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AMAZING ANCIENT STRUCTURES

Engineering with LEGO Bricks
Brain Builders Educational Programs

What is an "Amazing Ancient Structure?" These are the structures that went down in the history books and withstood time. Many of these structures you will be learning about still exist today! They are known as the architectural and engineering marvels of history.

In this class, you will learn about how these marvels were engineered and use these ancient designs to complete our class challenges! Make sure you pay attention, because some of these designs were a bit tricky.

Here are some of the "Amazing Ancient Structures" you will be learning about.

The Colosseum in Rome

The Pyramids of Giza

The Great Wall of China

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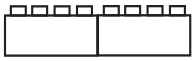
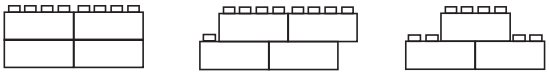
Before we learn about the complex ancient designs, we need to first learn the basic designs that were known since the first engineers.

Learning to build strong *JOINTS!*

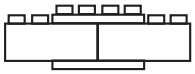
Joints are where two or more blocks meet. In a house, a joint would be where two pieces of wood meet.



You can build strong joints a couple of ways. One way is by overlapping the blocks on top of eachother. If you have ever seen a brick wall, this is how the bricks are structured. Here are some examples of weak joints and strong joints. Which joint is the strongest? Build the examples and test them out!



Sandwiching is another way to make a very strong joint. In this type of joint, you use two plates, placing one on top and one on the bottom. Just how a "sandwich" has two pieces of bread, the plates are the bread that holds everything in the middle together!



Pass out this weeks worksheets

- Pass out worksheet 1 and read through it with the students.
  - *-Interactive questions-*
  - -Has anyone ever visited any of these ancient structures?
  - -Have you heard about or seen the structures in class or on TV?

-Pass out worksheet 2 and read through it with the students.
  - -Using the actual LEGO bricks, show the students what each joint looks like.
  - -Put together a "LEGO Sandwitch" for the students to see.

Challenge 1 - Individual build

-Build a free standing wall that is at least 10 bricks tall and test it with the engineering hammer. If it falls or breaks, students must rebuild their project.

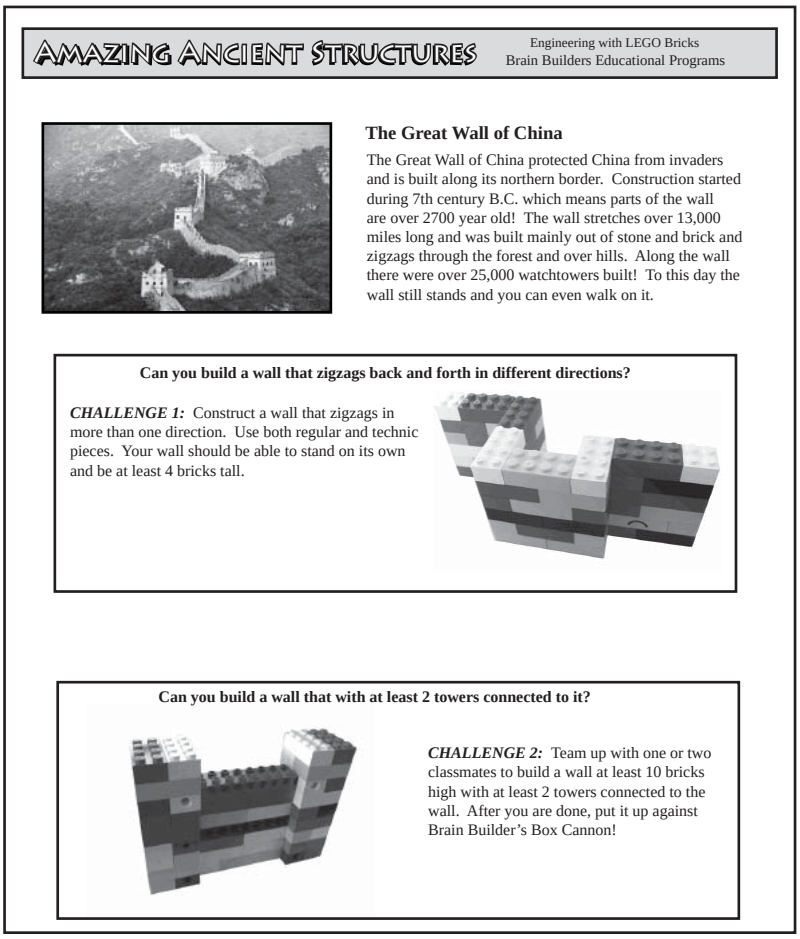
Challenge 2 - Individual build

-Build a free standing wall at least 14 bricks tall that wont fall over.
-For advanced students, see who could build the tallest structure, and they can receive a few engineering bucks at the end of the day.
-Encourage the use of technic pieces from their individual boxes.

Review last weeks lesson
-Sample Questions-
-What is a joint?
-What does a strong joint look like?
-What are different ways to make a joint strong?

Pass out this weeks worksheets
-Go over and have students read through the worksheet in class.

Extra Facts about the Great Wall
-Reportedly millions of people died putting up the wall and many were buried next to the wall. Making it the longest "cemetery" on earth.



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The Great Wall of China

The Great Wall of China protected China from invaders and is built along its northern border. Construction started during 7th century B.C. which means parts of the wall are over 2700 year old! The wall stretches over 13,000 miles long and was built mainly out of stone and brick and zigzags through the forest and over hills. Along the wall there were over 25,000 watchtowers built! To this day the wall still stands and you can even walk on it.

Can you build a wall that zigzags back and forth in different directions?

CHALLENGE 1: Construct a wall that zigzags in more than one direction. Use both regular and technic pieces. Your wall should be able to stand on its own and be at least 4 bricks tall.

Can you build a wall that with at least 2 towers connected to it?

CHALLENGE 2: Team up with one or two classmates to build a wall at least 10 bricks high with at least 2 towers connected to the wall. After you are done, put it up against Brain Builder's Box Cannon!

Challenge 1 - Individual build

Build a wall that zigzags in more than one direction and is self standing. Must be at least 4 bricks high.
-Allow students to use the extra 2x4 bricks provided
-encourage the incorporation of technic bricks in the wall
-Test its strength by hitting the wall with the wrecking ball. If it topples over or breaks, the student must rebuild.

Challenge 2 - Individual build or Team of 2 or 3 Build

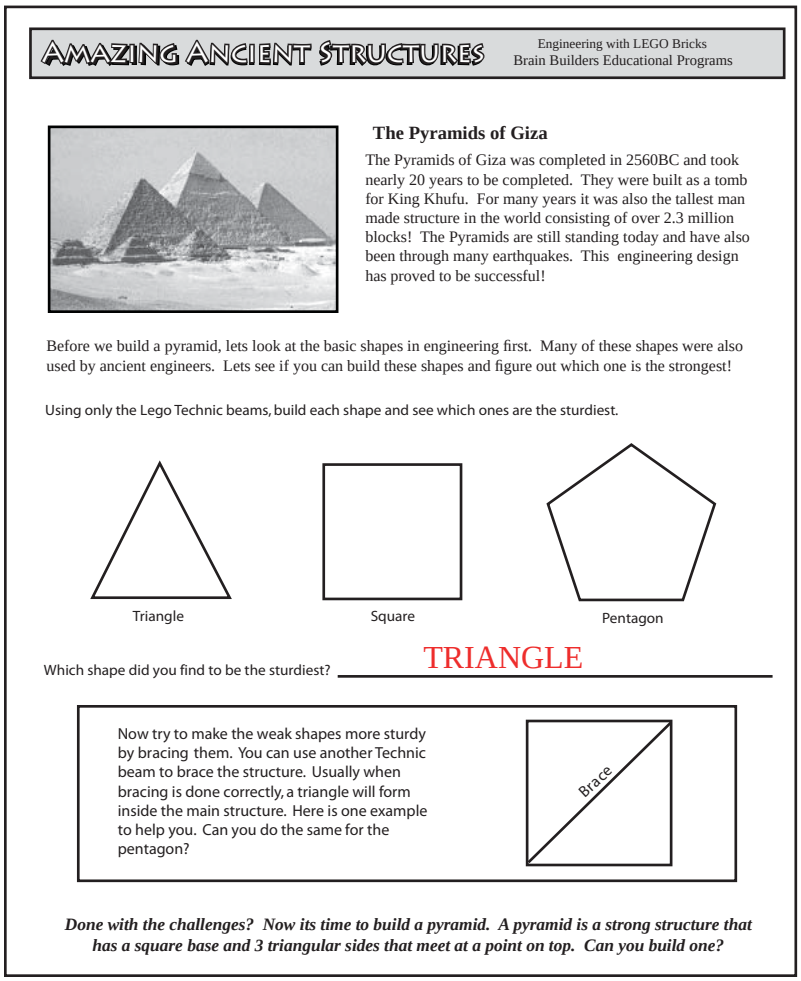
Build a wall with at least 2 towers connected to it. Wall must be at least 7 bricks high and self standing. Test it out against the wrecking ball.
- Build a wall at least one foot long.
- What team can build the longest wall. Award engineering bucks for the team that builds the longest wall.

Review last weeks lesson
-*Sample Questions*-
-Where is the Great Wall of China?
-What is a joint?

Pass out this weeks worksheets
-Go over and have students read through the worksheet in class.

Interactive Activities
-Have students identify different shapes in the class.

Construct an example for the students to follow. Show students how to use the technic bricks to build a square. This will show them that the square is weak because it will colapse on itself.



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The Pyramids of Giza

The Pyramids of Giza was completed in 2560BC and took nearly 20 years to be completed. They were built as a tomb for King Khufu. For many years it was also the tallest man made structure in the world consisting of over 2.3 million blocks! The Pyramids are still standing today and have also been through many earthquakes. This engineering design has proved to be successful!

Before we build a pyramid, lets look at the basic shapes in engineering first. Many of these shapes were also used by ancient engineers. Lets see if you can build these shapes and figure out which one is the strongest!

Using only the Lego Technic beams, build each shape and see which ones are the sturdiest.

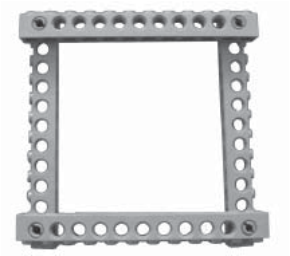
Triangle Square Pentagon

Which shape did you find to be the sturdiest? TRIANGLE

Now try to make the weak shapes more sturdy by bracing them. You can use another Technic beam to brace the structure. Usually when bracing is done correctly, a triangle will form inside the main structure. Here is one example to help you. Can you do the same for the pentagon?

Brace

Done with the challenges? Now its time to build a pyramid. A pyramid is a strong structure that has a square base and 3 triangular sides that meet at a point on top. Can you build one?



This is how the square should look like. It is connected with pins at the corners. If you shake the square it will colapse.

Challenge 1 - Individual build

-Construct each shape on the worksheet and answer the question on the worksheet. The students will be constructing the shapes out of the technic pieces.

-Now make the weak shapes stronger by bracing.
-emphasize to the students that they need to build triangles inside the main shape to make it sturdy.

Challenge 2 - Team Build

-Have students build a pyramid to see if it is a strong structure or not. Students can use any of their pieces and may team up.

Review last weeks lesson
-Sample Questions-
-What are strong shapes?
-What is bracing?
-What is sadwitching a joint?

Building and testing day
-Students will be building any strong structure and putting it up to the test against the box cannon.
-Who's ever structure survives the most pumps will receive a LEGO Minifigure.

NO WORKSHEET THIS WEEK

Using the Box Cannon

-For safety reasons, no student is to touch or play with the cannon. Teacher use only! Make sure they know that it will be an automatic strike 2 if they play with the cannon.

-Make an "X" on the ground, with tape supplied, where the students will be placing their projects.

-Setup the cannon at least 5-6 feet away from the project.

-Make sure students watch from behind the cannon.

Challenge 1 - Individual build or team build

-Engineer a structure at least 10 bricks tall that can withstand 3 pumps of the box cannon.
-project cannot fall over or break.
-project can be as wide or deep as they want.

Challenge 2 - Individual or Team Build

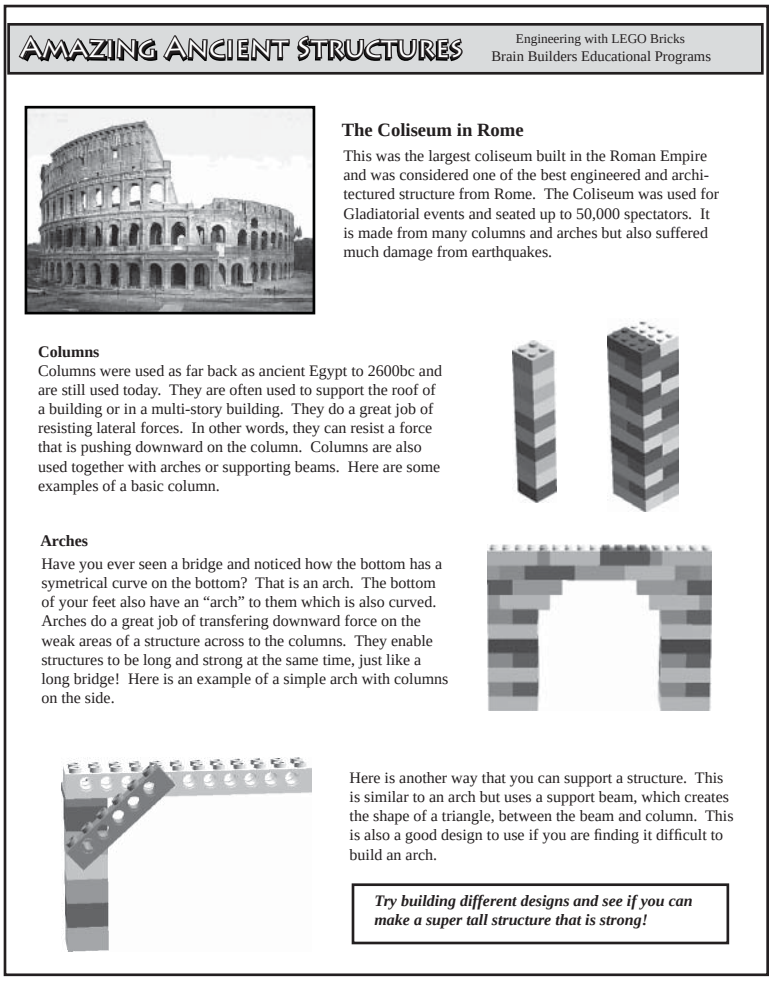
-Increase the number of pumps 1 at a time to see whose structure can survive the most amount of pumps.

-Award the strongest structure team/individual with a LEGO Minifigure.

Review last weeks lesson
-Sample Questions-
-What are strong shapes?
-Is a pyramid strong?
-What is sadwitching a joint?

Fun Facts
- The Coliseum still stands today and can be seen.

- The Coliseum doesn't only have damage from earthquakes but also by stone robbers!



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The Coliseum in Rome

This was the largest coliseum built in the Roman Empire and was considered one of the best engineered and architectured structure from Rome. The Coliseum was used for Gladiatorial events and seated up to 50,000 spectators. It is made from many columns and arches but also suffered much damage from earthquakes.

Columns

Columns were used as far back as ancient Egypt to 2600bc and are still used today. They are often used to support the roof of a building or in a multi-story building. They do a great job of resisting lateral forces. In other words, they can resist a force that is pushing downward on the column. Columns are also used together with arches or supporting beams. Here are some examples of a basic column.

Arches

Have you ever seen a bridge and noticed how the bottom has a symetrical curve on the bottom? That is an arch. The bottom of your feet also have an "arch" to them which is also curved. Arches do a great job of transfering downward force on the weak areas of a structure across to the columns. They enable structures to be long and strong at the same time, just like a long bridge! Here is an example of a simple arch with columns on the side.

Here is another way that you can support a structure. This is similar to an arch but uses a support beam, which creates the shape of a triangle, between the beam and column. This is also a good design to use if you are finding it difficult to build an arch.

Try building different designs and see if you can make a super tall structure that is strong!

Have students build on a platform. This will help the stability of their structures.

You may also pass out extra 2x2 bricks for the teams to use.

Challenge 1 - Team Build

-Engineer a structure at least 15 bricks tall that can support the weight of a heavy book.
-Must have columns

Challenge 2 - Team Build

-See which team can build the tallest structure that can support the weight of the book.
-Award that team with builder bucks!

Review last weeks lesson
-Sample Questions-
-What are strong shapes?
-Is a pyramid strong?
-What is sadwitching a joint?
-What was the Great Wall of China?
-What are the engineering structures used to build the Coliseum?

Experimentation day:
Students will get a chance to experiment with different designs and put it up against the earthquake simulator. They will be finalizing the designs for the final challenge happening next week.

Explain the last day challenge:
Who can build the tallest structure that will survive on the earthquake simulator for at least 5 seconds

There will be a medal awarded on the final day for the teams with the strongest structure and one for the tallest structure.

NO WORKSHEET

Earthquake simulator - teams of 2
- Which team can build the tallest structure that can survive at least 5 seconds on the simulator

If there is a tie, the medal will be awarded to the team that also has the best sportsmanship, teamwork and design.

Main Competition for Medals.
Same challenge as week 6.

NO WORKSHEET