Rope Bridge
Episode 2: Bridge designs

Introduction

In the Rope Bridge unit, students take on the role of intern engineers for a company which is commissioned to build various types of bridges around Kazakhstan. From the news, there is a broken bridge, which was built in the era of the Soviet Union and has been used for crossing the Kigash river between Kotyaevka village of Kurmangazy district, Atyrau region, Kazakhstan and Koshelevka village of Krasnoyarsk district, Astrakhan region, Russia. The company aims to involve the local people in the design of the bridge so you have been asked to explain the science behind the various possible bridges in a way that non-scientists can understand.

In this unit, students learn about the factors causing damage to the bridge, forces and resultant forces acting on an object, how to calculate a resultant force, Newton’s First Law of Motion and the size of gravitational forces acting on an object.

Episode 2, Bridge designs, takes one hour. Students look at the forces acting on a bridge through investigative work and then use their insights to develop a design for a suitable bridge for the village.

Key words

Force, Force acting on an object, gravity, weight, balanced forces.

Learning Objectives

Students will:
- Map the forces acting on a rope bridge.
- Investigate the effects of tower height and number of rope supports on bridge strength.
- Choose a design for a rope bridge.

Learning Activities 110 min

Engage 20 min
Introduce students to the context and ask them to develop criteria for a good river crossing for the local people.
Slides 1-2 Introduce the unit and explain the objectives for this episode to the students.

Slides 3 - 4 The chief engineer welcomes the students back and introduces the next issue - which design should they use for their rope bridge? Talk through some of the design options shown on slide 4 and emphasise that these are only initial ideas - students should feel free to produce some of their own. The graphics are hand drawn to reinforce the idea that this is really an opportunity to ‘think on paper’ rather than produce a detailed blueprint.

Explore 30 min
Students investigate some of the factors that will affect the strength of the bridge to come up with a cost-effective design.

Slides 5 - 6 In groups, students should investigate the possible designs for the bridge. Allow them to design their own investigation but be prepared to offer support - they might need reminding about the best way to use a spring balance, for example. Most students will come up with a workable design provided they have a clear hypothesis to test at the outset so spend time making sure they are clear about what they are trying to find out before they begin. The suggestions below might be helpful to some students:

- Use a spring balance to look at the force between the rope and the walkway in different parts of the rope support.
- Use towers of different height to attach the support ropes and see which can carry the greatest load without sagging.
- Compare bridges with vertical ropes coming down from a main support rope to the walkway with bridges where each walkway support is attached to the tower.

Explain 20 min
Students present their experimental methods and findings as a poster.

Slide 7 Students should present their investigations as posters. Ensure that they include a description of their method and the data produced on the poster. Ask them to add notes to explain why they are sure that their investigation is fair and that it produced reliable data. Each poster should also include a sentence or two explaining what their data means.

Allow students to put their posters up in the classroom so that everyone can see all of them. Then take time to review them drawing out useful insights as appropriate from each poster.
Elaborate  
30 min
Students apply the results from their investigations and their growing understanding of the forces acting on a bridge to explain the choices made by two bridge designers.

Slides 8 - 10  Ask students to explain the design choices made by the engineers and architects who produced the designs for the Atyrau bridge in Astana and rope bridge across the river. Draw out ideas about the weight the platform has to carry and the cost of construction.

Evaluate  
10 min
Students produce outline designs for their bridges.

Slide 11  Students should now produce the outline design for their bridge. Ask them to draw on their understanding of the way the forces will act and any ideas they have got from pictures of bridges they have seen in the presentations.

Assessment and differentiation

Formative assessment
Take the opportunity to assess the students during questioning and whilst facilitating through questioning and observation when the students are completing the investigation and while they apply their insights into bridge design.

Differentiation
Some students will produce simpler investigations in the explore stage. This is acceptable but try to encourage all the class to opt for investigations that use quantitative rather than simply qualitative variables.

Preparing for the Lesson

RESOURCES USED

EQUIPMENT REQUIRED

Engage
None

Explore
The equipment will vary according to the practical investigations designed by the students but these are likely to require
Spring balances (up to 2 per group)
Assorted string or thin yarn
Assorted weights
Short lengths of wood to act as towers for the bridges

Explain
None

Elaborate

Evaluate