YuMi Deadly Maths

Year 8/9 Teacher Resource:

MG – How many people fit in a lift? (volume of a prism)

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YuMi Deadly Maths Year 8/9 Teacher Resource: **MG – How many people fit in a lift?**

ACKNOWLEDGEMENT

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refined and presented in professional development sessions.

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Year 8/9 Measurement and Geometry

How many people fit in a lift? (volume of a prism)

Learning goal	Students will determine the volume of a person using approximation.
Content description	Measurement and Geometry – Using units of measurement • Develop formulas for volumes of rectangular and triangular prisms and prisms in general. Use formulas to solve problems involving volume (ACMMG198) (Year 8) • Solve problems involving the surface area and volume of right prisms (ACMMG218) (Year 9)
Big idea	Measurement – area, volume, prisms (rectangular or cylinder), approximation
Resources	Metre rulers or measuring tapes; masking tape or chalk (to mark out a space on the floor/ground; 1 cubic metre kit set up in the classroom (if your school doesn't have one you can buy them from maths equipment suppliers or make it from 12 one-metre pieces of dowel and putty – see picture next page)

Reality

Local knowledge and Prior experience

Have you been in a lift (elevator)?

Show students this YouTube video about how an elevator works:
https://www.youtube.com/watch?v=CeOklEyUw0I (3:47 min)

How many people do you think can fit in a lift? What does it depend on?

Lifts often state their maximum capacity in mass (kg) or in number of people or both, as in this picture.

In the lift in this picture, what would be the average weight of a person in the lift if there were 25 people and their total mass was 1700 kg? Is that very heavy for an adult?

Is the limiting factor going to be the number of people that can fit into the lift or the mass of the people?

The dimensions of this lift are a floor space of 231 cm (2.31 m) × 157 cm (1.57 m) and height of 220 cm (2.20 m). Do you think 25 people could fit into this lift comfortably? We are going to investigate this.

Note: This context may not be at all relevant to your students. In this case think of a different context where people are standing close together that your students could relate to. For example: an outdoor or indoor event where people are standing together such as a mosh pit at a concert.

Abstraction

Body/Hand

Could 25 people fit in this lift?

We are now going to replicate the lift cabin in the classroom (as best we can).

- Choose a known lift and measure the dimensions. If you don't have access to one, the lift in the above picture has a floor space of 231 cm by 157 cm and a height of 220 cm (2.31 m × 1.57 m × 2.20 m). You can reveal the height of the lift later, after students estimate the volume of the cabin.
- Mark this area out on the floor. If possible, place it next to a wall so you can measure the height of the lift more easily.
- Get students to stand in the space you have marked out on the floor. *How many students can comfortably stand in the space? Is it equal to the capacity shown on our lift?* (in this case 25) *What else do people carry into a lift?* [Bags] If you like, experiment with students taking their school bags into the lift with them.

What is the volume of the lift cabin?

We have just looked at the area of the floor of the lift but when we discuss how many people can fit in a lift, what are we referring to? [volume, capacity]. Take the opportunity to discuss the meaning of the words volume and capacity.

If you have a 1 cubic metre unit set up, students have a visual guide for their estimation.

Estimate the volume of the lift (you will need to estimate the height). Now calculate the volume from the dimensions and compare with your estimate.

What is the volume of each person?

Ask students to estimate the volume of their body. *Is it 1 metre cubed?* (more or less?)

How can we approximately determine the volume of the body? Organise students into small groups to brainstorm ways to do this. Some ideas:

- Find the volume of one body – as a rectangular prism.
- Find the volume of the lower portion of the lift (where the people are) and divide by the number of people in the lift.
- Accept other options that students present and discuss the strengths and weaknesses of the different approaches.

Working in small groups, students measure and calculate the volume of one person as a rectangular prism.

Note: If you have already completed the Year 9 *Total body surface area* activity, students may suggest using the dimension prisms developed for surface area to now calculate volume.

Mathematics

Language/ symbols

dimensions, length, width, height, area, volume, capacity, surface area, millimetres (mm), centimetres (cm, cm^2, cm^3), metres (m, m^2, m^3), prism (rectangular), cubic metre, litres

Practice

Discuss the different results and come to a final agreed estimation, justifying your choice. As part of this process:

- Consider averaging the class results.
- Find a value you have researched online.
- Compare your result to your initial estimation.

Connections	Connect units for length and volume (cm, cm^3 and m, m^3) with those for capacity (litres) and look at conversion between units (1 cubic metre equals 1000 L). Convert the volume of the body in square metres to volume in litres.

Reflection

Validation	Compare the class's calculated results with researched results. How can you account for any differences?
Application/ problems	Provide applications and problems for students to apply to different real-world contexts independently; e.g. Investigate formulae for the relationship between the volume of a human body in litres and the mass in kilograms. For adult males, the formula is: Volume (L) = 1.015 × Mass (kg) – 4.937 http://stats.areppim.com/glossaire/bodyvol_def.htm
Extension	**Flexibility**. *S*tudents are able to apply the general formula to calculate the volume of any prism that has the base of a regular quadrilateral or triangle. From the volume and two other dimensions, they can find the third dimension. **Reversing**. *S*tudents are able to move between calculating the volume ↔ finding a missing dimension ↔ calculating the increase or decrease in volume given an increase or decrease in one dimension, starting from and moving between any given points. **Generalising**. *The volume of a regular prism is found by multiplying the area of the base by the height. The base layer is repeated throughout the height of the prism. A cross-section parallel to the base will always be congruent with the base.* **Changing parameters**: • Compare the volume of a child to an adult, using classroom calculations and researched figures. • Investigate the body surface area calculator: http://stats.areppim.com/calc/calc_bsa.php

Teacher's notes

- Be sure to research the approximate value of the volume of the human body, in both cubic metres and litres, so you have an idea of what is a reasonable estimate; it's probably smaller than you think.
- 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.
- 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 3D shape, 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 different 3D shape.
- 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.