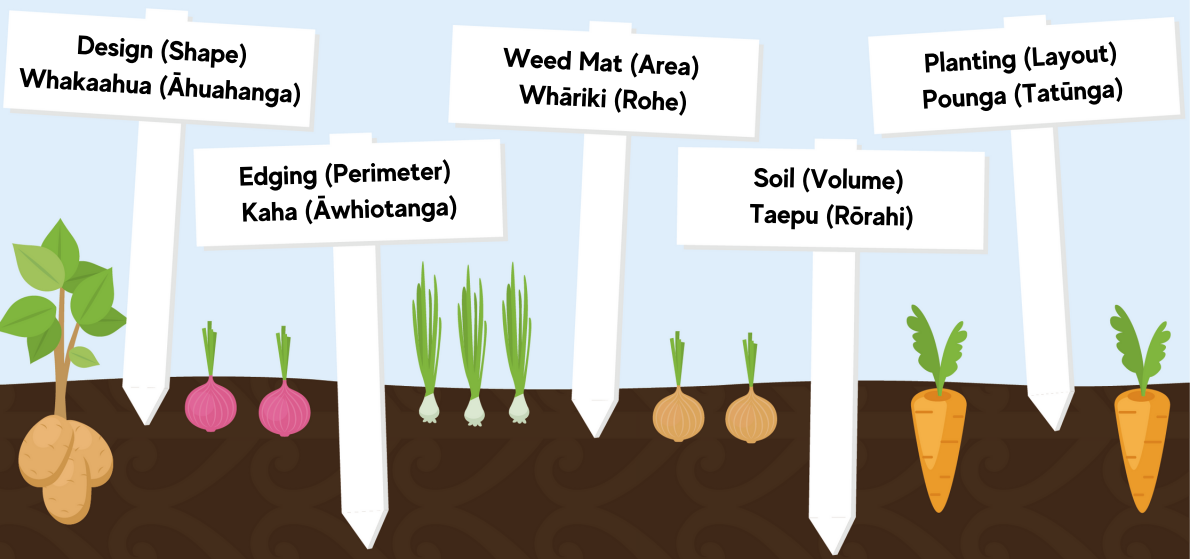
# Māra Hapori

## Community Garden




Maths-Whizz by whizz EDUCATION

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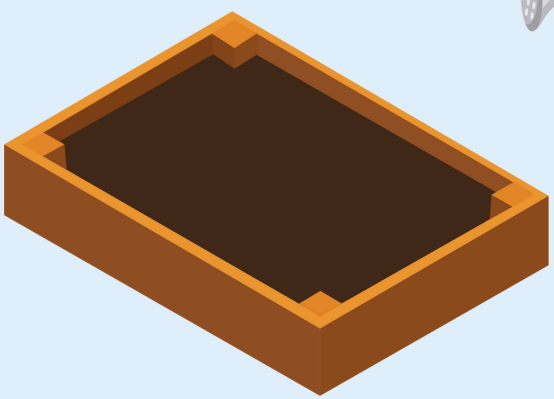
# Your task is to design a community garden where people will grow vegetables to share with others.

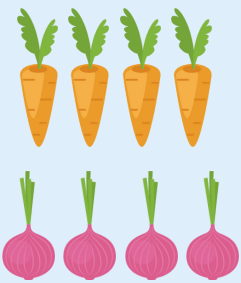
**Overall Aims:**

In this activity, you will not only learn about **shapes** (designing your garden), **perimeter** (building a border around your garden), **area** (laying some weed mat to stop weeds growing), and **volume** (amount of soil), you will also have the chance to look at some deeper level investigations. What happens if I change the perimeter? What happens if I change the area? How can I make my garden produce the most vegetables for the lowest cost? You may choose to do all sections, or just some of them.

**Sustainability:**

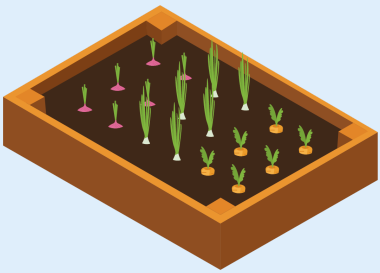
One great way that we can look after our planet and be kaitiaki is by using our scraps, making compost, and creating gardens to grow our own food. Not only can tamariki learn all about designing and creating a māra kai but they can also grow healthy kai to feed their bodies, and to share with whanau and friends.





# Design the Shape of your garden

## 2D Shapes/Composite shapes (NZC Level 2/3)



**Maths-Whizz Links**

2D shapes (L2)

Composite (compound) shapes (L2/3)

Explore a garden or another outside space that you think might be a similar size to your ideal garden. Measure the lengths of the of the spaces (shapes), and decide if your garden will have similar or different measurements.

On each side of your garden design, record how long you would like the garden to be. You can choose the most appropriate unit of measurement (metres (mita), centimetres (mitarau), or millimetres (mitamano)).

Choose a shape for your garden and draw a picture of it (if you are up to it, check out the next section for an extra challenge!)

a. What unit will you chose for measuring your garden, and why have you chosen this unit (what makes it better than the others?)

b. If you need help in working out lengths, you may be able to go outside with a tape measure and measure some gardens (or spaces) around your room to see how long they are.

**Or if you want more of a challenge**

- Your garden is to be no bigger than 20 $m^2$ (square metres). (If you need extra help on area, check out the links in the Weed Mat/Area section). Decide on a shape that you would like your garden to be. (You will have to think about how you will be able to access the plants without having to walk over all the soil. Will you need pathways?)

a. What is the name of this shape?

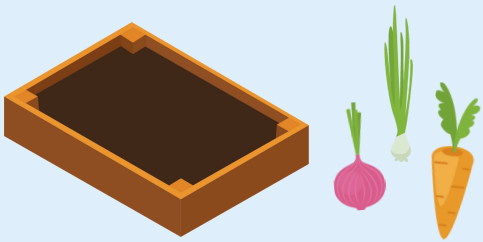
b. Discuss with your group;
   i. Is it better to have a garden with sides a similar length? Why or why not?
   ii. Is it better to have a garden that is longer than it is wide? Why or why not?

c. Once you have agreed on a design, draw a diagram of your garden. Include and name the shapes that you have included.

# How much Garden Edging do we need?

## Perimeter (NZC Level 2-4)

**Maths-Whizz Links**
Perimeter



**Come up with 2 different designs that have the same perimeter**

You will need to have the border of the garden made from treated wood so that it won't rot. You will need to give your community organisation an estimate of costs, and your design information may need to be shared with many different people e.g. builders, community members, adults, hardware stores, town planners etc. All of these people may think about the measurements differently so let's make sure we include all of the information, including having measurements in different units where needed (m, cm or mm). So;

1. You will need to work out how much wood to buy.
    - Calculate the total perimeter of your garden.
2. Different layout options.
    a. In your group, work together to see if you can take someone's garden, and create 2 new (different) garden shapes that have the same perimeter.
    b. Which shape do you think is better? Discuss this with your group and come up with a list of reasons why you would choose one garden shape over another.

# Purchasing and Unit conversions (NZC Level 4/5)

**Maths-Whizz Links**

Measuring Units | Estimate Units | Converting Units
Comparing Units | Relationship between Units

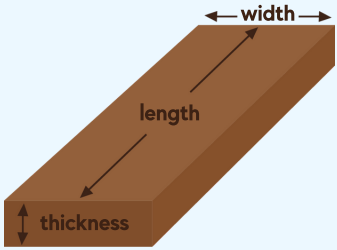
You have calculated the total length around the outside of your garden (the perimeter), with your measurements in metres (mita). Let's look at how we can write this same measurement in different ways.

1. Different units

   a. How long in the perimeter of your garden in metres (mita) (m)?

   b. How long is this in centimetres (mitarau) (cm)?

   c. How long is this in millimetres (mitamano) (mm)?




2. When buying wood, do you buy it by the metre (mita), centimetre (mitarau) or millimetre (mitamano)?
   Let's plan to build a border around your garden.
   Not only will the wood you buy have to be long enough, but you will also need to consider the width and thickness of your border timber.

   a. Compare the options for your wood from at least 2 different suppliers (search online for Bunnings, Mitre10, Carters, or you could phone your local hardware store.)

      i. You will need to consider the dimensions of the wood (width, length and thickness)
      ii. Show your comparisons in a table.
      iii. Which wood option have you chosen?
      iv. Why have you chosen this option?
      v. Do you have to buy/order your wood in metres (mita), centimetres (mitarau) or millimetres (mitamano)?
      vi. Calculate the total cost and note this down as you may need it later in this project. (Show all your working so that the community can see that you have made a wise purchase.

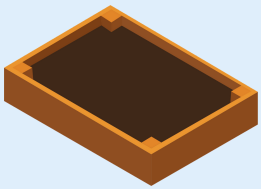
   b. When buying wood for your garden, would you buy exactly what you needed, or slightly more than you needed? Explain.

# How much Weed Mat do we need?

## Area (NZC Level L2-5)

**Maths-Whizz Links**

Area



To help your garden grow, we need to make sure that weeds don't. One way to help this is by placing a 'weed mat' covering your garden. To do this there are a few things we need to consider.

We need to find out the area of our garden to work out how much weed mat to buy.

a. What is the area of your garden?

   i. In square metres ($m^2$)
   ii. In square centimetres ($cm^2$)

b. Find out where you can buy weed mat, and what is the width of the mat?

c. How many metres (mita) of mat do you need to buy to cover your garden? Try these different ways. What do you notice?

   i. If you laid the mat horizontally (from one side to the other, when you have drawn it on paper)?
   ii. If you laid the mat vertically (from the top to the bottom when you have drawn it on paper)?

**Optional Extra Challenge**

To make your garden as productive as possible, you will need to make sure you get the maximum amount of produce (vegetables) growing in your garden and spend the least amount of money in setting it up. One thing you may have seen (in the previous section) is that laying the weed mat in different directions can reduce wastage, and in doing so reduce costs.

a. Remember in the Perimeter section, you had to come up with 2 different designs (shapes) that had the same perimeter, but different areas.

   i. Calculate the areas of each of your new garden. In each case explain how you worked out each area.
   ii. Are the 2 areas the same or different (when the perimeters are the same)
   iii. What sort of shape would give you the biggest area (discuss with your group and look at everyone's different designs/shapes to see what works best?

b. Let's go back to your original garden design.

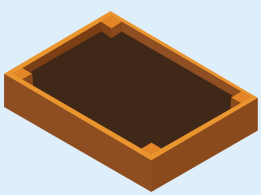
   i. What is the perimeter of your original design?
   ii. What is the area of your original design?

We have looked at gardens with the same perimeter and different areas.

Now try and design a garden that has the same area as your original garden, but a different perimeter?

   iii. Which one would you choose? Why?

c. Make a final decision on the overall shape of your garden. Calculate the total cost of weed mat to cover this area and note this down as you may need it later in this project.



# GST (NZC Level 4/5)

**Maths-Whizz Links**
Percentages

GST stands for "Goods and Services Tax", a tax that is charged and collected by the government, whenever we buy something, or pay someone to do a job for us.

1. If the garden centre you are purchasing off, bought rolls of weed mat at $100 each, and then wanted to add a 50% profit margin;

a. Do they add GST before or after adding their profit margin?

b. Does it matter (show details of all your calculations)

2. If the garden centre added a 50% profit margin, then had a 50% off sale, would they sell the weed mat at;

a. A higher price than they paid?

b. A lower price than they paid?

c. The same price that they paid? (give calculations, explanations, and details in your answers)

3. In NZ, how much is GST?

4. How much does your chosen type of garden edging wood cost?

a. After GST is added (GST inclusive).
Show a calculation showing how to work out the GST inclusive price if you are given the GST exclusive price.

b. Before GST is added (GST exclusive)?
Show a calculation showing how to work out the GST exclusive price if you are given the GST inclusive price.

# How much Soil do we need?

## Volume - 3D shapes (NZC Level 2-4)

**Maths-Whizz Links**
Volume

**If you have multi-link cubes, build a scale model of garden. Make each cube the equivalent of 0.5m x 0.5m x 0.5m.**

Once you have made your garden, you will need to fill it with dirt. Most plants require a good depth of soil to grow. Let us assume that your garden will have dirt that is 50cm deep. (When you purchased your garden edging, check that it is at least 50cm wide!)

1. How much soil will you need to fill your garden? To find out, calculate the total volume of your garden.
   a. In cubic centimetres ($cm^3$)
   b. In cubic millimetres ($mm^3$)

If you are keen to make your garden as productive as possible, with flourishing vegetables, then you **may want to consider** these questions (extra questions for an **extra challenge**);

2. If you wanted to put compost on your garden, and decided that you would like enough compost to cover your entire garden at a depth of 10cm, how much compost would you need?

3. If you wanted to use some mulch on the top of your garden, and you used 3 $m^3$ of bark for this part;
   a. If a bucket holds 20 litres (L), and the wheelbarrow holds 65 L. How many buckets will fill up the wheelbarrow?
   b. How many wheelbarrow loads will you need to move 3$m^3$ of bark?

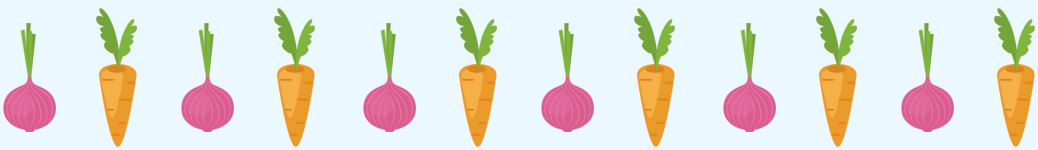
4. Now is time to add some fertiliser.
   a. If the fish fertilizer needs to be mixed at a 1:20 ratio with water how much should we mix up in our watering can?
   b. If the fertilizer for citrus trees is 5:10:5 what does that mean?

# Planting your garden

## Vegetables

1. What vegetables do you want to plant in your garden? Remember this is for the community, so you may wish to include vegetables hat you don't like! Find out what you can get from your local nursery, how far apart they need to be planted, how many of each you can plant, and therefore how much they will cost. (As an example, to enable good airflow, lettuces plants should be planted around 30 - 40 cm apart).

2. Finalise your garden design, with a drawing of your garden, a list of all the vegetables you are going to plant, and include them in your drawing (perhaps with pictures and a  key to show what each picture means). This will help someone else come along, take your plans, and build what you want. As an extra challenge, name your vegetables in Te Reo Māori and English.



# Prepare a budget

## Provide an overall budget for your garden.

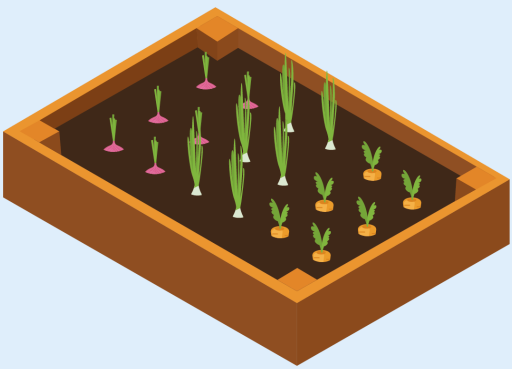
Now it's time to bring all of our information and prices together in the form of an overall budget. Go back to each of your sections, and record here the results of any price calculations you have done (let's assume that we can get the soil, compost and fertiliser from the school's worm farm and recycling centre - for free)

1. How much will the edging cost?
2. How much will the weed mat cost?
3. How much will the vegetables cost

## Final Checklist.

If you are presenting this investigation as a project, then use this checklist to help make sure you have included everything;

1. Have you shown your design (shape)?
2. Have your shown how much edging (perimeter)?
3. Have you shown how much weed mat (area)?
4. Have you shown how much soil (volume)
5. Have you shown your final budget/costs calculations?



# Supplementary Tasks

1. If your garden had a total perimeter of 20m, and was a rectangle, investigate different side lengths to find what length and width measurements would give you the largest garden area;

| Length (m) | Width (m) | Area ($m^2$) |
|---|---|---|
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2. So, we can see that you can have different shapes that have the same perimeter and different areas or have the same area but different perimeters.

   a. Looking at your different options, will you save more by choosing a smaller perimeter (keeping the areas the same), or by choosing a smaller area (keeping the perimeter the same)?

   b. How could you take what you have learnt here and apply this to a future job?

      i. What if you were a farmer, how would this affect your decision on the shape of any new paddocks that you were creating (and needing to fence)? The more fencing you require, the more money you will have to pay. The greater the area, the more money you will be able to earn from your farming activity. Explain your answer.

      ii. If you were putting a swimming pool in at your house, would you build one that was a similar width and length, or one that was long and narrow? Explain.

      iii. What other situations can you think of that will allow you to use this new learning? Discuss this with your group and see what ideas others may have.

3. A rectangular garden has long sides that are twice the length of the short sides. Its area, in $m^2$, is the same number as the perimeter in m.

   What are the possible dimensions of the garden?

# Supplementary Tasks

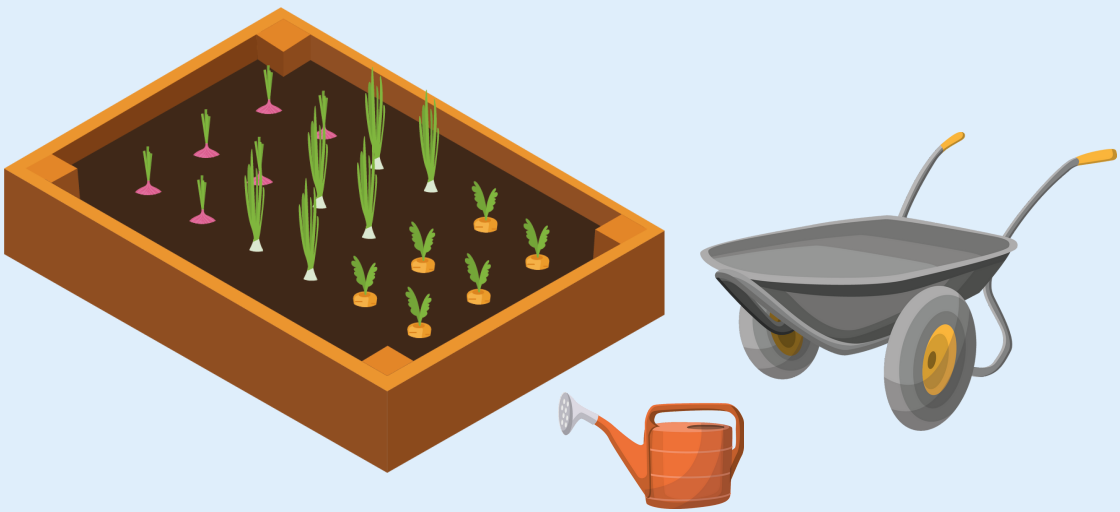
4. Choose 2 garden shapes with the same area (different shapes, different perimeters);

    a. Calculate the volume of soil needed for both gardens.

    b. Is it the same or different? Why?

5. If we had a garden that was 4m long, and I wanted to plant 12 strawberry plants 30cm apart, how long will the row need to be? If you wanted to plant 24 plants, you could have 24 plants in 1 row (if your garden was long enough). How many other combinations of plants and rows could you have, if you wanted to have the same number of plants in each row?

6. For a potato patch we need $12m^2$. How many different rectangles could we make that all had an area of $12m^2$?



# Links to Individual Maths-Whizz Exercises

## NZC Level 1

**Sort Objects By Their Appearance**
Use everyday language to describe features of 2D objects
Use language to describe the shape and size of solids (easier)
Use language to describe the shape and size of solids (harder)
Say which shapes are not square, triangle
Begin to relate solid shapes to pictures of them
Make and describe shapes, pictures and patterns

## NZC Level 2

**Sort Objects By Their Spatial Features, With Justification**
Identifying 2D shapes
Classify 2D shapes
Classifying 2D objects
Understanding faces, vertices and edges of 3D shapes
Use the mathematical names for common 2D shapes
Sort 2D shapes and describe some of their features
Recognise right angles in shapes such as squares and triangles
Recognise and describe faces of 3D shapes
Recognise and describe vertices of 3D shapes

**Identify And Describe The Plane Shapes Found In Objects**
Visualise 3D shapes from 2D drawings
Use everyday language to describe features of 3D objects
Visualise 3D shapes from 2D drawings
Begin to name flat shapes
Identify simple nets of solid shapes

**Predict and Visualise Line (reflection) Symmetry of 2D Shapes**
Recognise and visualise line (reflection) symmetry of 2D shapes

## NZC Level 3

**Represent objects with drawings and models**
Visualise 3D shapes from 2D drawings (from different orientation)
Visualise 3D shapes from 2D drawings
Use 2D representations to visualise 3D shapes and their properties
Make and describe shapes, pictures and patterns using solid shapes
Relate solid shapes to pictures of them

**Describe the transformations (reflection, rotation, translation, or enlargement) that have mapped one object onto another**
Recognise and visualise rotation symmetry of a 2D shape

**Classify Plane Shapes and Prisms By Their Spatial Features**
Identifying 3D shapes
Recognise and describe 3D shapes
Sort 3D shapes and describe some of their features such as number and shape of faces, edges and corners
Use the mathematical names for common 3-D shapes, including the pyramid and cylinder
Identify lines of symmetry in simple shapes
Explore different shapes made from four cubes
Relate solid shapes to pictures of them

**Find areas of rectangles and volumes of cuboids by applying multiplication**
Find area by counting methods
Finding area in square centimetres
Having a sense of area

## NZC Level 4

**Identify classes of two- and three-dimensional shapes by their geometric properties**
Know that if two 2D shapes are congruent, corresponding sides and angles are equal
Describe and visualise properties of solid shapes
Use correct vocabulary, notation and labelling conventions for lines, angles and shapes
Know and use geometric properties of cuboids and shapes made from cuboids

**Use side or edge lengths to find the perimeters and areas of rectangles, parallelograms, and triangles and the volumes of cuboids**
Solve puzzles involving 3D shapes and surface area
Practise measuring perimeters of shapes (easier)
Practise measuring perimeters of shapes (harder)
Find area and perimeter
Perimeter
Perimeters of compound shapes
Calculate the perimeter of shapes made from rectangles
Understand and calculate lengths of sides and perimeters given the area
Know and use the formula for the area of a rectangle
Calculate the surface area of cubes and cuboids
Solve puzzles involving 3D shapes and surface area

**Relate three-dimensional models to two-dimensional representations, and vice versa**
Explore nets of 3D shapes

**Convert between metric units, using whole numbers and commonly used decimals**
Use units of measurement to calculate and solve problems in everyday contexts involving length and area
Know and use the relationships between familiar units of length

**NZC Level 5**

**Find the perimeters and areas of circles and composite shapes and the volumes of prisms, including cylinders**
Areas of compound shapes
Calculate the area of shapes made from rectangles (by addition)
Calculate areas of compound shapes made from rectangles and triangles

## Extra Resources

Te Reo Māori words and phrases - https://nzmaths.co.nz/sites/default/files/images/TeMahiMara.pdf

Illustrated Maths Dictionary - https://www.mathsisfun.com/definitions/index.html

**Teacher Notes**

This resource is designed to help support you and your mathematics programme in class. It is not intended as a task where all children complete all tasks, as the concepts cover Levels 1 - 5 of the curriculum, and probably would best suit students already working at Level 2 and up - but we'll leave that to you!

Download this resource, and pick and choose the activities you want, or set as a deep level investigative project for more able students, who have the capability to work both cooperatively and independently.

Make sure you check out the links to individual exercises. Individual lessons and groups of lessons around a particular topic, can now be linked to directly from any of your planning documents of student centred resources. You may want to check out this short video showing you a brief overview of this latest product upgrade/release.

In terms of the tasks presented, here are some guides that we hope will help you, and also promote discussion among your learners.

**Design the Shape of your garden**

- Note the Maths-Whizz Links at the start of the activity that may help students with their independent learning
- We would recommend that you guide students to select regular shapes, as later they may be calculating area. Area calculations of irregular polygons involves calculations at a much higher level than would normally be expected at primary or intermediate school level.
- For younger students, then single regular polygons (square, rectangle).
- For older students encourage them to investigate composite/compound shapes, even circles.
- Composite shapes will enable deeper level investigations around optimisation, where there will be more options for variation of design, minimising cost of construction, and maximising production.
- There are deeper level investigations looking at variables of perimeter and area, and how we can change one without changing the other.
- Encourage group work and cooperative learning for higher ability students, as there will be opportunities for some deep level thinking and sharing of differing ideas here.

**Perimeter**

- Note the Maths-Whizz Links at the start of the activity that may help students with their independent learning
- There are deeper level investigations here looking at different layouts, variables of perimeter and area, and how we can change one without changing the other.
- Encourage group work and cooperative learning for higher ability students, as there will be opportunities for some deep level thinking and sharing of differing ideas here.

**Purchasing**

- Note the Maths-Whizz Links at the start of the activity that may help students with their independent learning
- Later in the project, where students may want to calculate volume (of soil), and prepare a budget (total cost), a suggestion is made that they should make their garden at least 50cm deep. It may be worth mentioning that here.
- Conversations around purchasing are intended to direct students to the fact that in construction, we will often plan and include measurements to the nearest mm, however when purchasing, often we have to buy by the metre. Therefore there may be wastage. We may have to order more materials than we require (to account for offcuts/wastage), but is there any way we can modify our designs to minimise this?

**Area**

- Note the Maths-Whizz Links at the start of the activity that may help students with their independent learning
- Some higher level unit conversions here! Remember that while there are 100 cm in a metre, there are 100 x 100 = 10,000 $cm^2$ in 1 $m^2$.
- Some optimisation questions here that will only be applicable if gardens have dimensions that are not whole metres (assuming that the width of garden mat is in whole metres). You may want to make up some of your own challenges e.g. "How would your calculations vary if the matting was available in 2m widths? 1m widths? 75cm widths?"

**GST**

- Why not introduce some Number work!
- Note the Maths-Whizz Links at the start of the activity that may help students with their independent learning
- Here we will look at percentages, percentage increase, and percentage decrease.
- One of the deeper level thinking tasks that more able students will be encouraged to look at, and explain, is that if you add a percentage amount to an item, and then discount it by the same percentage, you will not end up with the same price your started with! Could promote some interesting discussions here as to why!!
- Looking at the mathematics behind GST inclusive to GST exclusive calculations could involve some deep conversations linking to Level 5 Algebra (Equations) work for more able students. Encourage them to use formulae, and show full working for their calculations.

**Volume**

- Note the Maths-Whizz Links at the start of the activity that may help students with their independent learning.
- Some higher level unit conversions here! Remember that while there are 100 cm in a metre, there are 100 x 100 x 100 = 1,000,000 cm in 1 m . While there are 10 mm in 1 cm, there are 10 x 10 x 10 = 1000 mm in 1 cm $^3$ $^3$
- There is some litre to cubic metre conversions suggested here. It may help to remind students about the following
  1L = 1000 mL = 1000 cm
- Some higher level number concepts also suggested here with ratios, and ratios involving 3 numbers - again your call as to who you may want attempting these sections.

**Planting your Garden**

- Looking at having students do some internet based research here.
- This may prompt some learning conversations around internet searching, how we can get NZ based search results, or how we can get even more localised search results (my area).

**Supplementary Tasks**

- Linked to the activity but not necessarily part of the activity.
- Thinking outside the box stuff, how could these concepts and this learning apply to other situations?
- Essentially, with area optimisation, the closer the shape is to a square, the shorter the perimeter, and the larger the area. With volume, the closer a shape is to a cuboid, the larger the volume, and the shorter the sides.
- Other applications of these concepts - a farmer would be advised to, where possible, construct square paddocks. This would minimise fencing (costs) and maximise area (grass and therefore productivity). Are there any other real life contexts that these ideas would apply to?