
SUSTAINABILITY & ZERO-WASTE

Project-Based Learning Unit

Grades 5 — 9

Audit → Research → Prototype → Present

ENVIRONMENTAL SCIENCE

Ecosystems, waste cycles,
and human impact

DATA LITERACY

Auditing, graphing,
and interpreting data

REAL-WORLD IMPACT

Persuasive writing and
community action

3-Week Interdisciplinary Unit | 15 Days of Instruction

Students research waste in their school or community and design a practical solution

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Grade Level: 5–9 (adaptable)

Duration: 3 weeks (15 instructional days)

Subjects: Environmental Science, Mathematics, English Language Arts, Social Studies

Skills: Data collection & analysis, persuasive writing, design thinking, public speaking, collaboration

UNIT OVERVIEW: SUSTAINABILITY & ZERO-WASTE PBL

This project-based learning unit empowers students in Grades 5–9 to investigate real waste issues in their school or community and develop actionable solutions. Over three weeks, students move from observation to action through a structured yet flexible framework: **Audit** → **Research** → **Prototype** → **Present**.

By engaging in authentic data collection, collaborative problem-solving, and persuasive communication, students develop critical competencies across multiple disciplines while making a tangible impact on their environment.

DRIVING QUESTION

How can we, as informed community members, reduce waste in our school or neighborhood and inspire others to adopt sustainable practices?

LEARNING OBJECTIVES

- Conduct a systematic waste audit to collect, categorize, and quantify waste data
- Analyze waste data using charts, graphs, and statistical summaries
- Research existing waste-reduction strategies and evaluate their effectiveness
- Apply design thinking to prototype a practical waste-reduction solution
- Compose a persuasive community action letter using evidence-based arguments
- Deliver an engaging presentation that communicates findings and proposes action
- Reflect on personal and collective environmental responsibility

CROSS-CURRICULAR CONNECTIONS

Subject	Connection
Environmental Science	Ecosystems, resource cycles, human impact, sustainability
Mathematics	Data collection, graphing, percentages, statistical analysis
English Language Arts	Persuasive writing, research, presentation skills
Social Studies	Civic responsibility, community action, policy awareness
Technology	Digital research, data visualization tools, multimedia presentations

WEEK 1: DISCOVER & AUDIT (Days 1–5)

Week 1 Focus: Students build foundational knowledge about sustainability and waste, form teams, plan and conduct a waste audit, and begin analyzing their data. This week establishes the evidence base that will drive all subsequent work.

DAY 1 Launch: Why Waste Matters

Introduce the unit with an engaging hook that connects waste to students' daily lives. Establish the driving question, form project teams, and set expectations for the three-week journey.

- Open with a 'Trash Timeline' — display decomposition times for common items (banana peel: 2–5 weeks; plastic bottle: 450+ years; glass: 1 million+ years)
- Introduce the Driving Question and unpack key terms: sustainability, zero-waste, audit, prototype
- Form diverse project teams of 3–4 students; teams select a name and create a team agreement
- Complete a 'Waste Awareness' KWL chart (Know, Want to Know, Learned — return to this in Week 3)
- Preview the 3-week roadmap so students see the full arc of the project

Materials: Projector, decomposition timeline images, KWL chart handout, team agreement template

DAY 2 Audit Planning: Defining the Investigation

Teams plan their waste audit by selecting a location, defining categories, and preparing data collection tools. Emphasize scientific methodology — clear procedures yield reliable data.

- Review the Waste Audit Data Collection Sheet as a class; discuss each waste category and how to classify items
- Each team selects an audit location: classroom, cafeteria, hallway bins, school office, playground, or a community space (with approval)
- Teams define audit parameters: time period (e.g., one lunch period, one full school day), collection method, and safety protocols (gloves, tongs, no sharp items)
- Create a hypothesis: 'We predict the most common waste item in our location will be _____ because _____'
- Practice sorting sample waste items as a whole-class activity using a projected image of mixed waste

Materials: Waste Audit Data Collection Sheet, gloves, sample waste images, hypothesis template

DAY 3 Conducting the Waste Audit

Teams execute their waste audit, collecting and sorting waste according to their planned methodology. Safety and accuracy are paramount.

- Review safety protocols: wear gloves, use tongs, do not open sealed containers, wash hands thoroughly after
- Teams collect waste from their designated location during the assigned time period
- Sort waste into categories on the Data Collection Sheet: Paper, Plastic, Food/Organic, Metal, Glass, Textiles, Other
- For each category, record: item count, estimated weight (if scale available), and whether the item is recyclable, compostable, or landfill-bound
- Photograph sorted waste piles for visual evidence (use classroom camera or tablets)
- Quick debrief: What surprised you? Was anything different from your hypothesis?

Materials: Gloves, tongs, waste audit data collection sheets, scale (if available), camera/tablet, hand sanitizer

DAY 4 Data Analysis: Making Sense of the Numbers

Teams transform raw audit data into visual representations and identify key patterns. Data literacy skills — graphing, calculating percentages, drawing conclusions — are central.

- Calculate totals for each waste category and the overall waste collected
- Determine the percentage each category represents of total waste (formula: category count ÷ total count × 100)
- Create at least two visual representations: a bar graph showing category totals and a pie chart showing percentages
- Identify the top three waste items by volume — these become the focus for solution design
- Write 3–5 key findings statements (e.g., 'Food waste made up 42% of cafeteria waste, and most of it was half-eaten fruit')
- Compare findings across teams: Were patterns similar or different? What might explain variations?

Materials: Graph paper or digital graphing tool (e.g., Google Sheets), calculators, colored pencils, findings template

DAY 5 Research Begins: Exploring Solutions

With audit data in hand, teams begin researching existing waste-reduction strategies. The goal is to understand what has worked elsewhere and what might work in their context.

- Model effective research techniques: using credible sources, taking notes, citing references
- Provide a curated list of starting resources (EPA waste resources, local recycling guidelines, school district sustainability policies)
- Each team member researches one aspect: existing school programs, community resources, successful case studies from other schools, or innovative zero-waste technologies
- Teams compile an annotated 'Research Brief' with at least 5 credible sources and 3 potential solution ideas
- Reflective exit ticket: 'One solution I learned about today that excites me is _____ because _____'

Materials: Research Brief template, device with internet access, curated resource list, exit ticket slips

WEEK 1 CHECKPOINT

By the end of Week 1, each team should have:

- Completed waste audit data collection sheet with accurate tallies
- At least two data visualizations (bar graph + pie chart)
- 3–5 written key findings from the audit
- A research brief with 5+ sources and 3 potential solution ideas
- A team hypothesis compared to actual results

WEEK 2: RESEARCH & DESIGN (Days 6–10)

Week 2 Focus: Students deepen their research, analyze root causes of waste, brainstorm solutions using design thinking, and build prototypes of their proposed waste-reduction strategies. This week transforms data into actionable ideas.

DAY 6 Deepening Research & Root Cause Analysis

Teams move beyond surface-level research to understand why waste accumulates in their audit location. Root cause analysis reveals leverage points for effective solutions.

- Introduce the 5 Whys technique: ask Why? five times to drill down to the root cause of a problem
- Each team applies the 5 Whys to their top waste category (e.g., Why is there so much plastic waste? Because students buy packaged snacks. Why? Because the cafeteria offers few unpackaged options...)
- Research community and school policies related to the identified root causes (recycling programs, composting infrastructure, procurement policies)
- Interview a stakeholder (custodian, cafeteria manager, or administrator) about waste practices and challenges
- Update the Research Brief with new findings and refine the list of potential solutions

Materials: 5 Whys worksheet, Research Brief (ongoing), interview question guide

DAY 7 Solution Brainstorming: Design Thinking

Teams use structured brainstorming and design thinking to generate creative, feasible solutions. Emphasis is on quantity of ideas first, then convergence on the most promising concept.

- Review design thinking steps: Empathize, Define, Ideate, Prototype, Test
- Empathize: Teams consider perspectives of all stakeholders affected by the waste problem (students, staff, custodians, community members)
- Ideate: Conduct a Crazy 8s brainstorming session — 8 solution ideas in 8 minutes, no judgment, build on the ideas of others
- Evaluate ideas using a Feasibility-Impact matrix: rate each idea on a scale of 1–5 for feasibility (can we do it?) and impact (will it reduce waste?)
- Select the top solution concept and complete the Solution Design Template (Section 3)

Materials: Chart paper, markers, Feasibility-Impact matrix handout, Solution Design Template

DAY 8 Prototype Development

Teams build a tangible representation of their solution. Prototypes may be physical models, digital mockups, process diagrams, or action plan documents — whatever best communicates the concept.

- Discuss what counts as a prototype: physical model, poster, digital design, flowchart, skit, policy proposal, or action plan
- Teams sketch their prototype design before building, labeling key features and materials needed
- Build prototypes using available classroom materials (cardboard, paper, craft supplies, digital tools)
- Each prototype must clearly show: what the solution is, how it works, who it serves, and how it reduces waste
- Circulate to provide feedback and ask probing questions: What could go wrong? Who might this not work for?

Materials: Cardboard, craft supplies, markers, scissors, glue, devices for digital prototyping

SECTION 5: PRESENTATION RUBRIC

This rubric assesses your team's final presentation. Review each category before you present to ensure you meet the highest standards. Each category is scored on a 4-point scale.

Category	Exemplary (4)	Proficient (3)	Developing (2)	Beginning (1)
Problem & Data	Clearly defines the waste problem with detailed, accurate audit data; multiple statistics and observations cited effectively	Defines the problem with some data; statistics are mostly accurate but may lack specific detail or context	States the problem vaguely; minimal data used; statistics may be unclear or not well connected to the claim	Problem is not clearly stated; no data or inaccurate data presented; no connection between audit and argument
Solution & Prototype	Solution is creative, highly feasible, and directly addresses the root cause; prototype is polished and clearly demonstrates how the solution works	Solution is feasible and addresses the problem; prototype shows the basic concept but may lack some detail or polish	Solution is somewhat feasible but loosely connected to the problem; prototype is incomplete or does not clearly show how the solution works	Solution is unrealistic or unrelated to the problem; no prototype or prototype does not represent the solution
Persuasive Communication	Argument is compelling with strong evidence, clear reasoning, acknowledgment of counterarguments, and a specific, actionable call to action	Argument is clear with supporting evidence and a call to action; counterarguments may be weak or missing	Argument is present but weakly supported; call to action is vague; no counterargument addressed	No clear argument; no evidence or call to action; relies on opinion rather than data
Presentation Skills	All members speak clearly with confidence and eye contact; 4–6 minute time limit is met; smooth transitions between speakers; engages the audience	Most members speak clearly; time limit is mostly followed; transitions are adequate; some audience engagement	Some members struggle with volume or clarity; time limit is significantly over/under; transitions are abrupt; minimal engagement	Presenters are hard to hear or read entirely from notes; time limit is ignored; no transitions; no audience engagement
Collaboration & Teamwork	All team members contribute equally; seamless transitions; clear evidence of shared preparation and mutual support; professional during Q&A	Most team members contribute; generally shared preparation; team supports each other during Q&A	Participation is uneven; one or two members dominate; limited evidence of collaboration; struggles during Q&A	One person dominates the presentation; no evidence of teamwork; unable to answer questions as a team

Scoring Summary

Category	Score (1–4)
Problem & Data	
Solution & Prototype	
Persuasive Communication	
Presentation Skills	
Collaboration & Teamwork	
TOTAL SCORE	___ / 20

GRADE SCALE

- **18–20 points:** Exemplary — Solution is ready for real-world implementation
- **14–17 points:** Proficient — Strong work with minor revisions needed
- **10–13 points:** Developing — Good start; significant revisions required
- **Below 10 points:** Beginning — Needs substantial additional work

SECTION 6: TEACHER FACILITATION NOTES

This section provides essential guidance for implementing the Sustainability & Zero-Waste PBL Unit successfully. Read these notes before beginning the unit and refer to them throughout the three weeks.

THE PBL MINDSET

In Project-Based Learning, your role shifts from 'sage on the stage' to 'guide on the side.' Students will encounter ambiguity and struggle — this is by design. Resist the urge to provide answers; instead, ask probing questions that help students discover solutions themselves. Celebrate productive failure as a necessary step toward innovation.

Preparation & Logistics

- **Admin Approval:** Before conducting waste audits, secure approval from your administration and custodial staff. Communicate your plans clearly.
- **Safety First:** Procure nitrile gloves, tongs, and hand sanitizer. Establish a strict 'no sharp objects' and 'no open containers' rule.
- **Audit Logistics:** Coordinate with custodians to save bags of waste from specific locations (e.g., cafeteria, staff lounge) rather than having students dig through active bins, if preferred.
- **Materials:** Gather scales (bathroom or kitchen scales work well), chart paper, markers, craft supplies for prototyping, and devices for research and graphing.
- **Guest Speakers:** Consider inviting a local recycling coordinator, sustainability expert, or facilities manager for Days 5 or 6.

Grouping Strategies

Form heterogeneous groups of 3–4 students. Consider the following:

- Mix academic strengths (pair strong writers with strong data analysts).
- Balance personalities to ensure equitable participation.
- Assign roles initially (Data Manager, Materials Coordinator, Timekeeper, Lead Researcher) but rotate or let students self-assign as the unit progresses.
- For larger classes, consider having two teams audit the same location at different times to compare results.

Differentiation & Accommodations

Student Need	Support Strategy
English Language Learners	Provide bilingual vocabulary lists; pair with a language buddy; allow visual or bilingual presentation components; offer sentence frames for the community action letter.
Students with IEPs/504s	Break tasks into smaller chunks with checklists; provide graphic organizers for research and writing; allow alternative prototype formats (e.g., video, audio explanation); extended time.

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