

Bridge Building Lesson Plans

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Objective: Students will design and construct a bridge out of toothpicks.

Skills: This activity is a wonderful integration of math, science, art, drafting, problem solving and engineering. Students will measure, design, construct, and calculate the weight of their bridges.

Rational: Design and construction of any item leads students through a number of invaluable problem solving steps. The goal of a strong, well built bridge should be emphasized, but not to the exclusion of the building process. I try to encourage my students to look at the process and the results in conjunction. It is good to have a strong bridge, but better to learn the problem solving steps involved.

Timeline: I have broken lessons into typical 1 hour blocks. I do this lesson every year with 80 something 4th graders. I typically spend 10 class days to have bridges complete from design to final weigh in. If you have older/ more mature students or fewer to deal with adjust the timeline to fit your schedule.

Day 1: Introduce the idea of building a bridge out of toothpicks and the bridge building event. Talk about the design and engineering process. Compare the strength of triangles and squares, one span vs. several spans. Look at pictures of famous bridges, discuss the types of bridges, suspension, etc. It is great if you can find an engineer to come in and talk about the design elements of bridges. The “Building Big: Bridges” video from the Discovery channel is a great introduction.

Day 2: Students will begin designing blueprints for their bridges. Give students the required measurements and explain that the final bridge must meet the dimensions in order to compete. I have students work in pairs and design a single span. Span designs should be actual size for length and height.

Day 3: Students will begin bridge construction. Take individual span blueprints and tape them to stiff cardboard. Cover the blueprint with wax paper and tape it lightly to the cardboard. Make sure that students write their names on the wax paper. Demonstrate how to glue toothpicks directly to the wax paper. I have found that using film canisters filled with white glue works well. Students can dip the ends of the toothpicks into the glue canisters and then place them directly on the blueprint. Remind students to overlap toothpicks and make good connections between toothpicks. The success of their bridge will be a mixture of design and attention to detail during construction.

Day 4-5: Students will continue span construction. As spans are completed pull the tape off the wax paper. Carefully move the wax paper with the span to some flat location so it can dry completely. Put new wax paper on the cardboard/blueprint board and begin the next span. I encourage my students to make 3 spans. Depending on the weight of the spans some students might be able to make a 4th span.

Day 6-7: Students will begin joining the spans of their bridges. Gently peel the toothpick spans off the wax paper. Using classroom items (glue bottles, crayon boxes etc.) and clay prop two spans up on the blueprint board covered with wax paper again. I have the students make 4 or so clay “marbles” and stick them, evenly spaced, to the bottom of each span. Press the clay onto the wax paper, space spans a toothpick distance apart and use the crayon boxes, etc. to maintain the distance. Begin gluing and placing toothpicks across the spans. Depending upon the dexterity of your students you can set up all 3 or 4 spans and have students carefully connect the tops of all spans at one time. Let the top connection dry overnight.

Day 7-9: Students will complete spans/ connections. Carefully pull the dry connected spans off the wax paper, flip over and have students begin gluing toothpick across the bottom of the spans for connection. It is helpful to put crayon boxes, glue bottles between the spans again to hold them the correct distance apart. Be careful to not permanently glue the box into the middle of the bridge 😊

Day 10: Final weight check for bridges, and questionnaire. I recommend checking the weight of individual spans, all the spans students have constructed, and the weight of spans connected. It can be devastating to have a bridge go over weight. Individual toothpicks can be snipped out if weight goes over in the final stages. I have all of my students answer the questionnaire, it is a good wind up for the activity and will have them ready to speak to officials at the event.

Other notes:

- Students can use flat or round toothpicks. Total weight, with glue, is about 2 boxes of either kind of toothpick. If using round the individual picks are stronger, but you can use fewer to make total weight. We have had good results with both.
- If weight permits, students can add on “feet” at the bottom of their bridges. The ends of the bridge that will come in contact with the crushing machine benefit from a little extra reinforcement.
- My students typically have “elementary” looking bridges in comparison to some of the high school bridges. We have found however that they hold up pretty well in overall weight bearing. I was amazed at the bridge that held 90 pounds and was not very esthetically pleasing. The process over the product is what I emphasize.
- I have found my administration to be very supportive in regards to this activity. It is one of the lessons the principal typically brags on when he introduces new parents/ students to the school. It is the perfect integration of math and science. My students learn so much from this activity it is hard to quantify all of the individual elements.

Procedural Notes:

- I have noted a number of procedural ideas. The first time I tried this lesson I thought I would lose my mind with the questions from my students. My students do a lot of hands-on work so a little guidance and they were quickly able to be very independent with the majority of their work.
- Try setting up glue containers, masking tape, permanent markers, wax paper etc. in a central location. Have students help themselves to these items. I have a place

for full glue containers (film canisters) and empty ones. I refill at the end of each class. Otherwise I found myself constantly filling film canisters and not able to help with more important problem-solving tasks.

- I allow my students to move freely around the room to get supplies. However I do mandate that when bridge spans are being moved everyone is still. The tragedy of a span getting bumped and crushed BEFORE the event is rotten.
- This is the perfect opportunity to have all the parents that beg us to come in and help find their niche. An extra set of hands for the logistics is great, but not necessary. I have had really good helpers and really lousy ones that I didn't invite back. Something to think about.
- If you have any questions/ concerns/ panic attacks about trying this lesson please contact me and see if I can help. I am not a pro at it by any means, but we have participated in the event a number of times and have had pretty good success. It is a great learning experience for all ages.