

Re-igniting the spark

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Source Education & Consulting

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Example problem

Level: Junior or middle secondary

Self-generated modelling

(IM²C) international
mathematical
modeling
challenge

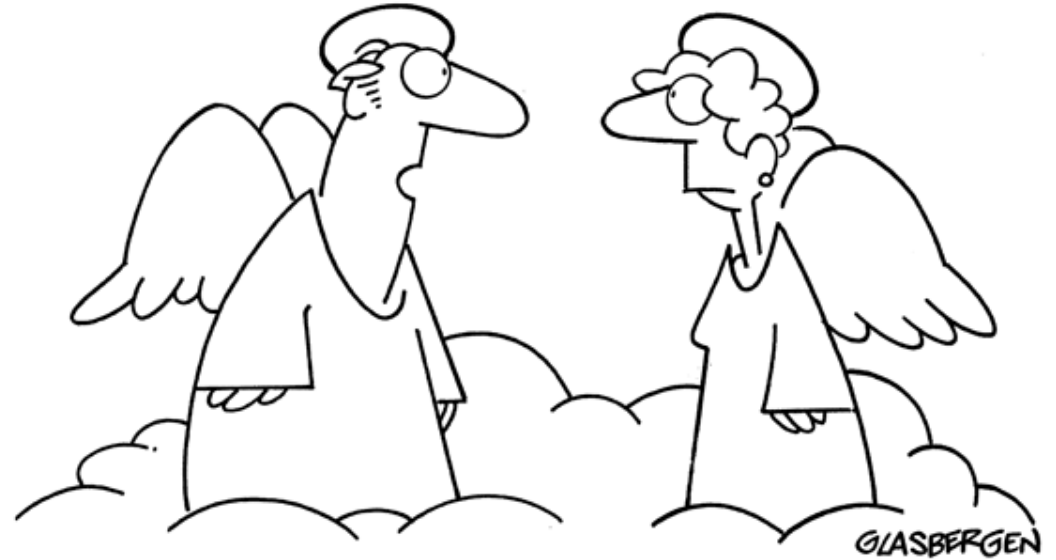
Howzat!



Courtesy of Teaching Mathematics and its Applications

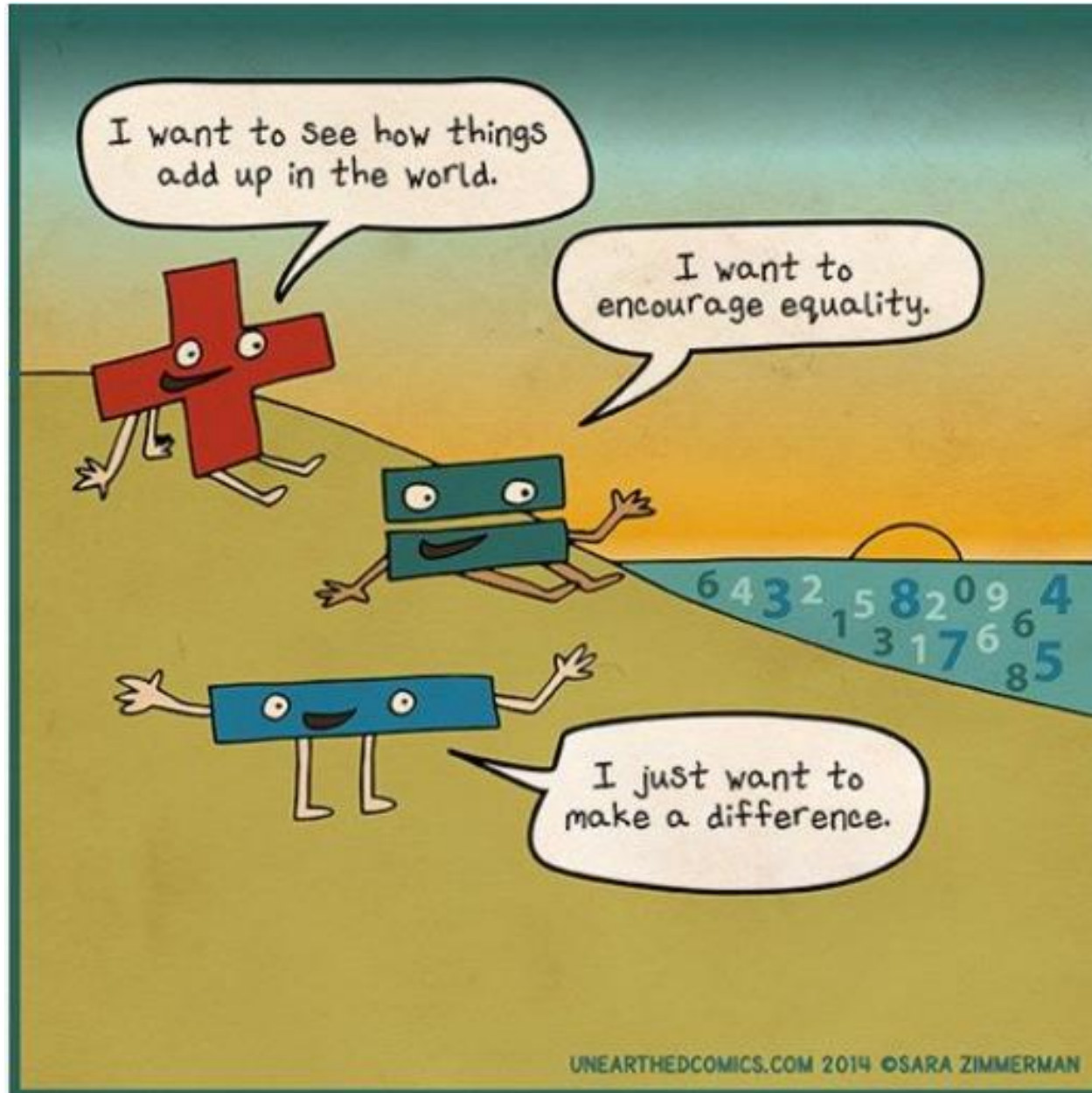
https://www.immchallenge.org.au/files/IM2C_sample_problem_Howzat.pdf

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www.glasbergen.com



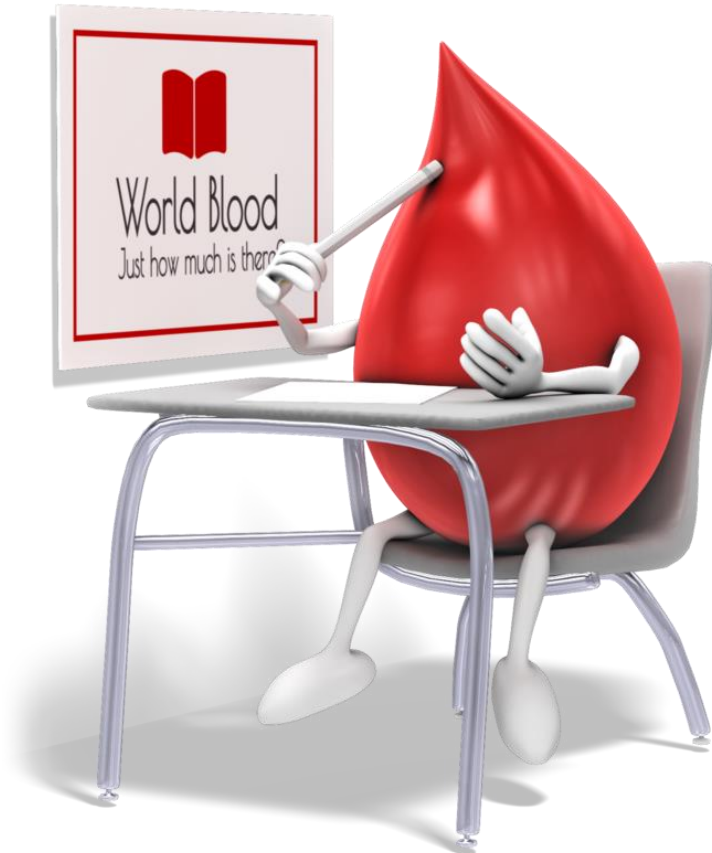
**“In 1953 you were my math teacher. You promised
that algebra would come in handy someday.
How much longer do I have to wait?”**





Just how much?

How much human blood is there in the world right now?



What did you do? How did it feel?

Amount of blood in an average person: Between 4.5L to 5.7L

(<https://www.healthline.com/health/how-much-blood-in-human-body>)

$$\therefore \text{Average in a human} = \frac{4.5+5.7}{2} = 5.1 \text{ L}$$

Current number of humans in the world $\approx 8,090,964,900$

$$\begin{aligned} \text{Total amount of blood in humans in the world} &= 5.1 \times 8\,090\,964\,900 \\ &= 4.0455 \times 10^{10} \text{ L} \end{aligned}$$



What did you do? How did it feel?

Blood capacity of an average adult = 5 L

Blood capacity of a baby = 270 mL

Blood capacity of a child = 2.65 L

Blood capacity of a pregnant woman = $1.4 \times$ blood capacity of an average adult

World population 25 May 2023 = 8 035 million

Number of children < 5 = 656.64 million

Number of pregnant women = 21 million

Blood in blood banks = 118.54 million donations per year

Blood donation size = 470 mL

Amount of blood

$$= (8\,035\,000\,000 - 656\,640\,000) \times 5 + 656\,640\,000 \times 2.65 + 21\,000\,000 \times 0.4 \times 5 + 118\,540\,000 \div 365 \times .047 \text{ L}$$

$$= 3.86 \times 10^{10} \text{ L}$$



How shall we measure achievement?



What achievement did we demonstrate?



Amount of blood in an average person: Between 4.5L to 5.7L
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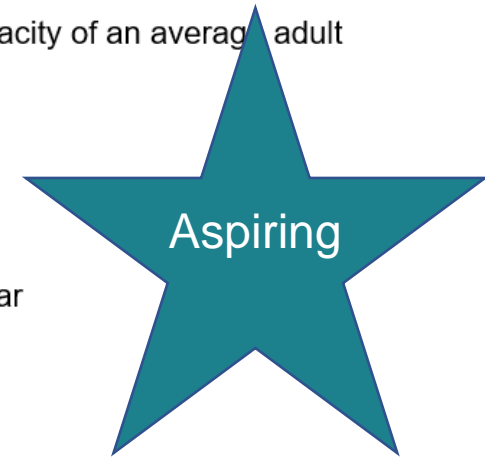
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Where could we go?

Amount of blood in an average person: Between 4.5L to 5.7L

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$$\begin{aligned} \text{Total amount of blood in humans in the world} &= 5.1 \times 8\,090\,964\,900 \\ &= 4.0455 \times 10^{10} \text{ L} \end{aligned}$$

What is the size of that amount of blood?

In ML = 40 455 ML

500 gigalitres =
1 Sydharb



SYDNEY DAM LOCATIONS

Last Updated: 05 Jun

Click on a dam to see detailed graph

| Storage | Capacity. (ML) | Level |
|----------------|----------------|--------|
| Sydney | 2399424 | 94.2% |
| Warragamba | 1958858 | 96.6% |
| Avon | 124604 | 84.9% |
| Cataract | 71701 | 73.8% |
| Cordeaux | 81848 | 87.4% |
| Woronora | 70829 | 98.7% |
| Nepean | 55610 | 82.1% |
| Tallowa | 8046 | 107.3% |
| Wingecarribee | 18240 | 75.6% |
| Fitzroy Falls | 6989 | 70.2% |
| Blue Mountains | 2699 | 93.4% |



<https://www.eldersweather.com.au/dam-level/nsw>



Where could we go?



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Aspiring



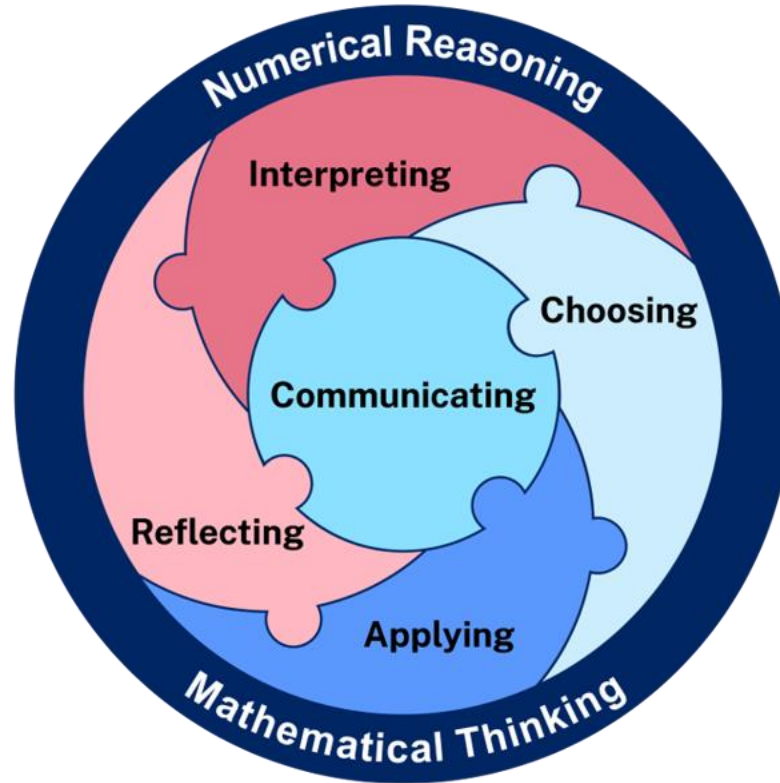
Our actions...cognitive verbs



- Reflect on the activity you have just completed and identify the cognitive verbs that relate to how you approached the situation.
- Create a personal network of terms that shows how you proceeded through the cognitive challenge. *You can revisit verbs, create loops and cycles but do not introduce new verbs.*
- As a table group, determine an agreed set of actions that you all engaged in.



The birth of NRMT



What evolved is a...

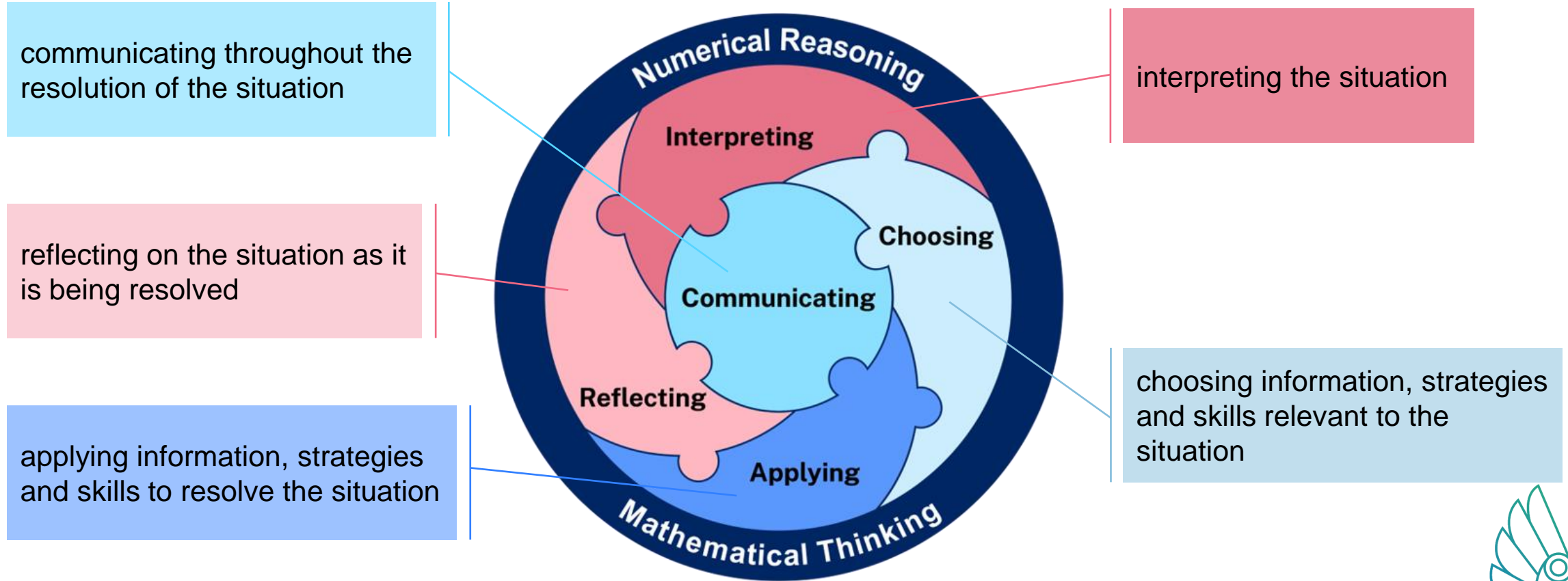
Unicorn



<https://mashupmath.com/blog/math-cartoon-unicorns>



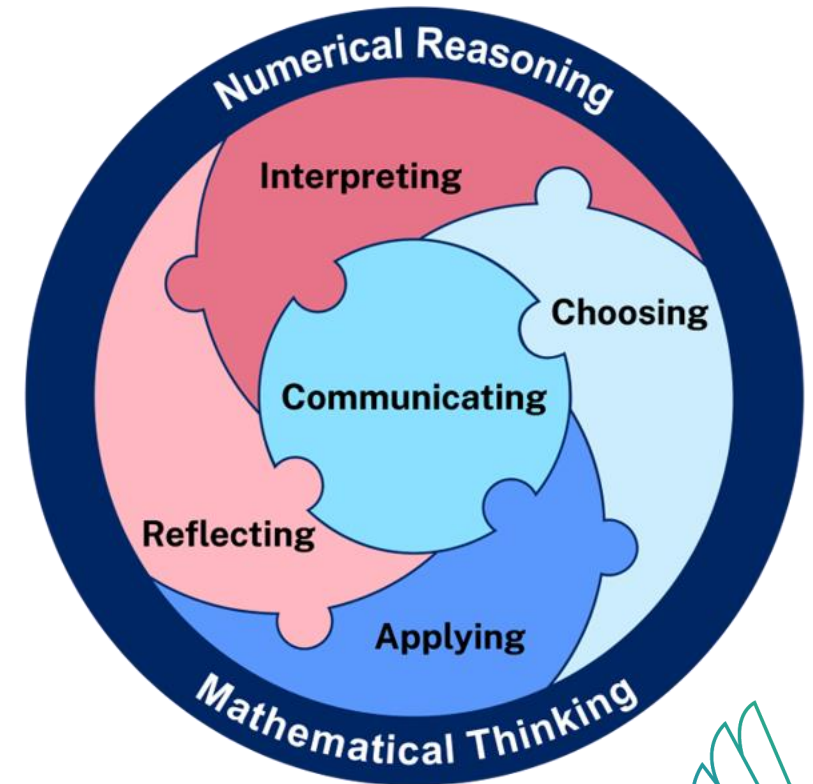
The Numerical Reasoning and Mathematical Thinking (NRMT) process



The NRMT process

The NRMT process includes the following steps:

- interpreting the situation
- choosing information, strategies and skills relevant to the situation
 - the strategies suitable to the situation
 - the types and sequence of decisions and calculations required
 - whether an estimation or accurate answer is needed, and the level of accuracy required
 - how to perform the calculations required: mental processes, by-hand, using technology, working/collaborating with others
- applying information, strategies and skills to resolve the situation
- reflecting on the situation as it is being resolved
- communicating throughout the resolution of the situation.

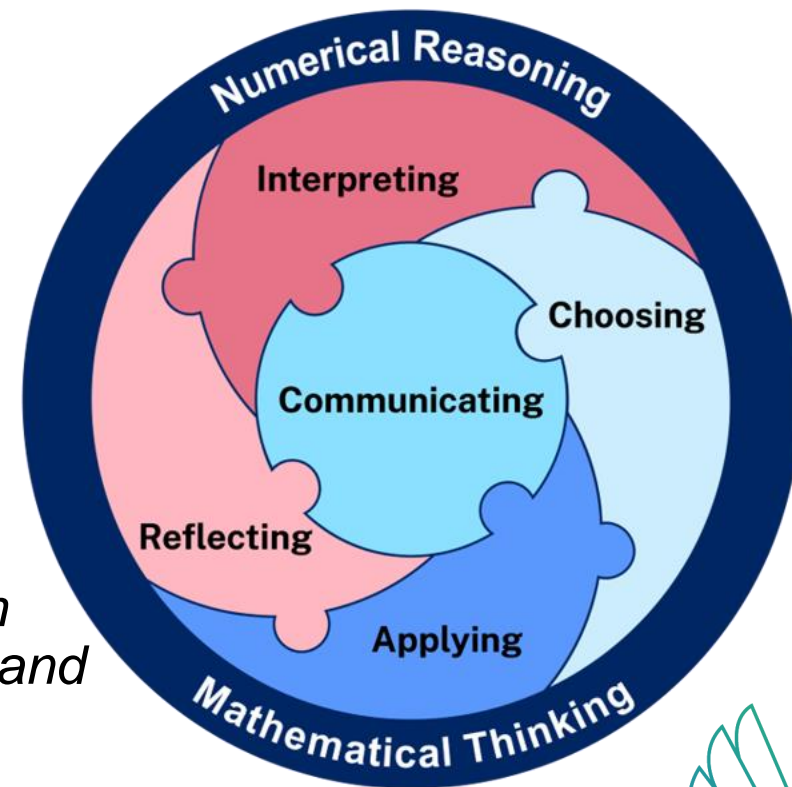


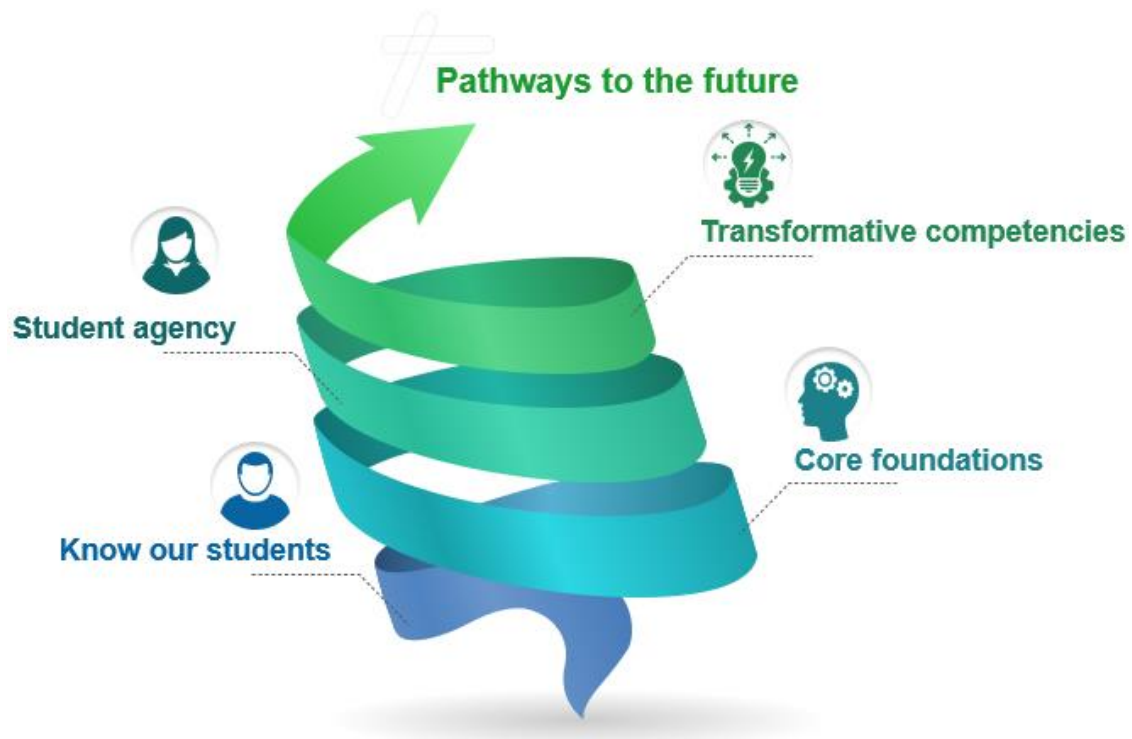
Is NRMT just WM in disguise?



MAO-WM-01 Working mathematically

- develops understanding and fluency in **mathematics** through exploring and connecting **mathematical** concepts, choosing and applying **mathematical** techniques to solve problems, and communicating their thinking and reasoning coherently and clearly





The Sun model

The light is brightest when we shine together



Accessed at: <https://www.oecd.org/education/2030-project/teaching-and-learning/learning/student-agency/>

Interacting differently – flexible thinking

It is not that the low achieving students know less mathematics, but that they interact with mathematics differently.

Gray and Tall (1994)

| Low-achieving students | High-achieving students |
|---|--|
| <ul style="list-style-type: none">▪ Rely on memorising facts▪ Fixed thinking▪ Formal procedures | <ul style="list-style-type: none">▪ Use number sense▪ Approach numbers flexibly |

*A critical thinking process that is exhibited when the learner remains **open to multiple possibilities**, ideas, or hypotheses, particularly early during a critical thinking problem when information and evidence is being gathered.*

*Also exhibited when learners **incorporate the thinking of others** into their own during collaborative critical thinking activities.*

IGI Global



Engagement

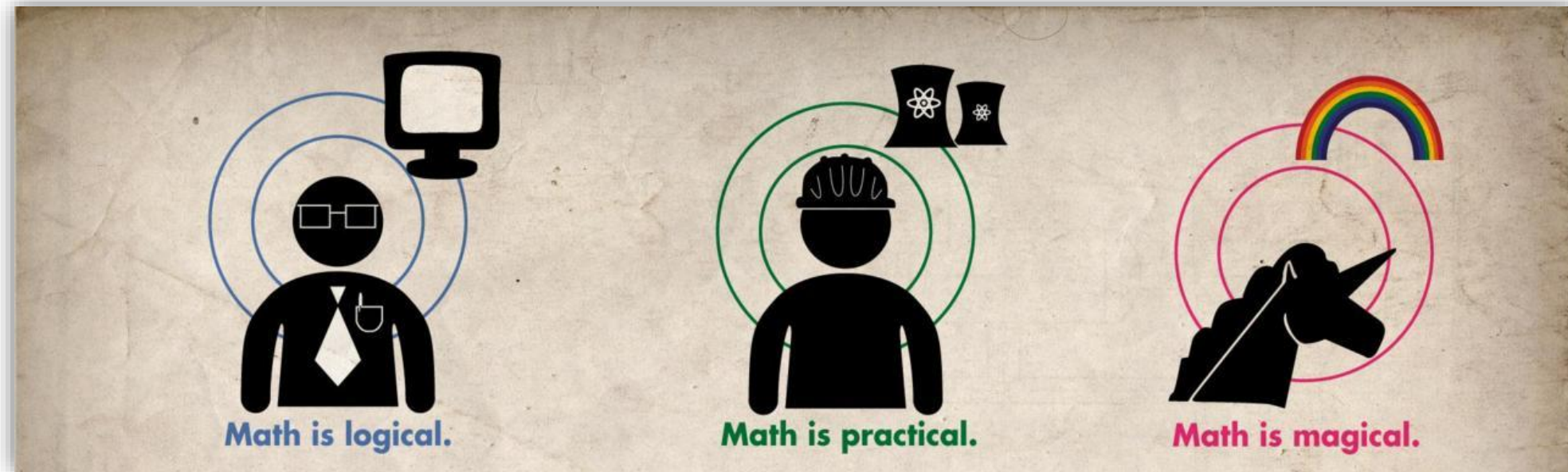
- How will you motivate and challenge each individual student?

Representation

- How will you present information so that it is equally perceptible and accessible to all students?

Action and Expression

- What variability can you offer your students in the way they will demonstrate their knowledge, skills and understanding?



See, play, learn!

*Play is the
highest form
of research.*

Albert Einstein

Target number is 23.

The first player chooses a whole number from 1 to 5.

Players take turns to add a whole number from 1 to 5 to the running total.

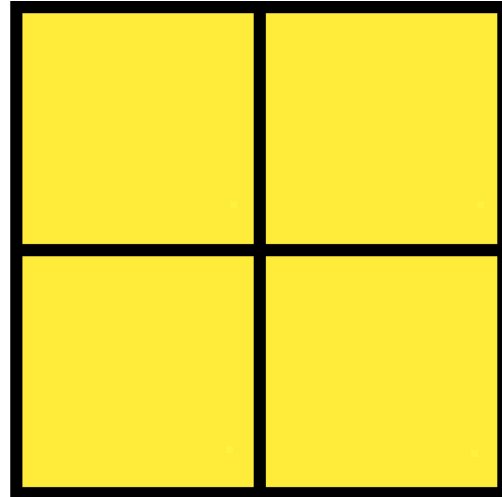
The player who hits the target is the winner.



Which one doesn't belong?

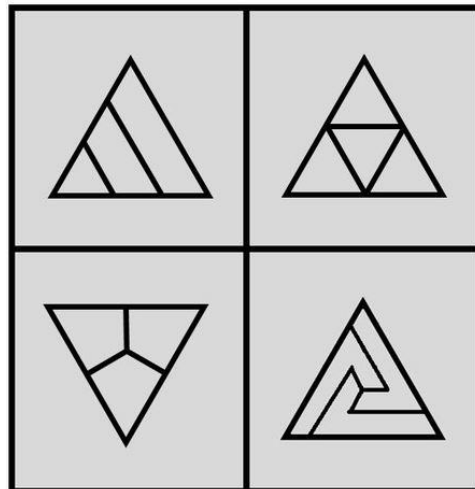
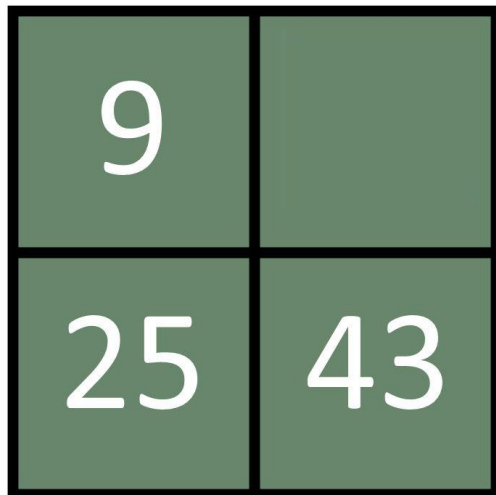


<https://imgflip.com/i/1alqra>



Taking WODB to the next level

- **Incomplete sets**
 - design a item for an empty square
- **Create a WODB set**
 - ideally all squares should be equally likely to be chosen
 - each square should have a reason not to belong
 - interesting
 - appropriately challenging



What do you need?

Below are eight clues that can be used to find a certain number on the hundred square grid.

Four of the clues are necessary to find it, and four of the clues are true but do nothing to help in finding it.

Which of the clues are not helpful? And what is the number?

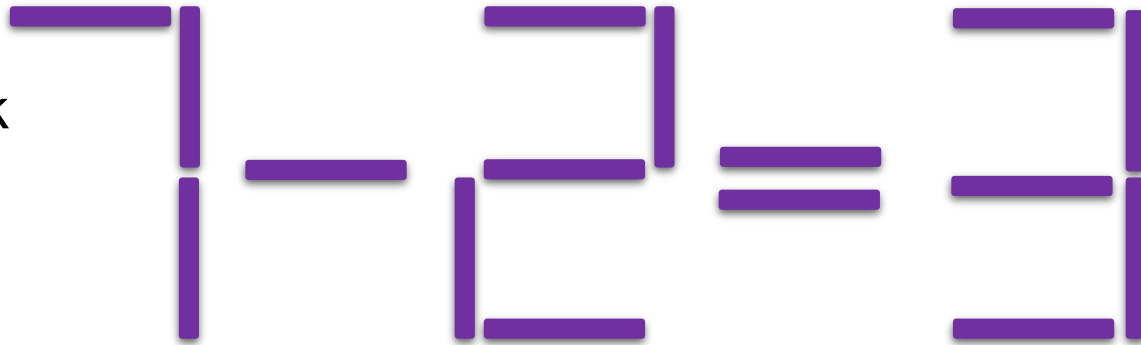
1. The number is greater than 9.
2. The number is not a multiple of 10.
3. The number is a multiple of 7.
4. The number is odd.
5. The number is not a multiple of 11.
6. The number is less than 200.
7. The ones digit is larger than its tens digit.
8. The tens digit is odd.

| | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|-----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
| 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 |
| 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |



A simple shift

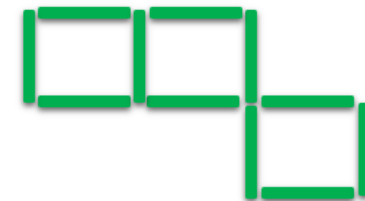
Move 1 stick
to fix the
equation



Move 1 stick
to fix the
equation



- **Different operations**
 - e.g. 2 sticks: $4 \times 9 = 46$
- **More operations**
 - e.g. 1 stick: $8 + 3 - 4 = 0$
- **Shapes instead of numbers**
 - e.g. turn 3 squares into 2



Explore the unusual...how to move a zoo!

- Sydney's first public zoological garden was established in 1879 in Moore Park, where Sydney Boys HS and Sydney Girls HS are now located.
- In 1916 the zoo moved to Mosman and was named Taronga Zoo.



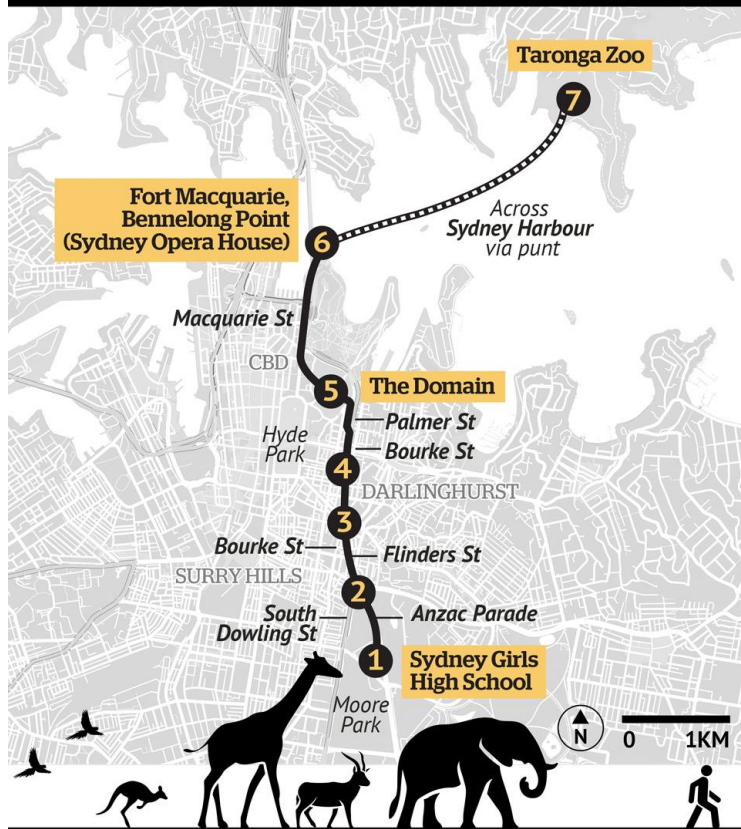
Imagine you are part of a team of logistics officers involved in the 1916 relocation project. What are some of the key questions you need answered in order to begin the task?



Explore the unusual...how to move a zoo!

If I could walk with the animals...

How a zoo was moved from Moore Park to Taronga



<https://sydneylivingmuseums.com.au/stories/story-how-move-zoo>

<https://www.9news.com.au/national/sydney-taronga-zoo-animals-move-moore-park-museum-of-sydney-pictures/ec83e1bb-df56-4fc6-bfd3-7af9ccdf8bec#8>

<https://www.smh.com.au/national/nsw/how-do-you-move-a-zoo-if-you-are-an-elephant-you-go-on-tiptoes-with-a-fairy-tread-20210923-p58ub5.html>

Tiny Oz Episode 1

Trailer – https://www.youtube.com/watch?v=vTYJ_FGUZmg



Explore the unusual...operating a zoo!

The animals

- How many animals of each species are there?
- How much space does the animal need?
- How many continents are represented?
- How much food is required for a specific animal?
- How much does it cost to feed the animals?
- Estimate the cost of feeding a meercat for a year.

The amenities and employees

- Compare the amount of chips served on a weekday to the weekend.
- How many types of amenities are there? What does this tell us about demand?
- How many people are employed at the zoo?
- What are the job opportunities? How likely is it to be employed in each role?
- How much does a zoo employee get paid?
- Explore the working hours of employees.



Seizing opportunities...outside the box

How big could the stack of tickets be?
What could it look like physically?



How big could the stack of tickets be?



About

Powerball is a weekly Australian lotto game played every Thursday night.

In Powerball there are two barrels of numbers. The first barrel holds 35 balls numbered from 1 to 35 inclusive. The second barrels holds 20 balls numbered from 1 to 20 inclusive.

From the first barrel 7 winning numbers are selected. From the second barrel one number, called the Powerball is drawn.

To win Division 1 you must match all 7 winning numbers plus the Powerball in a single game.

Odds

The chance of winning a Division 1 prize in Powerball is 1 in 134,490,400. The chance of winning any division prize with a single game in Powerball is 1 in 44.

<https://www.ozlotteries.com/powerball>

Assumptions:

- only one game per ticket
- only win if get first division

What do we need to know in this situation to find the stack height?

- Number of tickets
- Thickness of a ticket



How big could the stack of tickets be?



- ❑ Number of tickets

1 in 134,490,400 chance of winning
So assume 134,490,400 tickets sold

- ❑ Thickness of a ticket

? Guess thickness \approx ? ...say 1 mm

? Relate it to something we know ...

– a ream contains 500 sheets of paper and has a width of approximately 5 cm

1 sheet $\approx \frac{5}{500} \approx 0.01$ cm

– a pack of 52 cards has a width of approximately 1 cm

1 card $\approx \frac{1}{52} \approx 0.02$ cm

Assumptions:

- only one game per ticket
- only win if get first division

What do we need to know in this situation?

- ❑ Number of tickets

- ❑ Thickness of a ticket



How big could the stack of tickets be?



- ❑ Number of tickets

1 in 134,490,400 chance of winning
So assume 134,490,400 tickets sold

- ❑ Thickness of a ticket

? Guess thickness \approx ? ...say 1 mm **Too big**

? Relate it to something we know ...

– a ream contains 500 sheets of paper and has a width of approximately 5 cm

1 sheet $\approx \frac{5}{500} \approx 0.01$ cm **Too small**

– a pack of 52 cards has a width of approximately 1 cm

1 card $\approx \frac{1}{52} \approx 0.02$ cm **Just right**



How big could the stack of tickets be?



- ❑ Number of tickets – 134,490,400 tickets sold
- ❑ Thickness of a ticket – 0.02 cm
- ❑ Height of ticket pile



$$\begin{aligned} \text{Height} &= 0.02 \text{ cm} \times 134\,490\,400 \\ &= 2\,689\,808 \text{ cm} \\ &= 26\,898 \text{ m} \\ &= 26.89 \text{ km} \end{aligned}$$



Keeping it real!



<https://www.7eleven.com.au/products>



HOW BIG DO YOU THINK A LARGE SHOULD BE?

<https://www.aol.com/article/2014/10/27/mcdonalds-cup-sizes-around-the-world/20984430/#slide=3055345#fullscreen>



Numeracy springboards

<https://educationstandards.nsw.edu.au/wps/portal/nesa/11-12/stage-6-learning-areas/stage-6-mathematics/numeracy-cec>

Data, graphs and tables

Study the infographic, [Growing trends in wearable technology](#).

Design and conduct a survey to discover what types of wearable technology are most appealing to people. Factors such as age, gender and interests may influence this.

- Describe who will be surveyed and how they will be grouped.
- Include images and information with questions so respondents can give meaningful answers.

Use the data from the survey to form an argument for purchasing a form of wearable technology.

Measurement

Design and perform an experiment to test the accuracy of a fitness or activity tracker. Tests could include step count, distance, elevation, speed, etc. The experiment should test the tracker under a number of different conditions: where it is worn, terrain, activity intensity, ...

- How accurate do you think the tracker will be?
- List the measurements to be tested, eg step count, metres, average speed.
- Describe the way measurements for comparison with the tracker will be taken.
- Create a display that compares tracker and test measurements.
- Comment on the reliability of the tracker under different conditions.

Location and operations

Many devices and apps allow location sharing.

- Investigate the risks and benefits of this and present findings in a table of pros and cons.
- Attach a rank or rating to each finding and use these to argue for or against location sharing.

Numeracy Springboard Wearable tech*

(*including Apps)



Probability

Wearable tech is being used to reduce the probability of workplace fatigue and injury, for example, [Ford assembly line workers testing the EksoVest](#), and wearable [drowsy-driver](#) alerts.

- Research workplaces or situations where the probability of fatigue and/or injury is being reduced by wearable tech.
- Research can stem from workplaces and situations, or from device descriptions such as, [10 wearables that could save your life](#).

Space and design

Wearable technology is constantly evolving. Investigate key design elements of two, different wearable tech items:

- annotate images of the two items, showing the key design features
- compare and contrast the 'wearability' of each item, such as: weight, dimensions, appearance, variety of style options.

Based on this research, design an alternative version of one of the products, or a new wearable tech idea. Use an isometric, perspective, oblique or exploded drawing technique to show its details.

Finance

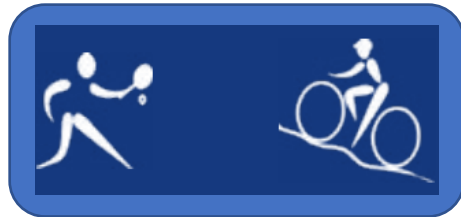
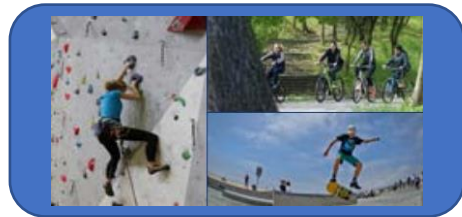
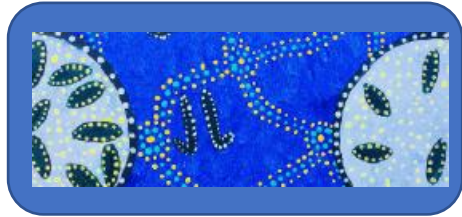
Many fitness and health tracking apps have free and paid versions. Select one to research online.

- Compare the features of the paid and free version, for example, what is measured, what data is accessible, how data can be used.
- Do you believe the paid version is value for money? Justify your opinion.

Select an example of existing, wearable tech to test the statement: 'Wearable tech will save you money.'

- What is the purpose of the wearable tech and what does it cost?
- What expenses could it replace or reduce and what do those things usually cost?

Numeracy Springboards





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EDUCATION & CONSULTING

Thank you

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