Maths in Context: ‘Mr Moon’s Bird Feeder’

Image Credit: Rawlinson, D., *‘Cacatua galerita perching on a branch’,* sourced from Wikipedia and labelled for non-commercial reuse. This image is a derivative work cropped from the original by Snowmanradio - originally posted to ‘Flickr’ as “Parrot” and uploaded to Commons.

An AMSI Schools Rich Task
for Students in Years 5 & 6

Thanks to Mr Aaron Moon and Ms Fiona Hillier at St Joseph’s Primary School, Denman, New South Wales, for their collaboration on the development of this task.

LEVELS 5 & 6 ('Stage 3' / Years 5 & 6): Multiplication, Measurement, Area and Capacity

Aims and Objectives for this Task:

The aim of this task is to provide a rich, contextual activity through which students can explore the applications of measurement (length, area and capacity), to a real problem in an everyday context.

- Students will demonstrate **understanding** by representing metric decimals in various ways, including units of area, length and volume and describing connections between them, and making reasonable estimations;
- Students will demonstrate **fluency** by measuring using metric units, converting between units of measurement and using operations with decimals;
- Students will demonstrate **problem-solving** by formulating and solving authentic problems using decimals and measurements;
- Students will demonstrate **communication skills** by describing and representing mathematical situations in a variety of ways using mathematical terminology and conventions appropriate to units of measurement; and
- Students will demonstrate **reasoning** by explaining mental strategies for performing calculations and explaining the transformation of one shape or measurement iteration into another.

Intended Syllabus Outcomes (Years 3 & 4)

Australian Curriculum (Mathematics):

- Select and apply efficient mental and written strategies and appropriate digital technologies to solve problems involving all four operations with whole numbers (ACMNA123);
- Investigate everyday situations that use integers. Locate and represent these numbers on a number line (ACMNA124);
- Multiply decimals by whole numbers and perform divisions by non-zero whole numbers where the results are terminating decimals, with and without digital technologies (ACMNA129);
- Multiply and divide decimals by powers of 10 (ACMNA130);
- Connect decimal representations to the metric system (ACMMG135);
- Choose appropriate units of measurement for length, area, volume, capacity and mass (ACMMG108);
- Calculate the perimeter and area of rectangles using familiar metric units (ACMMG109);
- Convert between common metric units of length, mass and capacity (ACMMG136);
- Solve problems involving the comparison of lengths and areas using appropriate units (ACMMG137); and
- Connect volume and capacity and their units of measurement (ACMMG138).

NSW Syllabus (Mathematics)

- Describes and represents mathematical situations in a variety of ways using mathematical terminology and some conventions (MA3-1WM);
- Selects and applies appropriate problem-solving strategies, including the use of digital technologies, in undertaking investigations (MA3-2WM);
- Gives a valid reason for supporting one possible solution over another (MA3-3WM);
- Selects and applies appropriate strategies for multiplication and division, and applies the order of operations to calculations involving more than one operation (MA3-6NA);
- Selects and uses the appropriate unit and device to measure lengths and distances, calculates perimeters, and converts between units of length (MA3-9MG);
- Selects and uses the appropriate unit to calculate areas, including areas of squares, rectangles and triangles (MA3-10MG); and
- Selects and uses the appropriate unit to estimate, measure and calculate volumes and capacities, and converts between units of capacity (MA3-11MG).

Task Grading Rubric

Achievement Grade	Achievement Performance Description
A	• Describes and represents length, area and capacity using accurate, clearly labelled diagrams and appropriate mathematical terminology and conventions; • Selects and applies problem-solving strategies and finds innovative solutions that are well-suited to the design investigation; • Gives several valid (ie, correct) and well-supported reasons for prescribing unit lengths and dimensions in the task; • Selects, articulates and applies appropriate strategies for multiplication and division, and correctly applies the order of operations to calculations resulting in valid and accurate solutions, showing clear and accurate working; • Selects and uses appropriate units and device to measure lengths and distances, accurately calculates areas and capacities and converts accurately and fluently between metric units.
B	• Represents length, area and capacity using clear diagrams, appropriate mathematical terminology and some conventions; • Selects and applies problem-solving strategies and suggests sound solutions within two or more aspects of the design investigation; • Gives one or more valid reasons for prescribing unit lengths and dimensions in the task; • Selects and applies workable strategies for multiplication and division, and correctly applies the order of operations to calculations, showing some working; • Selects and uses appropriate units to describe lengths and distances, calculates areas and capacities and converts between metric units with a reasonable degree of accuracy.
C	• Represents at least two aspects of length, area and/or capacity in the task using diagrams, correct mathematical terminology and some conventions; • Engages in problem-solving strategies and suggests sound solutions in at least one aspect within the design investigation; • Prescribes clear unit lengths and dimensions in the task, although may or may not provide robust reasons for their choice/s; • Shows evidence of some working to solve multiplication and division problems within the task using accurate but not necessarily efficient strategies; and • Uses some common units to describe lengths and distances, calculates areas and capacities although shows some limitations or inaccuracies in conversion.
D	• Seeks to represent at least one or more aspects of length, area and/or capacity in the tasks although with limitations or inaccuracies in diagrams and/or incorrect or incomplete mathematical terminology; • Engages to a limited extent in problem-solving and suggests incomplete solutions in at least one aspect within the design investigation; • Prescribes unit lengths and dimensions in the task, although these may be unjustified and/or inaccurate; • Shows evidence of solving multiplication and division problems within the task although these may be inaccurate or incomplete; and • Uses some common units to describe one of more of either length, area or capacity although shows limitations or misconceptions in conversion.
E	• Represents one aspects of length, area and/or capacity in the tasks although without any reference to clear diagrams and/or correct or complete mathematical terminology; • Suggests incomplete solutions in each aspect within the design investigation; • Misrepresents or misunderstands unit lengths and dimensions in the task; • Shows elementary evidence of solving multiplication and division problems within the task; and • Inadequately describes any of either length, area or capacity and demonstrates fundamental misconceptions in unit conversion.

Background

Image Credit: Bales, H., *'Cacatua galerita feeding in a flock, Sydney,* sourced from Wikipedia and labelled for non-commercial reuse.

Mr Moon has a feathery problem.

Mr Moon is the Principal and Year 5 & 6 teacher at a small primary school in country in the Hunter Valley of New South Wales. At his school, large flocks of sulphur-crested cockatoos regularly fly down from the big old angophora gums to visit the playground. They are beautiful birds and the students and teachers at the school are always happy to have them come visit.

Now, Mr Moon recently convinced the school council to have the lovely old school hall freshly painted and the decorative eaves around the building restored. It looks fantastic… but unfortunately the cockatoos think that the new eaves *taste* fantastic, too! The hungry birds have been flocking down in the afternoons and have gotten busy nibbling away at the new eaves, pecking off the paint and nibbling at the fresh timber underneath. It's not good for the birds, and certainly not good for the school's nicely restored hall!

Mr Moon and his fellow teachers and students want to keep the birds coming to the playground, but would rather them eat something much more healthy, thank you very much. So, he has decided to design and build them a bird feeder.

Mr Moon looked on the Internet for some designs, but nothing really was suitable either for big cockatoos or for the school playground. So, he did what all good teachers do – he delegated the task to his students!

The Task and Design Brief:

You are to imagine you are in Mr Moon's Year 5 & 6 class and he has given you the job of designing a bird feeder to keep the cockatoos happy and away from the apparently scrumptious school hall!

The following is the **'Design Brief'** – in other words, the rules you will need to follow when designing the measurements (dimensions) for the bird feeder.

We suggest you grab a piece of working paper and take notes or draw rough sketches / diagrams as you read carefully through each point below. During the task you will need to read the design instructions very carefully, be accurate with your measurements and working out, and use a ruler when drawing diagrams and sketches!

(a) The Feeder Platform and Pole

- The feeder needs to be *free-standing* (eg. on a pole in the ground) and the platform for the feeder needs to be at least **1.8 metres off the ground** (this is the height the average fox can jump), however;
- The platform cannot be too high to be reached by a student who is about **140 cm at eye-height *and* standing on a step-stool that is 70 cm high** (because Year 6 will have the job of replenishing the bird seed);
- The pole for the feeder needs to sink into the ground to **a depth of *one-third* (0.33) *times the distance of the above ground height,*** to keep the feeder platform stable;
- The platform for the birds (on which the birds will sit or perch to feed) needs to be a **minimum of 3 600 cm^2** and a **maximum of 8 100 cm^2**;
- The load capacity of the feeder should support at least 10 birds (they are 800 g each on average), a container of seed weighing about 1 kg and at least 1 litre of water[1]

Task: ***Design the feeder platform and pole and work out what the weight-bearing capacity of the platform will need to be.***

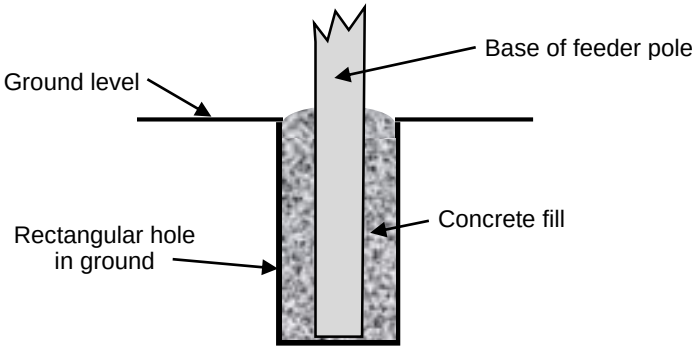
Design extension: ***What design features could you add to the feeder pole and platform to ensure the platform sits firmly and securely on the top of the feeder pole? (Sticky tape and blu-tack will NOT be strong enough!) How will you ensure the feeder is strong enough to support the weight?***

Notes / Working Area:

[1] **Hint:** *How heavy (in grams or kilograms will 1 litre of water be?)*

(b) The pole 'anchor'

- To ensure the pole sits firmly in the ground it will need to be sunk into a rectangular hole that will be filled with concrete:



- Look back at the depth into the ground to which the pole must sink. The hole for the concrete fill should be at ***least as deep as the depth of the pole below the ground***, and ***at least a quarter (0.25)*** of this distance wide.

Task: ***Calculate the capacity of the rectangular hole you will need to dig for the feeder pole, and work out the approximate volume of concrete you will need to mix to fill the hole in order to anchor the pole into the ground.***

Design extension: ***One 20 kg bag of concrete contains about 8 litres of concrete mix. If 16 litres of concrete mix plus 4 litres of water makes 20 litres of concrete, calculate the number of 20kg bags you will need to purchase to fill the hole for your bird feeder.***

Notes / Working Area:

(c) The Seed and Water Containers

- The seed container will need to hold about **1 kg of seed**. (Bird seed, on average, weighs about **2 000 grams per litre of seed**);
- The water container needs to be able to hold a litre of water.

Task: ***Design both the seed container and the water container for the top of the feeder platform, ensuring they are the right capacities for the task.***

Design extension: ***What design features could you add to allow the water to be replenished*** **without** ***having to remove the water container from the platform, fill it at a tap and then carry it back up again? Is there a way you could refill the water from*** **below** ***the platform – or even*** **automatically*****?***

Notes / Working Area:

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Name: _____

Class: _____

Your Final Bird Feeder Design

- Draw and label your final bird feeder design below, including the pole and platform, seed and water containers and the anchoring hole in the ground
- Use a ruler and make sure all your measurements are accurate
- Ensure you have followed the design brief instructions carefully
- Label all the parts / sections of your bird feeder
- At the conclusion of the task, provide reasons for the design and measurement choices you made in each of (a) the pole and feeding platform; (b) the seed and water containers and (c) the pole anchor hole in the ground.

Conclusion:

(a) I made the above design and measurement choices for the pole height and feeder platform dimensions of Mr Moon's bird feeder because:

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(b) I made the above design and measurement choices for the water and seed container dimensions of Mr Moon's bird feeder because:

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(c) I made the above design and measurement choices for the pole 'anchor hole' dimensions of Mr Moon's bird feeder because:

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