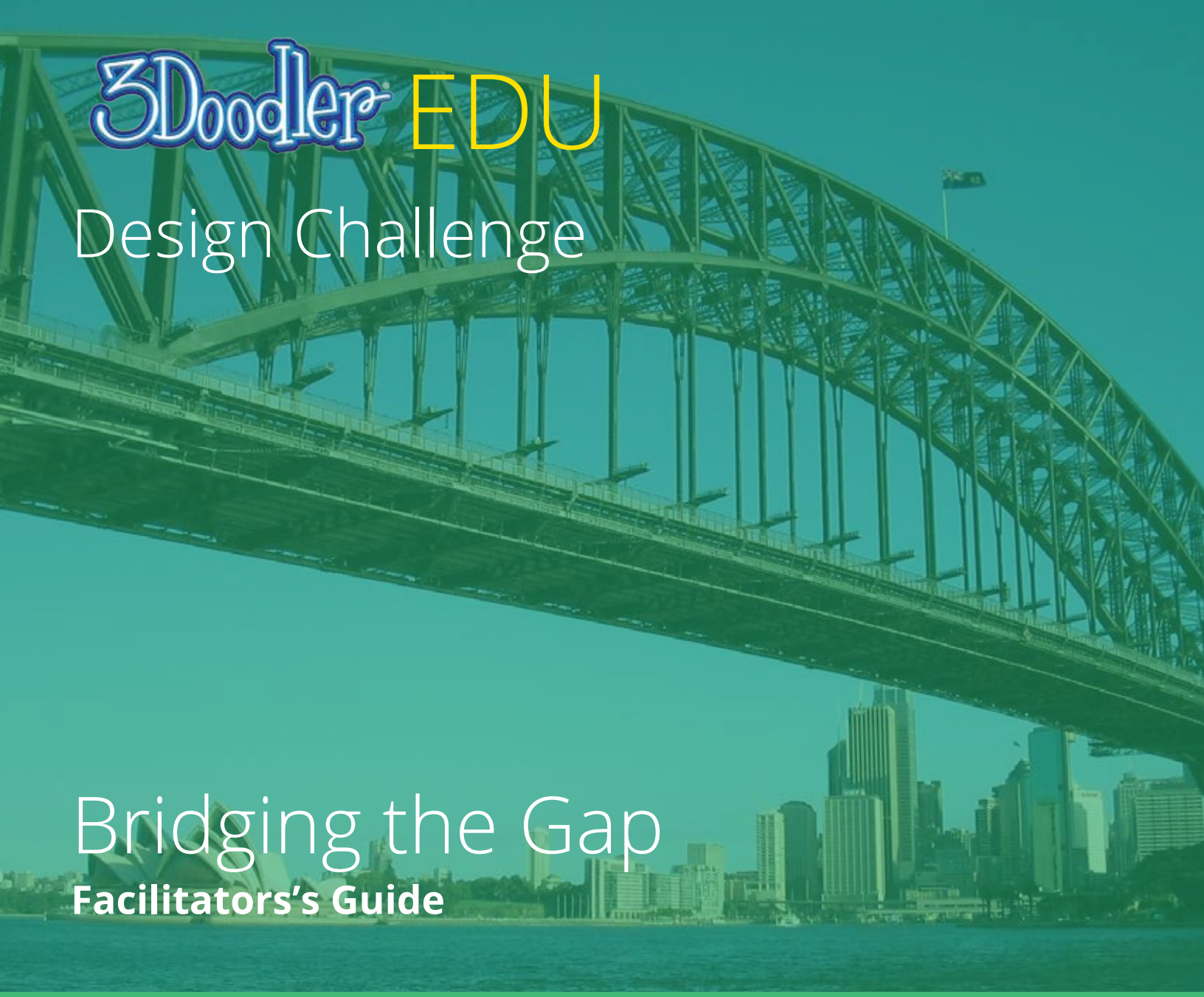


3Doodler EDU

Design Challenge

Bridging the Gap

Facilitators's Guide

The Challenge

Using 3Doodler pens, plastic strands, and the materials provided, each participant will create a 12" x 3" beam bridge section, then combine sections with other participants to experiment how modifications allows the bridge to carry more weight and expand longer distances.

Overview

Total Time: 200 minutes (4 Class Periods)

This challenge provides participants the opportunity to test bridge structures. The 12" x 3" spans will be very strong due to their short distance. However, when each team welds together the four bridge sections, additional supports will be needed to support the test weight. Use easy-to-find weights such as books, bricks or a bucket of water. Tie the weight below the bridge sections when testing.

Challenge Background

Challenge Tip
Use graph paper to design all of the components of the bridge first, then use that as your template for 3Doodling.

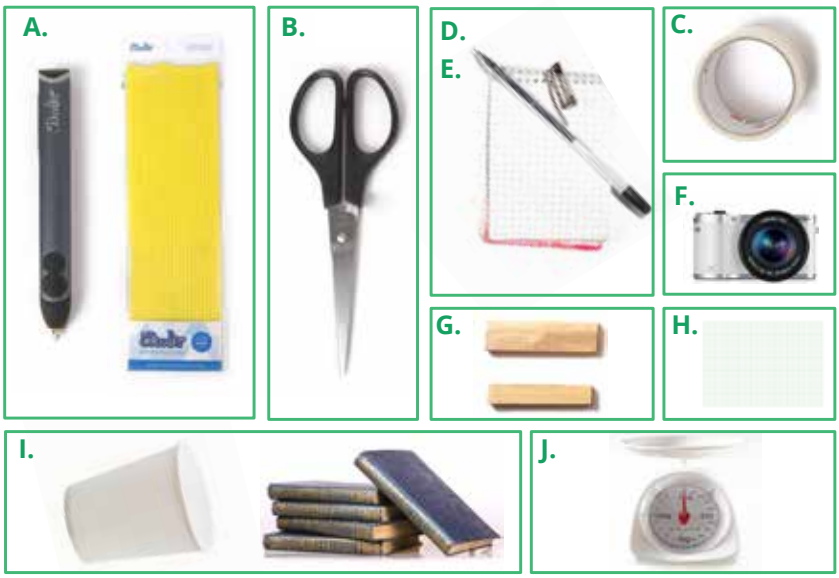

Fig.1


Fig.2

A bridge spans across gaps. Changes in technology have improved bridges from stone arches and beams to trusses and cables, but all of these types are still used today. Why would one type of bridge be preferable over another type? Which bridges can hold more weight and span longer distances?

Materials & Tools

Before You Start Doodling
We recommend using a DoodlePad or clear tape placed over paper as a foundation to keep your Doodles in place and so that you can peel them off with ease.



A. 3Doodler Pens and Plastic Strands of various colors (one per student, or have students work in pairs or small groups)
B. Tools (from your 3Doodler box) plus needle-nose pliers or scissors for snipping plastic ends
C. Clear plastic tape or DoodlePad for Doodling foundation
D. Paper for Doodling foundation and extra sketching/note-taking space
E. Drawing utensils (markers, pens or pencils)
F. Camera or video recording device to document the Challenge and results
G. Two blocks of wood, two tables or two chairs set apart
H. Graph paper for drawing out and building bridge components
I. Testing materials: string and a bucket or cup to hold coins, water, bricks or books to test the strength of the bridge
J. Scale for weighing materials

Challenge Organization

Remember to Snip Those Ends
We recommend pliers or scissors for snipping plastic ends. Make sure to keep your plastic ends clean to prevent clogs and jams. Snip plastic after removing it from the 3Doodler pen to make sure it's clean for the next time.

Challenges are organized into 50-minute periods so they can fit into a traditional classroom structure, or be combined into a single workshop with breaks in between activities. This Challenge is designed to have participants work in short sprints to quickly explore the concepts.

Class 1: Investigate, Build, Test & Design

Total time: 50 min.

Investigate (15min.)

Step 1: With your team, review the basics of beam, arch, truss and suspension bridges.

Step 2: Search on the internet for examples and investigate the following:

- What components make up these bridge types?
- From which materials are these types typically made?
- How do different bridges handle force and loads?
- What kinds of bridges are recommended to cross over short or long distances?

Step 3: Write and draw notes about your findings in the notes columns.

Facilitator's Notes
In Class 1, participants will break up into teams of 4 or 5. Access to the internet is necessary for participants to investigate the types of bridges and their engineering advantages.

Build & Test (20 min.)

Challenge Documentation
Take photos & videos of your process using a camera. Document what to do and what not to do. Share your experience with the online community using #3DoodlerEDU!

Step 1: Each team member will create an horizontal section of a beam bridge measuring 12" x 3".

Step 2: Teams will test one bridge section using two chairs placed 10" apart.

Step 3: The team will test how much weight the beam bridge can hold using a cup or bucket and coins, weights, water, stones or bricks as weights.

Step 4: Each team will record how and where the bridge failed.

Design (15 min.)

Step 1: Each team will blindly select one of the bridges types they investigated.

Step 2: With the remaining three beam bridge sections and knowledge of bridge design, teams will design a bridge to carry twice the load of the failed beam bridge tested in the previous exercise.

Consider the following questions:

- What kind of connectors are required to connect the beam bridge sections and other supports?
- Does the bridge design require both rigid and flexible components?
- How could plastic strands be used to accomplish this task?

Step 3: Teams will draw their design ideas on the paper provided and add notes about construction and determine the number of plastic strands needed to build their solution.

Class 2: Plan & Build

Total Time: 50 min.

Plan (15min.)

Facilitator's Notes
In Class 2, have participants develop their plan. Walk around the room and discuss the plans with each team.

Step 1: Teams will huddle to create their plan of attack, which should include the following:

- What tasks will need to be assigned to team members?
- How will you build the components?
- How will the components come together?

Step 2: Write down which team member will complete tasks in the notes column.

Step 3: Before the construction begins, the teams will make three assumptions about their bridge design. Write them down in the space below.

1.

2.

3.

Build Pt. 1 Components: (35min.)

Teams will begin to build the components of their assigned bridge. The bridge will need to be a total of 36 " or 100cm long and able to hold twice the weight from the failed beam bridge from Class 1. Ready. Set Doodle!

Class 3: Build (Cont'd)

Total Time: 50 min.

Build (Cont'd) (50min.)

This is another building day.

Facilitator's Notes
In Class 3, the building will continue. Walk around and ask teams about their status and how their team assignments are working out. Assist those teams who need some support or encouragement.

Step 1: Teams will complete all of the components of the bridge and start assembling. Assign new tasks to team members as needed.

Step 2: Teams should test out the bridges using a lower amount of weight to see if joints and connections need extra support.

Class 4: Present, Test & Evaluate

Total time: 50 min.

Present & Test (30min.)

Step 1: Each team will present their bridge to the group and explain the type of bridge, the qualities of the bridge and how the team constructed it. Test the bridge by starting with the failed weight from the first experiment.

Facilitator's Notes
In Class 4, participants will test their bridge to the point of failure. Have participants bring recording devices to capture the strength tests. Guide the group presentation using the questions provided.

Step 2: Now double that weight to see if your bridge meets the challenge. If the bridge is still holding strong, start adding more weight until you see the bridge begin to deflect and buckle.

- How much weight did it take before the bridge failed?

Step 3: Write your results in the notes column.

Evaluate (20min.)

Step 1: Write down how your team would improve the design of the bridge.

Step 2: Discuss what was successful and what failed about the construction of the bridge. Consider the following questions:

- How did the team work together?
- Were your assumptions correct or flawed?
- How would you change your assumptions about the bridge type now that you have completed the challenge?

More Information:

For further information and inspiration about bridge types and engineering, visit:

- http://www.historyofbridges.com/facts-about-bridges/types-of-bridges/
- https://goo.gl/LRzjPM

Images:

Cover Page: https://goo.gl/yAG5qX

Fig.1: https://upload.wikimedia.org/wikipedia/commons/1/1f/Abdoun_Bridge_%287%29.jpg

Fig. 2: https://upload.wikimedia.org/wikipedia/commons/2/2d/GirderBridge2.jpg