

MODULE 2: MOTORWAY BRIDGE CHALLENGE - TEACHERS' NOTES

In this activity students will use their maths, problem solving and teamwork skills to plan the construction of a road bridge across a motorway. Students will decide on the construction site and type of bridge, considering the environmental impact, cost and time to construct each option.

Learning objectives

Students will learn to:

- Describe how working mathematically is used in civil engineering to make decisions and solve problems;
- Understand the role that Project Managers play in planning civil engineering and construction projects.

Curriculum links

These objectives apply to and link to the following areas of the KS3 Maths 2013 programme of study:

Students should be taught to:

- Develop their mathematical knowledge, in part through solving problems and evaluating the outcomes, including multi-step problems;
- Develop their use of formal mathematical knowledge to interpret and solve problems, including in financial mathematics.

In addition, these objectives apply to and link to the following areas of the KS3 Design and technology 2013 programme of study:

Students should be taught to:

- Understand developments in design and technology, its impact on individuals, society and the environment, and the responsibilities of designers, engineers and technologists.

Skills Builder Essential Skills

In this activity students will use problem solving and teamwork steps 6-10.

See the Skills Builder framework(www.skillsbuilder.org/universal-framework/listening) for more explanation.

Inventory

For a class of 30 students you will need:

- 30 x Motorway Bridge Challenge Worksheets
- 1 x Motorway Bridge Challenge Teachers Notes
- 1 x Motorway Bridge Challenge Presentation
- Calculators (class set)
- Scrap paper for working out.

Preparation

Review the Motorway Bridge Challenge Presentation and presenter's notes. Decide how you will deliver the activities and adjust the timings below to suit your lesson length. This example lesson is based on a 60-minute session with a mixed ability Year 8 class.

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Sequence

Use the following sequence to plan this activity. You may wish to adjust the timings according to your style of delivery, group and workshop length.

Time (min)	Sequence	Instructions	Slides
5	Welcome 	Introduce yourself, the HS2 project, and the learning objectives for the lesson.	1
5	Motorway Bridge Challenge 	Introduce the themes and aim of the lesson, as well as the role of Project Manager. Put your students into groups of three and hand out the scrap paper.	2-4
5	Challenge 1: Choose a site 	Introduce Challenge 1, where students must choose a site for their bridge. Students should work together on their answer in their teams. Feedback answers from the class. Challenge students to justify their choices.	5
40	Challenge 2: Choose a bridge 	Using the slide, explain to students the aims and expected outcome of Challenge 2. Explain to students that they have a time limit. Five minutes before the end, stop the students and ask the students to feedback their answers and methods.	6
5	Plenary 	<p>Show the students the real life example of the A446 Bridge was built. Then, Use the plenary questions to recap the students learning.</p> <p>These questions refer to the learning objectives from the beginning of the lesson, and to the essential skill of problem solving and teamwork.</p>	7-8

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Questions

Use these questions to stimulate the students' learning during the activity:

- Why is working mathematically important to Project Managers?
- Why is working mathematically important on a civil engineering project?
- How can you organise yourselves as a team to complete this activity more quickly?
- Why is it important to consider the environmental impact of a project?
- What is more important: the cost or environmental impact of the bridge?
- Who can tell me an example of good teamwork?
- Who can tell me an example of good problem solving?
- What other factors would you need to consider if you were building a bridge in real life?

Tips and tricks

- Organisation is key to students completing Challenges 1 and 2 successfully and on time. Encourage students to split up the workload in Challenge 2. One student could be the Senior Project Manager, responsible for the whole groups' delivery.
- To make the activity harder, students could work individually rather than in a group.
- To make the activity easier, you could work through each of the calculations that students will have to complete as part of Challenge 2 on the whiteboard.
- To make this activity more student-led, combine Challenges 1 and 2. Set the overall challenge and then leave the students to it. Everything that the students need is on their sheet.
- Make Challenge 2 competitive. There could be a prize for the first group to finish.

Video content

You may wish to show these videos to compliment the learning from this activity.

- Animation and interview explaining plans to improve road network around Interchange Station:
<https://youtu.be/09j5UYftfSs>
- Footage of an actual bridge move and discussion of advantages of this building technique:
<https://youtu.be/bzfyH5IXkVE>
- Colleagues working on the bridge move talk about their career paths:
<https://youtu.be/5UJltj-7mFU>

As the HS2 project develops new videos are regularly added to our You Tube channel. There may be more detailed information about your local area, or new videos uploaded since this resource was made. Check out our You Tube channel for the latest updates:

<https://www.youtube.com/user/HS2ltd/videos>

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Answers

Challenge 1

- a) Site 1: 51,500 Site 2: 55,800 Site 3: 54,443
- b) Site 1 has the lowest ecological value, as half of the site is mainly a car park with old industrial buildings

Challenge 2

a)

Steel beam type	Length (m)	Quantity	Cost (£)	Time (Days)	CO ₂ (t)
A	15	12	£45,000	18	268.47
B	20	4	£20,000	6	117.75
C	10	2	£5,000	1.5	4.239
D	20	2	£10,000	1.5	8.007
E	10	7	£17,500	7	8.2425
F	20	7	£35,000	7	14.8365
G	16	8	£32,000	8	15.072
H	22	4	£22,000	4	10.362
I	16	6	£24,000	6	11.304
Total:			£210,500	59	458.283

b)

Type of Concrete Slab	Length	Quantity	Cost (£)	Time (Days)	CO ₂ (tCO ₂ eq)
L-Shaped Wall A	3	30	£150,000	11.25	64.96
L-Shaped Wall B	2	20	£60,000	7.5	28.87
Deck Slab	7	54	£648,000	3.375	245.56
Total:			£858,000	22.125	339.39

c)

Bridge Type	Materials Cost (£)	Crane Hire (Days of hire x Cost per day)			Operative Cost (Days of hire x Cost per day)			Cost of Running Site (Days of hire x Cost per day)			Total
		Days of hire	Cost per day (£)	Total (£)	Days of hire	Cost per day	Total (£)	Days of hire	Cost per day (£)	Total (£)	
Steel truss	£210,500	59	£10,000	£590,000	59	£3,500	£206,500	59	£5,000	£295,000	£1,302,000.00
Concrete slab	£858,000	22.125	£10,000	£221,250	21.250	£3,500	£74,375	22.125	£5,000	£295,000	£1,267,312.50

- d) Students should provide a reasoned argument that compares both bridge options, taking into account:
- Materials and construction costs;
 - The time to build;
 - The environmental impact.