

# STEAM Education & Leadership Workshops:

*Lesson Plan - Scrap to Shelf: A STEAM-Based Approach to Transforming Waste into Knowledge Hubs*

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## Age range

12 -15 years old

## Learning objectives

By the end of the lesson, students will be able to:

- Environmental Literacy:** Understand the concept of reuse and the environmental impact of abandoned materials.
- Material Science:** Identify physical properties of wood that make it suitable for repurposing.
- Technical Skills:** Apply precise measurement, tool-handling, and construction techniques.
- Collaboration:** Work in teams to plan, design, build, and decorate a functional bookshelf.
- Career Exploration:** Explore pathways in carpentry, engineering, architecture, and sustainability.
- Leadership:** Develop problem-solving skills and agency through hands-on project management.

## Structure of the lesson

- **Introduction to Waste Wood & Reuse:** A foundational discussion on how repurposing wood reduces the need for logging and keeps waste out of landfills.
- **Material Inspection & Categorization:** A hands-on "audit" where students sort wood scraps by size, type, and quality to determine what is usable.
- **Planning & Design:** A technical drawing session where teams sketch their bookshelf and calculate the necessary measurements using math skills.
- **Construction & Assembling:** The core engineering phase where students measure, cut (under supervision), and join wood pieces to build the structure.
- **Finishing, Decorating & Placement:** The aesthetic phase, where students sand down rough edges and paint their shelves to reflect their team's identity.
- **Reflection & Closing:** A leadership-focused debrief where students share the obstacles they faced and how they solved them.

## Standards Mapping

**Engineering:** Defining the criteria and constraints of a design problem (using scrap wood to create a functional shelf).

**Mathematics:** Solving real-world problems involving area, volume, and surface area of two- and three-dimensional objects.

**Sustainability: (SDG)Goal 12 - Responsible Consumption and Production:** Promoting the repurposing of "waste" into value-added products.

**Duration**

2 hours

**Note to Educators**

- Sourcing: Use authentic waste materials found within the school or local environment.
- Inquiry-Based Learning: Encourage curiosity with open-ended questions like: *"How can we transform this scrap into something structural?"*
- Inclusive Pedagogy: Incorporate visual, hands-on, and discussion-based learning styles.
- Safety First: Ensure the safe handling of tools and maintain a supportive, supervised learning space.

**Resources**

**Slides:** [\*Scrap to Shelf: A STEAM-Based Approach to Transforming Waste into Knowledge Hubs\*](#)

Timing	Facilitator's actions	Students outcomes	Technical notes
10mins	<p><b>Introduction:</b></p> <p>Encourage curiosity with open-ended questions like: <i>"How can we transform scraps around us into something structural?"</i></p> <p>Discuss the problem, opportunity and environmental impact of wood waste.</p> <ul style="list-style-type: none"> <li>● <b>The Problem:</b> Tons of wood waste end up in landfills or are burned, releasing CO2.</li> <li>● <b>The Opportunity:</b> Reclaimed wood reduces the demand for deforestation.</li> <li>● <b>The Impact:</b> By upcycling, we extend the life of a natural resource and lower our carbon footprint.</li> </ul>	<p><b>Awareness and Connectedness</b></p> <p><b>Focus: identification, Foundational Knowledge</b></p> <p>Students brainstorm and share the impact of wood waste in the environment.</p> <p>They define sustainability and engage in critical discussion on how to turn the challenge into an opportunity.</p> <p>Students identify physical properties of wood that make it suitable for repurposing.</p>	<p>Use photos of deforestation or overflowing landfills as visual aids.</p>

<p>20 Mins</p>	<p><b>Material Inspection &amp; Categorization:</b></p> <ul style="list-style-type: none"> <li>● Guide students through a physical "audit" of the reclaimed wood. Guide them to inspect each piece for structural integrity (checking for rot, deep cracks, or warping).</li> <li>● Group students into teams and guide them to sort their findings by specific criteria: size (length/width), strength (load-bearing potential), and quality (surface texture).</li> <li>● Prompt students to decide which pieces are best for the "skeleton" (the frame) and which are better for the "skin" (the shelves or backing).</li> </ul>	<p><b>Awareness, Mastery and Agency</b></p> <p>Focus: Social Awareness, Problem Solving, critical thinking, evaluation and collaboration.</p> <p>Students master the ability to evaluate material properties and suitability for construction.</p> <p>Teams demonstrate social awareness and communication as they negotiate how to share and organize limited resources.</p> <p>Students learn to distinguish between different types of wood waste (e.g., hardwood vs. softwood or plywood).</p>	<ul style="list-style-type: none"> <li>● <b>Safety Prep:</b> Provide heavy-duty work gloves and labels/markers for categorization.</li> <li>● <b>Visual Aid:</b> Use a "Wood Quality Checklist" to help students identify defects like "checking" (cracks) or "bowing" (curves).</li> </ul>
<p>25 mins</p>	<p><b>Planning &amp; Design:</b></p> <ul style="list-style-type: none"> <li>● <b>Drafting Support:</b> Assist students in translating their ideas into technical drawings, ensuring they include both 2D (front/side view) and 3D (perspective) sketches.</li> <li>● <b>Precision Mentoring:</b> Reinforce the "Measure twice, cut once" rule by reviewing student calculations before any wood is marked for cutting.</li> <li>● <b>Engineering Consultation:</b> Challenge teams to consider "Load Bearing" factors: <i>"Where will the most weight sit, and how will your joints support it?"</i></li> </ul>	<p><b>Awareness, Mastery, Agency and Connectedness</b></p> <p>Focus: Foundational Knowledge, Collaboration, Critical Thinking</p> <p>Students apply mathematical concepts—specifically geometry and linear measurement—to solve a physical construction problem.</p> <p>Teams negotiate design trade-offs, learning to reach a consensus on the most stable and aesthetic shelf design.</p> <p>Students develop the ability to read and create basic blueprints, bridging the gap between an abstract idea and a physical object.</p>	<ul style="list-style-type: none"> <li>● <b>Drafting Tools:</b> Provide rulers, measuring tapes, graph paper, and pre-drawn design templates for those who need a starting point.</li> <li>● <b>Joinery Guide:</b> Provide a visual chart of simple wood joints (like butt joints or lap joints) to help students visualize how pieces will connect.</li> </ul>

50 mins	<p><b>Construction &amp; Assembling</b></p> <p><b>Recommendation:</b> Pre-sort or "rough cut" some materials if time is tight, or extend the session to a two-part lab.</p> <ul style="list-style-type: none"> <li>● <b>Active Supervision:</b> Closely monitor the measuring, cutting, and joining process, ensuring students adhere to the "Design Thinking" blueprints created in the previous phase.</li> <li>● <b>Role Management:</b> Promote student leadership by ensuring each member fulfills their specific duty: <b>Project Manager</b> (workflow), <b>Safety Officer</b> (protocol), <b>Lead Engineer</b> (assembly), and <b>Design Specialist</b> (aesthetics).</li> <li>● <b>Communication Coaching:</b> Guide teams through "Pivoting"—helping them communicate calmly when a piece is cut incorrectly or a joint doesn't fit, and encouraging them to adjust the design rather than give up.</li> </ul>	<p><b>Mastery, Agency and Wellbeing</b></p> <p><b>Focus:</b> Safety, Collaboration, Problem solving, Innovation and creativity.</p> <p>Students gain hands-on mastery of mechanical assembly and structural problem-solving.</p> <p>Students develop agency and accountability by managing their assigned roles within a high-pressure, time-sensitive environment.</p> <p>Teams demonstrate the ability to troubleshoot real-world construction errors through collaborative decision-making.</p>	<ul style="list-style-type: none"> <li>● <b>Strict Supervision:</b> Direct, one-on-one oversight is <b>required</b> whenever a student is using a handsaw or hammer.</li> <li>● Encourage the Use of Eye Protection (Safety Goggles) during the sanding and cutting phases.</li> <li>● <b>Tool Safety:</b> Enforce the "Safety Zone" protocol—only the student cutting and the facilitator should be within arm's reach of a sharp tool.</li> <li>● Students should wear sturdy, closed-toe footwear.</li> </ul>
10 Mins	<p><b>Finishing, Decorating &amp; Placement</b></p> <ul style="list-style-type: none"> <li>● <b>Quality Control:</b> Guide students through the multi-step finishing process: sanding rough surfaces, cleaning away wood dust, and applying protective or decorative coats.</li> <li>● <b>Aesthetic Mentoring:</b> Encourage teams to choose colors or patterns that reflect their group identity or the specific "Knowledge Hub"</li> </ul>	<p><b>Agency, Wellbeing and Mastery</b></p> <p><b>Focus:</b> Creativity &amp; Ownership, Leadership, Environmental Stewardship:</p> <p>Students develop a deep sense of pride and agency by transforming raw construction into a polished, professional classroom asset.</p> <p>Students learn the importance of "the final 10%"—how sanding and cleaning elevate a project</p>	<p><b>Sanding Progression:</b> Provide various sandpaper grits; start with <b>60-grit</b> for heavy smoothing and finish with <b>220-grit</b> for a professional touch.</p> <p><b>Supply Safety:</b> Ensure all paints and stains are <b>non-toxic</b> (check the Safety Data Sheet for any stains used) and used in a well-ventilated area.</p>

	<p>theme (e.g., Science, Literature, or History).</p> <ul style="list-style-type: none"> <li>● <b>Sustainability Connection:</b> Remind students that a good finish is not just for beauty; it protects the wood and ensures the shelf lasts for years, further reducing waste.</li> </ul>	<p>from a "scrap" to a high-quality product.</p> <p>Students see the tangible results of their labor as they contribute directly to improving their school environment.</p>	<p>Provide drop cloths to protect the workspace floor.</p>
5 Mins	<p><b>The Reflection Circle:</b></p> <p><i>Gather the students in a circle, away from the tools and sawdust. Facilitate a "Circle Sharing" session where the hierarchy of roles is removed to create an equal playing field for every voice.</i></p> <ul style="list-style-type: none"> <li>● <b>Inquiry-Based Debrief:</b> Use targeted prompts to extract deeper meaning from the experience: <ul style="list-style-type: none"> <li>○ <b>The Struggle:</b> <i>"What was the most difficult moment during construction, and how did your team solve it?"</i></li> <li>○ <b>The Discovery:</b> <i>"What is one thing you learned about wood or tools today that you didn't know before?"</i></li> <li>○ <b>The Value:</b> <i>"How does it feel to know that this bookshelf was considered 'waste' just three hours ago?"</i></li> <li>○ <b>The Leadership Link:</b> <i>"How did you help a teammate today when they were stuck?"</i></li> </ul> </li> </ul>	<p><b>Awareness, Wellbeing, and Agency</b></p> <p><b>Focus:</b> Confidence, Agency, Gratitude, Global mindedness, Problem solving and Public speaking skills.</p> <p>Students develop self-awareness by reflecting on their personal growth and their ability to overcome physical and social challenges.</p> <p>Students practice articulating their thoughts and achievements clearly in a supportive group setting.</p> <p>Students recognize their own power to transform their environment, shifting their mindset from passive observers to active problem-solvers.</p>	<ul style="list-style-type: none"> <li>● <b>Inclusion Strategy:</b> Use a "talking piece" (like a small wood scrap) to ensure only one person speaks at a time and every voice is heard.</li> <li>● <b>Time Management:</b> Keep responses concise to ensure the session stays within the allocated time while maintaining high energy.</li> </ul>

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