curious minds
Discover STEM

Classroom Resource

Amazing Triangles

Science Foundation Ireland sfi For what's next

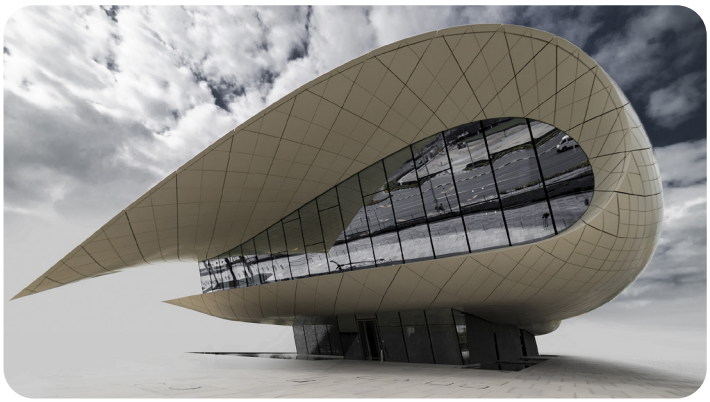
Design Challenge

Amazing Triangles – Investigate how materials may be used in construction

Class Level - All

Curriculum Links

Strand:	Materials, Energy and Forces
Strand Unit:	Properties and characteristics of materials
Curriculum Objectives:	Investigate how materials may be used in construction; Appreciate the application of science and technology in familiar contexts; Explore how the shape of objects can be changed by squashing, pulling and other forces; Identify some ways in which science and technology contribute positively to society
Skills Development:	Questioning, Observing, Estimating And Measuring, Designing And Making: Exploring, Planning, Making, Evaluating
New words / vocabulary:	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	• Cocktail sticks, bamboo skewers or spaghetti • Mini marshmallows or other soft sweets



Engage

Trigger questions:

- What shapes are used in construction?
- Can you pick out any shapes in this room?
- If you look at a bicycle, can you pick out any shapes?
- What shapes help the bicycle move? (circles for wheels)
- What shapes can you see in the frame? (triangles) What is their purpose?
- Are there any shapes that are stronger than others for use in construction?

Background information:

The triangle is a strong shape and is used to support structures. Under a heavy load, a square distorts easily – it ends up looking like a parallelogram. If you put a brace diagonally across a square, you create two triangles and a much stronger shape. The triangle cannot be deformed under force without changing the length of one of its sides (assuming the sides are rigid). Because it is not easily deformed, the triangle is an extremely popular shape for use in construction.

Real-world application:

Triangles can be found in many buildings and other constructions. The pitched roof of a house has a triangle shape in profile. Triangles are very often used in the construction of bridges, especially truss bridges, as they help to distribute forces evenly across the bridge. Adding struts or trusses to a construction will strengthen it. Geodesic domes are hemispherical structures with a frame made of triangles. Because of the way the triangles distribute forces evenly across the structure, geodesic domes are very strong.

Design Challenge: Make a 3D Structure Using Marshmallows and Cocktail Sticks

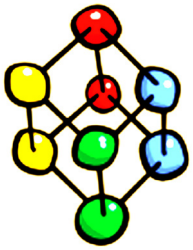
Explore:

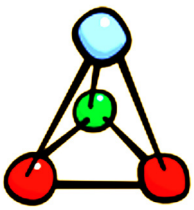
Ask each group to construct a cube using 12 cocktail sticks and 8 marshmallows. Start with the bottom square of 4 cocktail sticks and 4 marshmallows with the cocktail sticks poked into the marshmallows. Build upwards by placing a cocktail stick into each corner marshmallow. Place a marshmallow on top of each upright stick and join these together to complete the cube.

What happens when we press down on the top of the cube? (it will be flattened slightly)

Now make a triangular based pyramid with 4 marshmallows and 6 cocktail sticks. Start with a traingle made of 3 cocktail sticks and 3 marshmallows and add 3 more cocktail sticks at the corners and connect them together at the top with another marsmallow. You can make a square based pyramid in a similar way with 8 cocktail sticks and 5 marshmallows.

Press down on the pyramid shapes. What happens? (they should hold their shape)





Plan

- As a class decide what structure(s) will be made.
  - Will every group be making a similar structure, or will each group decide on their own?
  - Will every group be working with the same amount of material?
- Learners should decide on the type of structure they are making and its purpose. Ideas might include but are not limited to:
  - A tall tower.
  - A bridge to cross the span between 2 books.
  - A structure strong enough to support a book.
  - A prototype for a larger structure such as a geodesic dome or a model of an existing building such as the Eiffel Tower.
- Learners should set criteria for their structure such as the size and scale and decide how they will evaluate it. Criteria might include but are not limited to the following:
  - The tower must be at least 20cm tall and able to stand for 5 minutes on its own.
  - The bridge must be able to span the distance without falling apart.
  - The structure must be able to hold up a book without collapsing.
- Learners should discuss their design and draw a plan before construction.

Make

- Learners could work in groups or pairs to construct their design.
- Care should be taken with pointed cocktail sticks.
- Spaghetti can work but breaks more easily in construction. Balls of plasticine could be used instead of marshmallows.
- Learners should try to follow their original plan but adapt it as necessary.
- Cocktail sticks and marshmallows can be composted after use.

Evaluate

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

- Were you happy with your design?
- Did it meet the criteria: stand up, stay together, reach the height, hold up the book?
- Did you follow your original plan?
- What problems did you encounter and how did you overcome them?
- What might you do differently next time?

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.

Follow-up challenge/project/citizen science link:

- Examine objects that use triangles for strength or look at pictures of bridges and other constructions. Objects might include bicycles, corrugated cardboard, corrugated iron sheets, camera tripods, struts used to support basketball hoops, wooden gates and swing frames.
- Could you make structures using cardboard strips and split pins / paper fasteners?
- Could you incorporate triangles into designs when using construction toys such as K'Nex, Geomag or fort building kits?
- Design and test an earthquake proof structure by placing your construction on top of a tray of jelly and wobbling it.
- Could you make a larger structure outdoors using triangle shapes? How would you connect the sticks: string, elastics, clay? Remember to remove any non-natural objects after you are finished using your outdoor structure.
- Research unusual building designs that incorporate triangles e.g., geodesic domes or A-frame houses.