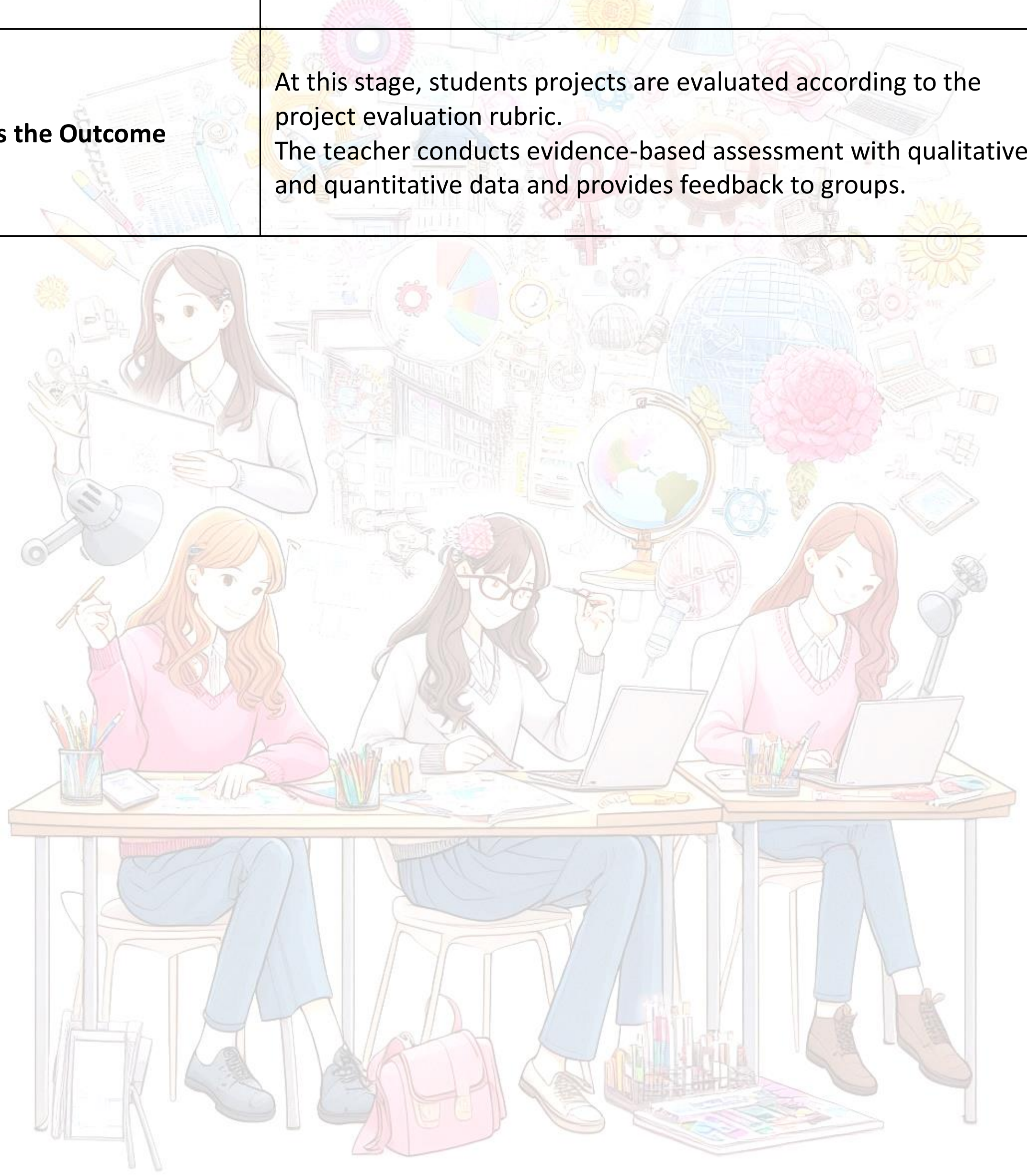
Activity_7	
Age Group	**15-17 years old -** Students in this age range are typically capable of understanding complex environmental issues and can engage in meaningful scientific inquiry and problem-solving.
Subject - Topic	**Climate Change and Its Impact on Land and Water Resources -** This project will explore the effects of climate change on local and global ecosystems, focusing on water bodies and land areas.
Learning objectives and STEM disciplines	Students will: • Explore the scientific concepts of climate change, including greenhouse gases and their effects on ecosystems. • Use technology to gather and analyze environmental data. • Apply engineering principles to design solutions that mitigate or adapt to the impacts of climate change. • Utilize mathematical skills in data analysis and modeling of predictions.

Key Vocabulary	**Climate Change, Greenhouse Gases, Ecosystem, Biodiversity, Sustainability, Resilience, GIS, Arduino -** These terms will be central to understanding and discussing project topics.
Keys Skills	Students will develop: • Problem-solving skills by addressing real-world issues. • Analytical thinking through data interpretation. • Creative thinking in designing innovative solutions. • Collaboration by working in teams. • Communication skills through presentation and documentation.
Safety concerns	• **Electronic and Electrical Safety:** Training on the safe handling of Arduino kits and any electrical components. • **Chemical Safety:** Proper use and disposal of chemicals used in soil and water testing. • **Field Safety:** Guidelines on conducting fieldwork safely, including weather considerations and terrain navigation.
Time	6-8 weeks, allowing time for in-depth exploration, data collection, and analysis, culminating in the presentation of solutions and findings.
Resources needed and materials	• Technological Tools: GIS software, Arduino kits for data collection, computers. • Research Materials: Access to climate data, scientific articles, environmental monitoring equipment. • Field Equipment: Water testing kits, soil testing kits, portable weather stations.
Implementation process	**Week 1-2: Introduction and Training** • Introduction: Educate students on the basics of climate change. • Digital Tools Training: Teach students how to use GIS and Arduino for data collection. • Safety Training: Discuss how to safely handle electronic components, field equipment, and any chemicals for testing. **Week 3-6: Research and Development** • Data Collection: Students conduct fieldwork, gathering data on local water and soil conditions. • Analysis: Use software tools to analyze the data collected. • Solution Design: Brainstorm and prototype solutions to mitigate the observed effects of climate change. **Week 7-8: Presentation and Reflection**

	• Preparation: Students prepare their findings and solutions for presentation. • Presentation: Present to classmates, teachers, and possibly community members. • Reflection: Discuss what was learned and how the project could be improved or expanded.
Group working	Small groups of 2-3 students will promote effective teamwork and ensure that all members can actively participate and contribute to all phases of the project.
Challenging Problem/Essential Question	• Essential Question: "How can our community adapt to the impacts of climate change on our natural land and water resources?" • This question encourages students to focus on local impact and global understanding, driving home the relevance of their findings.
Create a Schedule	**Timeline Planning:** Lay out a clear schedule for each phase of the project, from research to presentation. Flexibility: Allow for adjustments based on project needs and findings.
Inquiry	• **Resource Gathering:** Facilitate access to online databases, expert consultations, and scientific literature. • **Iterative Learning:** Encourage continuous refinement of hypotheses and solutions based on findings.
Monitor the Students and the Progress of the Project	• **Ongoing Support:** Provide regular check-ins to guide research and project development. • **Assessment:** Use rubrics to evaluate both group dynamics and project outcomes.
Presentation	**Diverse Methods:** Allow students to use digital presentations, posters, and physical models to explain their research and solutions.
Assess the Outcome	**Feedback:** Provide constructive feedback on both the scientific rigor of their work and the effectiveness of their communication.
Integration with Digital Tools	**GIS:** Analyze geographical data related to climate impacts. **Arduino:** Develop DIY environmental monitoring tools. **Online Platforms:** Use platforms like eTwinning to collaborate, share progress, and get feedback from peers across different regions.
Addressing Sustainable Development Goals	**Climate Action (Goal 13):** Educate about and develop solutions to combat climate change. **Life on Land (Goal 15) and Clean Water and Sanitation (Goal 6):** Projects focus on preserving ecosystems and ensuring sustainable water use.

Activity_8	
Age Group	17-18 ages
Subject - Topic	Fıghtıng Agaınst Gender Dıscrımınatıon And Prejudıce
Learning objectives and STEM disciplines	Related with science, math, computer science
Key Vocabulary	Determine the key vocabulary words and terms you need to teach based on your focus content and the prior knowledge and needs of your students. Gender discrimination, gender equality, stem
Keys Skills	Problem solving, crative thinking, communication, collaboration
Time	1 semester
Resources needed and materials	Computer lab, Internet
Implementation process	1) Brainstorming on gender equality 2) Presentation about gender gap in stem fields 3) Student group organization 4) Research about a female scientist for each group 5) Implementation of digital storytelling
Group working	Create groups consisted of 4 - 5 students
Challenging Problem/Essential Question	Teacher starts with the essential question about gender equality and viewing an italian documentary about the topic. Viewing a global Gender Gap Report
Create a Schedule	1) Brainstorming about the topic 2) They watch the documentary "Gli Speciali di Rai Scuola - Parità di genere" 3) The students are split in groups of four 4) The students choose a scientist 5) In-depth research about the assigned scientists; 6) Training on using Spatial o other technology platform; 7) Creation of the digital storytelling
Inquiry	Inquiry stage is iterative: Discussion about Agenda 2030 - Goal 5: Achieve gender equality and the empowerment of all women and girls At this stage students are asked to draw a scientist: will they draw a man or a woman? The teachers show data about the involvement of women in STEM disciplines and the roles of responsibility that they occupy students carry out in-depth research on the female scientists they want to learn more about.
Monitor the Students and the Progress of the Project	At this stage, the work of each group is monitored. Situations requiring guidance and mentoring are noted. Follow-up meetings

	are held with groups through various methods such as round table meetings. Deficiencies, improvement suggestions, emerging problems and group performances are discussed. Monitoring forms that provide qualitative and quantitative data for each group are created by the teacher.
Presentation	Teachers ask to the students present their findings in different ways (photos, presentation, video, infographics,)
Assess the Outcome	At this stage, students projects are evaluated according to the project evaluation rubric. The teacher conducts evidence-based assessment with qualitative and quantitative data and provides feedback to groups.



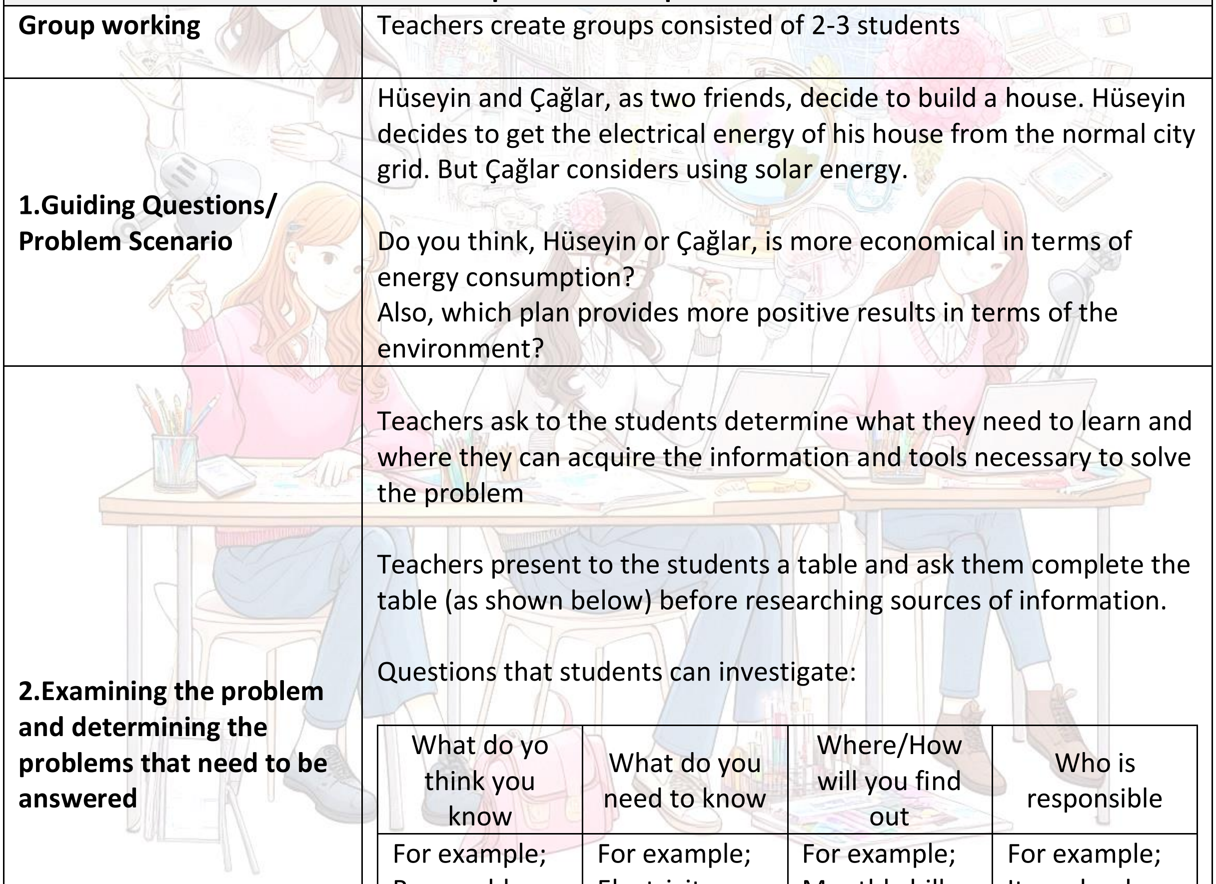
Problem Based Learning

<table>
<tr><th colspan="2">Activity_9</th></tr>
<tr><td>Age Group</td><td>14-17 ages</td></tr>
<tr><td>Subject - Topic</td><td>Renewable and non-renewable energy comparison</td></tr>
<tr><td>Learning objectives and STEM disciplines</td><td>Calculates daily, monthly and annual electricity consumption amounts for home or workplace.
Knows and compares non-renewable and renewable energy sources.
It offers ideas about the importance of renewable energy and the added value it provides.
Designs physical and virtual models to compare non-renewable and renewable energy sources.</td></tr>
<tr><td>Safety concerns</td><td>Be careful when using electricity.
Care should be taken when using cutting tools for model making.</td></tr>
<tr><td>Time</td><td>3 weeks / 6 hours</td></tr>
<tr><td>Resources needed and materials</td><td>Energ3d program (https://energy.concord.org/energy3d/) , computer, Various materials for real model</td></tr>
<tr><th colspan="2">Implementation process</th></tr>
<tr><td>Group working</td><td>Teachers create groups consisted of 2-3 students</td></tr>
<tr><td>1.Guiding Questions/ Problem Scenario</td><td>Hüseyin and Çağlar, as two friends, decide to build a house. Hüseyin decides to get the electrical energy of his house from the normal city grid. But Çağlar considers using solar energy.

Do you think, Hüseyin or Çağlar, is more economical in terms of energy consumption?
Also, which plan provides more positive results in terms of the environment?</td></tr>
<tr><td>2.Examining the problem and determining the problems that need to be answered</td><td>Teachers ask to the students determine what they need to learn and where they can acquire the information and tools necessary to solve the problem

Teachers present to the students a table and ask them complete the table (as shown below) before researching sources of information.

Questions that students can investigate:
<table>
<tr><th>What do yo think you know</th><th>What do you need to know</th><th>Where/How will you find out</th><th>Who is responsible</th></tr>
<tr><td>For example; Renewable and non-renewable energy sources, Daily, monthly and annual</td><td>For example; Electricity consumption amount or electrical power of electrical household</td><td>For example; Monthly bill showing electricity consumption, Parents, Experts in the field,</td><td>For example; It can be done by 2 people in a group or individually.</td></tr>
</table></td></tr>
</table>



electrical energy consumption, …etc	appliances, The extent to which non-renewable energy sources affect the environment, …etc	Internet, …etc	

3.Research

I this step teachers ask to the students:

1. Search “sources of information” to find answers to questions. Studets research and collect information about the problem.

2.Write down the information they gathered from the research below.

For example;

	Information
Question 1	Is it more economical to use the city grid or the electrical energy obtained from the sun?
Question 2	Which of the non-renewable or renewable energy sources is more positive for the environment?

3.Generates hypotheses for questions
For example;

	Hypothesis
Hypothesis 1	Using electrical energy obtained from solar energy gives better results for budget management.
Hypothesis 2	Renewable energy sources, such as electrical energy obtained from the sun, pollute the environment less.

4.Plan an experiment to test the hypotheses they have identified

Experiment 1: The experiment students propose to test the first hypothesis

For this experiment, students are given sample applications in the energy3d program to design a house model with solar panels. Guidance is given to find the most ideal design. In addition, the daily, monthly and annual electricity consumption of houses that do not benefit from solar energy for electrical energy and the bills paid for this are calculated. After the designs are completed, necessary

	calculations are made for budget usage and design cost. The data obtained as a result of the calculations are compared and interpreted by the students. Experiment 2: The experiment students propose to test the second hypothesis Daily, monthly and annual electricity consumption and carbon footprints of the virtual house designs designed in the previous experiment and benefiting from solar energy and other houses (using the city grid) are calculated. Thus, energy efficiency and environmental impacts are compared and interpreted by students.
4. Determination of possible solutions	In this step teachers ask to the students: 1.Discuss possible solutions and decide the best solution of the problem. 2.Select the most appropriate experiment and write it.
5.Implementation of the chosen strategy	Teachers ask to the students do the set experiments as a group and write the result.
6.Evaluation of solution strategy	Teachers ask to the students if the experiment result support their hypothesis and let them discuss with their group friends. Teachers must provide an opportunity for students to LOOK BACK and evaluate their conclusions where they will eventually communicate, orally and/or in writing their possible actions, recommendations, and solutions. The final product should include the scenario, guiding questions, data gathered, analysis of data, and support for solutions or recommendations based on the data analysis.

Activity_10	
Age Group	15-17
Subject - Topic	Renewable energy, specifically focusing on its application in addressing energy needs in isolated islands.
Learning objectives and STEM disciplines	Learning Objectives: ● Understand the challenges faced by isolated islands in meeting their energy needs. ● Explore various renewable energy technologies suitable for isolated islands. ● Analyze the environmental, social, and economic impacts of renewable energy deployment in isolated islands. ● Design sustainable energy solutions tailored to the specific needs of isolated islands. STEM Disciplines: This activity can encompass multiple STEM disciplines such as: ● Engineering (renewable energy systems design) ● Environmental Science (impact assessment) ● Economics (cost-benefit analysis) ● Mathematics (data analysis and modeling)
Safety concerns	Since this activity may involve discussions about renewable energy technologies and potentially hands-on design activities, safety considerations related to handling equipment or working with renewable energy systems should be addressed. Participants should also be mindful of environmental safety considerations.
Time	The duration of the activity can vary depending on the depth of exploration and the level of detail you want to achieve. A comprehensive problem-based learning activity on this topic could span several sessions, ranging from a few days to a few weeks.
Resources needed and materials	● Access to research materials such as articles, case studies, and reports on renewable energy in isolated islands. ● Multimedia resources like videos or documentaries showcasing renewable energy projects in similar settings. ● Data sets related to energy consumption, renewable energy potential, and environmental factors of isolated islands. ● Possibly access to simulation software or tools for renewable energy system design and analysis. ● Materials for group work and presentation such as whiteboards, markers, and presentation slides.

Implementation process	1. Introduction and Problem Statement: ● Begin the activity by providing background information on the energy challenges faced by isolated islands, such as dependence on fossil fuels, high energy costs, and vulnerability to supply disruptions. ● Present the problem statement: "Design sustainable renewable energy solutions to meet the energy needs of an isolated island community." 2. Group Formation: ● Divide participants into small groups, ideally consisting of 3-5 members each. ● Aim for diversity within groups, including students with backgrounds in engineering, environmental science, economics, and other relevant fields. 3. Research and Exploration: ● Provide access to a variety of resources, including articles, case studies, reports, and multimedia materials, related to renewable energy technologies and their application in isolated island settings. ● Encourage groups to conduct research on the energy profiles of specific isolated islands, considering factors such as energy demand, available renewable resources (solar, wind, hydro, etc.), geographic constraints, and existing infrastructure. ● Facilitate discussions and brainstorming sessions where groups can explore different renewable energy options and assess their suitability for addressing the unique needs and challenges of isolated islands. 4. Problem Solving and Design: ● Guide groups through the process of analyzing data, identifying potential renewable energy solutions, and designing sustainable energy systems tailored to the characteristics of their chosen island community. ● Encourage groups to consider the integration of multiple renewable energy sources, energy storage technologies, smart grid solutions, and energy efficiency measures in their designs. ● Provide support and guidance as needed, helping groups navigate technical challenges and make informed decisions based on their research findings and analysis. 5. Presentation and Peer Feedback: ● Allocate time for each group to prepare a formal presentation of their proposed renewable energy solution.

	● Encourage groups to use visual aids, such as slides or posters, to communicate their ideas effectively. ● After each presentation, facilitate a peer feedback session where other groups can ask questions, provide constructive criticism, and offer suggestions for improvement. ● Emphasize the importance of constructive dialogue and mutual learning, fostering a collaborative learning environment where participants can learn from each other's insights and perspectives. 6. Reflection and Application: ● Conclude the activity with a reflection session where participants have the opportunity to share their reflections on the problem-solving process, their learning experiences, and the insights gained from engaging with real-world renewable energy challenges. ● Encourage participants to consider the broader implications of renewable energy deployment in isolated islands, including environmental sustainability, economic development, and social equity. ● Challenge participants to think critically about the potential barriers to implementation and the role of policy, regulation, and community engagement in driving sustainable energy transitions in isolated island communities. ● Encourage participants to explore opportunities for further research or practical engagement in renewable energy projects aimed at addressing the energy needs of isolated islands beyond the scope of the activity.
Group working	Teachers create groups consisted of 2-3 students
1.Guiding Questions/ Problem Scenario	In this step: Teachers must present students with the problem statement. Teachers define and frame the problem. It is extremely important that the students should not have enough prior knowledge to solve the problem which means that they will have to gather necessary information or learn new concepts, principles, or skills as they engage in the problem-solving process.

As group working, students read the scenario and write down questions about the problem scenario

2.Examining the problem and determining the problems that need to be answered

Teachers ask the students to determine what they need to learn and where they can acquire the information and tools necessary to solve the problem.

Teachers present to the students a table and ask them to complete the table (as shown below) before researching sources of information.

Questions that students can investigate:

What do yo think you know	What do you need to know	Where/How will you find out	Who is responsible

3.Research

In this step teachers ask to the students:

1. Search “sources of information” to find answers to questions. Students research and collect information about the problem.

2.Write down the information they gathered from the research below.

	Information
Question 1	
Question 2	

<table>
<tr><td></td><td>3.Generates hypotheses for questions
<table><tr><td></td><td>Hypothesis</td></tr><tr><td>Hypothesis 1</td><td></td></tr><tr><td>Hypothesis 2</td><td></td></tr></table>
4.Plan an experiment to test the hypotheses they have identified
Experiment 1: The experiment students propose to test the first hypothesis
Experiment 2: The experiment students propose to test the second hypothesis</td></tr>
<tr><td>4. Determination of possible solutions</td><td>In this step teachers ask to the students:
1.Discuss possible solutions and decide the best solution to the problem.
2.Select the most appropriate experiment and write it.</td></tr>
<tr><td>5.Implementation of the chosen strategy</td><td>Teachers ask the students to do the set experiments as a group and write the result.</td></tr>
<tr><td>6.Evaluation of solution strategy</td><td>Teachers ask the students if the experiment result supports their hypothesis and let them discuss it with their group friends.
Teachers must provide an opportunity for students to LOOK BACK and evaluate their conclusions where they will eventually communicate, orally and/or in writing their possible actions, recommendations, and solutions.
The final product should include the scenario, guiding questions, data gathered, analysis of data, and support for solutions or recommendations based on the data analysis.</td></tr>
</table>

Activity_11	
Age Group	**15-17 years old** - This age group is appropriate as students are capable of handling more complex scientific concepts and engaging in meaningful problem-solving.
Subject - Topic	**Sustainable Energy Solutions** - Exploring renewable energy sources and their implementation to combat climate change.
Learning objectives and STEM disciplines	Students will: • Understand the basic principles of renewable energy sources (solar, wind, hydro, and geothermal). • Analyze the environmental impacts of different energy sources. • Design a small-scale renewable energy solution for their school or community. • Engage in critical thinking, collaboration, and communication throughout the project.
Safety concerns	• Electrical safety when handling solar panels, batteries, and other components. • General safety during field trips or experimental setups.
Time	Approximately 8-10 weeks. This includes phases of planning, execution, and evaluation.
Resources needed and materials	• **Access to research materials:** Books, scientific journals, online databases. • **Renewable energy kits:** Solar panels, wind turbine kits, small hydroelectric generators. • **Digital tools:** Software for data analysis and simulation, GIS tools for mapping potential local energy sites.
Implementation process	• **Introductory Workshops:** On renewable energy technologies and environmental impacts. • **Field Visits:** To local renewable energy plants if possible (e.g., solar farms, wind turbines).
Group working	Form groups of 2-3 students to foster a collaborative environment where each member can contribute effectively.
1.Guiding Questions/ Problem Scenario	Given the pressing issue of climate change, how can our school/community reduce its carbon footprint by implementing a feasible renewable energy project?
2.Examining the problem and determining the problems that need to be answered	Teachers ask to the students determine what they need to learn and where they can acquire the information and tools necessary to solve the problem Teachers present to the students a table and ask them complete the table (as shown below) before researching sources of information.

<table>
<tr>
<td></td>
<td>Questions that students can investigate:
<table>
<tr><th>What do yo think you know</th><th>What do you need to know</th><th>Where/How will you find out</th><th>Who is responsible</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>
</td>
</tr>
<tr>
<td>3.Research</td>
<td>I this step teachers ask to the students:

1. Search “sources of information” to find answers to questions. Studets research and collect information about the problem.

2.Write down the information they gathered from the research below.
<table>
<tr><th></th><th>Information</th></tr>
<tr><td>Question 1</td><td></td></tr>
<tr><td>Question 2</td><td></td></tr>
</table>

3.Generates hypotheses for questions
<table>
<tr><th></th><th>Hypothesis</th></tr>
<tr><td>Hypothesis 1</td><td></td></tr>
<tr><td>Hypothesis 2</td><td></td></tr>
</table>

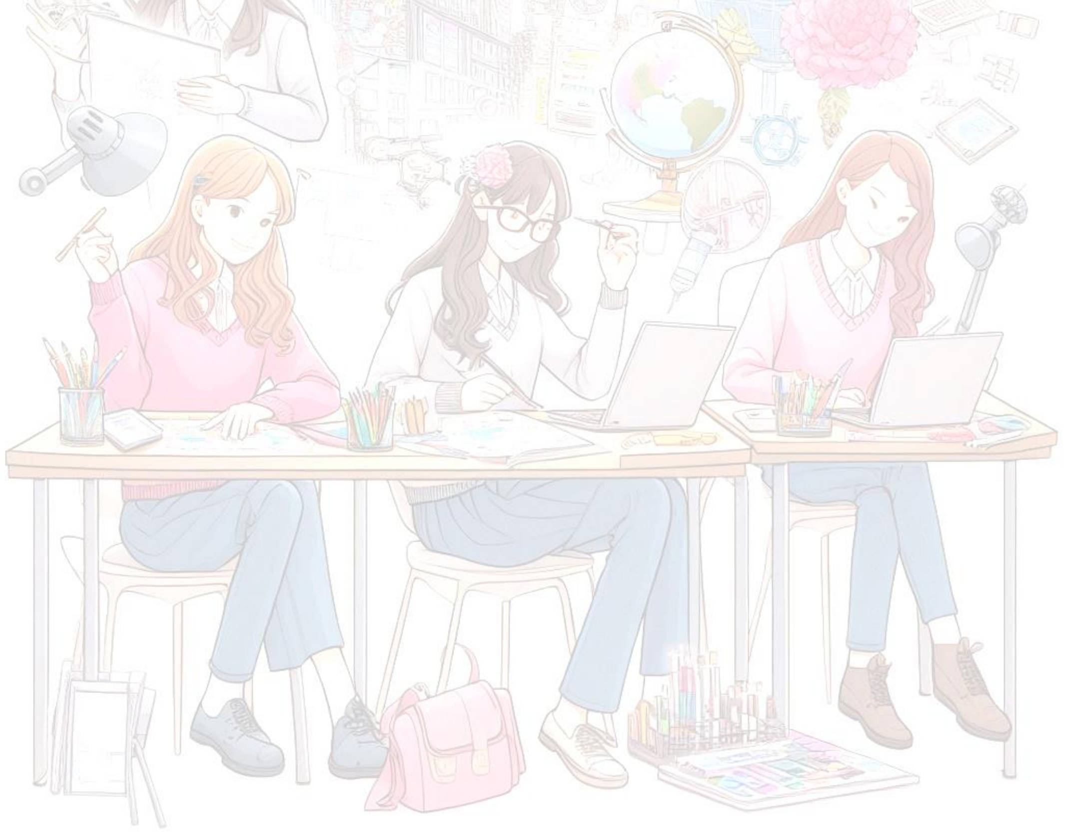
4.Plan an experiment to test the hypotheses they have identified

Experiment 1: The experiment students propose to test the first hypothesis
Experiment 2: The experiment students propose to test the second hypothesis</td>
</tr>
<tr>
<td>4. Determination of possible solutions</td>
<td>In this step teachers ask to the students:

1.Discuss possible solutions and decide the best solution of the problem.

2.Select the most appropriate experiment and write it.</td>
</tr>
<tr>
<td>5.Implementation of the chosen strategy</td>
<td>Teachers ask to the students do the set experiments as a group and write the result.</td>
</tr>
<tr>
<td>6.Evaluation of solution strategy</td>
<td>Teachers ask to the students if the experiment result support their hypothesis and let them discuss with their group friends.</td>
</tr>
</table>

	Teachers must provide an opportunity for students to LOOK BACK and evaluate their conclusions where they will eventually communicate, orally and/or in writing their possible actions, recommendations, and solutions. The final product should include the scenario, guiding questions, data gathered, analysis of data, and support for solutions or recommendations based on the data analysis.
Integration with Digital Tools	• **Data Collection and Analysis:** Use software to analyze energy output, efficiency, and environmental impact. • **Collaboration:** Utilize platforms like Google Classroom or Microsoft Teams to collaborate on documents, share data, and manage the project.
Addressing Sustainable Development Goals	This activity directly supports SDG 7 (Affordable and Clean Energy) by exploring renewable energy solutions and SDG 13 (Climate Action) by proposing actionable solutions to reduce carbon footprints.



<table>
<tr><th colspan="2">Activity_12</th></tr>
<tr><td>Age Group</td><td>14-15 years</td></tr>
<tr><td>Subject - Topic</td><td>Hooke’s law. Measure of the weight using springs.</td></tr>
<tr><td>Learning objectives and STEM disciplines</td><td>The aim of the activity is to project and build a scale, using springs. <i>Hooke's</i> Law provides a mathematical relationship between the force applied to a <i>spring</i> and the resulting deformation.
Students must derive the theoretical law (not known to them) from the experimental observations and should be able to use that information to solve the experimental problem.</td></tr>
<tr><td>Safety concerns</td><td>No Personal Protection Equipment needed.</td></tr>
<tr><td>Time</td><td>Two lessons of 90 minutes.</td></tr>
<tr><td>Resources needed and materials</td><td>A laboratory can be equipped with several springs, masses of assigned value and with commonly used materials: ruler, paper. Data can be represented using an electronic spreadsheet.</td></tr>
<tr><td>Implementation process</td><td>The success of any educational initiative in the school hinges on effective implementation. The four crucial steps of this process are Explore, Prepare, Deliver, and Sustain.
Explore the problem or challenge at hand: this requires a deep understanding of the issue, its root causes, and its impact on the overall learning environment.
Prepare: teachers ensure that in the laboratory the chosen plan can be executed.
Deliver: in this step, teachers implement the chosen intervention, requiring careful monitoring and adaptation.
Sustain: the new practices have to become ingrained in the school culture.</td></tr>
<tr><td>Group working</td><td>Teachers create groups consisting of 2-3 students.</td></tr>
<tr><td>1. Guiding Questions/ Problem Scenario</td><td><i>The activity is inspired by “escape rooms”. To complete a certain mission, students must measure the mass of an unknown weight, but they don't have a scale. They have to project and build scales, using masses of assigned value and one spring or a system of two identical springs.</i>
Students know what a force is, but they have no information about how a spring behaves when stressed. In a first phase, they will have to observe the connection between force and length of deformation and experimentally derive Hooke's law. They should understand how to use it for the proposed problem.
While working in groups, students read the scenario and write questions about the problem scenario:
1) How does a spring work?
2) What changes if we use more than one spring?
3) How can this information be useful in solving the Problem?
4) How can we build our scale, using a spring, a sheet of paper and a ruler?
5) How can we improve our scale, if we want a better accuracy in the results?</td></tr>
<tr><td>2. Examining the problem and determining the problems that need to be answered</td><td>Teachers ask the students to determine what they need to learn and where they can acquire the information and tools necessary to solve the problem. Teachers present the students with the table below and ask them complete it before researching sources of information.
<table>
<tr><th>What do you think you know</th><th>What do you need to know</th><th>Where/How will you find out</th><th>Who is responsible</th></tr>
<tr><td>Force; weight force; mass and weight force; measure of lenght</td><td>Property of the materials</td><td>Physics books.
Internet</td><td>The group</td></tr>
<tr><td></td><td>Law of deformation of</td><td>Experimental way</td><td>The group</td></tr>
</table></td></tr>
</table>

	a spring	Physics books	Teachers
	Coupling of more springs	Experimental way Physics books	The group Teachers

3. Research

In this step:

1. Teachers ask the students to search “sources of information”. Physisics book and internet can be used only with teacher supervision, because the Hooke’s law must be derived experimentally.

2. Students consolidate their knowledge on the vector nature of forces, weight force and its linear dependence on the mass, the equilibrium condition and the elasticity properties of materials from books and the internet. At the same time, wanting to use a laboratory approach, they dedicate time to the instruments, the associated uncertainty, and the representation of the data collected in tables and graphs.

	Information
Question 1	What numerical relationship can be deduced from an experiment in which a mass is hung from a spring? How can we use this information to measure unknown masses?
Question 2	How can the two springs be connected? Can the accuracy of the measure be improved using a system of two springs?

3. Students generates hypotheses for question 1

	Hypothesis
Hypothesis 1	Linear dependence between mass and the length of the spring
Hypothesis 2	Linear dependence between mass and the elongation of the spring

4. Students plan a single experiment to test both the hypotheses they have identified for question1.
Measure the rest length of a spring. After that, hang one of the weights on the spring and measure the new length, then repeat the measurement as many times as the weights available. Calculate each value of the elongation. Build a graph with spring’s length on the abscissa axis and the mass on the ordinate axis, reporting the experimental data on this. Build a graph with spring’s elongation on the abscissa axis and the mass on the ordinate axis.

4. Determination of possible solutions

1. Students discuss the two hypotheses of question 1.
In the graph with spring’s elongation on the abscissa axis, the trend of the points is well approximated by a straight line passing through the origin (direct proportionality relationship between the two quantities). In the graph with spring’s length, this is also a straight line, but passing through a point on the positive abscissa semi-axis. The hypothesis number 2 is the true one and it will be used for the proposed problem.
They also discuss what steps to take if they want greater precision in the results: direct measurement of elongation reduces error propagation and provides a more accurate value.

Students discuss, also, about the second question: Can the accuracy of the measure be improved by using a system of two springs?
An answer can be found by comparing the experimental results, with the relative errors, obtained with three different system.

1) Only one spring
2) Two springs one after the other (series)
3) Two springs next to each other (parallel).

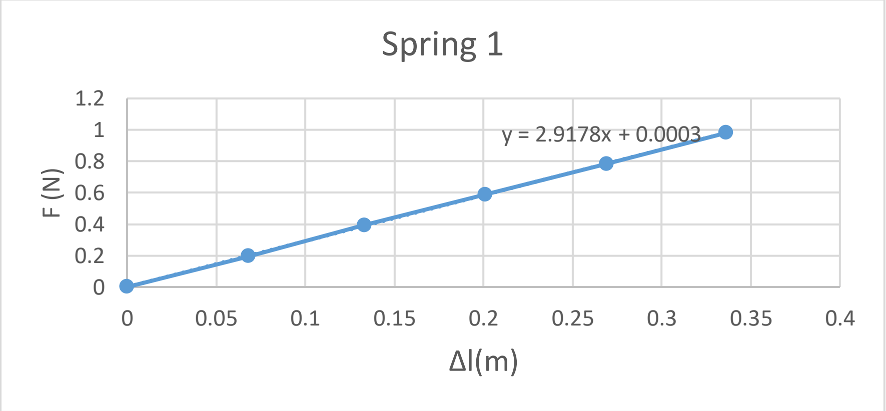
2. The experiment chosen.
In order to build such handmade scale, we exploit the equilibrium condition with the weight force (*F*) exerted by some small weights of known mass *m* attached vertically to the spring. This equilibrium situation provides that the vector sum of the forces is zero.
For each spring available, we hang one of the weights on the spring and measure its elongation, then we repeat the measurement as many times as the weights available. We then calculate the value of weight force (using the nominal value of the gravitational constant, *g*), an estimate of the spring constant (*k*) and its error associated.
We report in a table the data obtained for different masses applied and we build a graph with the elongation on the abscissa axis and the force exerted on the spring on the ordinate axis, reporting the experimental data on this.
We measure the spring constant alternatively graphically as best-fit from the chart via the Microsoft Excel “add trendline” command. It is noted that the trend of the points is well approximated by a straight line passing through the origin: the ratio between the force and the elongation are constant (direct proportionality relationship between the two quantities).
Using this value for the spring constant, the unknown mass of a weight can be determined experimentally by measuring only the elongation of the spring from the rest position, starting from the formula obtained, and/or by interpolating the value graphically.

5. Implementation of the chosen strategy

Students set experiments as a group and write down the result: they carry out a test using six springs. At the beginning, they measure the elastic constant of each spring, obtaining it both as a best fit from the graph and as an average of *F/Δl* for tests with different weights. The results are shown in the following table.

	k_1(N/m)	k_2(N/m)	k_3(N/m)	k_4(N/m)	k_5(N/m)	k_6(N/m)
best fit	2,92	2,92	3,17	3,15	3,16	3,09
Mean F/Δl	2,92±0,03	2,91±0,03	3,18±0,02	3,13±0,02	3,17±0,02	3,12±0,02

The best-fit is the most correct method, but the average also gives similar results.
Below is the summary table of the measurements and values calculated with the respective errors and the graph with spring’s elongation on the abscissa axis and the force on the ordinate axis, for spring 1 only.



m(kg) $\pm 10^{-4}$kg	*F*(N) ± 0,001N	Δl(m) ± 0,002 m	*k* (N/m)
0	0	0	//
$2{,}00{\times}10^{-2}$	0,196	0,068	2,90± 0,08
$4{,}00{\times}10^{-2}$	0,392	0,133	2,94± 0,05
$6{,}00{\times}10^{-2}$	0,588	0,201	2,92± 0,03
$8{,}00{\times}10^{-2}$	0,784	0,269	2,91± 0,02
$1{,}00{\times}10^{-1}$	0,980	0,336	2,92± 0,02

Using the values of the spring constants, measuring the elongation for these six “scales” and remembering that m = k Δl / g, an unknown mass can now be estimated. An example in the table below:

	1	*2*	*3*	*4*	*5*	*6*
k_j (N/m)	2,92±0,03	2,91±0,03	3,18±0,02	3,13±0,02	3,17±0,02	3,12±0,02
Δl (m)	0,249±0,002	0,246±0,002	0,225±0,002	0,225±0,002	0,221±0,002	0,226±0,002
m (kg)	0,071±0,001	0,070±0,001	0,070±0,001	0,069±0,001	0,069±0,001	0,069±0,001

In the second part of the experiment, the students use only two identical springs and first arrange them one after the other (in series) and then next to each other (in parallel).
With the same procedure used before, the experimental values of the elastic constants for the two configurations and the unknown mass of the weight used before are determined.
In the table below, the values for this measure:

	One spring	*Two in series*	*Two in parallel*
k_j (N/m)	2,92±0,03	1,44±0,02	5,75±0,02
Δl (m)	0,249±0,002	0,498±0,002	0,120±0,002
mass percentage relative error (%)	1,8	1,8	2,6
m (kg)	0,071±0,001	0,073±0,001	0,070±0,002

The two springs in series have the same mass percentage relative error of the single spring. The configuration with two springs in parallel is the worst.

6.Evaluation of solution strategy

Teachers and students agree on the validity of the hypotheses advanced and discuss the strategy adopted to solve the proposed problem. Using multiple spring configurations does not improve the accuracy of the result, sometimes it worsens it.
This activity sparks reflection on teaching methodologies and how a collaborative and active approach can improve students’ learning.

The 5 E- Inquiry-Based Learning

Activity_13	
Age Group	15-17 ages
Subject - Topic	Machine Learning, the Future of Water
Learning Objectives and STEM disciplines	Learns about water and water saving. Develops digital solutions for water saving. Calculates daily or monthly water consumption. Knows the water cycle. It uses digital tools to minimize water consumption.
Key Vocabulary/Definitions	Machine, Water, Machine Learning, Artificial Intelligence,
Time Required	2-3 weeks / 6 hours
Group Size	Suitable for groups of 2-5 people.
Resources Needed and materials	Computer, Resources to research things to do about saving water
Safety Issues	There are no security concerns.
Pre-Req Knowledge	Analytical Thinking, Problem Solving
Summary/Description	

<table>
<tr><th colspan="2">Implementation process</th></tr>
<tr><td>PHASE</td><td></td></tr>
<tr><td>ENGAGE</td><td>
<p>In this step,
The teacher starts with the basic question and chooses a question about a topic that students believe they will have an impact on by answering.</p>
<p>Questions;
• What does water mean to you?
• What do you think about saving water?
• Will water be in our lives in the future?</p>
<p>➢ The teacher helps students develop questions and direst them complete the KWL Chart.</p>
<table>
<tr><th>What I Know</th><th>What I Would Like To Learn</th><th>What I Learned</th></tr>
<tr><td>For example;
Water is the basic resource for life.
Thanks to the water cycle, the amount of water in nature is maintained.
Fresh water is drinkable, but salt water is not.
If water resources are not protected, major natural problems will arise in the future…etc</td><td>For example;
How can water saving be done more effectively?
What are new ways to reduce water consumption?
Is it possible to save water with digital technologies or tools?…etc</td><td>Must write after activity</td></tr>
</table>
<p>➢ The teacher can ask questions to find out what students already know,</p>
</td></tr>
</table>

	or think they know, about the topic and concepts to be covered. These questions typically start with "how" instead of with "why For example; Can water conservation be encouraged through mobile applications or other digital methods? Why is water saving important? How can people's awareness about the importance of water and water consumption be increased? …etc
EXPLORE	At this stage, the teacher; • Students are given guidance on project work and how to work in groups. • Students are mentored to focus on the questions in the previous section. • First of all, questions and answers about the future of water are prepared for the project. • There should be a period of 2 weeks to prepare the questions and answers. • 2 lesson hours will be sufficient for changes and updates. While creating the Schedule, teacher need to answer the questions given below: ➢ The project will take 2-3 weeks. ➢ 6 lesson hours and 2-3 weeks of communication via distance connection. The project will be done free of charge from the website called machine learning for kids.
EXPLANATION	This step allows the teacher to use teachable moments. In this step, the teacher; ➢ asks open-ended questions to the students. ➢ Students should be encouraged to conduct research from different sources. ➢ Directly introduce students to mobile app development, basic AI implementation, and key concepts, process, or skill related to the topic/project. Tips for research; EU commission and UN reports regarding the future and conservation of water should be checked. Additionally, government publications and statements should be checked. Articles written on Google Scholar should be scanned.
ELABORATE/ EXTENSİON	In this step teachers challenge and extend students' conceptual understanding and skills. • Students are asked to practice from sample digital platforms. • Students are expected to embody their projects in a digital environment. • Group members should have divisions of duties. • The student who will use the Machine learning for kids website must work on this website. • Checks should be made whether the source scanning has been done

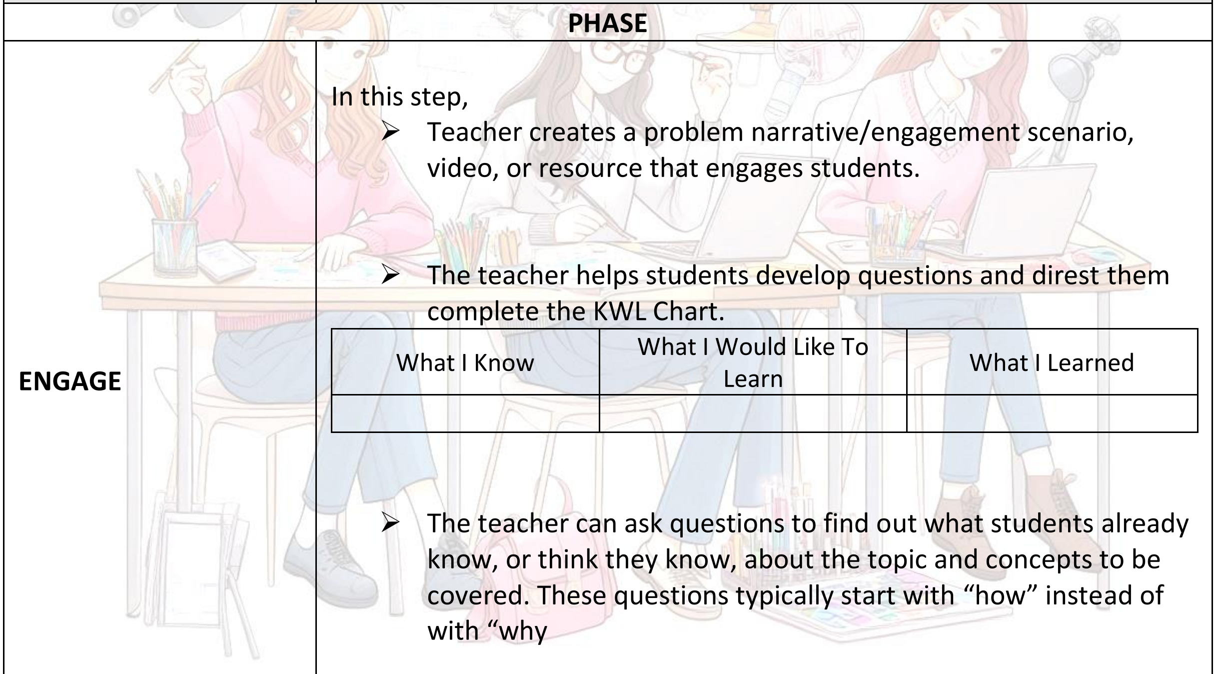
	correctly. • What does machine learning mean and how does the process proceed? A student is assigned to do this. • Participation of group members in the process is evaluated and deficiencies are corrected. • The future of water and savings topics created with machine learning on the Machine learning for kids website are presented by students. Meanwhile, one student uses the website and the other students explain what has been done.
EVALUATE	In this step teachers; ➢ Feedback is given regarding the completed project. ➢ In the project created using machine learning and artificial intelligence, questions are asked to both the machine and the students about whether the subject is understood. ➢ It is desirable to conduct new research on the existing developments in the field of machine learning and artificial intelligence and to identify the shortcomings.

Activity_14	
Age Group	15-17 years old
Subject - Topic	Biology - Plant Photosynthesis
Learning Objectives and STEM disciplines	• Understand the process of photosynthesis. (Biology) • Explore the role of light, water and carbon dioxide in photosynthesis. (Chemistry) • Use inquiry-based learning methods to investigate and analyse the factors that influence photosynthesis.
Key Vocabulary/Definitions	• Photosynthesis: The process by which green plants and some animals use sunlight to synthesise food using chlorophyll. • Carbon dioxide (CO2): A gas produced by the combustion of carbon and organic compounds and by respiration, and absorbed by plants during photosynthesis. • Oxygen (O2): A reactive gas essential for the respiration of living organisms, produced during photosynthesis.
Time Required	6 sessions of one hour each
Group Size	3-4 students per group
Resources Needed and materials	• Potted plants (e.g., small flowering plants or herbs) • Grow lights or access to natural sunlight • Clear plastic bags • Watering cans or spray bottles • Carbon dioxide source (e.g., baking soda and vinegar) • pH testing kits • Notebook and pens for each student • Magnifying glasses • Safety goggles
Safety Issues	Ensure proper ventilation when using carbon dioxide sources. Wear safety goggles when conducting experiments involving chemicals.

Pre-Req Knowledge	Basic understanding of the structure of plant cells and the process of photosynthesis.
Summary/Description	Each session will include hands-on experiments, discussion and data analysis to deepen understanding. Students will explore the factors that influence photosynthesis, such as light intensity, water availability and carbon dioxide concentration, through controlled experiments with potted plants. They will measure factors such as plant growth, oxygen production and pH levels to draw conclusions about the optimal conditions for photosynthesis. Throughout the activity, students will record their observations, hypotheses and conclusions in their notebooks, developing critical thinking and scientific enquiry skills.
PHASE	
ENGAGE	The teacher presents the students with a scenario in which a local farmer wants to increase crop yields in his greenhouse but is unsure how to optimise plant growth. Then the teacher aske open-ended questions to the students to assess their prior knowledge. Some examples are: • How do plants make their own food? • How do plants get the nutrients they need to grow? • How do changes in light or water affect plant behaviour?
EXPLORE	The teacher organises the students into groups in which different skills of different students work together. Then basic activities related to plant photosynthesis are introduced. Students are given clear research instructions. The teacher then assigns research tasks to the students to carry out practical laboratory activities to explore different aspects of plant photosynthesis. Throughout this phase, the teacher fosters a supportive learning environment where students feel encouraged to ask questions, explore ideas and collaborate with their peers.
EXPLANATION	Students are asked to think critically through open-ended questions that encourage them to articulate their understanding of the concepts explored in the previous phase. Questions such as "Can you explain how light intensity affects plant photosynthesis?" or "What role does carbon dioxide play in the process of photosynthesis?" encourage students to express their understanding in their own words. At the same time, the teacher directly introduces new concepts related to plant photosynthesis. Students are also given the opportunity to demonstrate their understanding by creating a media product using storyboarding and script writing techniques. Throughout this phase, the teacher provides guidance and support as students plan and develop their media products, ensuring alignment with learning objectives and standards.
ELABORATE/ EXTENSİON	The teacher will guide students in applying their knowledge of plant photosynthesis to real-life scenarios or novel situations. This may involve presenting case studies, simulations or practical experiments that require students to use previously introduced concepts and experiences. The teacher will encourage students to analyse and evaluate these situations, using critical thinking skills to solve problems and make informed decisions.
EVALUATE	In this step, teachers asess student knowledge, skills and attitudes using selected assessment techniques such as rubrics.

Activity_15	
Age Group	**Ages 15-17** - This age group can handle complex concepts and engage in activities that require higher-order thinking and problem-solving skills.
Subject - Topic	**Biology and Environmental Science:** The focus is on urban biodiversity and the ecological services it provides, emphasizing how biological diversity within urban areas contributes to overall ecosystem health.
Learning Objectives and STEM disciplines	• **Biology:** Identify and classify various species found in urban areas, understanding their roles and interactions within ecosystems. • **Technology:** Use technology tools like GIS (Geographic Information Systems) and biodiversity tracking apps to gather and analyze ecological data. • **Engineering:** Design solutions to enhance urban biodiversity through the creation of green infrastructure like green roofs, walls, and community gardens. • **Mathematics:** Apply statistical methods to analyze biodiversity data, such as species count and distribution patterns.
Key Vocabulary/Definitions	• **Biodiversity:** The variety of life in the world or in a particular habitat or ecosystem. • **Ecosystem Services:** The benefits that humans freely gain from the natural environment and from properly-functioning ecosystems. • **Urban Ecology:** The study of ecological processes in urban environments. • **Native Species:** Species that have originated and evolved in a particular area. • **Invasive Species:** Non-native species that spread widely and cause damage to the environment, human economy, or health. • **Green Infrastructure:** A network providing the ingredients for solving urban and climatic challenges by building with nature.
Time Required	**8 weeks total:** Each week includes several sessions, each lasting about 1-2 hours, allowing students to deeply engage with the project phases from initial exploration to final presentations.
Group Size	**3-4 students per group:** Small groups encourage collaboration and allow each student to actively participate and take on significant roles in the project.
Resources Needed and materials	• **Digital Tools:** Smartphones or tablets with apps for species identification (e.g., iNaturalist), GIS software for mapping data. • **Field Equipment:** Binoculars for bird watching, magnifying glasses, and sample collection kits for small organisms and soil samples. • **Gardening Supplies:** Native plants, seeds, soil, and tools for any biodiversity enhancement installations.
Safety Issues	• **Outdoor Safety:** Proper attire for fieldwork (e.g., hats, boots,

	gloves), awareness of surroundings to avoid hazards (e.g., traffic, water bodies). • **Data Security:** Educate on the safe and ethical use of apps and data, particularly concerning location sharing and photographing potentially sensitive areas.
Pre-Req Knowledge	• **Basic Ecology:** Understanding of ecosystems, species interactions, food webs, and environmental factors affecting biodiversity. • **Data Collection and Analysis:** Basic skills in using tools for data collection and simple statistical analysis.
Summary/Description	**1. Engage:** Objective: Spark interest and curiosity about urban biodiversity. - Activity: Begin with an interactive presentation featuring images and videos of diverse urban ecosystems around the world. Discuss how urban areas can support or hinder biodiversity. - Discussion: Pose questions like "What types of wildlife can we find in our city?" and "How does urban biodiversity benefit us?" Encourage students to think about their own observations and experiences with nature in urban settings. **2. Explore:** Objective: Investigate local urban biodiversity firsthand. - Activity: Organize field trips to various urban habitats (parks, vacant lots, green roofs). Equip each student group with a simple field kit including a species identification guide, a digital camera or smartphone, and perhaps an app like iNaturalist to record observations. - Task: Students identify and document different plant and animal species, noting where they found them and their abundance. **3. Explain:** Objective: Make sense of the exploration data to understand the role and importance of biodiversity in urban areas. - Activity: Back in the classroom, students compile their data and use it to create simple maps or databases of local biodiversity. They research the species they found to learn about their roles in the ecosystem. - Presentation: Each group shares their findings, discussing patterns and surprises in urban biodiversity. The teacher helps connect these observations to broader ecological principles like species interdependence and the impact of human activity on ecosystems. **4. Elaborate:** Objective: Apply understanding of urban biodiversity to a real-world problem.



<table>
<tr><td></td><td>- Project: Students choose a specific area in their community that could benefit from increased biodiversity. They design a plan to enhance biodiversity in that area, such as creating a pollinator garden, designing a green roof, or developing a community awareness campaign about invasive species.
- Collaboration: Groups develop their project proposals, outlining the expected benefits, necessary resources, and steps for implementation. They might use digital tools like CAD software for design, budgeting tools for resource management, and presentation software to prepare their proposals.

5. Evaluate:
Objective: Assess students' understanding and ability to apply their knowledge to solve problems.

- Assessment: Each group presents their biodiversity enhancement project to the class, possibly including models, digital presentations, or posters. They should demonstrate their understanding of urban biodiversity, the importance of their project, and how it will benefit the community.
- Reflection: Students write a reflective essay or complete a survey on what they learned about urban biodiversity and how they can contribute to its enhancement. Teachers provide feedback based on a rubric that assesses understanding, creativity, and scientific thinking.</td></tr>
<tr><td colspan="2">PHASE</td></tr>
<tr><td>ENGAGE</td><td>In this step,
➢ Teacher creates a problem narrative/engagement scenario, video, or resource that engages students.

➢ The teacher helps students develop questions and direst them complete the KWL Chart.
<table><tr><td>What I Know</td><td>What I Would Like To Learn</td><td>What I Learned</td></tr><tr><td></td><td></td><td></td></tr></table>
➢ The teacher can ask questions to find out what students already know, or think they know, about the topic and concepts to be covered. These questions typically start with “how” instead of with “why</td></tr>
<tr><td>EXPLORE</td><td>In this step, the teacher;
➢ create student groups

➢ provide students with a common base of activities within which</td></tr>
</table>

	current concepts (i.e., misconceptions), processes, and skills are identified and conceptual change is facilitated. ➢ sistribute the worksheets containing the design problem scenario to the groups. ➢ ask the students read the problem and discuss the information needed to solve it. ➢ ask the students research the topics they have determined then they formulate the solution suggestions for the problem. ➢ enable students to explore their ideas, singly and in groups ➢ provide students time to think, plan, investigate, and organize collected information ➢ may direct students complete lab activities that help them use prior knowledge to generate new ideas, explore questions and possibilities, and design and conduct a preliminary investigation.
EXPLANATION	This step allows the teacher to use teachable moments. In this step, the taceher; ➢ asks open-ended questions to the students. ➢ let students explain their understanding of the concept. Students can create a media product (e.g. video, podcast), digital story or plan a web site using storyboarding and script-writing to share their learning ➢ explains the missing parts of the students' answers ➢ directly introduce a concept, process, or skill.
ELABORATE/ EXTENSİON	In this step teachers challenge and extend students' conceptual understanding and skills. • The teacher direct students apply or extend previously introduced concepts and experiences to new situations or apply their knowledge to real world applications
EVALUATE	In this step, teachers asess student knowledge, skills and attitudes using selected assessment techniques such as rubrics
Integration with Digital Tools and Technologies	• **Data Collection and Analysis:** Use apps like iNaturalist for species identification and data recording during field trips. • **Project Design and Presentation:** Utilize GIS software to map biodiversity data and CAD software for designing biodiversity enhancement projects. • **Collaboration and Communication:** Platforms like Google Classroom or Microsoft Teams can be used for sharing resources, discussing ideas, and submitting assignments.
Addressing Sustainable Development Goals	This activity directly contributes to: • SDG 11 (Sustainable Cities and Communities) by promoting sustainable urban development through biodiversity enhancement projects. • SDG 15 (Life on Land) by focusing on the protection, restoration, and promotion of sustainable use of terrestrial ecosystems.

Activity_16	
Age Group	15-16 years
Subject – Topic	Stevino's law; magnetic field; period of oscillation of a simple pendulum
Learning Objectives and STEM disciplines	The inquiry learning space (ILS) is an online learning environment that gives students a set of digital tools to guide scientific research through smartphones and notebooks. An ILS can be customized with virtual or remote laboratories, multimedia resources (video, text, tables, Google documents, etc.), tools such as calculators, notepad and conceptual maps. Physics.
Key Vocabulary/Definitions	Inquiry Learning Spaces (ILS) *Physics Toolbox Sensor Suite* (PTSS)
Time Required	4 lessons of 90 minutes.
Group Size	Teachers create groups consisting of 4-5 students.
Resources Needed and materials	Access to all the resources of the physics laboratory. Data can be represented using an electronic spreadsheet.
Safety Issues	Water-repellent smartphone case
Pre-Req Knowledge	No pre-req knowledge required
Summary/Description	Inquiry Learning Spaces (ILS) are personalized learning resources for students, including a lab, apps, and any other type of multimedia material. ILS follow *an inquiry cycle*. With ILS students identify a situation of world around them, acquire information and environmental data (i.e. using personal smartphones), and then move on to test your hypotheses by building graphs or through experiments online, until reaching a guided conclusion of the phenomenon investigated. Students will be assigned different physics experiences: check Stevino's law, find in a solenoid the direct proportionality relationship between the intensity of the magnetic field and the number of turns and calculate the period of oscillation of a simple pendulum. Each group will investigate the phenomenon assigned through an ILS designed with teachers in relation to abilities, the educational needs of the students and the given time.
PHASE	
ENGAGE	After a quick introduction of the activity and a reflection on the aware use of the web and smartphones in the classroom, the students watched introductory videos of the physical phenomena to be investigated and how to create ILS at school, and they read a

document with the story that led to the discovery of physical laws. A useful tool is also presented: the Graasp platform, developed thanks to the European collaborative project Go-Lab2 e co-financed by the European Commission. Furthermore, everyone installed on their smartphone or tablet the application *Physics Toolbox Sensor Suite*. (PTSS)

The teacher helped students develop questions and direct them to complete the KWL Chart.

What did I learn from the videos?

Can we find useful information in the videos to solve our problem?

What I Know	What I Would Like To Learn	What I Learned
Basic physical concepts Simple elements of statistics Graphs and tables with electronic spreadsheet	How can we measure physical quantities using our smartphone? How can we improve the precision in measures? What are physical laws? Can I find similar examples in other physics problems?	Physical laws. Measuring?? using smartphone.

Teacher can ask questions to find out what students already know, or think they know, about the topic and concepts to be covered. These questions typically start with “how” instead of with “why”

How can we use this information to solve the problem?

How can we test our hypotheses?

How can we use this information to solve other similar problem?

How we can generalize some deductions?

EXPLORE

Students will be distributed in groups. Each group will set up the assigned physical phenomenon, following the instructions scrupulously provided by the video tutorial and the procedure map. In particular:

- 1) the first group, gradually immersing the iPhone in a bucket full of water, will study how hydrostatic pressure increases with increasing depth

- 2) the second group will measure with the smartphone the period of oscillation of a simple pendulum;

- 3) the third group will wrap a common thread around a nail and will connect it to a

battery, measuring with the smartphone the intensity of the magnetic field generated by the number of turns that each time will be increased by the students.

Teachers ask students to read the problem and discuss the information needed to solve

	it. They also ask students to research the topics they have determined and then make suggestions for solving the problem. *How can we set the assigned physical phenomenon?* *How do we use PTSS?* *What are physical laws?* Teachers allow students to explore their ideas, individually and in groups, and give them time to think, plan, investigate and organize the information they gather. They can direct students to comprehensive laboratory activities that help them use prior knowledge to generate new ideas, explore questions and possibilities, and design and conduct preliminary investigation. The division of the class in heterogeneous work groups stimulated and encouraged the active participation of all members, as well as tutoring, development, reasoning and socialization, integrating learning of each one through experience. *How can we change the assigned physical phenomenon?* *How can we represent experimental data if we want to highlight the physical law?* *What other physical variables can be deduced from the experiment?*
EXPLANATION	This step allows the teachers to use teachable moments. In this step, the teachers ask open-ended questions to the students. Teachers consolidate physical concepts deduced from experimental observations integrating with theoretical information and help formulate mathematical expressions of physical laws. Each group presents its results to the class obtained from its members' experience on the LIM. The teachers provide food for thought and stimulates the activation of new research channels, providing links for the launch of new ILS and new projects. Students are planning a ***web site*** using storyboarding and script-writing to share their learning.
ELABORATE/ EXTENSİON	In this step teachers challenge and extend students' conceptual understanding and skills. The teacher directs students to apply or extend previously introduced concepts and experiences to new situations or apply their knowledge to real world applications. In the collective discussion that follows the presentation of the works, the class group tries to identify common strategies to solve more complex problems than those proposed by the activity. In particular, 1) for the first activity (gradually immersing the iPhone in a bucket full of water), technical measures are proposed to improve the precision and new stimulating exam cases (e.g. the bucket filled with two liquids of different densities); 2) for the second activity (measure of the period of oscillation of a simple pendulum), the students identify a limitation to the validity of the isochronism of oscillations for increasing angular displacements and propose to theoretically investigate this aspect;

	- 3) for the third activity (intensity of magnetic field) the students create experiments to deduce the dependence of the intensity on other physical quantities (batteries of different voltage, increased or decreased solenoid section, nails of different material).
EVALUATE	The groups activate a moment of self-evaluation, or peer evaluation, compared to work carried out and learning levels achieved. The students express their enthusiasm for using smartphones for educational purposes and innovative environments learning, demonstrating how to use new technologies in teaching underline the playful aspects, motivating students to learn. In this step, teachers assess student knowledge, skills and attitudes using selected assessment techniques such as rubrics. See the table **Competences and competence indicators for evaluation for 5E IBL** at the end of this document.

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