LOESS INTEGRATED LEARNING SCENARIO TEMPLATE

Introduction

In LOESS, the acquisition of soil health knowledge is facilitated using integrated STEM teaching and learning, which is carried out via the Biology Science Curriculum Study (BSCS) 5E Instructional Model by Bybee and colleagues (Bybee et al. 2006) as well as the application of innovative pedagogical approaches (PBL, IBL, etc).

Keywords

Sustainability, recycle, water management, nature friendly buildings, insulation with earth.

Title

Green Roof = The City's Garden Opening to the Sky

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Summary

Together with the students, we will create an environmentally friendly, green roof to contribute to the sustainability of the ecosystem. We will proceed like an engineer while creating this plant ecosystem on the roof. We will emphasize the importance of recycling while making our composts. We will examine the soil and observe what it offers us. We will explore the benefits of an environmentally friendly solution for our living space while explaining how to conserve water. We will integrate an interdisciplinary process with social studies by integrating research and observation processes with science and mathematics. We will encourage students to be environmentally conscious.

Subject (s)

Science, mathematics, social studies, technology and design.

Real-life questions

- How can we replace the use of concrete with soil?
- How thick should the soil used in a green roof be so that a roof can grow plants and not damage the building?
- How can we create an eco-friendly roof using recycling?
- Considering the soil ecosystem, what can we recycle on green roofs?
- What is the role of green roofs in water management?

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Learning objectives

Students will be able to:

- *comprehend and evaluate alternative environmental applications to concrete.*
- *develop solutions by applying soil science and engineering principles at a simple level.*
- *gain awareness of resource utilization and recycling through sustainable design.*
- *explain how rainwater management can be improved through green roofs and how this can reduce flooding and water conservation problems in the city.*

Link to curriculum

This learning scenario is directly linked to the curriculum of Science, Mathematics, Social Studies, Technology and Design. In connection with STEM, basic analytics such as problem solving, creativity, critical thinking and collaboration are developed. Students gain experience of the engineering design process, analytical thinking and practice in manufacturing with green solutions. The scenario is also related to the UN Sustainable Development Goals Goal 11: Sustainable Cities and Communities, Goal 12: Responsible Production and Consumption, Goal 13: Climate Action, Goal 15: Terrestrial Life. Protecting the environment and building nature-friendly structures through green roofs, using resources efficiently and creating structures that support nature against climate change, mobilizing all resources to protect biodiversity and ecosystems and using them sustainably, and supporting creativity in this context are also supported by sustainable development goals.

Age of students

8 – 9 years old

Time

Preparation time(total): 5 hours
Mathematics and Science: 2 hours
Social Studies and Technology Design**:** 3 hours

Teaching time: 4 lessons 40 minutes each lesson)
Subject 1 Social Studies**:** 1 lesson
Subject 2 & 3 Science & Mathematics: 2 lessons
Subject 4 Technology Design: 1 lessons

Teaching resources (materials & online tools)

Materials for Lesson 1 / Social Studies

- Large sheets of paper to be used for brainstorming
  (to write and visualize in groups the solution proposals regarding the impact of green roof use on the environment)
- Computers or tablets (to access the internet)
  (examples of green roofs around the world will be researched, written on cards and hung)

Materials for Lesson 2 / Science

- Examples of soil types

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(Several types such as sandy soil, clay soil, garden soil can be brought. They make comparisons).
- Plastic transparent containers
  (To observe the soil-water balance, to do a drainage test.)
- Dropper or pipette
  (To drip a little water into the soil and observe how the water is absorbed.)
- Seeds
  (Fast growing seeds such as grass - for growth observation.)
- Water spray
  (For constant controlled irrigation.)
- Thermometer
  (A mini experiment can be done to measure the temperature difference between surfaces with and without a green roof.)
- Compost prepared at school (vegetable and fruit waste, twigs)

Materials for Lesson 3 / Mathematics
- Ruler
  (for measuring roof surface area, soil thickness, plant placement.)
- Small scale
  (for measuring soil weight - dry and wet - and comparing data.)

Materials for Lesson 4 / Technology Design

For the base
- Cardboard box
- Styrofoam (lightweight and cuttable)
- Cardboard (for a durable base)
- Plastic container

For insulation and waterproofing:
- Plastic bag or stretch film (to cover the roof base)
- Membrane (we will compare which material is waterproof)
- Aluminium foil (as waterproof layer)

For the soil and plant layer, we will use the soil we studied in science class and determined by weight measurement in math class.
- A small amount of light soil (peat mixed is good)
- Tiny succulents or grass seeds (for quick results)
- Pebbles (to create a drainage layer)
- Silicone gun (To be used under teacher supervision)

Online tools:

Lesson 1. Entry and attention
- This article will be visualized by the teacher during the attention-drawing phase to examine the examples of green roofs that have developed from the Hanging Gardens of Babylon to the present day.)

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https://tez.yok.gov.tr/UlusalTezMerkezi/tezDetay.jsp?id=DXWh05SBA1ctxpQvS8TBKg&no=5_kMvdXZNAF_pgYXm6YhH0A
https://www.proquest.com/openview/d3c75e3dd770ffc2f5ed704f896bcaad/1?pq-origsite=gscholar&cbl=2026366&diss=y

Lesson 2. & 3. The Importance of Soil/ Soil Types / Sustainability

- Why is soil important? Animation
  https://topraktema.org/cocuklar_icin
  https://www.youtube.com/@NGScience
  https://www.youtube.com/watch?v=OiLITHMVcRw
- Compost making
  https://topraktema.org/bolum/topragin-gelecegi/kompost
  https://www.gardenersworld.com/how-to/diy/how-to-build-a-compost-bin/
- Article to be simplified by the teacher for the selection process of suitable soil and plants for green roofs
  https://tez.yok.gov.tr/UlusalTezMerkezi/tezDetay.jsp?id=DXWh05SBA1ctxpQvS8TBKg&no=5_kMvdXZNAFpgYXm6YhH0A
  https://www.sciencedirect.com/science/article/abs/pii/S136403211830217X
- To raise global awareness on sustainable cities and natural resource management.
  https://topraktema.org/bolum/topragin-gelecegi/surdurulebilir-toprak-yonetimi
  https://www.youtube.com/watch?v=7cJdyL78JsM
- To learn about the UN Sustainable Development Goals and environmental policies.
  https://www.kureselamaclar.org/amaclar/surdurulebilir-sehirler-ve-topluluklar/
  https://www.kureselamaclar.org/amaclar/sorumlu-uretim-ve-tuketim/
  https://www.kureselamaclar.org/amaclar/iklim-eylemi/
  https://www.kureselamaclar.org/amaclar/karasal-yasam/
  https://sdgs.un.org/goals/goal11
  https://sdgs.un.org/goals/goal12
  https://sdgs.un.org/goals/goal13
  https://sdgs.un.org/goals/goal15

Lesson 4. Engineering design processes

- For a green roof example, its benefits and an architectural simulation, watch the 5th-7th minutes of the relevant video.
  https://www.youtube.com/watch?v=QL04SRILDNU
  https://www.youtube.com/watch?v=2LmuiWNaruc

STEM Strategy Criteria

Developing the LOESS learning scenario will help you and your school comply with the STEM School Label criteria. This scenario fulfils the criteria listed in the table below.

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Elements and criteria	How is this criterion addressed in the learning scenario?
Instruction	
Problem and project-based learning (PBL)	Experiments in science and measurement objectives used in mathematics lessons bring students face to face with real-life problems. In the engineering design process, they encourage them to solve problems by integrating the concrete experience they have gained in science and mathematics with a critical approach for the green roof they will create.
Inquiry-Based Science Education (IBSE)	Students participate in questioning by testing the type of soil and plant selection they will use for the green roof with experiments. They also question the product they will use for insulation by testing it with experiments.
Curriculum implementation	Green roof application aims to provide interdisciplinary learning, problem solving, critical thinking and sustainability awareness. According to the education model applied in Türkiye; in science class, it emphasizes the themes of living beings and life, physical events, the world and the universe. In the theme of problem solving in mathematics class, it produces solutions for the amount of materials and the use of space. In social studies class, it emphasizes the themes of People, Places and Environments, Production, Distribution and Consumption, and Active Citizenship. In technology and design class, it designs eco-friendly roofs by choosing recyclable and environmentally friendly materials.
Emphasis on STEM topics and competencies	
Interdisciplinary instruction	In this learning scenario, integrated learning will bring together science, mathematics, social studies and engineering design processes, allowing students to see the connections between these courses.
Contextualisation of STEM teaching	With the green roof activity, students will create an environmentally friendly solution to a real environmental problem using science, mathematics, technology and design to reduce the increasing heat island effect in cities and protect natural resources.
Assessment	
Continuous assessment	Every work done by the students will be observed and immediate and constructive feedback will be given. Analytical rubrics will be used to ensure that children know what to do and how.
Personalized assessment	Since the green roof design to be created will be unique to each student, a product evaluation will be made.
Professionalization of staff	
Highly qualified professionals	The facilitator of the process (Teacher) is an officially certified STEM educator trainer.
School leadership and culture	
School leadership	Since the school principal is the project manager, she is extremely determined to provide the necessary time and financial support.
Connections	
With parents/guardians	In cooperation with parents, compost to be used in science classes was prepared. Parents also provided small plants to be used on the green roof.
With local communities	Land was requested with support from the Ministry of Agriculture and Forestry.
School infrastructure	
Access to technology and equipment	The roof of our school is structured as a green roof and an area has been created for students to put their practical skills into practice within the scope of the subject.

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Elements and criteria	How is this criterion addressed in the learning scenario?
High quality instruction classroom materials	There is a FCL (future classroom lab) in our school and there is sufficient technological equipment.

Description of activities

Name of activity	Procedure	Time
	1st Lesson	
5E Phase	***Engage, Explore, Explain***	
Subject 1	***Social Studies***	
Brainstorming session - The City's Garden Opening to the Sky	Students will participate in a brainstorming session to assess their prior knowledge of green roofs. The implementation of green roofs in the school will be used as a starting point and based on the links below, a question-based discussion will be initiated (Annex 1) The links below is used and examples of famous green roofs in the world (Hanging Gardens of Babylon, Delft University Campus/Netherlands, City Hall/Chicago, Nanyang Technological University Faculty of Art and Design/Singapore) are shown. Immediately afterwards, they go up to the roof of the school. https://tez.yok.gov.tr/UlusalTezMerkezi/tezDetay.jsp?id=DXWh05SBA1ctxpQvS8TBKg&no=5_kMvdXZNAFpgYXm6YhH0A https://www.proquest.com/openview/d3c75e3dd770ffc2f5ed704f896bcaad/1?pq-origsite=gscholar&cbl=2026366&diss=y Going back to the classroom and to arouse students' curiosity: "Have you ever seen a garden that opens to the sky? Can you imagine such a place?" Students' opinions are listened to and a story is told by asking them to close their eyes (Imagine that the city you dream of has a garden that opens to the sky. Various plants have been planted in this garden by you. Imagine the soil. How thick can it be for your roof? How will the soil handle it when it rains? Think about this... Can rainwater pass through the soil and enter your house? Imagine the plants you planted. Are they very big or very small? Will your roof be able to support them all? Butterflies are flying. Birds in the sky come here to visit. They are the guests of your garden...) (Engage) Students are divided into 3 groups of 4. The groups are asked to produce questions based on the story just told and the visuals shown. (For example: "Why are there green roofs? What might they be used for?"). Students are encouraged to explore by asking their own questions. They build on a process of discovery about what green roofs are good for. (Explore)	30'
Discussion and preparation for the next lesson	After this collaboration, students prepare a poster visual to correctly explain the basic concepts about green roofs. Each student edits their own visual and prepares their poster with the theme of "The Garden of the City Opening to the Sky". They write the benefits of green roofs on their posters. (For example: "Cleaning the air, reducing the heating of cities, saving water, etc.") Then each student sticks their poster on the wall.	10'

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Name of activity	Procedure	Time
	Students who correctly explain the basic concepts present information with their posters. They reflect the physical properties and durability of the roof on their posters. (Explain). To prepare for the next lesson, the teacher encourages the students to think about and develop posters they have drawn about the soil and plants they will use on green roofs and how the roof should be insulated. They are asked to think about what materials could be used.	
Learning products	Poster visuals explaining the concepts behind green roofs.	
2nd Lesson		
5E Phase	**Engage, Explore, Explain, Elaborate**	
Subject 2 & 3	**Science & Mathematics**	
Determining soil type	A short video is watched with the students who examine their visual designs on the posters prepared in the previous lesson and hanging on the wall. https://topraktema.org/cocuklar_icin https://www.youtube.com/@NGScience https://www.youtube.com/watch?v=OiLITHMVcRw This video will activate our prior knowledge about "soil". After the video, students are asked the following question: "Considering the weight of the roof, how do we find the most suitable soil type for plants?" (Engage) We set up a simple experimental setup and bring samples such as garden soil, compost, sandy soil to the classroom. (These samples are available in our school garden) Water retention test is done with these soils (Annex 2, Table 1). Pour the same amount of water on each soil type and observe which one holds water better. They are asked "Which soil stayed wetter? / Which soil retains water better? Why?" and asked to fill in the observation form (Annex 3, Table 2). At the end of the observation, students who conclude that compost is the wettest are shown the video https://topraktema.org/bolum/topragin- gelecegi/kompost and https://www.gardenersworld.com/how-to/diy/how-to-build-a-compost-bin/ (students have knowledge about compost from previous applications) (Explore) The power of compost and its contribution to the ecosystem is explained after the video. (Explain) At this stage, students decide that compost is the soil type that holds water best as a result of their observations. Tools and materials used in the process of recognizing soil types and discovering the most suitable soil for green roofs: • 3 types of soil (garden soil, sandy soil, compost) • Transparent plastic containers or cups • Water bottles • Paper towels (to observe leaking water) • Printed version of Table 1 and Table 2 (optional)	40'
Learning products	Observation Tables 1 and 2 regarding the properties of different soil types	

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Name of activity	Procedure	Time
3rd Lesson		
5E Phase	**Engage, Explore, Explain, Elaborate**	
Subject 3	**Science & Mathematics**	
Weight and area calculations for the roof	In the previous lesson, the students have come to a conclusion about the water retention properties of compost and the teacher reminds them to imagine their own roofs and asks the following question: "Which soil would you choose so as not to increase the load on the roof?" This question arouses an impression and curiosity in them. Immediately afterwards, the relevant parts of the article simplified by the teacher for the selection process of appropriate soil weights and plants for green roofs and site layout design are projected on the screen. https://tez.yok.gov.tr/UlusalTezMerkezi/tezDetay.jsp?id=DXWh05SBA1ctxpQvS8TBKg&no=5_kMvdXZNAFpgYXm6YhH0A https://www.sciencedirect.com/science/article/abs/pii/S136403211830217X After the explanation and presentation: All students use the small scale in the classroom to measure the weight of 3 types of soil (Annex 4, Table 3). The garden soil is the heaviest. Compost is a little lighter. Sandy soil is the lightest. The children note these weights and a discussion begins about which soil would be appropriate to use. The sandy soil is eliminated because it does not hold water even though it is very light. The garden soil is eliminated because of its weight, leaving the compost. The teacher asks the students "where should we pour the compost?" and shows them a rectangular piece of cardboard. Ask them to estimate the dimensions of this cardboard and write them on the board. The results of the measurements (Annex 5, Table 4) are compared and a calculation activity is carried out to design the area where they will pour the compost.	20'
Plant selection by weight calculation	Establishing a connection with the subject of weight calculation, students construct the plants they will place in this context. Reviewing their previous experiences and knowledge in order not to increase the weight of the roof they will create, the students decide to use small plants with the reflection of the visuals they watch.	10'
Elaborate on the scope of the Sustainable Development Goals	We calculated and planned the roof areas correctly by choosing the right soil and water management for green roofs. "When we design our roof, we contribute not only to our school but also to the world we live in. So why are green roofs not only beautiful but also important for the future of the world? Transition to the Global Goals with the questions: How will your small roof save the big world? https://topraktema.org/bolum/topragin-gelecegi/surdurulebilir-toprak-yonetimi https://www.youtube.com/watch?v=7cJdyL78JsM https://www.kureselamaclar.org/amaclar/surdurulebilir-sehirler-ve-topluluklar/ https://www.kureselamaclar.org/amaclar/sorumlu-uretim-ve-tuketim/ https://www.kureselamaclar.org/amaclar/iklim-eylemi/ https://www.kureselamaclar.org/amaclar/karasal-yasam/ https://sdgs.un.org/goals/goal11 https://sdgs.un.org/goals/goal12	10'

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Name of activity	Procedure	Time
	https://sdgs.un.org/goals/goal13 https://sdgs.un.org/goals/goal15 While following the teacher's presentation accompanied by these questions, the following conclusions are identified and added to the posters prepared in the first lesson. • SDG 11: Sustainable Cities and Communities (Green roofs create an eco- friendly living space) • SDG 12: Responsible Consumption and Production (Encourage the use of recyclable materials in roof construction) • SDG 13: Climate Action (Green roofs reduce carbon footprint, reduce the heat island effect in cities) • SDG 15: Terrestrial Life (New habitats for plants, supporting biodiversity)	
Learning products	Observation Tables 3 and 4 regarding the properties of different soil types.	
4th Lesson		
5E Phase	***Engage, Explore, Explain, Elaborate***	
Subject 4	**Technology - Design**	
Engineering design processes	In this section, we mobilize engineering design processes and create the final product. We recall the course integration of Science (material selection and ecosystem knowledge), Mathematics (measurement and area calculations), Social Studies (sustainable living and environmental awareness). Based on our previous knowledge, we watch minutes 5-7 of the video on the construction of a green roof. https://www.youtube.com/watch?v=QL04SRILDNU https://www.youtube.com/watch?v=2LmuiWNaruc In science and math classes, children have already made their knowledge discovery and explanations and are ready. Currently in the process of implementation and product development, children are asked the following question after the video: "If you were an engineer, how would you create a roof that is in harmony with nature and balanced with the ecosystem?" Students start designing their own green roofs to turn their knowledge into a real product. (Elaborate) In this stage, where engineering design processes are applied, prototypes will be made, tested, redesigned and finalized. Since our school runs eco schools and forest in schools projects, recyclable materials are available and students will use these materials from the warehouse.	10′
Design	**Building process** <u>For the base</u> • Cardboard box • Styrofoam (lightweight and cuttable) • Cardboard (for a durable base) • Plastic container <u>For insulation and waterproofing:</u> • Plastic bag or stretch film (to cover the roof base) • Membrane (we will compare which material is waterproof) • Aluminium foil (as waterproof layer)	30′

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Name of activity	Procedure	Time
	For the soil and plant layer, we will use the soil we studied in science class and determined by weight measurement in math class. • A small amount of light soil (peat mixed is good) • Tiny succulents or grass seeds (for quick results) • Pebbles (to create a drainage layer) • Silicone gun (To be used under teacher supervision) In the example from the video: • For the base: Cardboard box, Styrofoam or plastic container were used • For waterproofing: Stretch film, plastic bag, aluminium foil and membrane are tried and their water tightness is observed. They are asked to note the results of their observations on a simple form. The membrane passes the test with its waterproof feature. • For soil and plants: Predetermined light soil (mixed with compost), small succulents, pebbles are used from the garden. At this stage, they are asked why pebbles are used and the answers are followed by a short explanation to reinforce prior knowledge about the drainage layer. • At this stage, some students made a base out of cardboard, some made it out of plastic. Some students used aluminium foil and Styrofoam along with the membrane for insulation and strengthened the base. After the base is waterproofed with a membrane, a drainage layer is created with pebbles, the compost is spread and the plants are planted.	
Learning products	The model of the green roof designed and implemented by the students.	

Initial assessment

A brainstorming session to assess their prior knowledge about the Green Roof. This inquiry-based discussion focuses on what students already know about green roofs and what they are interested in learning. Some of the brainstorming questions the teacher can suggest are:

- *Why do we want more green space in a city?*
- *Do you think it is possible to grow plants on the roofs of buildings? What would it be like?*
- *Why do you think soil is important for plants?*
- *What can happen to a roof if we put soil and plants on it?*
- *Which soil holds water best? Why do we think so?*
- *What materials would we use if we tried to make a green roof with recycling?*
- *How do you think making a green roof contributes to nature?*
- *If you were to open a garden in the sky of the city, which plants would you want to have there? Why?*
- *Are plants grown only for beauty? What other benefits do they have?*
- *Think about soil, water and plants: how do they relate to each other?*

.A participation assessment checklist is in Annex 1.

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Formative evaluation

Activities where formative assessment takes place:
Lesson 1: After brainstorming in groups with students in the social studies lesson, everyone prepares a poster and hangs it on the classroom wall. The benefits of green roofs are also included in their posters.
Lesson 2: A simple observation form was applied including "Soil Type", "Water Retention" observations (Annex 2, Table 1). To determine the choice of soil in science according to water retention, feedback was also applied to the students who made observations. (Annex 3, Table 2)
Lesson 3: Students measuring soil weights in math class will use Table 3 (Annex 4) to record their observations and Table 4 (Annex 5) to measure the area of the roof base.
Lesson 4: Activating their engineering design processes in the technology design class, the children chose different materials for insulation and tested water tightness while building the roofs. The observation form prepared for this was used in the formative evaluation phase and restructured according to the feedback (Annex 6).

Final assessment

- A portfolio assessment scale is applied to review and summarize all the work done by the students before a general assessment at the final exam (Annex 7).
- If we think of the portfolio as a front cover and summative assessment, a written assessment is added to evaluate the students' learning process and experiences in the project. Since it is aimed here to reveal the interpretation and analysis skills related to the process, a reflection essay form is organized (Annex 8). This form is used for students to reflect on their own processes in their projects.
- The final assessment process is completed with a short quiz to measure students' overall knowledge and understanding of the project process (Annex 9).

Student feedback

At the end of the lesson, students are asked to fill in a short exit ticket (Annex 10). In this ticket the students give short feedback about what they have learned that day. They leave this ticket in the box hanging on the wall after the lesson and it is feedback for the facilitator (teacher). An example is provided in Annex.

Teacher feedback

The form prepared for this process (Annex 11) allows teachers to identify their strengths and areas for improvement in the implementation of the lesson. It also encourages teachers to comment on the overall functioning of the lesson. It provides concrete feedback to guide the teacher's development. It also encourages teacher reflection on the applicability of the lesson and the overall progress of the students. The teacher feedback form is organized in the form of checkboxes for a faster and more systematic evaluation.

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Reflection on the development process

I have been coordinating as a project manager and school principal at the same time for many years. Since 2018, I have been focusing on projects that contribute to biodiversity. In addition to working with local non-governmental organizations, I coordinate the forest in schools and eco schools projects led by FEE. In this sense, I have been awarded the flag award 4 times within the scope of two projects. At the same time, I have been training STEM trainers for the last 2 years and I have a trainer certificate in this field. The idea of combining these two fields that I work in inspired and intrigued me. The school where I work is newly built and we are laboriously transforming this structure into an ecological form. We have a green roof. When I saw this green roof, I thought, “Can we design a STEM activity with the children?” I love biomimicry practices and we redesigned the green roof like an engineer by reviewing them in the process. The official letter of your community reached the institution where I work and this is how I became aware of it. I was doing these practices all the time, but my plans were always scattered. I am happy to be able to put forward an organized plan in this process.

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Annex 1 :Participation assessment checklist

Student Number	1	2	3	4	5	6	7	8	9	10	11	12
What benefits do green roofs provide to cities?												
What materials are needed to build a green roof?												
How can we reduce concrete use and support soil use?												
What materials can we recycle to create a green roof?												
What type of soil should we use for a green roof?												
What is the role of green roofs in water management?												
Participates actively In group work												
Expresses creative ideas												
Demonstrates problem-solving skills												
General Participation												

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Annex 2: Soil Type and Water Retention Observation Form (Table 1)

Student No	Soil Type (e.g., Garden Soil, Compost, Sandy Soil)	Initial Condition (Dry/Wet)	Water Retention (High/Medium/ Low)	Observations (Color, Texture, Smell, etc.)	Result and Evaluation
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

Annex 3: Soil selection and observations (Table 2)

student number	What soil Did they choose?	Observations on Soil Type	Suitability of Soil for Green Roof	Feedback
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

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Annex 4: Soil Type and Water Retention Observation Form(Table 3)

Student No	Soil Type (e.g., Garden Soil, Compost, Sandy Soil)	Initial Weight (grams)	Final Weight (grams)	Weight of Water Added (grams)	Observations (e.g., soil texture changes, water retention)	Result and Evaluation
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Annex 5: Area Calculation(Table 4)

Student No	Roof Size (cm^2)	Soil Area (cm^2)	Calculation Method Used	Area Calculation (cm^2)	Observations (e.g., formula used, any difficulties)	Result and Evaluation
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

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Annex 6: Material Usage Evaluation Form (Formative Assessment)

Student Name	Selected Insulation Material (Membrane, Stretch Film, Aluminum Foil, Styrofoam, etc.)	Material Selection (Is it suitable?)	Material Usage (Proper Placement)	Sealing Application (Neat Coating)	Durability (Model Strength)	Reason for Material Choice (Short Explanation)	Comments
		☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement		
		☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement		
		☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement		
		☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement		
		☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement		
		☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement		
		☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement		
		☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement		
		☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement		
		☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement	☑ Successful ☑ Needs Improvement		

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Annex 7: Portfolio Evaluation Form

Criteria	Evaluation	Score (1-5)
Research and Information	Has the student conducted necessary research for the green roof design?	
Creativity and Innovation	Has the student presented innovative and creative solutions?	
Depth of Thought	Has the student demonstrated deep thinking in project development?	
Visual Organization and Presentation	Is the portfolio organized and clear?	
Collaboration and Participation	Has the student participated effectively in group work?	

(1 is the lowest, 5 is the highest)

Annex 8: Reflection Writing Form

Materials Used in the Project:
What materials did you use and why did you choose these materials?

Design Process:
What challenges did you face while developing your design and how did you overcome them?

Sustainability:
What do you think about the contributions of your design to the environment and ecosystem?

Group Work:
What role did you take in group work and how did you collaborate with your team? (Consider the group work done in the first lesson)

Future Improvements:
What would you do to improve this project in the future?

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Annex 9: Final assessment quiz

Which material provides the best waterproofing for green roofs?
A: Membrane
B: Stretch Film
C: Aluminum Foil
D: Styrofoam

Which material used for water retention in roofs might be the most efficient?
A: Sandy Soil
B: Compost
C: Peat
D: Regular Garden Soil

How do green roofs contribute to the environment? Explain their benefits.
Energy efficiency/Water management/Aesthetics…

A green roof helps with building insulation by providing __coverage on the roof.
A: Vegetation
B: Paint
C: Metal
D: Water

One of the benefits of green roofs is that they absorb ____during heavy rainfall.
A: Rainwater
B: Sunlight
C: Dust
D: Air

Green roofs help reduce rainwater runoff.
A: True
B: False

Green roofs do not contribute to energy efficiency.
A: True
B: False

What factors make green roofs environmentally friendly? (Multiple answers may apply)
A: Energy efficiency
B: Pollution absorption
C: Increased urban heat
D: Biodiversity support

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Annex 10: Exit ticket

Exit Ticket - Green Roof Project
Name:_ Date: _____

What is the most important thing you learned today?

_____
_____

In the green roof design process, which stage did you find most challenging? Why?

_____
_____

Which part of the lesson did you find most interesting? Why?

_____
_____

What else do you think you could do to improve your design?

_____
_____

Which material or concept would you like to learn more about during the project?

_____
_____

What role did you take in group work? How did you collaborate with your team?

_____
_____

How do you think what you learned about green roofs can contribute to your daily life?

_____
_____

What are your general thoughts on the lesson? Do you have any suggestions for improvement?

_____
_____

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Annex 11: Teacher feedback form

General Objectives and Content of the Lesson

What do you think about the alignment of the course objectives and content?

- Very suitable
- Suitable
- Somewhat suitable
- Not suitable
- Not suitable at all

Student Participation and Engagement

What do you think about student participation and engagement during the lesson?

- Very high
- High
- Average
- Low
- Very low

The Process of Implementing the Lesson

What do you think about the process of implementing the lesson?

- The process worked very well
- The process worked well
- The process worked somewhat well
- There were challenges in the process
- The process was very challenging

Student Learning Process

What do you think about the student learning process?

- The students were very successful
- The students were successful
- The students were somewhat successful
- The students were unsuccessful
- The students were not successful at all

Lesson Structure and Time Management

What do you think about the lesson duration and structure?

- Time management was excellent
- Time management was good
- Time management was somewhat good
- Time management was weak
- Time management was very poor

Materials and Resources Used

What do you think about the materials and resources used in the lesson?

- The materials and resources were very effective
- The materials and resources were effective
- The materials and resources were somewhat effective
- The materials and resources were ineffective
- The materials and resources were not effective at all

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Overall Evaluation and Suggestions

What do you think about the overall implementation of the lesson?

- The lesson was very successful
- The lesson was successful
- The lesson was somewhat successful
- The lesson was unsuccessful
- The lesson was very unsuccessful

Personal Development and Improvements

What do you think about your personal teaching development in this lesson?

- My development was very good
- My development was good
- My development was somewhat good
- My development was weak
- My development was non-existent

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