Teacher Materials

How is the Q'eswachaka an example of innovation?

Lesson Components

The Q'eswachaka Bridge

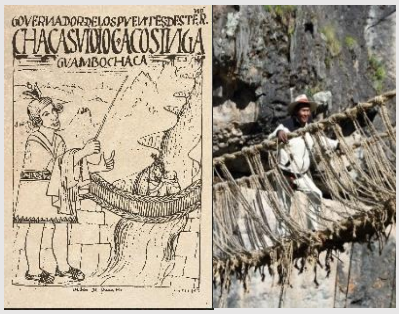
Image	Description
	"Weaving the Bridge at Q'eswachaka" video: Short documentary on the Q'eswachaka annual construction process by Quechua communities in Huinchiri, Cusco Region, Peru.

Engineering Activities that Demonstrate Inka Innovation
Activity 1: Explore Tension and Compression

Image	Description
	Explore and experience the two types of forces used to construct bridges—tension and compression.
"Quotes"	Read and analyze quotes and paraphrased quotes on Inka engineering innovation from a Quechua bridge master, Spanish chroniclers, and a professor of engineering at the Massachusetts Institute of Technology (MIT), a university known for its excellence in technology and innovation, to better understand differences between tension and compression forces.

	Explore tensile strength by watching an animation.

Activity 2: Be a Bridge Maker

Image	Description
	Create a plank bridge and modify it to become a suspension bridge, experimenting with bridge loads to see which design is stronger.
"Quotes"	Read and analyze quotes and paraphrased quotes on Inka engineering innovation from a Quechua bridge master, Spanish chroniclers, and a professor of engineering at the Massachusetts Institute of Technology (MIT), a university known for its excellence in technology and innovation, to better understand differences between tension and compression forces.
	Look at two images to reflect on the role of Victoriano Arizapana and compare it to the Guaman Poma de Ayala lithograph of the *Chakacamayuc*, or bridge master of Inka times.

How is the Q'eswachaka an example of innovation?

Student Worksheet

- ***Building the Q'eswachaka***

Connection to the Compelling Question

- Why are the Q'eswachaka and other suspension bridges built during the time of the Inka Empire important components of the Inka road system? How can a grass bridge be an example of innovation and sustainability?

Ideas

- **Engineering Activities that Demonstrate Inka Innovation—Explore Tension and Compression and Be a Bridge Maker:** Students explore a video, an interactive, images, and quotes to understand how the Q'eswachaka is a unique and innovative component of the Inka road system.
- The hands-on activities serve to illustrate important engineering principles used by the Inka. Activity 1, "Explore Tension and Compression," is best done in student pairs. Activity 2, "Be a Bridge Maker," is more suited for small groups.

Suggested Lesson Procedure

Hook

- Show the "The Bridge at Q'eswachaka" video.
- Ask the students to identify and record the bridge construction steps in Part A of the *Building the Q'eswachaka* worksheet.

Engineering Activities that Demonstrate Inka Innovation

- Working in pairs, students explore tension and compression forces and use the tensile strength animation to understand how blades of grass can be made into a strong bridge. Students work in small groups to do the hands-on "Be a Bridge Maker" activity.
- Part B of the worksheet *Building the Q'eswachaka* is a tool for helping students synthesize the big ideas of Inka bridge-building innovation in the context of the Inka road system.
- The three-page *Instructions for Hands-On Activities* guides the students through hands-on exercises to help them understand key bridge-building engineering concepts. As students do the activities, take time to check for understanding of key content and concepts.
  - Explore Tension and Compression

Suggested Lesson Procedure

  - Tension is a pulling force and compression is a pushing force.
  - In suspension bridges, including Q'eswachaka, cables work through tension, or the stress resulting from a pulling force.
  - The tensile strength of the grass cables is how much they can be pulled from opposite directions before they break.
  - The tensile strength of a grass rope depends on the type of grass, how much grass is used to make it, and how it is twisted and braided together with other ropes.
  - The largest cable of the Q'eswachaka is as thick as a man's thigh and can hold 5,175 pounds, or 2,347 kilograms. This is more than the weight of an average automobile or the combined weight of twelve llamas.
- Be a Bridge Maker
  - As students design and test a simple plank bridge, ask: What forces are primarily at play in this type of bridge, compression or tension?
  - Once the students design a suspension bridge, ask: What forces are primarily at play in this type of bridge, compression or tension? Where are the forces felt as you add more books? How is this bridge similar and how is it different from Q'eswachaka?
  - The Q'eswachaka suspension grass bridge is an example of innovative Inka engineering. The Inka designed suspension bridges using tension forces in contrast with the compression forces used in European arch bridges at the time.
  - The Q'eswachaka, the only remaining bridge of its kind, is part of approximately six percent of the original Inka road system that is still used and maintained by indigenous Andean people.

Contemporary Connections

The quotes included can serve as a springboard for student discussion. They offer insights on Inka engineering innovation from an engineering professor and perspectives on cultural connections from an Inka bridge master.

Wrap Up

Pose a question to the students: "How can people use innovation to tackle difficult problems and find solutions to challenging situations?" Ask for examples from their own experiences.

Next: *Students apply what they learned about the engineering innovations of the Inka road system, and the Q'eswachaka as an integral and unique component of the system, to answer the compelling question, "How can a road system be an example of innovation?"*