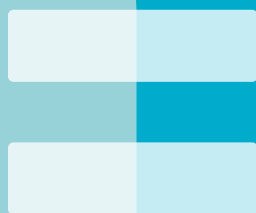




curious
minds
Discover STEM



Classroom Resource



Design a bridge



Design Challenge

Design a bridge

Class Level – All

Curriculum Links

Strand:	Materials
Strand Unit:	Properties and characteristics of materials
Curriculum Objectives:	Observe and investigate a range of familiar materials in the immediate environment; Investigate materials for different properties; Investigate how materials may be used in construction
Skills Development:	Questioning, observing, estimating and measuring. Designing and making: exploring, planning, making, evaluating
New words / vocabulary:	Bridge, Span, Forces, Engineer, Collapse, Corrugated, Compression, Tension
Focail nua:	Droichead (bridge), Innealtóir (engineer)
Cross curricular links:	Maths: Shape and space, measures, weights; History: explore features of local environment, technological developments over time; Geography: human environments, features of the built environment; Visual arts: making constructions, make drawings from observations to analyse the structures of buildings, looking and responding to collections or photographs of built structures
Equipment / materials	Paper, rulers, books or boxes and a selection of recycled materials or natural objects. Materials to be used will be identified by the learners during the planning process. This activity can be conducted outdoors, remember to leave nothing behind and take nothing away! Materials could include: • Natural materials (such as sticks, stones, pebbles that can be found in the local environment). • Recycled materials (such as egg cartons, cardboard, plastic bottles etc.) • Reusable materials such as Lego, K'Nex or other construction toys.



Engage

Trigger questions:

Visit a bridge from the local area or look at pictures of bridges from Ireland and from around the world; use a story such as the Billy Goats Gruff; use a scenario such as the need to create a wildlife bridge over a new motorway to allow animals to cross safely.

- What is a bridge?
- Where would you find bridges?
- What types of materials are bridges made from?
- What makes a good bridge?
- What types of bridges are there? Can you name any?
- Do you know of any famous bridges around the world? What type of bridges are they?
- Are there any bridges near where you live or go to school?
- What shapes are used in bridge construction?

Background information:

Bridges are structures built over railroad tracks, roads, rivers or some other obstacle. They allow people or vehicles to cross from one side to another. Bridges must be built strong enough to safely support their own weight as well as the weight of the people and vehicles that pass over.

Even though bridges are standing still their parts are always pulling and pushing on each other. Structures remain standing because some parts are being pulled or stretched and other parts are being pushed or squashed. These forces are present in all bridges, and it is the job of engineers to design bridges capable of withstanding these forces without bending or breaking.

The material from which a structure is made is important, but you can strengthen a material by changing its shape. Bridge designers often use different shapes, e.g., arches and triangles. The curve of the arch bridge spreads the load on the bridge and makes it stronger. A shape which is weak in one direction may be stronger in another.

Real-world application:

The type of materials and the design of different bridges depend on their use. A bridge that needs to carry lots of cars or trains will need to be larger and stronger than a pedestrian bridge. Bridges may also be designed to suit their surroundings.



Investigation: Testing different shapes of bridges for strength

Using sheets of A4 paper or other paper cut to the same size, encourage learners to test different shapes of bridges for strength.

Starter question:

- Does the design of the bridge affect its strength? Discuss with the class how they might test the strength of a paper bridge.
- Each group decides on the width of their 'river' and arranges books or boxes on the table to represent the riverbanks. A span of approximately 14cm works well for A4 paper.

Predicting:

The group makes a variety of bridges using the available paper. The paper can be cut or folded in whatever way they wish but to ensure fair testing each bridge must use the same amount of paper (1 or 2 sheets). They then predict which bridges will support the greatest weight by ordering them from best to worst, giving reasons for their choices. They should record their predictions in some way.

Conducting the investigation:

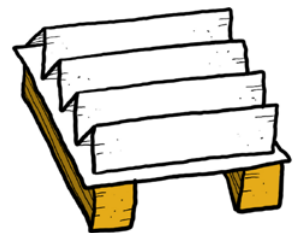
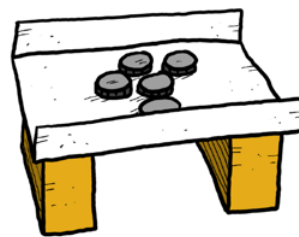
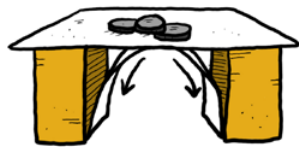
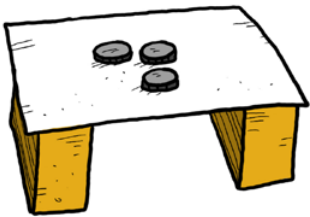
The group tests each bridge in turn by placing coins or other weights on it until it collapses and records their results.

Sharing data / results

Each group shares their results with the class highlighting what went well with the investigation and what they learned from it. They can discuss what shapes gave the greatest strength to their bridge, and whether their results matched the initial predictions.

Explore

Research different types of bridges – beam bridges, truss bridges, arch bridges and suspension bridges. Discuss the design and purpose of these bridges. Think about the materials used. If possible, visit a bridge close to the school to look at the design.



Some possible bridge designs are shown here but learners should be encouraged to try their own designs.

Design Challenge: Design and make a bridge

Plan

- As a class discuss how the bridges will be made. Can we apply what we learned when testing the paper bridge designs? The teacher could introduce the project using a story or scenario so that each bridge is fulfilling the same purpose, or individual groups could decide on the purpose for their bridge.
- Learners should decide on the type of bridge they are making and its purpose. It could be a traffic or pedestrian bridge over a river or over a road or could have some other purpose.
- Learners should set criteria for their bridge such as the size and scale and decide how they will evaluate it. For instance, it might need to be suitable for two toy cars to travel on it in opposite directions and for a boat to pass underneath. They might consider how much weight the bridge needs to take, how it will connect with the road / path on either side; if it needs to lift to allow larger boats to pass underneath and if there is room for a river to flow underneath.
- Learners should discuss the materials they will use for their design and draw a plan. Recycled materials could be supplied or collected at home.
- Plans could be drawn on paper or ICT tools such as MS Paint, Minecraft or Solidworks could be used to plan designs.



Make

- Learners could work in groups during school time or individually at home to complete their bridges. Alternatively, planning could be done in school followed by time to gather materials and bridges could be made on a later date.
- This would be an ideal project for outdoor learning where learners could mark a river on the ground or gather natural materials such as sticks, stones, fallen bark, leaves or grasses to complete their bridges. If building in a location away from the school grounds, bridges should be dismantled after building to avoid disturbance to the natural environment and any man-made materials should be taken away after testing.

Evaluate

Learners can evaluate their bridges based on their chosen criteria. Questions for consideration might include:

- Was the bridge strong enough to carry the chosen load?
- Was it high enough / was there enough space between supports to allow traffic or boats to travel underneath?
- What materials were used in each of the bridge designs?
- Did your completed bridge follow the initial plan, or did you need to alter the design?
- Did you encounter any problems? How did you overcome them?
- How would you improve your bridge design?
- What was your favourite part of this design challenge and why?
- What have you learned from the process?

Take the Next Step

Adapt for home:

This activity can be easily adapted, using materials that are readily available in the home.

Adapt for junior/senior level:

This can work at any level if learners work to their own ability. The paper bridge investigation could be used as an activity on its own to shorten the lesson or combined with building with Lego or construction toys. For junior classes it could be incorporated with Aistear and for senior classes it could be expanded to include written or ICT research projects on bridges or design using ICT programmes.

Follow-up challenge/project/citizen science link:

- Look at the history of bridge design. Which aspects of design have changed and which have remained the same?
- Research different uses of bridges: aqueducts for carrying water; viaducts for railways, roads, pedestrians and even canals; unusual bridges such as rope bridges, floating pontoon bridges or ziplines.
- Look at the use of bridges for farm animals where farms are split by road developments.
- Research the use of wildlife bridges for allowing wild animals to travel safely over roads to access habitats.
- Consider the impacts of climate change and land use changes on bridges. Research cases where bridges have been swept away by excess flooding on rivers.
- Research unusual building designs that incorporate triangles e.g., geodesic domes or A-frame houses.

