Palade Põhikool

Lesson Plan

Building Robots from Recycled and Natural Materials

Science, Technology, Engineering, Art and Mathematics

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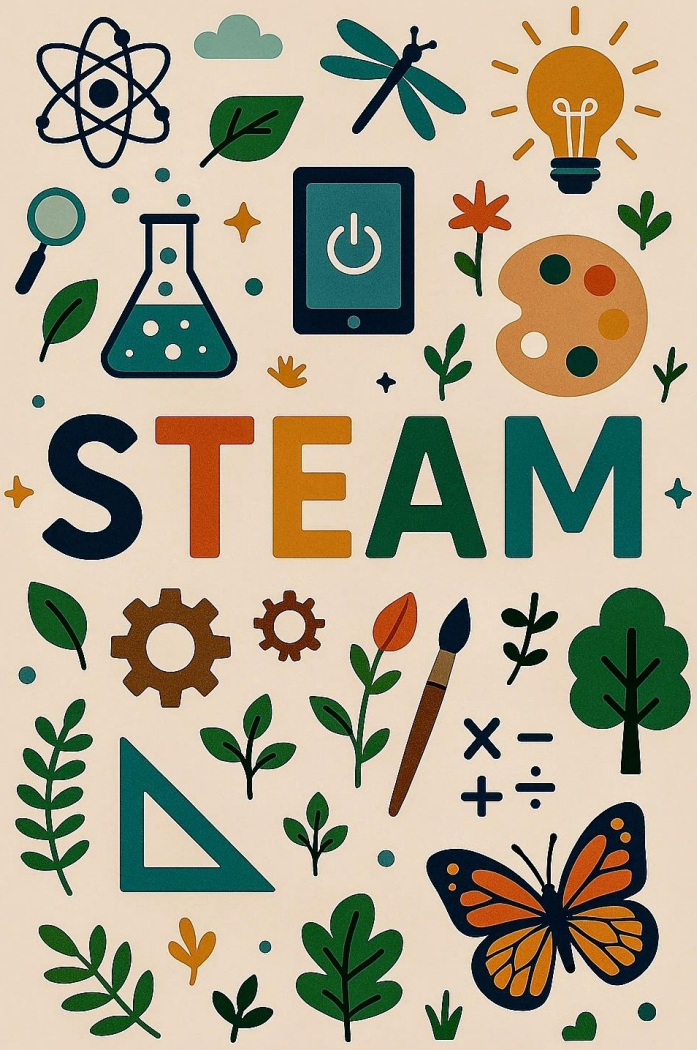

STEAM Focus: Science, Technology, Engineering, Arts, Mathematics

Ages: 9-12 years

Keywords: Sustainability, Creativity, Robotics, Environmental Awareness, interdisciplinary learning

Duration: 2 × 90-minute sessions, 1 x 45-minute session

Project-based learning: adjustable to 45-minutes sessions using different subjects

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"STEAM - take it outside!"

Scenario

Teachers at Palade School often conduct lessons outside the school building, frequently by the sea, on forest trails, or in the surrounding area. As the trash in nature, especially near the sea, has increased, students must clean up their learning area. At school, the waste is sorted into the appropriate containers with the help of the teachers.

What if we could give the trash found in nature a second life — by turning it into robots? In this project, students are challenged to design and build a robot using either recycled (non-biodegradable) or natural (biodegradable) materials. They will explore material types, make environmental decisions, and collaborate to create a robot that reflects both creativity and sustainability. Since students at this age do not yet produce very thorough and in-depth written analyses, the main emphasis is on their creativity, ability to use materials, and willingness to experiment. There are certainly students who are capable of and interested in building a robot on their own, to fully use their potential in terms of creativity, spatial awareness, and practical experience. In such cases, it is important to be tolerant and allow these students to participate individually in the lesson plan, even if the teacher's primary preference is for students to work in groups.

Inclusion & Support: Strategies for Students with Special Educational Needs (SEN)

To ensure that all students can meaningfully participate and succeed in this project, consider the following differentiation strategies and adaptations:

1. Visual and Multisensory Aids
Use visual schedules to outline the structure of each session clearly. Include images or icons for key vocabulary (e.g., biodegradable, robot, reuse). Offer examples of robot designs and material types to support visual learners. Provide hands-on sorting activities with tactile feedback for kinesthetic learners.

2. Clear and Simplified Instructions
Break tasks into small, manageable steps and repeat instructions as needed. Use simple, concrete language and check for understanding. Provide written instructions alongside verbal directions.

3. Flexible Roles and Groupings
Allow students to choose or be assigned roles that suit their strengths (e.g., designer, builder, presenter, material organizer). Group students intentionally to ensure peer support and balanced participation. Offer peer buddies or learning partners for students who may need extra help.

4. Alternative Expression and Communication

Allow alternative ways to communicate ideas, such as:
Drawing instead of writing
Voice recordings or photos instead of written reflections
Using assistive technology (e.g., speech-to-text tools)

5. Sensory and Physical Considerations

Provide noise-reducing headphones or quiet zones for students sensitive to noise. Allow extra time for tasks involving fine motor skills (cutting, glueing). Adapt materials (e.g., pre-cut items, larger tools) for students with physical challenges.

6. Behavioural and Emotional Support

Offer predictable routines and clear expectations to reduce anxiety. Use positive reinforcement and visual behaviour cues (e.g., traffic light system). Encourage self-regulation breaks (e.g., stretching, sensory tools).

7. Assessment Adjustments

Allow verbal reflections instead of written ones if needed. Use checklists or rubrics with visual cues for self-assessment. Provide individualised goals for participation, based on each student's IEP* or support plan. (*Individualized Education Plan)

Final Learning Products

- A physical robot model made from selected materials
- A gallery walk with peer feedback

Learning Outcomes

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

- ✓ Distinguish between biodegradable and non-biodegradable materials
- ✓ Sort and classify waste materials accurately
- ✓ Apply design thinking and engineering to build a simple robot prototype
- ✓ Collaborate effectively within a team setting
- ✓ Justify design choices based on environmental impact and sustainability
- ✓ Reflect on how material usage affects the planet

Pedagogical Approach and Learning Modes

Approach:

Inquiry-Based Learning: Students explore concepts through questioning and discovery.

Project-Based Learning: Learning culminates in a tangible, collaborative product.

Design Thinking: Students follow a cycle of ideation, planning, prototyping, and reflection.

Learning Modes:

Collaborative: Team-based sorting, planning, and building.

Hands-on/Experiential: Physical manipulation of materials and prototyping.

Discussion & Reflection: Class and group conversations to deepen understanding.

Visual & Kinesthetic: Sketching, building, and comparing material types.

Preparations Before the Lesson

1. Collecting Materials

Ask students to bring clean waste materials from home in advance (plastic, paper, cardboard, natural materials, etc.). Send a list home with examples: bottles, boxes, egg cartons, wooden sticks, leaves, strings, etc. If possible, take the class outside and collect natural materials such as branches, pinecones, stones, etc. If you have previously held outdoor lessons and collected trash from nature during those sessions, using that in the project adds extra value to the topic.

Sort the materials in the classroom into two boxes or onto two tables:

 Biodegradable (decomposable)

 Non-biodegradable (non-decomposable)

2. Preparing Supporting Materials

Print out:
Worksheets and problem maps
Sorting charts
Overview of assessment criteria

3. Physical Environment

Set up work areas for teams (e.g., groups of 4–5 students, depending on how many students are in that grade).
Designate a "station" for tools and materials (scissors, glue, tape, etc.).
If possible, prepare visual materials (slides via projector, robot photos, etc.).

Goals

This lesson plan has its very own goals. Some of them are going to be cognitive, while some others are going to be social and emotional. Learning itself is not enough, as well as getting information is not enough either. That is why our students will be working in groups. Regarding this, our goals are mentioned below:

In terms of cognitive goals, students will be able to:

- Identify and classify biodegradable vs. non-biodegradable materials.
- Apply design thinking to plan and construct a prototype robot using repurposed materials.
- Analyze the environmental impact of different material choices.
- Solve practical problems collaboratively during the building process.
- Use specific vocabulary related to sustainability, recycling, and robotics.

Regarding the socio-emotional support, we would like students to be able to:

- Work cooperatively in a team, taking on defined roles and responsibilities.
- Listen actively to peers' ideas and contribute constructively to group decisions.
- Practice turn-taking, sharing materials, and resolving conflicts respectfully.
- Present their project clearly and confidently to others.
- Offer and receive peer feedback with openness and respect.
- Express their opinions about environmental issues and reflect on personal responsibility.
- Show pride in their creative work and effort, regardless of outcome.
- Demonstrate resilience when facing challenges (e.g. a robot design that doesn't work initially).
- Recognise and appreciate different strengths in themselves and their peers.
- Develop a sense of purpose by connecting their project to real-world sustainability goals

Learning Activities

Session 1 (90 minutes): Discover, Sort & Design

Time	Activity
0-10 min	**Warm-up Discussion:** “What is waste?” / “What is a robot?”/ "How can the two be combined?"
10-25 min	**Mini-Lesson:** Biodegradable vs. non-biodegradable materials
25-40 min	**Sorting Challenge:** Students classify mixed materials using a sorting chart
40-50 min	**Material Exploration:** Hands-on examination and brainstorming uses
50-55 min	**Lesson break/ free discussion**
55-80 min	**Robot Design Planning:** Work in groups: Worksheets according to the mini-lesson and sorting challenge
80-90 min	**Exit Reflection:** “Which material type do you prefer and why?”

Teacher Guide – Session 1

Use real-world examples: Compost vs. plastic packaging.
Provide a sorting chart or template with two categories.
Introduce vocabulary: Decompose, reuse, waste stream, sustainability.

Facilitate the sorting challenge with a timer and a fun atmosphere.
Encourage divergent thinking: “What if a robot could be built from pinecones?”
Prompt students to justify why they chose a certain material base

Materials for Session 1

- Waste material collection (prepared by students or provided):
- Biodegradable: cardboard, leaves, wooden sticks, paper, cork, cotton, twine, etc.
- Non-biodegradable: plastic containers, bottle caps, foil, packaging, wires, rubber, etc.
- Sorting charts or printed classification charts
- Scissors, glue, tape, hot glue gun
- Markers, sketch templates
- Projector/slides

Supporting Materials for Critical Thinking

Visual Aids:

Examples of recycled art or sculptures
Comparison chart: Decomposition time of common materials (e.g., plastic bottle = 450 years, paper = 2–6 weeks)
Image prompt: "What if robots helped clean the Earth?"

Discussion Starters:

"What if everything we used was reusable?"
"Can something made from 'trash' be more valuable than something new?"
"How can technology help the planet?"

Learning Activities

Session 2 (90 minutes): Build & Create

Time	Activity
0-10 min	**Let's go outside:** Seek and you shall find: collecting natural materials, and/or cleaning up trash
10-85 min	**Robot Building Time:** Collaborative creation using selected materials
Lesson breaks	**During the session, if needed**
85- 90 min	**Check-ups:** conclusions, open discussion

Teacher Guide – Session 2

- Support safe tool use (scissors, hot glue if used).
- Encourage design iteration if something fails.
- Help groups stay focused with checkpoints: "Is your robot taking shape?"
- Ensure presentations include environmental reasoning.
- Highlight different strengths (creativity, teamwork, message).

- Celebrate all ideas: no “wrong” robots.

Materials for Session 2

- All materials gathered in Session 1
- Extra adhesives, tapes, and connectors
- Labels or tags for robot names
- Timer
- Camera (optional) to document process

Learning Activities

Session 3 (45 minutes): Present & Reflect

The table presents some possible solutions: the teacher may choose which options to use, whether to use them at all, or select alternative solutions from other sources.

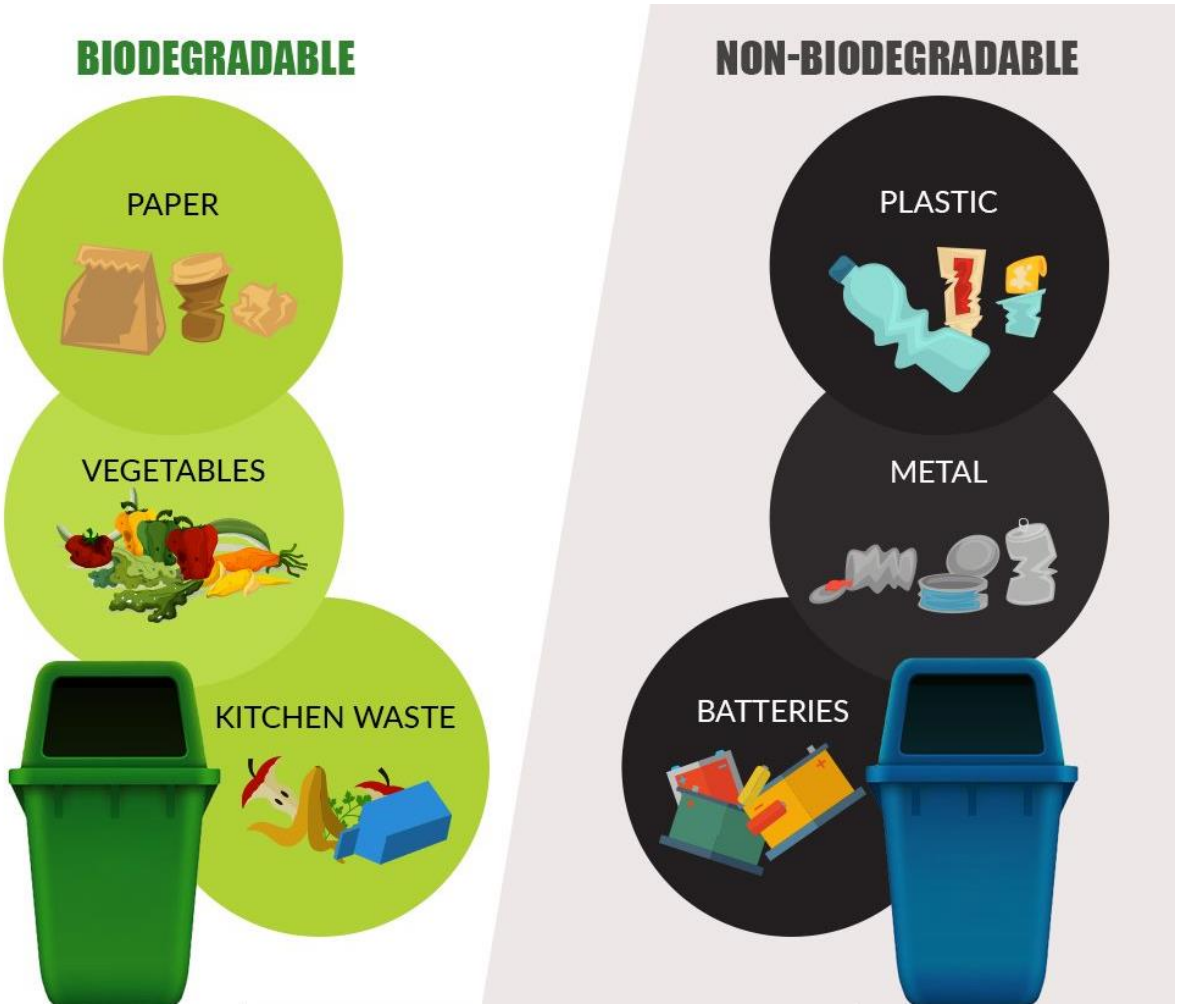
Time	Activity
0-10 min	**Pimp our robot:** Putting the finishing touches on the robots and getting ready for presentations
10-25 min	**Team Presentations:** Robots are introduced with explanations
25-30 min	**Gallery Walk:** Students observe and comment on others' robots
30- 45 min	**Final Reflections:** Written or verbal, using guiding prompts

Reflection Prompts for Students: open discussion

- What was the most fun or surprising part of this project?
- Which robot do you think was more environmentally friendly? Why?
- If you did this again, what would you do differently?
- How can we reduce the waste we produce every day?

Example sheet 1 (Session 1)

Biodegradable vs. non-biodegradable materials



https://shapiroe.com/blog/biodegradable-waste-vs-non-biodegradable/

Example sheet 2 (Session 1)

Biodegradable vs Compostable vs Recyclable

- Both designed to break down into soil over time
- Compostable (best option) takes a shorter amount of time in optimal conditions
- Biodegradable may take decades to break down

- Products can be reprocessed into the same product or a different product
- Plastic is usually recycled into a lower quality product (if at all)

https://ceh.org/yourhealth/biodegradable-vs-compostable-vs-recyclable/

Example sheet 3 (Session1, Session 2)

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AI generated example of a robot made from pinecones

Student Problem Map Worksheet (Session 1)

Building Robots from Waste or Natural Materials

Team Name: _____

Group members: _____

Date: _____

Grade: _____

1.1 What is waste? Write 3 examples of waste you see around you.

_____

_____

_____

1.2 What do we usually do with waste? (You can choose more than one)

☐ Throw it away

☐ Recycle it

☐ Reuse it

☐ Compost it

☐ Burn it

1.3 What happens to waste that is not biodegradable (e.g. plastic)? Give 3 examples

_____

_____

_____

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2.1 Look at your collected items. Sort them:

Material	Biodegradable? (✓/✗)	Recyclable? (✓/✗)	Use in Robot? (Y/N)

3.1 What problem are we trying to solve in this project?

(Answer in your own words. Think about waste, pollution, and creativity.)

3.2 Why is it important to reuse or recycle materials?

_____

_____

3.3 What can a robot made from waste materials do or show?

☐ Help clean the environment

☐ Show how we can reuse things

☐ Solve a small task (like holding pencils or moving)

☐ Look cool and creative

_____

Student Design Worksheet (Session 2) Your Project Challenge

Robot Name: _____

Team name: _____

Students: _____

Grade: _____

1. Will your robot be made of mostly:

☐ Natural / biodegradable materials

☐ Recycled / non-biodegradable materials

☐ A mix of both

2. What is the purpose of your robot?

(Choose one or describe your own)

☐ A helper robot

☐ A cleaning robot

☐ A message-carrying robot

☐ A nature robot

☐ _____

3. What problem will your robot help solve or demonstrate?

 _____

 _____

Assessments

Adaptable assessment methods (depending on the student's age group):

1. Oral Presentation / Interview

Description: Students explain their design choices, materials, and eco-thinking to the class or teacher.

Best for: Communication, reasoning, and understanding of the topic.

2. Checklist Assessment

Description: A simple list of key tasks or features (e.g. "Used at least 3 recycled materials", "Worked well in a team").

Best for: Younger students or quick formative feedback.

Robot Project – Checklist Assessment Example

Student name: _____

Team name: _____

Date: _____

Mark (✓) the box if the task/feature is completed or observed.

Criteria: ✓

- ☐ Brought clean recycled or natural materials from home
- ☐ Helped collect materials outdoors or sort classroom materials
- ☐ Sorted materials into biodegradable and non-biodegradable categories
- ☐ Used at least 3 different materials in the robot
- ☐ Robot design is functional (can stand, move, or show purpose)
- ☐ Robot includes creative details (e.g. antennae, decorations, features)
- ☐ Eco-thinking is visible (e.g. reused trash, natural parts, explanation)
- ☐ Worked well in a team and helped others
- ☐ Gave or received peer feedback (e.g. during gallery walk)
- ☐ Participated in presenting the robot or explaining it

3. Rubric with Descriptors

Description: A scoring guide with detailed levels (e.g. Excellent / Good / Needs Help) for multiple criteria.

Best for: Fair and transparent grading.

Assessment Criteria (Group & Individual):

Category	☺ ***Excellent***	☺ ***Good***	***Needs help***
Material Sorting	Sorted correctly and explained why	Mostly sorted right	Needed help to sort
Robot Design	Works well, carefully planned	Simple, but it works	Messy or hard to understand
Creativity	Very unique and full of ideas	Some original parts	Not very creative yet
Teamwork	Everyone helped equally	Some helped more than others	One or two did most of the work
Presentation	Spoke clearly and explained well	Explained the basics	Hard to understand or unfinished