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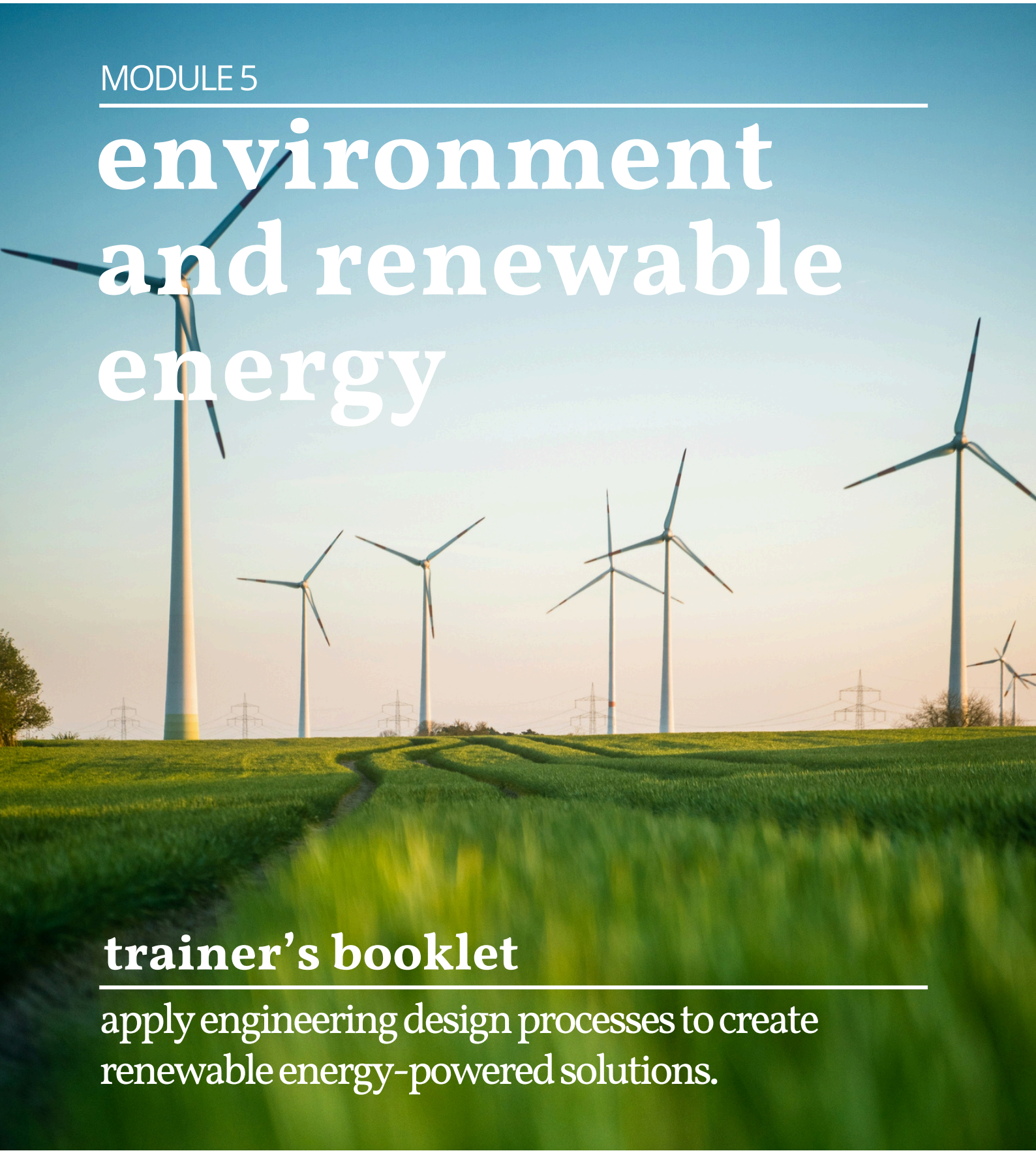
MODULE 5

environment and renewable energy



trainer's booklet

apply engineering design processes to create renewable energy-powered solutions.

IDEA Universal (Turkey)
DUTH (Greece)
UABSC (Ukraine)
İO-BAS (Bulgaria)

ENVIRONMENT AND RENEWABLE ENERGY

NO	ACTIVITIES	STATUS
1	Explore Renewable Energy Types	80 minutes
2	Let's Design with Eco-Friendly Energy	120 minutes

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BACKGROUND

Renewable Energy and Non-Renewable Energy

Energy resources are divided into two main categories: renewable energy and non-renewable energy resources according to their renewal status in nature. Non-renewable energy is derived from sources that, once consumed, cannot be replenished in a short time by natural processes. These include fossil fuels such as oil, coal and natural gas, and nuclear energy. Renewable energy, on the other hand, comes from sources that are replenished in a relatively short period of time through continuous cycles in nature. Renewable energy sources include solar energy, wind energy, hydroelectric energy, geothermal energy. Renewable energy sources play an important role in reducing environmental impacts.

Renewable Energy Types

Solar energy

Solar energy is the radiant energy released as a result of nuclear reactions in the center of the sun. One of the most common methods of generating electricity from solar energy is photovoltaic systems. Photovoltaic systems use solar cells made of semiconductor material (e.g. silicon) that can convert solar energy directly into electrical energy. Sunlight consists of particles called photons. When sunlight hits the surface of solar cells, the photons move the electrons in the cell, creating an electric current. Thus, electrical energy is obtained from solar energy. Solar panels are formed when a large number of solar cells come together. Large-scale energy facilities created by connecting solar panels in series or parallel to each other are called solar power plants or solar fields.

Wind Energy

The forces arising as a result of the unequal heating and cooling of the earth air movements, i.e. wind. The kinetic energy of this moving air mass is called wind energy. Wind turbines are systems that convert the kinetic energy of the wind into electrical energy. The wind turbine generally consists of three basic parts: 1- tower, 2- nacelle and 3- rotor and blades. The tower is the body part that carries the blades and nacelle. The blades are the part that captures the wind and transfers the power to the rotor. The aerodynamic structure of the wings creates a pressure difference and ensures rotation. The rotor transmits power to the gearbox through the shaft. The nacelle is where the equipment that generates electricity and ensures turbine safety and maintenance is located. The gearbox and generator are located here. The gearbox increases the low rotational speed of the shaft to the speed required by the generator. The generator converts mechanical energy into electrical energy.

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Hydroelectric Energy

Hydraulic energy is solar-generated energy and is created by the water cycle. The water in the sea, lake or rivers evaporates with solar energy. The resulting water vapor condenses in the atmosphere and descends back to the earth in the form of precipitation and feeds the rivers. In this way, hydraulic energy is among the renewable energy sources. Hydroelectric power plants are facilities where the potential and kinetic energy of flowing or falling water is converted into electrical energy. When they are built in accordance with environmental conditions, they provide environmentally friendly energy. Hydroelectric power plants constitute about one third of the installed capacity of our country. The most widely used type is hydroelectric power plants with dams. In dammed hydroelectric power plants, a dam set is built in front of the rivers and water is collected in a reservoir. This reservoir is called the reservoir lake. The water accumulated in the reservoir is released from a certain height and its potential energy is converted into kinetic energy, allowing the turbines to rotate. The generator connected to the turbine converts the mechanical energy into electrical energy.

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Geothermal Energy

Geothermal energy is heat energy in the form of hot water, steam or gas containing various chemicals under pressure accumulated at various depths in the earth's crust. Geothermal power plants are facilities where electricity is generated using hot water and steam underground. In the power plant, hot water and steam are brought to the surface by drilling wells several kilometers deep in the earth's crust. Most of the hot water turns into water vapor due to the reduced pressure when it reaches the surface. The steam turns the turbine. The generator connected to the turbine converts mechanical energy into electrical energy. Thus, electrical energy is obtained. The temperature of the used steam is reduced in the cooling tower and condensed back into liquid. This condensed liquid and the water that was not initially converted into steam is pumped back into the hot underground environment to restart the process. 3

Biomass Energy

Biomass energy is the energy generated by converting biomass into heat, electricity and liquid fuel. Wood, plants, oil seeds, vegetable wastes, animal wastes, etc. are examples of biomass sources. Biogas, biodiesel and bioethanol are products obtained from biomass. One of the biomass processing technologies is incineration. In incineration, biomass is burned in an incineration chamber. The heat generated from the incinerated waste produces steam. The steam turns turbines. The generator connected to the turbine converts mechanical energy into electrical energy.

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Wave Energy

Wave energy is a type of energy obtained by utilizing the waves formed by the winds in the seas and oceans. Thanks to systems called wave energy converters, wave movements are captured and converted into electrical energy. Wave energy converters have many different designs. One of them is oscillating body systems. As the waves move up and down, the float moves with the waves. The magnet column moves up and down with the waves inside the generator coils. As the magnets move up and down, an electric current is generated in the coils. The wave energy converter is safely moored on the seabed. The electric current from the wave energy converter is carried by cables to the shore.

Tidal Energy

Tidal energy is the kinetic and potential energy of water masses displaced by tidal movements. The periodic rise and fall of the sea level due to the gravitational pull of the Moon and the Sun on the Earth and the rotation of the Earth around itself is called tidal phenomena. One of the most common tidal energy systems is tidal turbines. Tidal turbines are systems that convert the kinetic energy of tidal currents into electrical energy. In tidal turbines, the blades capture the energy from the tidal currents. The generator connected to the turbine converts the mechanical energy into electrical energy. In tidal dams, another system, when the sea rises, the gates open and the dam fills with water. During low tide, the water released into the sea rotates the turbines and generates electrical energy in the generator.

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EXPLORE RENEWABLE ENERGY TYPES

Ages 8-15

Environment and Renewable Energy

80 minutes

Key Concepts

- Renewable energy
- Solar energy
- Wind energy
- Hydroelectric power plant

Purpose: This activity aims to enable students to discover the types and working principles of renewable energy.

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Learning Outcomes

By the end of this activity, students will be able to:

- Classify renewable energy types.
- Analyze the working principles of renewable energy types.
- Inquiry the effects of energy use on the environment.

Materials

Renewable Energy Kit, Multimeter, Desk Lamp, Fan, Worksheets

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EDUCATOR GUIDELINES

Step 1

The instructor begins with a short question and answer activity. Students are asked "Why is energy important for our lives? What are the renewable energy sources?" questions are asked to test students' prior knowledge. The instructor talks about renewable energy types, their working principles, and the advantages and disadvantages of these energy types (10 min.).

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Step 2

Students work in teams to investigate how a solar panel works and the effect of the angle of the solar panel by conducting experiments within the scope of task 1. Within the scope of Task 2, students investigate the working principle of wind turbines and the effect of wind speed by conducting experiments. Students determine the dependent, independent and controlled variables in the experiment they design, perform their experiments and fill in the worksheet (20 min.).

Step 3

Teams share their results with other teams. At this stage, the instructor asks the students "How does a solar panel work? How does the angle of the solar panel cell affect the electrical power? What are the parts of a wind turbine? How does a wind turbine work? What is the effect of wind speed on electrical power?" (10 min.).

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Step 4

Teams prepare a digital poster to introduce the working principles of solar panels and wind turbines (25 min). Microsoft Powerpoint program or web 2.0 tools such as Canva, Visme can be used to prepare digital posters. The prepared posters are presented in front of other teams (15 min).

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WORKSHEETS

Task 1: Use the Renewable Energy Kit to power the LED with the energy produced by the solar panel with your teammates.
Task 2: Use the Renewable Energy Kit to power the LED with the energy produced by the wind türbine with your teammates.

WHAT I KNOW	WHAT I WANT TO KNOW	WHAT I LEARNED

1. Define the Problem

Identify a key problem situation to investigate in Task 1 and Task 2.

2. Determine your hypothesis.

Compare your results with the AQI thresholds. Were any environments above the limits?

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3. Design an experiment to test your hypothesis.

Fill in the table below by determining the dependent variable, independent variable and controlled variables in your experiment.

DEPENDENT VARIABLE (WHAT DID YOU OBSERVE?)	INDEPENDENT VARIABLE (WHAT DID YOU CHANGE?)	CONTROLLED VARIABLES (WHAT DID YOU KEEP THE SAME?)

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4. Record the data obtained from the experiment in the table.

a. In Task 1, change the angle of the solar panel and determine the most effective angle value.

Solar Panel Angle	Current(I)	Voltage Difference (V)	Electrical Power (P=VxI)	Observation

Is the data you obtained consistent with your predictions? What were you wrong or what did you predict correctly?

What conclusion did you reach at the end of the experiment? Which is the most effective factor in erosion? What could be the reason for this? Discuss with your teammates.

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b. In Task 2, determine the most effective fan speed by changing the speed of the fan.

Fan Distance	Fan Speed Level	Current (I)	Voltage Difference (V)	Electrical Power (P=VxI)	Observation
cm	Stage 1 (Low speed)				
	Stage 2 (High speed)				

Is the data you obtained consistent with your predictions? What were you wrong or what did you predict correctly?

What conclusion did you reach at the end of the experiment? Which is the most effective factor in erosion? What could be the reason for this? Discuss with your teammates.

Choose one of the renewable energy types you have examined. Design a poster to introduce the type of renewable energy you have chosen.

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LET'S DESIGN WITH ECO-FRIENDLY ENERGY

Ages 8-15

Environment and Renewable Energy

120 minutes

Key Concepts

- Renewable energy
- Solar energy
- Wind energy

Purpose: This activity aims to enable students to design a product that works with renewable energy.

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Learning Outcomes

By the end of this activity, students will be able to:

- Analyze the working principles of renewable energy types
- Design a product powered by renewable energy using the engineering design process

Materials

Renewable Energy Design Kit, Multimeter, Silicone gun, Silicone, Soldering iron set, Colored cardboards, Glue, Scissors/Cutlery knife, Desk lamp, Fan, Worksheets

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EDUCATOR GUIDELINES

Step 1

The instructor begins with a short question and answer activity. Students are asked "What are renewable energy sources? What is the impact of energy use on the environment?" questions are asked to test students' prior knowledge. The instructor talks about the usage areas of renewable energy types and their advantages and disadvantages. It is stated that engineers produce solutions by using renewable energy sources. At this stage, the engineering design process is introduced to the students (15 min).

Step 2

Students work in teams to design a product powered by renewable energy. First, the teams read the design problem, identify the problem situation, the criteria and constraints that the design should meet (10 min).

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Step 3

The instructor asked the students "What kind of design are you being asked to make? Who can be the target audience of your design? Which renewable energy do you plan to use? What is the working principle of this renewable energy? What steps will you follow in the design process?" Students brainstorm and identify a few design ideas (15 minutes).

Step 4

Team members brainstorm and evaluate all the design ideas they have identified in terms of the desired criteria and constraints. Then they choose the best design idea and explain it by drawing it on the worksheet. They answer the questions on the worksheet according to their design (10 minutes). Afterwards, teams prepare prototypes of their designs using the materials provided (30 min).

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Step 5

Teams test their prototypes. They measure current (I) and voltage difference (V) using a multimeter and calculate the electrical power (P) of their design using the formula P= V. I. The data obtained are tabulated and interpreted. Successful and unsuccessful aspects of the prototype are identified. The instructor allows students to fail and learn from their failures. It is emphasized that failed designs are a natural part of the design process (20 min).

Step 6

Teams present their prototypes in front of other teams. In addition, they evaluate their own designs or the designs of other teams with the help of rubrics. They discuss the environmental and economic impacts of the designs. Team members discuss the failures of their prototypes and decide on the improvements to be made (20 min)

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WORKSHEET

Dear Team Members,

You are tasked with designing a product that works using renewable energy. Your design must meet the following criteria and constraints:

- It must be powered by renewable energy.
- At least one type of renewable energy must be used.
- It must consist of at least 5 different materials.
- The materials provided by the instructor must be used.
- The project must be completed within the given time frame

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Step 1: Identifying the Need/Problem

Identify a key problem situation to investigate in Task 1 and Task 2.

Step 2: Research

Do research on the design to be developed. Read the Theoretical Background section to fill in the gaps in your knowledge about the design topic.

Step 3: Developing Solution Proposals

Brainstorm with your teammates to identify possible design ideas.
My design ideas and sketches:

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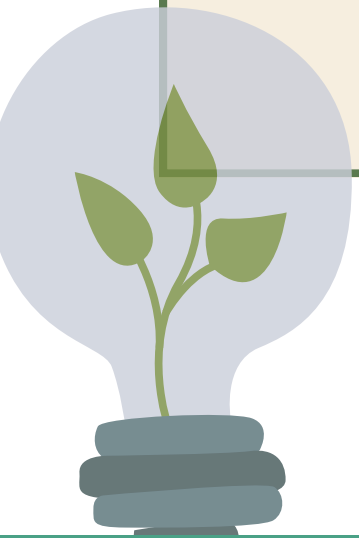
Step 4: Choosing the Best Possible Solution

Considering the criteria and constraints, determine the most appropriate solution proposal by "joint decision".

Draw the solution you have decided on for the prototype.

Specify the materials to be used in your prototype

State its features, its function in design, reasons for preference and alternatives.



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Step 5: Prototyping

Prepare the prototype that you have determined with a joint decision.

Step 6: Testing and Evaluation

Measure the current (I) and voltage difference (V) using a multimeter to test the effectiveness of your prototype. Then calculate the electrical power (P) of your design using the formula P= V. I. Compare your data with the data of other teams.

Design Evaluation Table

Team	Current(I)	Voltage Difference (V)	Electrical Power (P=VxI)	Current(I)

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Based on the data obtained, which team has the best design and what could be the reason for this?

Step 7: Sharing the Solution

Make a presentation of your design, test and evaluation results and share it with other teams.
What are the criteria and constraints it provides? What is your evidence based on your observations? Are there any aspects that are missing or need to be improved? Share with other teams.

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Step 8: Redesign

What are the successes and failures of your design?

Successful Aspects	Unsuccessful Aspects

What changes can be made to optimize your design?

Step 9: Completion

The design process continues until your design meets all criteria and constraints.

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Proje Adı / The Title of The Project
E-STEM ile Çocukların Çevresel Sürdürülebilirlik için Güçlendirilmesi / Empowering Children for Environmental Sustainability through E-STEM

Proje Ortağının Adı / Name of The Project Partner
Uluslararası Kalkınma ve Çevre Derneği – IDEA Universal / International Association for Development and Environment – IDEA Universal

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