Build to Budget: The Strongest Beam Bridge Challenge

Grade Levels: 4th and 5th Grade

Subject: STEM - Civil Engineering

Duration: 1 hr 45 min.

Standards:

- Next Generation Science Standards (NGSS):
    - 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
    - 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Objectives:

- Students will apply the engineering design process to solve a problem by planning, building, testing, and redesigning a beam bridge.
- Students will develop an understanding of budget management and resource allocation in engineering projects.
- Students will enhance their teamwork skills through collaborative decision-making and problem-solving.

Materials:

- Fake money (play currency)
- Straws
- Cardboard pieces (e.g., from cereal boxes)
- Paper clips
- Two 4x4x6 wooden blocks (for bridge supports)
- Weights for testing bridge strength
- Measuring tapes or rulers
- Scissors
- Engineering design worksheets for planning and reflection

Procedure:

1. Introduction (10 minutes):
    - Discuss the role of civil engineers and the importance of bridges in infrastructure.
    - Introduce the concept of the engineering design process and budget constraints.
2. Planning Phase (15 minutes):
    - Explain the budget and the cost of materials.
    - Groups receive their budgets and begin planning their bridges on the engineering design worksheets. They must decide which materials to buy within their budget to create the strongest bridge.
3. Building Phase (20 minutes):
    - Groups purchase materials and construct their beam bridges using the wooden blocks as supports.
    - Encourage groups to measure and cut their materials carefully to fit their design specifications.
4. Testing Phase (20 minutes):
    - Test each bridge by gradually adding weight until the bridge fails.
    - Record the weight each bridge held before failure.
5. Evaluation and Redesign Phase (30 minutes):
    - Discuss what designs were most effective and why.
    - If time and resources permit, allow groups to redesign and rebuild their bridges using leftover materials or by purchasing additional supplies if they have remaining money.
6. Conclusion (10 minutes):
    - Recap the day's activities.
    - Discuss the importance of budgeting and planning in engineering.
    - Allow students to share what they learned and how they might apply these lessons in future projects.

Assessment:

- Evaluate students through their participation in planning, building, and discussing phases.
- Review completed engineering design worksheets to assess understanding and application of the engineering design process.
- Assess final bridge designs and their ability to handle weight relative to their cost-effectiveness.

Extension Activity (Optional):

- Math Connection: Have students calculate the cost per unit of weight supported by their bridges to determine which bridge was the most cost-effective, integrating math skills with engineering principles.
- Research Project: Students can research various types of bridges and their engineering designs. They could then present their findings and discuss which designs might be more effective based on their hands-on experience.
- Community Involvement: Invite a local civil engineer to speak to the class about bridge design and construction in the real world, providing students with career insights and real-world application of their learning.