



Building Shapes Grades 9-12

Introduction

This is one of our favorite team building activities. Students work together using a rope to create 3-D shapes. The teacher plays the role of the skeptic and asks students to justify how they know their shape satisfies its defined characteristics. Students will need everyone in their group to successfully build these complex shapes and provide a convincing argument.

Agenda for the activity

Activity	Time	Description	Materials
Mindset Message	5 min	Play the mindset video.	Mindset Video
Open the activity	5 min	Explain the activity. Today you will work together in groups of 4 where you will build shapes using a piece of rope. Your role is to convince me, the skeptic.	
Levels of convincing	5 min	Introduce the Idea of being a skeptic: <ul style="list-style-type: none"> • Convince yourself • Convince a friend • Convince a skeptic 	
Building Shapes	30 min	<ol style="list-style-type: none"> 1. Teams build shapes with the rope and then call the teacher over when they are ready to share. 2. Discuss strategies for convincing each other. 	<ul style="list-style-type: none"> • Building Shapes Handout • 7-8 feet of masonry line, yarn or rope tied in a loop
Writing a proof (optional)	30 min	<ol style="list-style-type: none"> 1. In groups: <ul style="list-style-type: none"> • Select a shape and create a way to write your proof. • Record your proof on a poster or whiteboard. 2. Discuss the different proofs created by groups. 	<ul style="list-style-type: none"> • Poster paper or white boards • Markers or white board markers



Debrief Mindset Message	5 min	Debrief the mindset messages for this activity.	Math journal (optional)
-------------------------	-------	-------------------------------------------------	-------------------------

Activity

We let students know they are going to work together to build shapes and there are four rules to follow.

1. Everyone in the group must have at least one hand on the rope at all times.
2. You cannot untie the rope.
3. You must use all of the rope for each shape.
4. Convince the teacher that your shape is accurate.

Students may ask what order they should build the shapes. We let students decide their order.

Introduce the Skeptic framework by telling students they need to be convincing. A wonderful teacher named Cathy Humphries uses this framework¹. In mathematics we must always be convincing. The first level of convincing is when you convince yourself. The second level of convincing is when you convince a friend. The third and most challenging level is when you try to convince the skeptic.

After students complete a shape they should work through convincing each other that the shape is accurate. When they have convinced each other they should call over the skeptic for the final stage of convincing.

Today, you the teacher are going to model the role of the skeptic. When a group calls you over to confirm their shape is accurate you can begin by asking them questions like,

- What are the characteristics of the shape you built?
- How do you know it's a "_____".
- How can you prove those two segments are congruent?
- How do you know that's a right angle?
- How do you know those angles are congruent?

¹ See Cathy Humphries use this strategy in Boaler & Humphreys, 2005



When the building time is up you might want to bring up a group to model a shape. Ask the class, who wants to be a skeptic and ask the group a question about how the group knows they've created the shape. As the skeptic asks questions, do the job of recording the statements that are being said and the justification that is given. In some cases the justification may be that students move the segments towards each other to show congruence or they might use the corner of a wall or some other object to show the shape has a right angle. At this point you can choose to have a conversation about how they have been creating proofs. You can also discuss how mathematicians make a statement and justify the statement as a form of proof. Share that proofs are an integral part of mathematics because they communicate to others a convincing argument for proving a connection. Once these connections are proven we can use them again to make proofs that show other connections.

If you want to travel further into proof you can ask groups to select one of the shapes and create a proof and make a poster to share. You might choose to have students create their proofs on whiteboards. Tell them to think creatively about how to communicate the ways they convinced each other when making the shape. Remind them to include diagrams, numbering, bulleting, color-coding, arrows, circling, symbols, etc. to describe and show their strategies.

After giving groups time to create a proof, have groups trade posters (or whiteboards) and ask the other group to study the proof and share with the class something they appreciate about the proof they have studied and a question they have about the proof. After groups share you might ask students to write in their journals about their experience building the shapes and convincing someone the shapes were accurate.

Extensions

- Give a second set of shapes that teams can build if they build all on the handout (see Building Shapes Handout). These include a circle and create your own.
- We love to add the icosahedron and watch to see what happens. In groups of 4 students don't have enough hands or rope to complete this one. We like to see how students' problem solve this challenge. We have seen groups join with other groups to get more hands. We have had groups ask for a longer piece of rope/string. We celebrate their creativity and do our best to accommodate their requests for more materials. Afterwards we discuss being open to creativity and problem solving. Often we hear students say that they didn't think it was possible to think "outside the box".



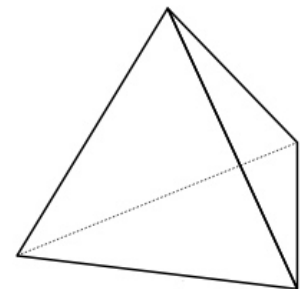
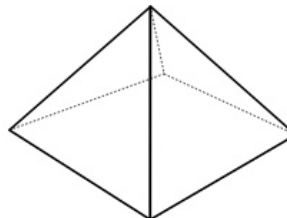
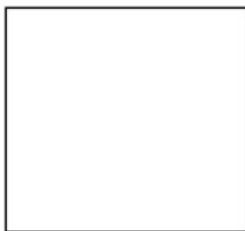
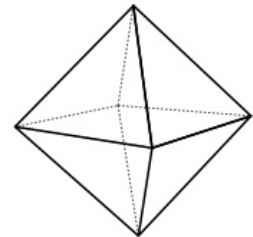
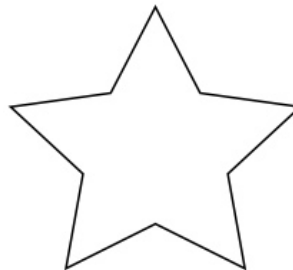
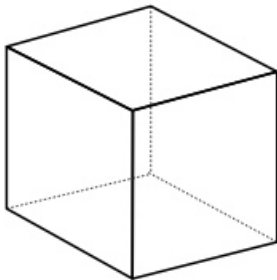
Building Shapes Handout

Each group has a 7-8 foot piece of rope that is tied securely in a loop. You will work together to make the following shapes: square, 5 pointed star, square pyramid, tetrahedron, octahedron, and cube.

Rules:

- All group members must have at least one hand on the rope.
- You cannot untie the rope
- You must use all of the rope

Groups must check in with the teacher before making the next shape. You can make the shapes in any order.





Building Shapes Extension Handout

Each group has a 7-8 foot piece of rope that is tied securely in a loop. You will work together to make the following shapes: regular pentagon, regular icosahedron or create your own.

Rules:

- All group members must have at least one hand on the rope.
- You cannot untie the rope
- You must use all of the rope

Groups must check in with the teacher before making the next shape. You can make the shapes in any order.

