Stringy Shapes

Purpose

The purpose of this activity is to introduce students to the concept of regular and irregular shapes, how shapes are dynamic, and how we can manipulate features of one shape to make another. It also allows students to explore shapes and to discover how shapes are named based on their properties. Students develop skills in justifying their ideas and providing reasons to explain why they think they have made a particular shape. This links to the working mathematically outcome of reasoning (MAe-3WM, MA1-3WM, MA2-3WM). Students need experiences with visualising, manipulating and making shapes not just drawing them or sorting them using physical pre-made shapes. The activity provides students with opportunities to make mistakes, readjust the side lengths and angles, and think about properties and features and how they are related.

Syllabus Links

The activity can be differentiated and adapted to suit a range of grades. The focus matches a number of content areas of the NSW mathematics syllabus. Here are just a few suggested connections:

Early Stage 1 Two-Dimensional Space MAe-15MG	○ manipulate circles, triangles, squares and rectangles, and describe their features using everyday language, e.g. 'A square has four sides'
Stage 1 Two-Dimensional Space 1 MA1-15MG	○ manipulate, compare and describe features of two-dimensional shapes, including triangles, quadrilaterals, pentagons, hexagons and octagons ○ identify and name two-dimensional shapes presented in different orientations
Stage 1 Two-Dimensional Space 2 MA1-15MG	○ make representations of two-dimensional shapes in different orientations using concrete materials
Stage 2 Two-Dimensional Space 1 MA2-15MG	○ manipulate, compare and describe features of two-dimensional shapes, including the special quadrilaterals: parallelograms, rectangles, rhombuses, squares, trapeziums and kites ○ identify and describe two-dimensional shapes as either 'regular' or 'irregular' ○ construct regular and irregular two-dimensional shapes from a variety of materials
Stage 2 Angles 2 MA2-16MG	○ create, draw and classify angles of various sizes

Structure of the activity

The activity is quite open, where the activity ends will depend on your students' prior knowledge of shapes and their properties. It also depends on the questions you pose to enable and extend your students' understanding. You could use it as a five-minute introduction or extend it into a 40-minute investigation of shapes. The launch, explore, summarise model for teaching is recommended.

Activities should have the ability to be adapted, this activity uses enabling and extending prompts to guide how the students explore shapes. You as the teacher can make the decisions around which questions to use and when.

It is also beneficial to think about the possible misconceptions students may have around the concept prior to teaching the lesson so you are prepared and can pose specific questions to work through potential misconceptions.

For shapes, **common misconceptions** might be that students think:

- shape names change when the shape is in a different orientation
- a rectangle is a regular shape
- there is only one type of triangle (equilateral)
- a rhombus is called a diamond
- a square on its vertex is a rhombus

Materials

String approximately 8 m in length, tied to make a loop, ipad or camera, paper, pencils.

Launch

Set the scene

I have a piece of string, and I'm wondering what shapes I could make using the string.
What shapes do you think we could make?
Students brainstorm and share ideas (using think, pair, share). Write on the board the students' suggestions. Choose one of their ideas to try.

How could we make the triangle?

Enabling prompt: *How many students do you think we need?*

Allow students to provide a variety of ideas, students will hopefully see that we need three people to make the triangle, each holding onto the string.

Have students come out and hold the string to make the triangle.

Possible questions to pose while students are holding the string include:

- *How do we know it's a triangle?*
- *How could we check?*
- *Is this the only triangle we can make?*
- *How could we make another triangle?*

Enabling prompt: *Who would need to move and where?*

What if I now wanted to make a square?
What could we do?

Once they realise they need an extra person to hold the string, allow students time to think and share ideas of how they might go about making the sides and vertices equal.

Enabling prompt: *Where could you add another person?*

Enabling prompt: *What would everyone else holding the string need to do?*

Possible questions to pose while students are holding the string include:

- *Does everyone think they have made a square?*
- *What features (or properties) does a square need?*
- *How can we check to see if they are right (or accurate)?*

Extending prompt: *What is the most efficient way to check that the sides are all equal?*

Do students realise they need to technically 'fold' the square in half, then half again to check the side lengths. Do students then know how to fix the problem if the side lengths are not all equal?

How can we check the angles are all right angles?

Enabling prompt: *What in the classroom could help them?*

What if I stood over here (stand at one of the vertices)*, is the shape still a square?* (repeat process if needed)

Extending prompt: *What if I stretched this vertex, what shape do I have now?*

Explore

Try to make/ form some of the other shapes the students suggested. Students may tend to use 'guess and check' or continuous readjustments to make the regular shapes have equal side lengths e.g. for a regular pentagon. You could now explore using fractions to assist with some of the shapes that have an even number of sides.

What happens to the side lengths and the angles when we add another person?

Extending prompts: *Without the students holding the string, how can I make the side lengths equal to create a hexagon? What about an octagon?*

Extending prompt: *Does this technique work for a pentagon? Why or why not?*

Students can work in smaller groups with shorter string to make other shapes or explore making different quadrilaterals, taking photos of their string work each time.

Student can also explore different types of triangles (leading to a Stage 3 focus).

Explore - further

The investigation could also be extended to explore shapes that have the same area for example, squares, rectangles and triangles (as the area within the string doesn't change but the dimensions of the shapes do).

The following questions extend the learning to other concepts such as 3D Space (objects): Students may like to work further to create objects, they will need more pieces of string (not joined). Students also need to record how they made their shapes, what was interesting or difficult.

Extending prompt: *I wonder if we can make three-dimensional objects with our string?*

Extending prompt: *How many students would we need to make a pyramid?* (where there is one student per vertex). *Can you make it with one piece of string with no overlaps along the edges?*

Summarise

Select students to present their string shapes either by physically recreating them or sharing their photos. Choose students who showed a variety of shapes or ways of solving the problems.

Choose a group to present that may have had difficulty and overcame the issue. What did they learn from their initial mistakes?

Look for similarities and differences in students reasoning and solutions. Highlight what makes shapes regular and irregular.

References

Board of Studies NSW. (2012) Mathematics K-10 syllabus. Retrieved from https://syllabus.nesa.nsw.edu.au/download

Lappan, G., Phillips, E. D., Fey, J. T., Friel, S. N., Grant, Y., & Stewart, J. (2014). *Connected mathematics 3*. Boston, MA: Pearson.

Further ideas

Stringy quads and Exploring 2D Shapes by nrich.maths.org

A similar task is String shapes by exploratorium.edu

Maths300 also have an investigation titled String Shapes

Reasoning with 2D Shapes lesson sequence by mathematics by inquiry

Building shapes lesson (making 2D shapes and 3D objects) from www.youcubed.org Week of Inspirational Maths 2017 (Day 4)