# Collaborative Constructors: The Truss Bridge Project

**Grade Levels:** 4th and 5th Grade

**Subject:** STEM - Civil Engineering

**Duration:** 2-3 hours

**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 learn the principles of truss bridge construction and their applications in civil engineering.
- Students will utilize teamwork and collaboration by working in groups to design and build a truss bridge.
- Students will analyze the structural integrity of their bridges through a weight-bearing test.

**Materials:**

- Popsicle sticks
- Hot glue guns and glue sticks
- Zip ties
- Hanging scale
- Weights for testing bridge strength
- Rulers or measuring tapes
- Safety goggles for each student

**Procedure:**

1. Introduction (15 minutes):
    - Begin by introducing truss bridges and their significance in civil engineering.
    - Explain the engineering design process and the importance of teamwork in construction.
    - Discuss the geometric strength of the triangle, emphasizing why it is often used in bridge design and other structures for its ability to evenly distribute weight and add stability.
2. Design and Planning (30 minutes):
    - Outline the project's criteria and constraints, including the budget for materials if applicable.
    - Each group of 9 students splits into 3 smaller teams, with two focusing on constructing the side walls and one on building the base.
    - Teams sketch their design plans, considering how to integrate the triangular elements effectively.
3. Construction Phase (60 minutes):
    - Students begin constructing their parts of the bridge using popsicle sticks and hot glue.
    - Focus on precision and stability in their constructions, incorporating triangular shapes for enhanced strength.
4. Assembly (30 minutes):
    - Assist with using zip ties to securely combine the walls and the base into a single structure, ensuring each bridge is stable and correctly aligned.
5. Testing and Evaluation (30 minutes):
    - Test each bridge by gradually adding weights using the hanging scale until the bridge fails or the maximum expected load is reached.
    - Record the maximum weight each bridge holds.
6. Discussion and Reflection (15 minutes):
    - Discuss the outcomes of the tests and what factors contributed to the strength or failure of the bridges.
    - Encourage students to reflect on their teamwork and problem-solving strategies.
7. Conclusion (10 minutes):
    - Summarize what was learned about truss bridges and the engineering design process.
    - Highlight the importance of collaboration, careful planning, and the geometric advantages of using triangles in engineering.

**Assessment:**

- Evaluate students on their ability to work collaboratively, follow design plans, and apply problem-solving skills.
- Assess students' understanding of truss bridge design and the principles of engineering through a quiz or a reflective essay.

**Extension Activity (Optional):**

- Research Project: Students research different types of bridges and their structural advantages and disadvantages. They present their findings to the class.
- Rebuild and Redesign: Allow students to redesign their bridge with the same materials, aiming to improve the structure based on their initial test results.
- Math Connection: Have students calculate the ratio of the weight the bridge held to the amount of material used, discussing efficiency in engineering designs.