MINISTRY OF EDUCATION
TE TĀHUHU O TE MĀTAURANGA

Supporting NCEA Numeracy in Visual Arts

Numeracy encourages curiosity towards learning and creativity, and promotes critical and alternative thinking.

These ideas are strongly represented in Visual Arts, and while the output may look different from Numeracy, explicitly relating these skills across the Arts and Numeracy allows ākonga to make connections and transfer these skills beyond the classroom.

This Numeracy Pedagogy Guide (NPG) takes a selection of mathematical and statistical content ideas from Unpacking Numeracy and illustrates the small, effective steps that you can trial and weave into your teaching practice.

Visual Art Numeracy Pedagogy Guide

Operations with numbers	What can this look like in Visual Arts?	What can I do as a kaiako of Visual Arts?
Choose an appropriate approach to calculation (written, mental or digital)	Apply knowledge of ratios to develop a new colour, medium or other material. *Ākonga need to know the correct ratios of materials to create a sculpture that is not too brittle and not too dense.*	Encourage ākonga to consider how much of each type of material they are combining when developing a new colour, medium or other material. This is especially important if the ākonga needs significant amount of the new material or if they may need more new material later. *An ākonga creates a light brown skin colour using 3 drops of yellow, 2 drops of blue and 2 drops of red. This is represented as a ratio of 3:2:2.* *If they use 4 drops of yellow, then to make the same colour, ākonga would need two and two-thirds of blue and two and two-thirds drops of red.*[1] Here is a mathematical example of using ratios when mixing paint.
Work with whole numbers up to billions, fractions, decimals to 3 places, percentages, and integers	Use fractions and the language of fractions to appropriately draw people, items, or objects. Reference the golden ratio (also known as the Rule of Thirds or the Fibonacci sequence) when analysing composition of artworks or designing artwork. *Ākonga use unit fractions[2] such as half ($\frac{1}{2}$) and a quarter ($\frac{1}{4}$) and phrases such as "evenly distributed" to describe where the eyes, nose and mouth are located on a human face.*	Discuss with ākonga how fractions are relative to the whole and are evenly split. This means that if an ākonga draws a smaller face shape, the eyes will still be halfway down the face, although this position will be different on a larger face shape. Use the Fibonacci sequence of 1, 1, 2, 3, 5, 8 and relate this to how the sequence is used to draw the golden spiral/rule of thirds. Discuss how the Fibonacci sequence is found in nature, and how this might help ākonga in their renderings of the natural world or compose a piece of artwork of their own.

Spatial properties and representations of objects	What can this look like in Visual Arts?	What can I do as a kaiako of Visual Arts?
Recognise symmetry	When analysing the composition of artwork, ākonga determine whether there is › line symmetry › rotational symmetry *Ākonga analysing the intricate carvings on a marae may note that the designs on the tekoteko (figurehead) have a line of symmetry and uncover the pūtake (story) of the tekoteko.*	Ask ākonga to define line symmetry and rotational symmetry. [3] Relate the definitions used in visual arts to the definitions used in mathematics.
Transform objects to design for purpose (ie. enlarge, reflect, rotate, and translate)	Describe and use reflection, rotation, and translation in artwork. Relate the concept of enlargement to one-point perspectives and isolations. *Ākonga may analyse the reflections, rotations and transformations in tukutuku panels and uncover the pūtake (stories) the panels tell.* *Ākonga may consider how the transformations used in tukutuku panels were so accurately done without the assistance of stencils, or computer software.*	The language used in mathematics when describing a transformation is exact. This may be useful for ākonga when they communicate how they have developed an art-work, and explain how they know the transformation has been applied correctly.
Make connections between representations of objects in simple 2D and 3D	Draw the two-dimensional perspective of a three-dimensional object. Transform a two-dimensional isometric rendering into a three-dimensional shape. *Ākonga use shadowing to convey the 3D form of an object. For example, ākonga wanting to create the shadow of an apple need to know how the apple in 2D would look and how this should be drawn from a particular perspective.*	Move from concrete to pictorial to abstract models to help ākonga connect two-dimensional and three-dimensional representations. *Ākonga draw the two-dimensional perspectives from a set of connected math link cubes and progress to imagining how a set of connected math link cubes have been put together from two-dimensional drawings only.* Here is a mathematical example of how maths link cubes could be used. This activity may be useful to help ākonga think creatively about the different types of shadows 3D objects can make, depending on the direction of the light source.

Measurement	What can this look like in Visual Arts?	What can I do as a kaiako of Visual Arts?
Select appropriate units and convert between metric measures for the same attribute.	Observational drawings require accuracy, including proportionality in the item drawn. Select the right tools to measure and use when doing observational drawings. *Ākonga who are drawing technical illustrations or for architectural purposes need to ensure that their renderings are exact.* Use measurement to develop a new paint colour, material or medium to work with. Use measurement to set out a folio layout.	Discuss with ākonga how exacting each type of artwork they design or develop should be and ask them to explain why a certain level of precision is appropriate. Talk about different forms of measurement ākonga might use to create a new paint colour, material or medium. Ākonga may choose to use metric measures such as cm, g, or ml or they may use non-metric measures such as cups, spoons or using a body part[5]. Discuss the benefits and disadvantages of using different types of measurement methods.
Solve measurement problems in practical contexts » **perimeter** » **volume (cuboids only)** » **area (rectangles, parallelograms, triangles)** » **mass** » **temperature**	These concepts contribute to the development of numeracy skills: » Draw basic two-dimensional shapes such as rectangles, triangles and parallelograms and combining them to create compound shapes. » Draw basic three-dimensional shapes such as a cuboid. » Use language to describe types of shapes and the shape themselves. *Ākonga can describe the different types of triangles used – equilateral, isosceles, scalene, or right-angled and explain their choice in the context of their artwork.* *Ākonga know that a two-dimensional shape is flat and has only length and width. A three-dimensional shape "pops out" and has length, width, and depth.* Discuss the definitions of words in the visual arts world that may be used differently in a mathematical context. *Ākonga use colour temperature (measured in Kelvin) to adjust the "read" of an image.*	Encourage ākonga to use appropriate language to describe shapes[6]. Ask ākonga to identify words that have been used in class that may be used in other learning areas. Unpack how the usage of the words are the same or different, and how they relate to each other. *In mathematics, volume is defined as the amount of space a three-dimensional space occupies and is measured in cubic units (such as cm^3 or m^3). In sculpting, volume is a sensory property of a three-dimensional form, and is not related to the measurement cubic units. This means that the size of the sculpture is not the measure of volume, but the way in which the sculpture was designed and created in the round.* *In mathematics, temperature is measured in °C, and is often used in the context of adding/subtracting integers (positive and negative numbers). In painting, temperature relates to colour temperature, and is measured in Kelvin. A warmer toned photo in the lower ranges can create feelings of comfort, while a cooler colour temperature adjustment reads as a starker, unwelcoming image. Both measures relate to temperature, with Kelvin a temperature measure commonly used in science.*

Footnotes

[1] To do this calculation, ākonga need to know:

What value 3 needs to be multiplied by to get 4. This is the mathematical calculation $3 \times ? = 4$.

Division is the opposite of multiplying. This means $? = 4 \div 3 = \frac{4}{3}$ (four-thirds).

Each portion of the ratio must be multiplied by $\frac{4}{3}$ to obtain the correct ratio if 4 drops of yellow is used.

This calculation can also be useful if ākonga only have a small amount of paint left.

[2] A unit fraction is a fraction where the numerator (top number) is 1.

[3] Line symmetry (also called reflectional symmetry or mirror symmetry) is where one half of an artwork is the reflection of the other half.

Rotational symmetry is the number of times an image can turn onto itself within one full turn (360°). This means that every object has at least one **order** of rotational symmetry.

Total order of symmetry = number of line symmetries + order of rotational symmetry.

[4] New Zealand uses metric measurement. The conversions are in powers of 10. This means that to convert between units, we multiply or divide by 10, 100 or 1000.

Non-metric units (incl. imperial units such as pound, quart, inch) are not commonly used in New Zealand.

While a non-metric measure such as cup, spoon or body part may be more convnient, it may not be easily replicated by another person.

[5] Some common descriptions of shapes are:

Equilateral triangle. Three-sided shape, where all the sides are the same length, and all the angles are the same.

Isosceles triangle. Three-sided shape where two of the sides are the same length, and two of the angles are the same.

Scalene triangle. Three-sided shape where all sides are different lengths, and all angles are different.

Right-angled triangle. Three-sided shape where two of the sides in the triangle create a 90 degree angle.

Rectangle. Four-sided shape, where the angles are 90 degrees. A square is a special rectangle, where all the sides are the same length.

Parallelogram. This is a rectangle, that has been “pushed” one two parallel lengths.