Lesson 31

engineering

Spanning a gap: beams, arches and triangles

Lesson at a glance

Open with photos of a flat deck bridge and an Irish stone arch and take quick shape predictions. Groups bridge the same 15 cm gap three ways with equal card strips—flat beam, arch, and braced beam with triangle braces—fixing both ends with sticky tape. They stack 1c coins in the middle until each span fails, then record type, coin count and failure point in the Investigation Journal. You pool one clear set of numbers on the data-recorder interactive into a bar chart, then groups make one improvement to their weakest span and re-test.

Learning objectives

- Compare a flat beam, an arch and a braced beam for load carried across the same gap
- Keep a span test fair by fixing both ends the same way and using equal materials
- Make one change to the weakest span and measure whether it holds more coins

Before the bell — prep

Cut equal card strips (~20 cm) the day before. Pre-fold spare triangle braces per table. Set two same-size books 15 cm apart per group. Put sticky tape and a tub of 1c coins at each table; keep a shared reserve of extra 1c coins or identical washers for strong spans.

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Materials

Item	Qty	Per	Source	Low-cost substitute
equal card strips (about 20 cm long)	8	group	classroom	strips cut from cereal boxes
sticky tape	1	group	classroom	masking tape
same-size hardback books for supports	2	group	classroom	two identical wooden blocks or sturdy boxes of equal height
1c coins	40	group	classroom	identical metal washers or identical counters of the same mass
30 cm ruler	1	group	classroom	a marked 15 cm strip of card as a gap gauge
pre-folded card triangle braces (scaffold set)	2	group	classroom	plain card scraps groups fold themselves
Investigation Journal page	1	pupil	provided printable	plain paper with headings span type, coins held, where it failed

Safety watch-point

Load low and slowly in the middle; hands clear as a span collapses; keep 1c coins on the desk, not on the floor.

Teaching moves

- **Getting Started:** Show a flat footbridge and an arched stone bridge on the IWB. Take three or four predictions with reasons, but do not reveal which shape is stronger. Key question: if the gap and material stay the same, does shape still matter? Keep card in the box until talking is done.
- **Three ways to span a gap:** Write only Beam, Arch and Braced beam on the board with one image cue each. Live-model one flat strip across 15 cm, tape both ends the same way, and add one or two 1c coins so the middle sags—no full failure test yet. Ask what must stay the same so you are testing shape, not slipping.
- **Build three spans:** Circulate and check gap still ~15 cm, both ends taped on every span, and braces really triangles (point down, both sides touching). If an arch flattens before loading, re-form a deeper curve and re-fix the feet firmly.
- **Load until they fail:** Assign three jobs per group: counter, stacker, failure-watcher. Coins one at a time in the middle only. Stop after each failure and have them write span type, coins held and where it failed before the next span. Re-tape and re-run any trial that slipped off weak tape.
- **Record and chart:** Drive the data-recorder yourself on the IWB in explore mode—columns Span type and Coins held. Enter Beam, Arch, Braced beam from one clear group or a class middle value, then show the bar chart. Ask which shape held most and whether every group got the same rank order.
- **One change, then re-test:** Hold groups to one improvement only on the weakest span: add a brace, fix a foot more firmly, or deepen the arch. They rebuild or repair, re-test once, and say aloud: Our one change was... The coins went from ... to ... Celebrate gains and flat or lower counts alike as useful evidence.

What it should show

Expect the flat beam to fail first by sagging or folding in the middle; the arch often fails by feet spreading or tape peeling at the ends; the braced beam usually holds longest until a joint peels or a brace folds. Exact coin counts vary with card thickness—compare rank order, not a magic number. An arch that beats a braced beam often had a shallow curve or a brace that was not a real triangle under the middle.

Misconceptions & interventions

- **Thicker material is the only way to make a span stronger.** — Point back to the equal card strips: same material, same gap—only shape changed. Ask which shape held most on their chart and why the middle of the flat beam sagged first.
- **If the arch slips or spreads, the shape is weak rather than the feet being free to slide.** — Re-voice the fair-test rule: ends fixed the same way on every span. Re-tape the arch feet firmly, re-run that span only, and compare the new count.
- **Changing two things at once (deeper arch plus extra tape) still proves what worked.** — Stop the group and name one change only. Rebuild, re-test once, and compare the single new coin count with the first result.

Differentiation

Emerging	Developing	Proficient
• Offer a pre-folded triangle brace and have the group build beam and arch first, then add bracing with teacher-table support. • Simplify recording to span type and coins held; teacher scribes the failure point if needed.	• After the first three tests, prompt: why did that span fail there? Link failure point to shape. • Re-check gap and end-fixing before the one-change re-test so the new count is fair.	• Try two triangle braces under the beam and compare with the single-brace count. • Critique another group's trial: was the load in the middle and were both ends fixed the same way?

Cross-curricular hook

Tie to Maths Data—bar-chart the coin counts and read which span was the mode top rank across groups.