YuMi Deadly Maths

Year 9 Teacher Resource:

NA – How does my garden grow?

Prepared by the YuMi Deadly Centre
Faculty of Education, QUT

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YuMi Deadly Maths Year 9 Teacher Resource: **NA – How does my garden grow?**

ACKNOWLEDGEMENT

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Prepared by the YuMi Deadly Centre
Queensland University of Technology
Kelvin Grove, Queensland, 4059

research.qut.edu.au/ydc/

Year 9 Number and Algebra

How does my garden grow?

Learning goal Students will explore the rule for calculating gradient.

Content description Number and Algebra – Linear and non-linear relationships

- Find the midpoint and gradient of a line segment (interval) on the Cartesian plane using a range of strategies, including graphing software (ACMNA214)

Big idea Algebra – patterns; variable/pronumeral

Resources Stimulus picture, 10 blue plastic 30 cm rulers, 5 wooden 30 cm rulers, Maths Mat (6 × 10 squares), coloured elastics, cards to represent numbers on the x and y axes, cards for names of both axes and title of graph (Week, Height in dm, Sunflower's Growth respectively)

Reality

Local knowledge Reflect on the contours of the surrounding countryside. Discuss the various hills/mountains and different slopes encountered in walking from one place to another. Some of the territory may be flat.

Prior experience Check students' understanding of patterns and the Cartesian plane:

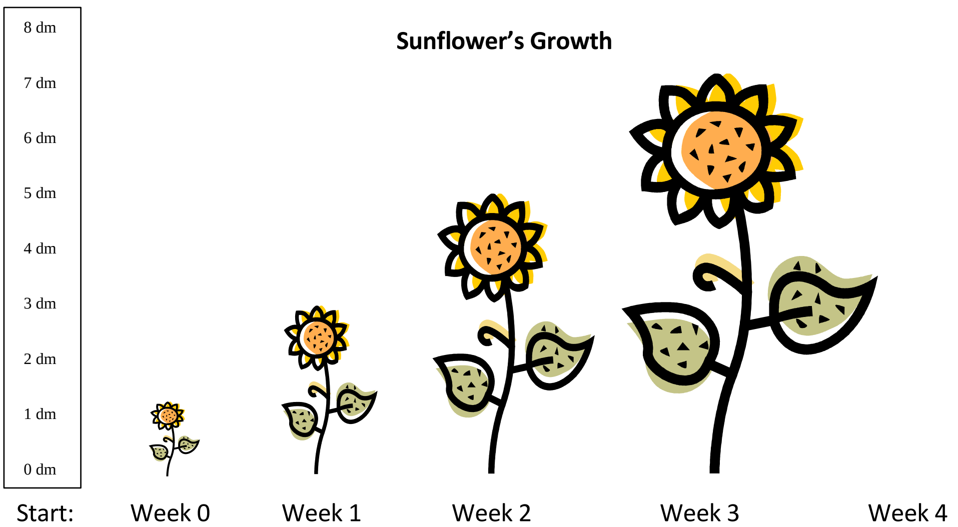
- *What parts need to be identified in growing patterns?* [fixed and growing parts]
- *How can growing patterns be shown?* [models, tables, graphs, algebraic equations]
- *What are the elements of a Cartesian plane?* [4 quadrants positive and negative, x and y axes (named), plotting coordinates, scale, name of the graph]
- *Describe the direction of the x and y axes in the Cartesian plane. How does the order of a pair of coordinates align with the axes?*

Also check they are familiar with decimetres:

- *How many centimetres are in a decimetre?* [10 cm]

Kinaesthetic Show the stimulus picture of the growth of a plant. This is better done using real plants, e.g. grass, corn, peas, beans, cut to the appropriate sizes (e.g. 5 cm, 15 cm, 25 cm, 35 cm) and laying them out in a straight line at ground level on the chart.

When the farmer started to measure the growth of the sunflower (position 0, as it is the starting point for the measurements), it was 1 decimetre (dm) high. A week later it was 3 dm high. The week after that it had grown another 2 dm and at Week 3, the sunflower's height was 7 dm.



Ask students:

- *How is the plant growing? Is it growing at the same rate?*
- *If we drew a line or placed an elastic from the top of the first sunflower to the top of the last sunflower, how would you describe that line?* [It is a straight line passing across the tops of each flower.]
- *Describe the direction of the slope of the plant's growth.* [upwards – positive]
- *If the plant keeps growing at the same rate, predict its height at Week 4. Identify the fixed and growing parts*. [Prediction: 9 dm. When the measurement starts, Week 0, the plant is 1 dm high and each week it grows 2 dm, so the fixed part is 1 dm and the growing part is 2 dm each week.]
- *How can we generalise this?* [The plant was 1 dm when we started to measure it and the growth is double the position or week of measurement.]
- *Write this in algebraic terms (let the number of weeks be x and the height be y)*:

$$y = 2x + 1$$

- *This is called the **position rule equation** and we can use it to find the value of y (in this case, the height) for any position x (in this case, number of weeks).*

Reverse (weeks to height):

- *So we know how to work out the height for any number of weeks, but what if we wanted to work out how many weeks it would take for the sunflower to reach a certain height?* [We can still use the equation, substituting the height for y and finding the value of x, the number of weeks.]
- *Reverse the equation so we can do this.* [$x = \frac{y-1}{2}$]
- *How many weeks will the sunflower take to reach 27 dm (assuming it keeps growing at the same rate)?*

  [Substitute 27 as the y value:

$$x = \frac{(27 - 1)}{2}$$
$$x = 13$$

  It would take 13 weeks.]

Tabulate the coordinates of the sunflower's growth:

Week (x)	0	1	2	3	4
Height in dm ($y = 2x + 1$)	$2 \times 0 + 1 =$ 1 dm	$2 \times 1 + 1 =$ 3 dm	$2 \times 2 + 1 =$ 5 dm	$2 \times 3 + 1 =$ 7 dm	$2 \times 4 + 1 =$ 9 dm

Abstraction

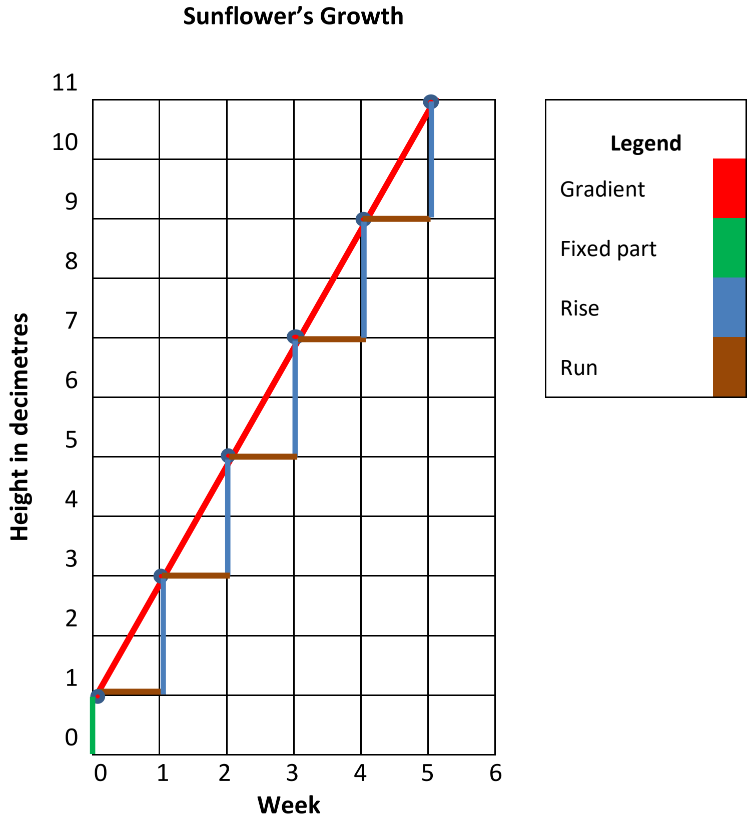
Body

Graph the sunflower's growth

On the Maths Mat starting at the bottom left-hand corner, place number cards 0 to 6 along the x axis to represent number of weeks. Place number cards up the y axis, 0 dm to 11 dm. Students plot the points from the table of coordinates established above and a student stands at each point of intersection.

- *How can we show the slope or gradient of the growth?* [Run an elastic to join the coordinates.]

From each coordinate, place a wooden ruler parallel to the x axis and two blue rulers vertically up the y axis, forming a right triangle with the gradient shown as the hypotenuse of the right triangle thus formed (see diagram below).



The gradient can now be calculated as the height divided by base, in this case: $2 \div 1 = 2$.

- *Gradient = change in vertical quantity ÷ change in horizontal quantity*
- *Gradient = rise ÷ run*
- *Write this in algebraic terms (let the gradient be m)*:

$$m = \frac{rise}{run}$$

- *At what point does the gradient cross the y axis?* [0, 1]
- *So what is the y-intercept?* [1]

Hand

Students represent the above graph with straws, matchsticks or blocks and then on graph paper. Students calculate the gradient using the formula:

$$m = \frac{rise}{run}$$

Ask students to write the position rule equation in the form $y = mx + c$, where m is the gradient and c is the y-intercept.

Mind

Ask students to visualise and project the sunflower's growth in 6, 7, 8 weeks. Trace the gradient on the desk starting from Week 0 when the plant was 1 dm high through to Week 10. *What will the height of the sunflower be now?* [21 dm]

Creativity

Students choose their own context to create a story using words, symbols and pictures to establish connections and relationships in a growing pattern, then tabulate coordinates, graph the slope and calculate the gradient.

Mathematics

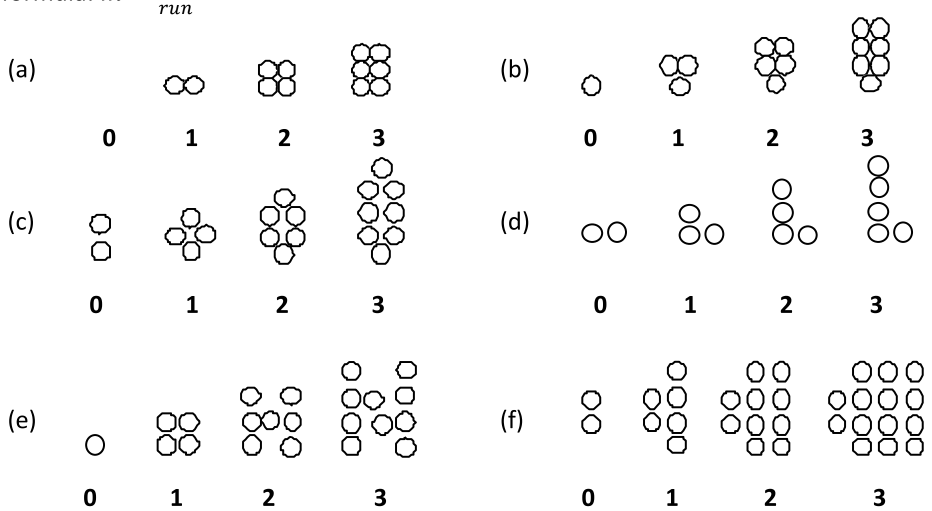
Language/ symbols

slope, gradient, axis/axes, coordinates, rate

Practice

Provide examples of patterns that have fixed growing parts (pattern rule is a linear equation) and are related in a way that enables relationships with regard to graphs and functions to be seen.

Students put the patterns below into a context, tabulate the coordinates, write the equation, graph the points on a Cartesian plane, calculate and show the gradient using the formula: $m = \frac{rise}{run}$



Connections

Connect to variables, equations, intercept, trigonometry.

Reflection

Validation

Students discuss: *Who would want to know the gradient and rate of plant growth?* [farmers, scientists] *Why?* [to establish times for planting and harvesting, to improve the species]

Application/ problems

Provide applications and problems for students to apply to different real-world contexts independently; e.g. problems relating to calculating an appropriate slope for house roofs, ramps for wheelchairs, design jumps for skateboard rinks that cater for different levels of ability, gradients for roads.

Extension

Flexibility. *What if the plant grew at 3 dm each week or it was 2 dm at the start? How could you increase the pitch of a roof?*

Reversing. Students are able to create a context ↔ develop the pattern ↔ draw a model ↔ tabulate coordinates ↔ plot the graph ↔ write the $y = mx + c$ equation ↔ calculate the gradient from the graph or formula, starting from and moving between any given point.

Generalising. The gradient is calculated by dividing the rise by the run and is equal to the coefficient m in linear equations in the form: $y = mx + c$.

Changing parameters. Use the four quadrants of the Cartesian plane. Calculate gradients using $m = rise \div run$ with plots that have negative integer gradients. Explore situations that involve more than one linear function.

Teacher's notes

- The table below relates to the patterns in the Mathematics section above:

PATTERN	COMPOSITION	POSITION RULE	GRAPH CHARACTERISTICS
(a)	Grows by 2, no fixed part, starts with 0	$2n$	Slope 2, y-intercept 0
(b)	Grows by 2, fixed part of 1, starts with 1	$2n + 1$	Slope 2, y-intercept 1
(c)	Grows by 2, fixed part of 2, starts with 2	$2n + 2$	Slope 2, y-intercept 2
(d)	Grows by 1, fixed part of 2, starts with 2	$n + 2$	Slope 1, y-intercept 2
(e)	Grows by 3, fixed part of 1, starts with 1	$3n + 1$	Slope 3, y-intercept 1
(f)	Grows by 4, fixed part of 2, starts with 2	$4n + 2$	Slope 4, y-intercept 2

- Students need to be able to translate the pattern into a linear relationship that identifies the fixed and growing parts before proceeding to tabulate, graph and then calculate the gradient.
- Students need to be taught the skill of visualising: closing their eyes and seeing pictures in their minds, making mental images; e.g. show a picture of a steep hill, students look at it, remove the picture, students then close their eyes and see the picture in their mind, then make a mental picture of a low hill.
- Suggestions in Local Knowledge are only a guide. It is very important that examples in Reality are taken from the local environment that have significance to the local culture and come from the students' experience of their local environment.
- Useful websites for Aboriginal and Torres Strait Islander perspectives and resources: www.rrr.edu.au; https://www.qcaa.qld.edu.au/3035.html
- Explicit teaching that aligns with students' understanding is part of every section of the RAMR cycle and has particular emphasis in the Mathematics section. The RAMR cycle is not always linear but may necessitate revisiting the previous stage/s at any given point.
- Reflection on the concept may happen at any stage of the RAMR cycle to reinforce the concept being taught. Validation, Application, and the last two parts of Extension should not be undertaken until students have mastered the mathematical concept as students need the foundation in order to be able to validate, apply, generalise and change parameters.