Making Mathematical Games Meaningful

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University of Canberra

Canberra Mathematics Association

Annual Conference 2026

What makes mathematical games "meaningful"?

~~*What makes mathematical games "meaningful"?*~~

What makes games "mathematical meaningful"?

Let’s play a game

The aim of the game PRIME DICE is to get the highest score.

https://resolve.edu.au/

There are six rounds in the game. You must roll the prime factorisation of six numbers that have the properties listed below. You can record only one number in each category.

Category	Score for the category
A number to the 4th power	The product of the prime numbers showing on the dice
A number ending in double zeros	This roll scores 500 points
A number ending in one zero	The product of the prime numbers showing on the dice
Square	The product of the prime numbers showing on the dice
Odd	The product of the prime numbers showing on the dice
Even	The product of the prime numbers showing on the dice

How to Play

Players take turns. On your turn, you may have up to two rolls.

First roll:

- Roll the prime dice.
- Think about the product of the numbers rolled.
- Consider which scoring categories the product could fit into.

Second roll (optional):

- You may re-roll any or all of the dice to improve your score.
- You may choose not to roll again if you are satisfied with your first result.
- Your score is the product of the dice (unless the product ends in “00”).

The game finishes when all players have filled all six sections on their scorecard.

You can record only one number when it is your turn.

You can score only once in each category.

You can roll the dice again only once during each turn.

If your product doesn’t fit any of the remaining categories, you must choose a remaining category and assign it a score of zero.

Prime Dice

Is it a mathematical meaningful game?

Why, or why not?

WORTHWHILE TASKS NCTM, 2010	**COGNITIVE DEMAND** Stein et al., 1996	**INQUIRY-BASED TASKS** Jaworski, 2015

• Focuses on important mathematical ideas
• Provides students with the opportunity to engage in higher-order thinking and problem solving
• Contributes to students' development of conceptual understanding of mathematics
• Should allow students to solve the problem using multiple solution strategies
• Has more than one solution and supports students' use of alternative strategies and perspectives to defend their solutions
• Promotes students' engagement and discourse
• Enables students to make meaningful connections to other important mathematical ideas
	• Higher-level demands - Procedures with connections
	  • Generalised understanding of procedures by connecting to underlying concepts and ideas
	  • Represented in multiple ways
	  • Require some level of cognitive effort
	• Higher-level demands - Doing mathematics:
	  • require complex non-algorithmic thinking
	  • require students to explore and understand the mathematics
	  • demand self-monitoring of one's cognitive process
	  • require considerable cognitive effort and may involve some level of anxiety because solution path isn't clear
		• Inspire involvement
		• Provide access to mathematical ideas
		• Enable everyone to make a start
		• Provide opportunity to ask questions, solve problems, imagine, explore, seek generality, test conjectures, express and formulate
		• Encourage discussion and reasoning, diverse directions and levels of thinking, fluidity and flexibility
		• Encourage student ownership in/of the mathematics

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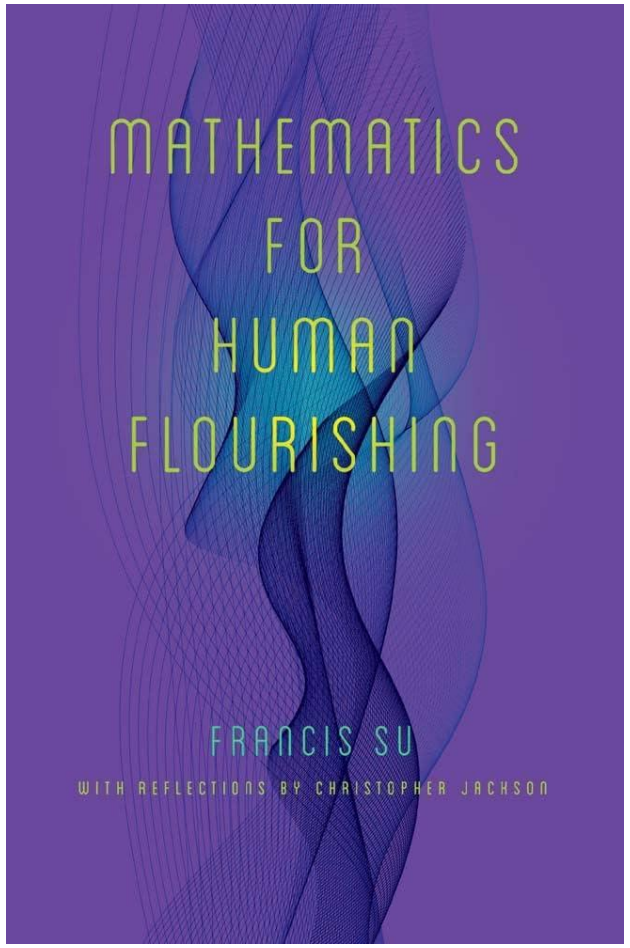

*"**Exploration** and **understanding** are at the heart of what it means to do mathematics."*

Francis Su

AC:M - Proficiency in Mathematics

Understanding – *"…build and refine a robust knowledge and understanding of mathematical concepts and procedures."*

Fluency – *"…carry out procedures flexibly, accurately, efficiently and appropriately, and apply knowledge and understanding of concepts readily."*

Reasoning – *"…developing an increasingly sophisticated capacity for logical thought and actions, such as analysing, proving, experimenting, modelling, evaluating, explaining, inferring, justifying and generalizing."*

Problem Solving – *"…Students engage in mathematical problem solving when they are presented with a problem situation for which they do not immediately know the answer, and they work through a process of planning, applying strategies and heuristics to find a solution to the problem, reviewing and analysing their solution."*

Meaningful mathematical games

Meaningful mathematical games, puzzles and tasks:

- Build students' **understanding** of important mathematical ideas
- Engage students in genuine mathematical **inquiry**

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Building Understanding

"[An] appreciation of mathematical structure is vital for understanding"

(Mason et al. 2009, p. 12)

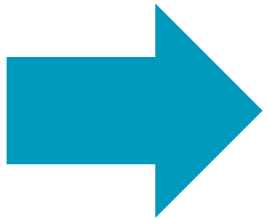
What is mathematical structure?

Building Understanding

We take mathematical structure to mean the identification of general properties which are instantiated in particular situations as relationships between elements.

(Mason et al. 2009, p. 10)

Exploring particular situations to notice regularity (patterns) and relationships

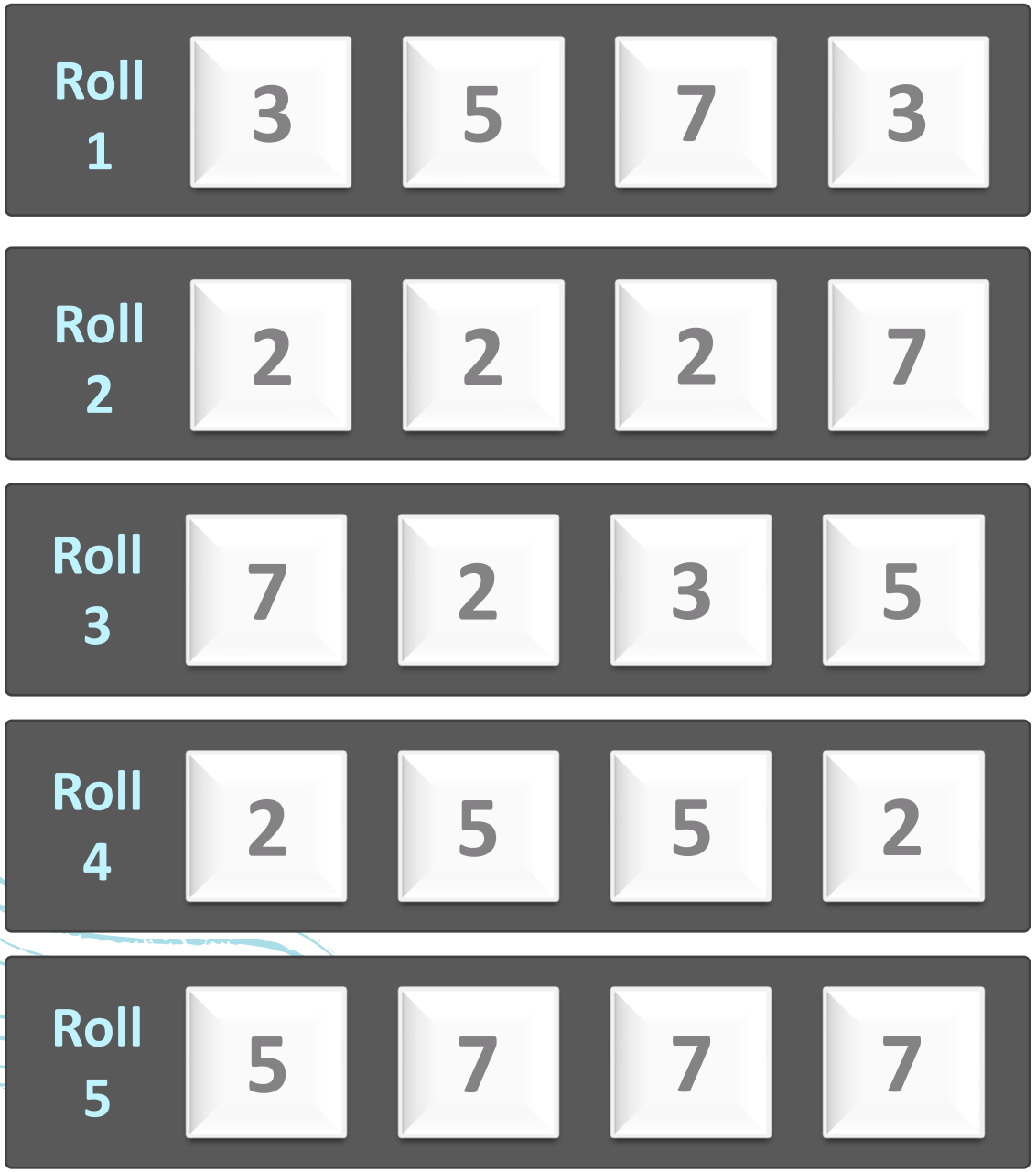


Using regularities (patterns) and relationships to identify general properties

Building Understanding

A focus on mathematical structure means a focus on:

- **Noticing** means *seeing with interpretation* (Chapman & Tripet, 2024)
- **Patterns** are the regularities we notice
- **Relationships** show how mathematical elements connect or influence one another
- **Properties** are the general mathematical rules or truths that describe how mathematical objects behave and help explain why patterns and relationships occur



Category
A number to the 4th power
A number ending in double zeros
A number ending in one zero
Square
Odd
Even

- Are there particular rolls that fit well into specific categories?
- Which dice would you choose to roll again?
- How did you decide?

Time for a puzzle

- Change between addition and subtraction to make 27
- Change between addition and subtraction to make 15
- Change between addition and subtraction to make 12

https://resolve.edu.au/

What did you notice?

The effect of “flipping” a tile on the final sum is twice the value of that tile

$10 + 9 + 8 - 7 + 6 + 5 - 4 - 3 - 2 + 1 = 23$

$10 + 9 + 8 - 7 + 6 + 5 + 4 - 3 - 2 + 1 = 31$

Creating the desired sum with a few tiles means the other tiles need to add to 0

$\underbrace{10 + 9 + 8}_{27} \underbrace{- 7 + 6 + 5 - 4 - 3 + 2 + 1}_{0} = 27$

You cannot make 12!

- What can’t you not make 12?
- What other numbers cannot be made?

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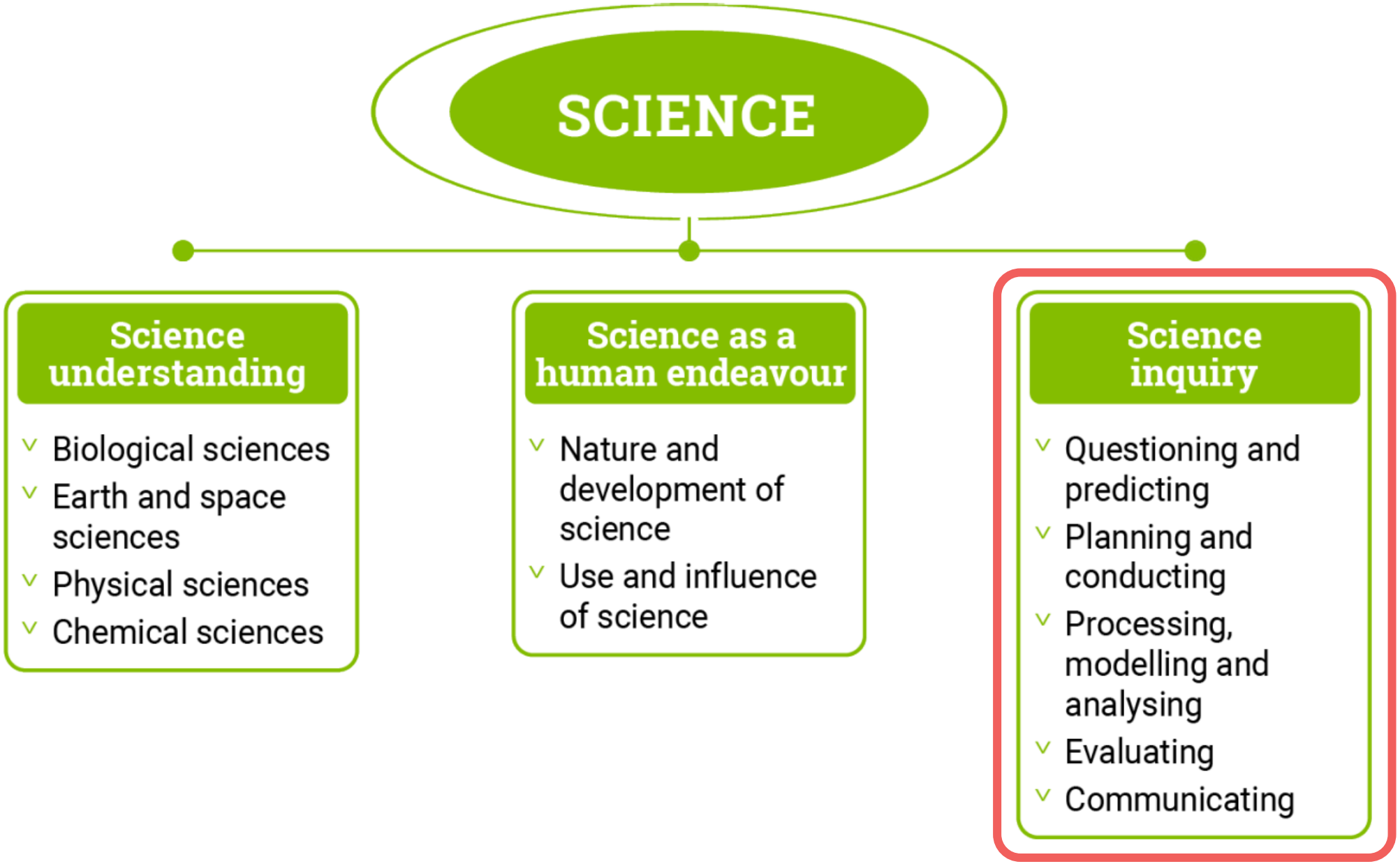

SCIENCE
Science understanding
Biological sciences
Earth and space sciences
Physical sciences
Chemical sciences
Science as a human endeavour
Nature and development of science
Use and influence of science
Science inquiry
Questioning and predicting
Planning and conducting
Processing, modelling and analysing
Evaluating
Communicating

Mathematical inquiry practices

Exploring – Exploring specific examples of mathematical ideas to see what is noticed.

Conjecturing – Asking questions and making conjectures about what is noticed, and then testing these conjectures

Generalising – Forming generalisations based on the mathematical patterns and relationships that have been noticed.

Justifying – Justifying conjectures and generalisations that are made using convincing arguments and proofs.

Representing – Representing mathematical thinking and concepts in multiple forms.

- Why is it not possible to make 12?
- What other numbers cannot be made?

$$10 + 9 + 8 - 7 + 6 + 5 - 4 - 3 + 2 + 1 = 27$$

$$10 + 9 + 8 - 7 + 6 - 5 - 4 - 3 + 2 + 1 = 17$$

$$10 + 9 + 8 - 7 + 6 - 5 + 4 - 3 + 2 + 1 = 25$$

$$10 + 9 - 8 - 7 + 6 - 5 + 4 - 3 + 2 + 1 = 9$$

$$10 + 9 - 8 + 7 + 6 - 5 + 4 - 3 + 2 + 1 = 23$$

$$10 + 9 - 8 + 7 + 6 - 5 + 4 + 3 + 2 + 1 = 29$$

What do you notice?

10 + 9 + 8 + 7 + 6 + 5 + 4 + 3 + 2 + 1 = 55

8 + 7 + 6 + 5 + 4 + 3 + 2 + 1 = 36

8 + 7 – 6 + 5 + 4 + 3 + 2 + 1 = 24

10 + 9 + 8 + 7 + 6 + 5 + 4 + 3 = 52

9 + 8 + 7 + 6 + 5 + 4 + 3 + 2 + 1 = 45

$$10 + 9 + 8 + 7 + 6 + 5 + 4 + 3 + 2 + 1 = 55$$

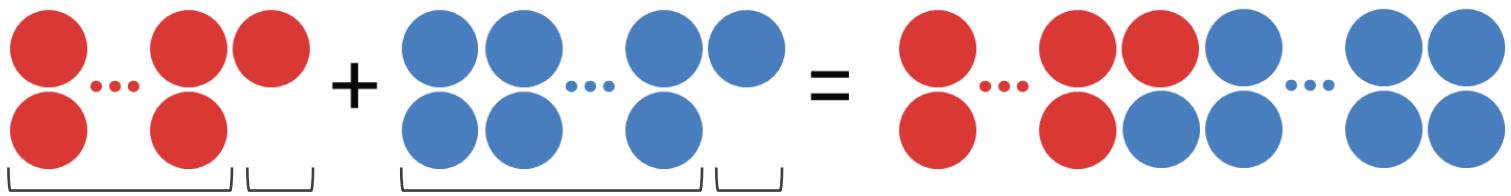
5 evens and 5 odds given an odd

$$8 + 7 + 6 + 5 + 4 + 3 + 2 + 1 = 36$$

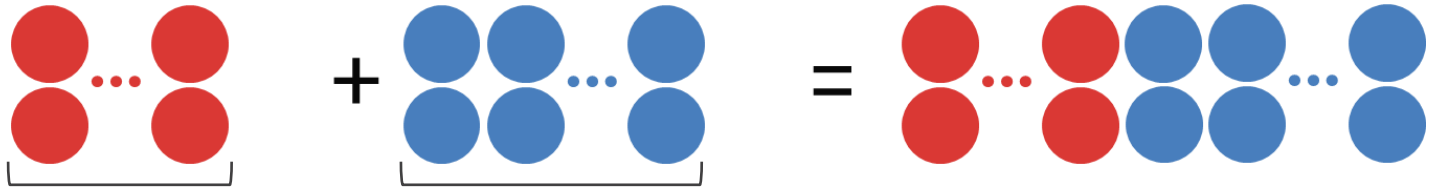
4 evens and 4 odds give an even

$$9 + 8 + 7 + 6 + 5 + 4 + 3 + 2 + 1 = 45$$

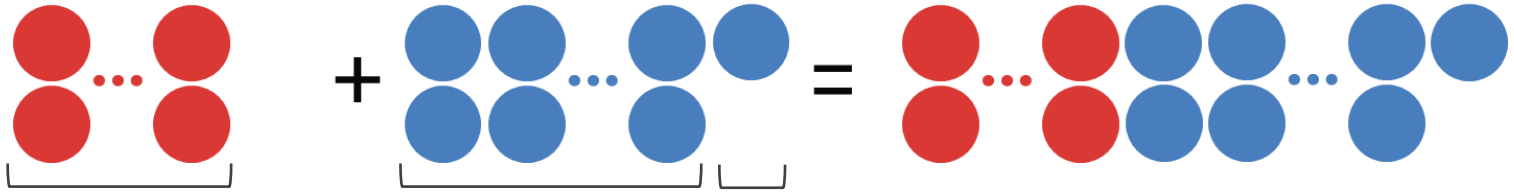
4 evens and 5 odds give an odd



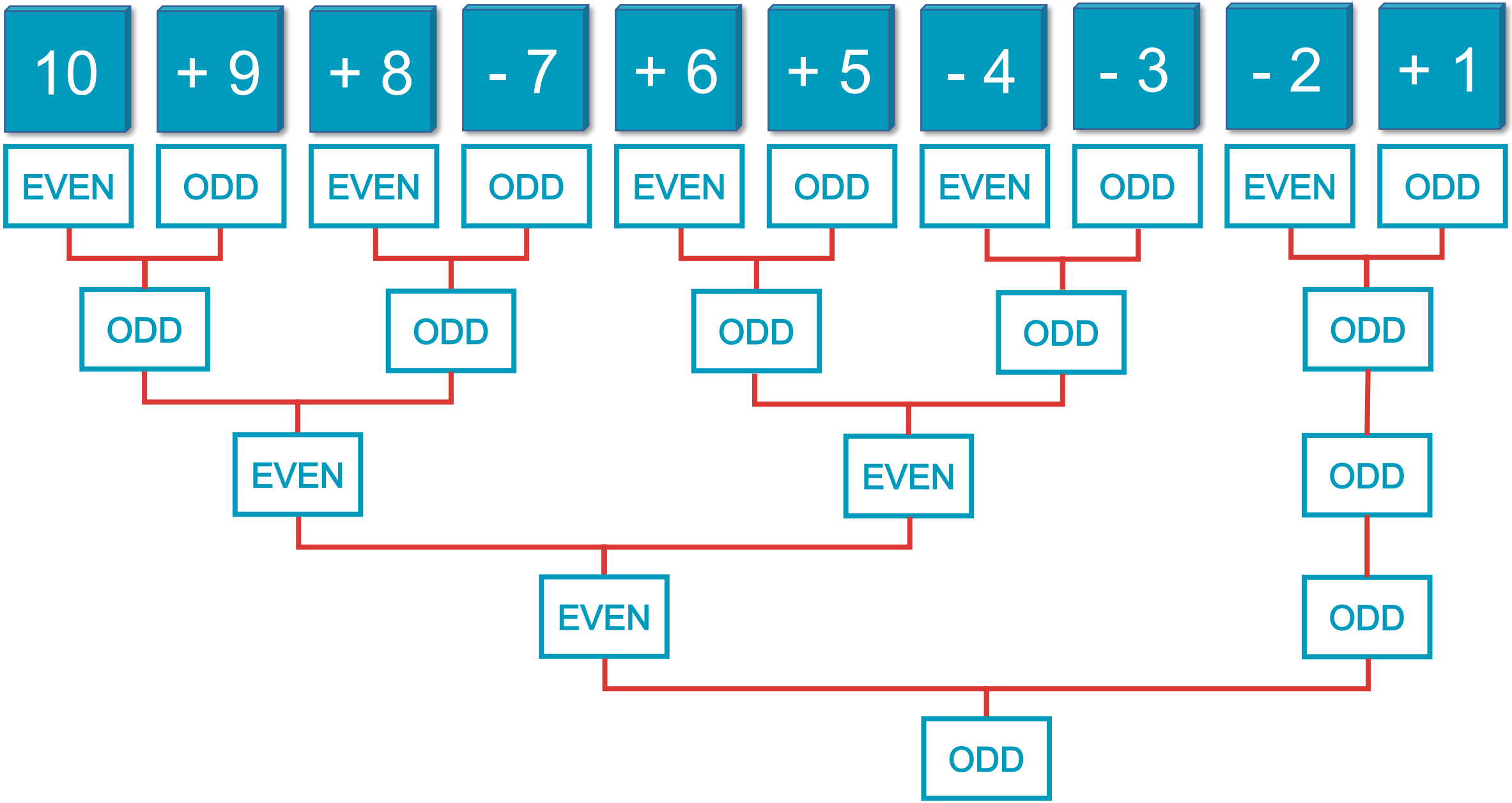
$2a + 1 + 2b + 1 = 2(a + b) + 2$



$2a + 2b = 2(a + b)$



$2a + 2b + 1 = 2(a + b) + 1$


10
+ 9
+ 8
- 7
+ 6
+ 5
- 4
- 3
- 2
+ 1
EVEN
ODD
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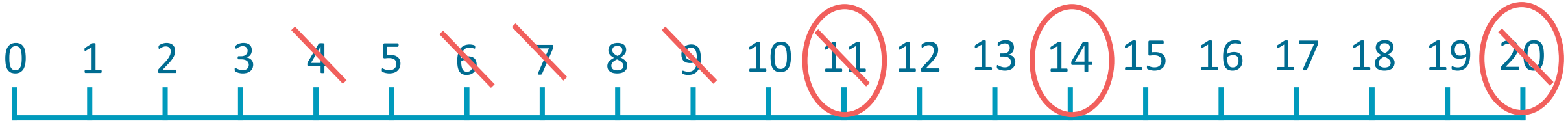
Let’s play another game


0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20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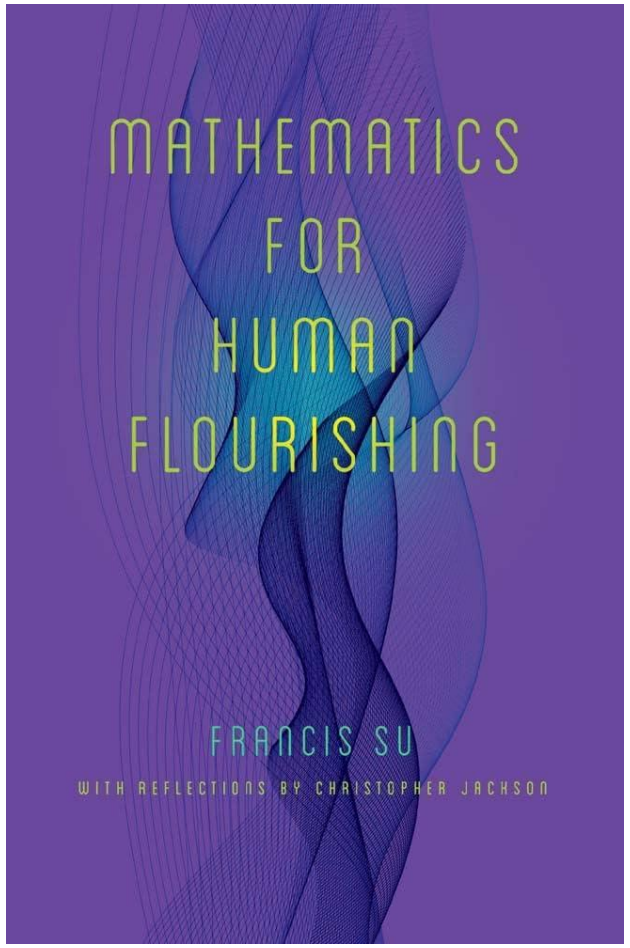

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UNIVERSITY OF CANBERRA

The University of Canberra acknowledges the Ngunnawal people, traditional custodians of the lands where Bruce Campus is situated. We wish to acknowledge and respect their continuing culture and the contribution they make to the life of Canberra and the region. We also acknowledge all other First Nations Peoples on whose lands we gather.