

**Canberra Mathematical Association  
Conference 2024**

**Mathematicians  
- agents of change**

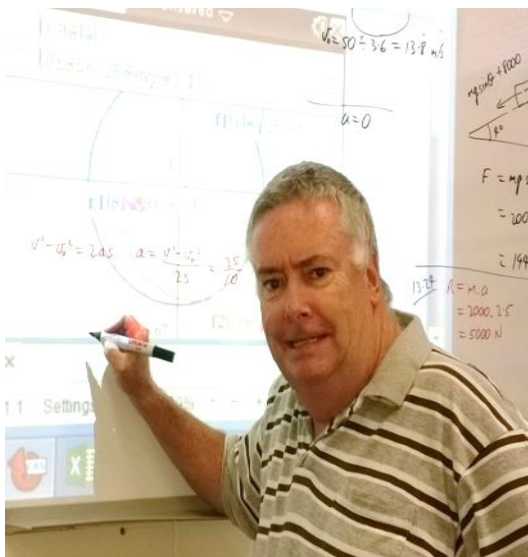
**Changing maths tasks and problems – Developing rich  
tasks and investigations**

**Brian Lannen**    [murray.math@bigpond.com](mailto:murray.math@bigpond.com)

## Warm up problem

**Evaluate  $6 \times 4 =$**

- Discuss with a delegate next to you ways in which this problem could be changed to promote deeper learning.
-



# Brian Lannen

Murray Mathematics Curriculum Services

T<sup>3</sup> National Instructor

## Changing maths tasks and problems – Developing rich tasks and investigations

There is certainly a satisfying sense of achievement in finding the solution to a clearly defined task or problem. Let's firstly look at the problem-solving process and how we can help students with that. Then let's look at how we can further challenge and extend students by making subtle changes to problems, setting the course for rich tasks and open investigations. We will not only examine the underlying pedagogy of these things, but the presenter will share a suite of favourite problems & investigations and point to places to find more.

# Warm up problem

Evaluate  $6 \times 4 =$

- $6 \times 8 =$
  - Solve for  $x$ :  $6x = 24$
  - List the factors of 24
  - If two numbers multiply together to produce 24, what could these numbers be?
  - $48 \times \frac{1}{2}$ ,  $-6 \times -4$ ,  $6i \times (-4)i$
-

# Find the function game

Evaluate  $f(x) = 2x + 3$  when  $x = 5$

```
DEG
FUNCTION TABLE
1: Add/Edit Func
2: f(
3: g(
```

```
DEG
TABLE SETUP
Start=1
Step=1
Auto  % = ?
CALC
```

```
DEG
f(x)=2x+3
↑
↓
```

```
DEG
%  f(x)
5  13
10 23
0  █
f(x)=3
```

```
DEG
f(5)  13
f(10) 23
```

```
DEG
%  f(x)
1  5
2  7
3  9
x=1
```




# What is (mathematical) Problem-Solving?


Does Problem-Solving need to be explicitly taught?

**Yes, it does. Here's my Year 9 story**




- Polya 4 steps
  - Problem-Solving Process
  - Problem-Solving Strategies
  - Rich Problems to engage with and practise
-

# Some definitions of Problem-Solving

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## ➤ Mathematics proficiencies

# Problem-Solving

Foundation to Year 10

## Problem-Solving

### Portfolio summary

In F–2, students solve problems when they use mathematics to represent unfamiliar or meaningful situations.

In Years 3–6, students solve problems when they use mathematics to represent unfamiliar or meaningful situations and plan their approaches.

In Years 7–8, students formulate and solve problems when they use mathematics to represent unfamiliar or meaningful situations, plan their approaches, when they apply their existing strategies to seek solutions, and when they verify that their answers are reasonable.

In Years 9–10, students formulate and solve problems when they use mathematics to represent unfamiliar or meaningful situations, when they design investigations and plan their approaches, when they apply their existing strategies to seek solutions, and when they verify that their answers are reasonable. Students develop the ability to make choices, interpret, formulate, model and investigate problem situations, and communicate solutions effectively.

# Some definitions of Problem-Solving

Collins

English: problem-solving Example sentences

**Definition of 'problem-solving'**

## problem-solving

in British English

(ˈprɒbləmsɒlvɪŋ)

**NOUN**

the act or process of finding solutions to problems, esp by using a scientific or analytical approach

*Problem-solving is often carried on by processes of visualization.*  
*an approach to problem-solving*

*Collins English Dictionary. Copyright © HarperCollins Publishers*

**Derived forms**

problem-solver **NOUN**

Oxford Reference

OVERVIEW

### problem solving

QUICK REFERENCE

Cognitive processing directed at finding solutions to well-defined problems, such as the Tower of Hanoi, Wason selection task, or a water-jar problem, by performing a sequence of operations. Problem solving by means of logic or logical analysis is usually called reasoning. See also 2-4-6 problem, algorithm, brute force algorithm, convergence-divergence, functional fixedness, General Problem Solver, ill-defined problem, insight (2), intelligence, lateral thinking, Monty Hall problem, muddy children problem, Newcomb's problem, nine-dot problem, oddity problem, problem-solving stages, taxicab problem, travelling salesman problem, well-defined problem. [From Latin *problema*, something put forward, from Greek *pro* before or forward + *ballein* to throw]

**From:** problem solving in A Dictionary of Psychology »

**Subjects:** Science and technology — Psychology



# Some definitions of Problem-Solving


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problem solving

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About 305,000,000 results (0.54 seconds)

**Problem solving** is the act of defining a **problem**; determining the cause of the **problem**; identifying, prioritizing, and selecting alternatives for a solution; and implementing a solution. The **problem-solving** process. **Problem solving** resources.



asq.org › quality-resources › problem-solving

[What is Problem Solving? Steps, Process & Techniques | ASQ](#)

About Featured Snippets Feedback

# George Polya – 4 Step Process

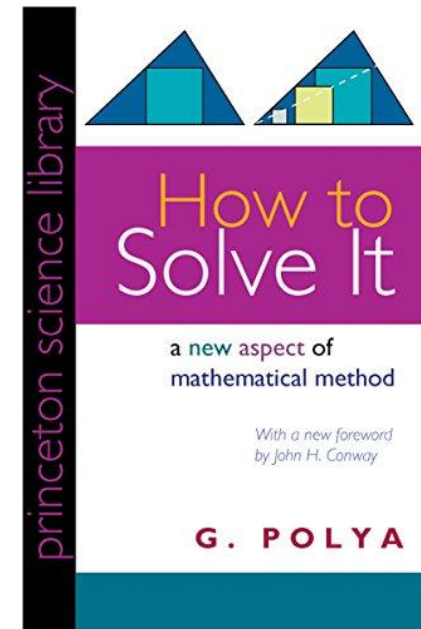
The 4 stages of problem solving (Polya)

- **Find Out** what the problem is asking for
  - ~ identify relevant data
  - ~ look for the question or verb in the problem
- **Select** a strategy
- **Apply** the strategy
- **Look Back** ~ Does your solution make sense?
  - ~ Reread the original question
  - ~ Should your solution include units?

A demonstration problem

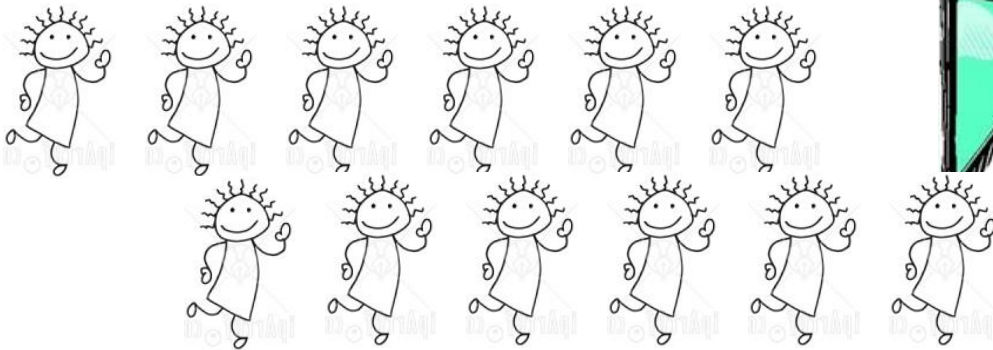
List of problem-solving strategies

Some problems for you to practise



# Demonstration Problem– handshakes

If there are 12 people at a party and each person shakes hands with each other person, then how many handshakes are there in total?



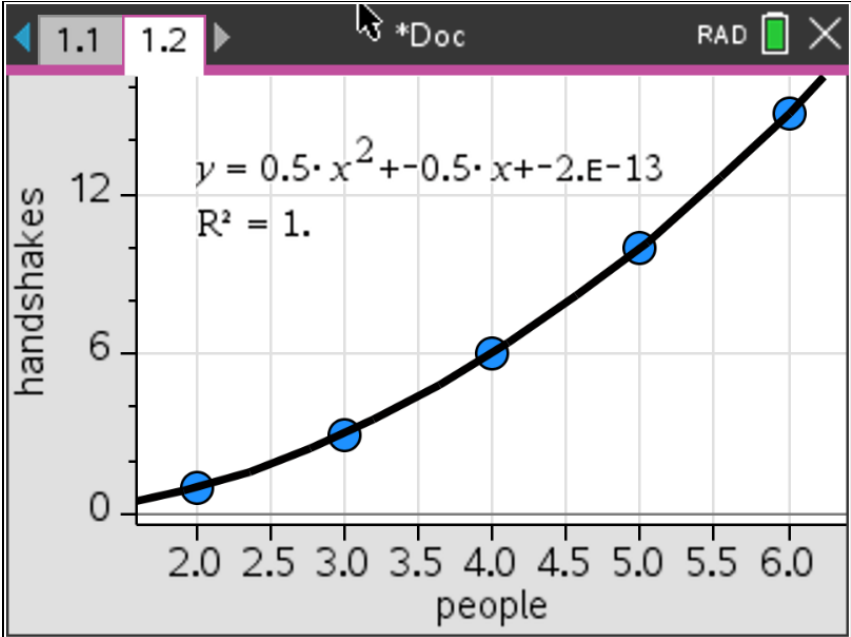
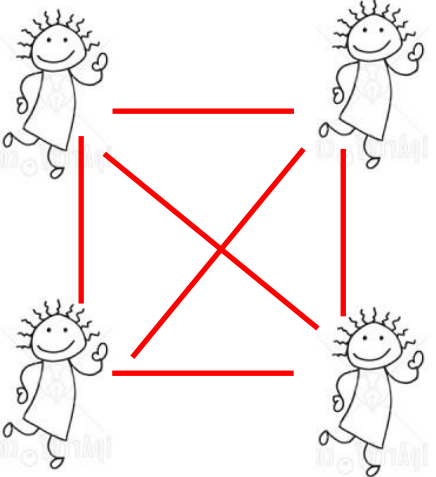
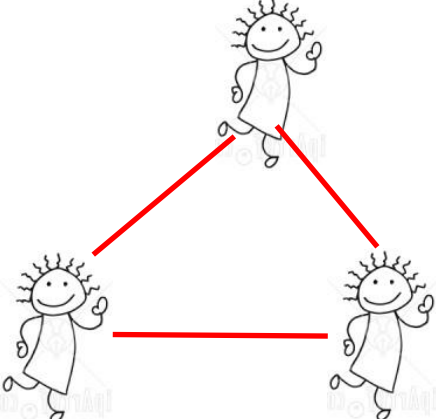
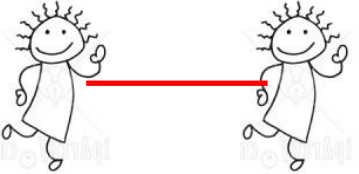
sca0413 www.fotosearch.com

## Problem-Solving Strategies

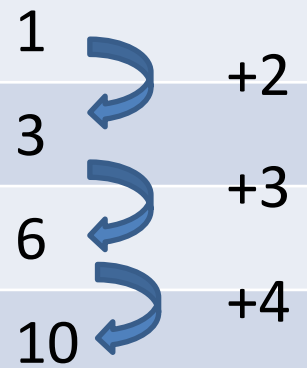


- .Find a Pattern
- . Make a Table, Graph, or Chart
- .Make an Organized List
- .Draw a Picture or Diagram
- .Guess, Check, and Revise
- .Logical Reasoning
- .WORK BACKWARD
- .Write an Equation
- .Solve a Simpler Problem
- .Use Multiple Strategies
- .Simulate a Problem
- .Choose a Formula

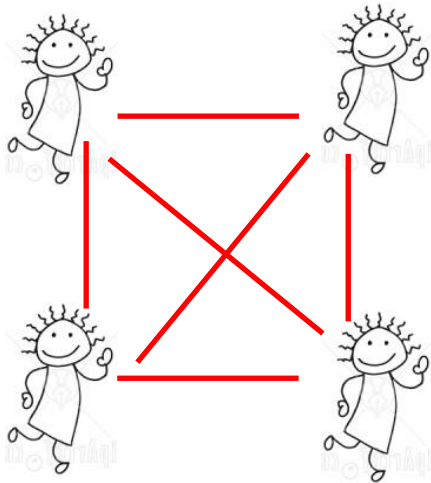
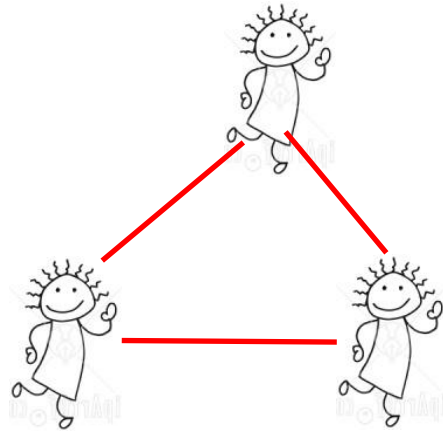
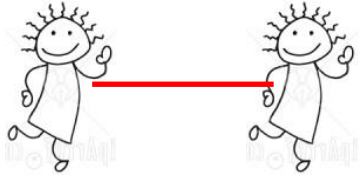
# Demonstration Problem– handshakes



people	handshakes
1	
2	1
3	3
4	6
5	10
12	?



# Demonstration Problem– handshakes



people	handshakes
1	
2	1  +2
3	3  +3
4	6  +4
5	10 
	
12	?

$$h(12) = \frac{12(12 - 1)}{2} = 66$$

# Demonstration Problem– handshakes

TI-SmartView™ for MathPrint™ calculators

File Edit View Actions Help

The calculator interface shows the TI-30X Plus MathPrint calculator. The display shows  $L2(4)=10$ . The keypad includes various mathematical functions and constants. The bottom of the screen shows a taskbar with system icons.

```

L1 1
L2 10
L3
L4
L5
L6
L7
L8
L9
L10
DEG

```

L2(4)=10

```

DEG
f(12) 66

```

```

DEG
STAT-REG DISTR
6↑RecipReg a/x+b
7↓QuadraticReg
8↓CubicReg

```

```

DEG
xDATA: L1 L2 L3 ↑
yDATA: L1 L2 L3
FREQ: ONE L1 L2 L3
Re9EQ→: NO f(x) g(x)
y=a.x^2+b.x+c CALC

```

```

DEG
QuadReg:L1,L2,1
1:a=0.5
2:b=-0.5
3↓c=0

```

# Demonstration Problem– handshakes

TI-SmartView™ for MathPrint™ calculators

File Edit View Actions Help

TI-30X Plus  
MathPrint

1+2+3+4+5+6+7+8  
66

quit insert  
2nd mode delete

stat-reg/distr  
ln log math data

random expr-eval  
e<sup>□</sup>10<sup>□</sup> EE 1<sup>nCr</sup><sub>nPr</sub> table clear

complex  
π i sin sin<sup>-1</sup> cos cos<sup>-1</sup> tan tan<sup>-1</sup> ÷

constants op set op  
x<sup>□</sup> ( ) ×

convert base n  
x<sup>2</sup> 7 8 9 -

clear var D E F 0→  
x<sup>yzt</sup><sub>abcd</sub> 4 5 6 +

recall A B C f↔d  
sto→ 1 2 3 ≈

off reset , answer  
on 0 . (-) enter

Key Press History

+ 9 + 1 0 + 1 1 enter

DEG

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

66

DEG

MATH NUM DMS R↔P

3↑9cd(

4:▶Pfactor

5↓sum(

DEG

$$\sum_{x=1}^{11} (x)$$

66



# Demonstration Problem– handshakes

TI-SmartView™ for MathPrint™ calculators

File Edit View Actions Help

TI-30X Plus  
MathPrint

DEG

L3(1)=1

quit insert  
2nd mode delete

stat-reg/distr  
ln log math data

random expr-eval  
e<sup>□</sup> 10<sup>□</sup> EE nCr nPr table clear

complex  
π i e sin<sup>-1</sup> cos<sup>-1</sup> tan<sup>-1</sup> %

constants op set op  
x<sup>□</sup> □ ( ) ×

convert base n  
x<sup>2</sup> 7 8 9 -

clear var D E F →  
x<sup>yzt</sup><sub>abcd</sub> 4 5 6 +

recall A B C f ↔ d  
sto → 1 2 3 ↔ ≈

off reset , answer  
on 0 . (-) enter

DEG

12 nCr 2 66

DEG

SUM LIST ↑

SUM OF LIST=66

STORE: NO x y z t a b c d

DONE

DEG

CLR FORMULA OPS

1:Sort Sm-L9...

2:Sort L9-Sm...

3↓Sequence...

DEG

EXPR IN x:x ↑

START x:1

END x:11

STEP SIZE:1

SEQUENCE FILL

DEG

CLR FORMULA OPS

2↑Sort L9-Sm...

3:Sequence...

4 Sum List...



# Resources from Mathematics Task Centre

Search Mathematics Centre ... Big Picture ... News ... Research & Stories ... Cube Tube ... Indigenous Students ... Web Papers ... Contacts ... Site Map  
Professional Development ... Working Mathematically ... Mathematics Task Centre ... Calculating Changes ... Picture Puzzles ... Maths300  
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## Mathematics Task Centre



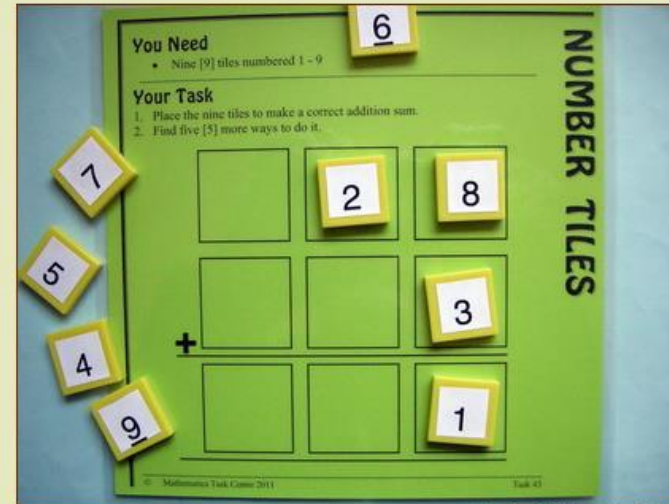
### Hands-on Problem Solving

Tasks invite students to work like a mathematician.

Use the links below to explore the wisdom of practice collected here from more than 40 years of using tasks in classrooms around the world. Tasks are designed for Years 2-10.

In Sweden, Maths Tasks are called Mattegömmor...  
*a place where mathematics is hidden.*  
Mattegömmor på Svenska, [klicka här](#).

Build your own Task Library using our eTasks and your equipment.



Task 43, Number Tiles

There is no reason for mathematics to be taught the way it always has been.

<http://www.mathematicscentre.com/taskcentre/>



# Resources from Maths 300

The screenshot shows the Maths 300 website's home page. At the top, there is a navigation menu with links for ABOUT US, SUBSCRIBE, COMMUNITY, LESSONS, and SOFTWARE. The main heading is "MATHS LESSON LIBRARY". Below this, there are four search filters: "Select year levels", "Select content strands", "Select pedagogies", and "Select curricula". A search input field is labeled "Enter search key words (title/number/summary)". A green "SEARCH" button is positioned below the input field. At the bottom of the page, a tagline reads "Maths 300: A rich inquiry-based approach to teaching maths."

<https://www.maths300.com/>

The screenshot shows the "Garden Beds" lesson page on the Maths 300 website. The page features a large header image of two students in a classroom. The main heading is "Garden Beds". Below the heading, there is a "Summary" section with a paragraph of text: "Garden Beds is a very rich context from which many mathematical concepts can be explored. The story shell of paving around a garden bed quickly captures students' interest. The mathematics of counting, area and perimeter, and pattern and algebra, are all very evident. It is a concrete and active lesson which suits students working at a range of ability levels..". To the right of the text is an image of students working on a project. Below the summary, there is a quote: "I find this task fascinatingly 'rich'. Some students were quite happily counting. Others started to draw diagrams and were generalising the patterns into a rule. Students are delighted when they are told they are 'doing algebra!'". At the bottom, there is a "Year Levels" section with a grid of buttons for years 1 through 12 and K. On the right side of the page, there is a sidebar with filters for "Year Levels", "Content Strands", "Pedagogies", "Curricula", and "Key Words". The "Key Words" filter has "garden beds" entered. A green "SEARCH" button is at the bottom of the sidebar.

# Resources from Texas Instruments

 Education Technology Search 

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Australian Curriculum Nspired

Year 7

Year 8

**Year 9**

Measurement and Geometry

**Number and Algebra** ▶

Statistics and Probability

STEM

Year 10

Year 10A

## Year 9: Paving Problem

by Texas Instruments

### Objectives

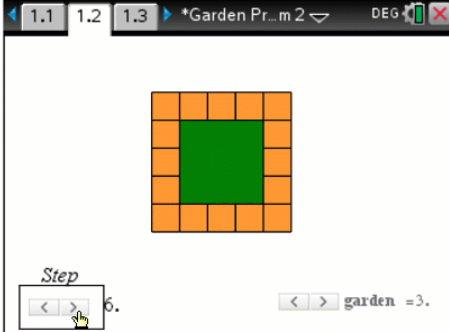
- **ACMNA213:** Apply the distributive law to the expansion of algebraic expressions, including binomials, and collect like terms where appropriate.


### Vocabulary

- Factorise
- Expand
- Simplify

### About the Lesson

A square garden bed is surrounded by pavers, how many pavers are required for a 1m x 1m garden? What about a 2m x 2m or n x n garden. Students use animations that support the development of the rules followed by algebraic techniques such as factorise, expand and simply to illustrate that these abstract algebraic representations are equivalent. Students take this knowledge and experience and apply it to a different style of garden bed.



 **Download**

[Download All Files \(ZIP\)](#)

[Tinspire Activity File 1](#)

[Tinspire Activity File 2](#)


[Tinspire Activity File 3](#)


[Tinspire Activity File 4](#)

[Student Activity](#)

[Teacher Notes and Answers](#)

**Device**

 TI-Nspire™ CX

 TI-Nspire™ CX CAS

**Software**

TI-Nspire™


TI-Nspire™ CAS


**Standards**

ACMNA213

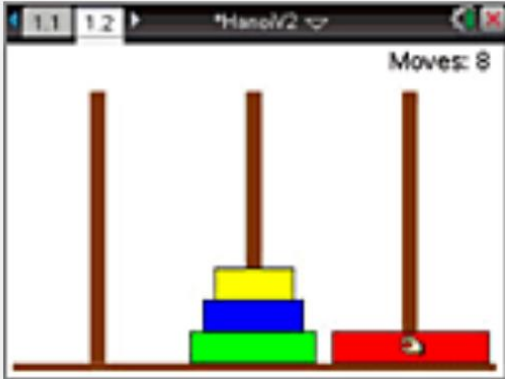
**TI-Nspire Version**

4.5

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# Resources from Texas Instruments

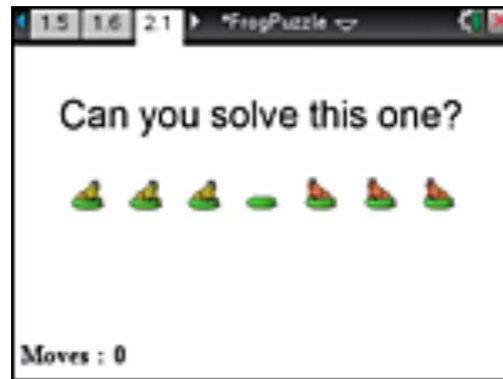


## Standard ACMNA296

Graph simple non-linear relations with and without the use of digital technologies and solve simple related equations

### Activity: Towering Mathematics

The classic "Tower of Hanoi" puzzle involves moving three discs of different sizes from one peg to another, following the restrictions that larger discs cannot be placed on top of smaller discs and discs cannot be moved to the same peg they came from. The challenge is to move all the discs to the other side in the fewest moves possible. This activity explores the problem and to find the minimum number of moves and the sequence of moves. The document contains a virtual



## Standard ACMNA296

Graph simple non-linear relations with and without the use of digital technologies and solve simple related equations

### Activity: Leap Frog

This classic puzzle requires all the frogs on the left side of the pond to reach the right side and vice versa. How many moves does it take to solve the puzzle? What if there were more frogs? Click on the frogs in this TI-Nspire document to make them move, the moves are counted automatically. Set the number of frogs on each side and start solving!

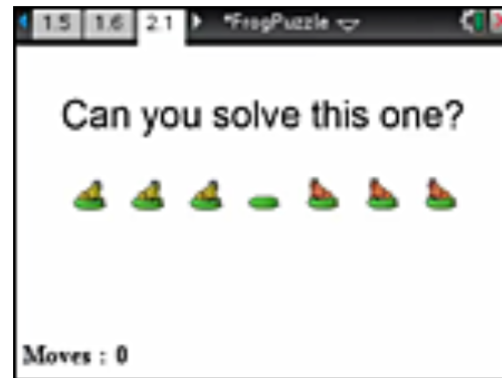


# Resources from Texas Instruments

$\frac{2}{4}$ $\frac{6}{8}$	$\frac{3}{8}$ $\frac{15}{24}$	DEG	$\frac{1}{2}$
L3(1)=			

DEG  
QuadReg:L1,L2,1  
1:a=0.25  
2:b=1  
3:c=0

DEG  
f(100) 2600

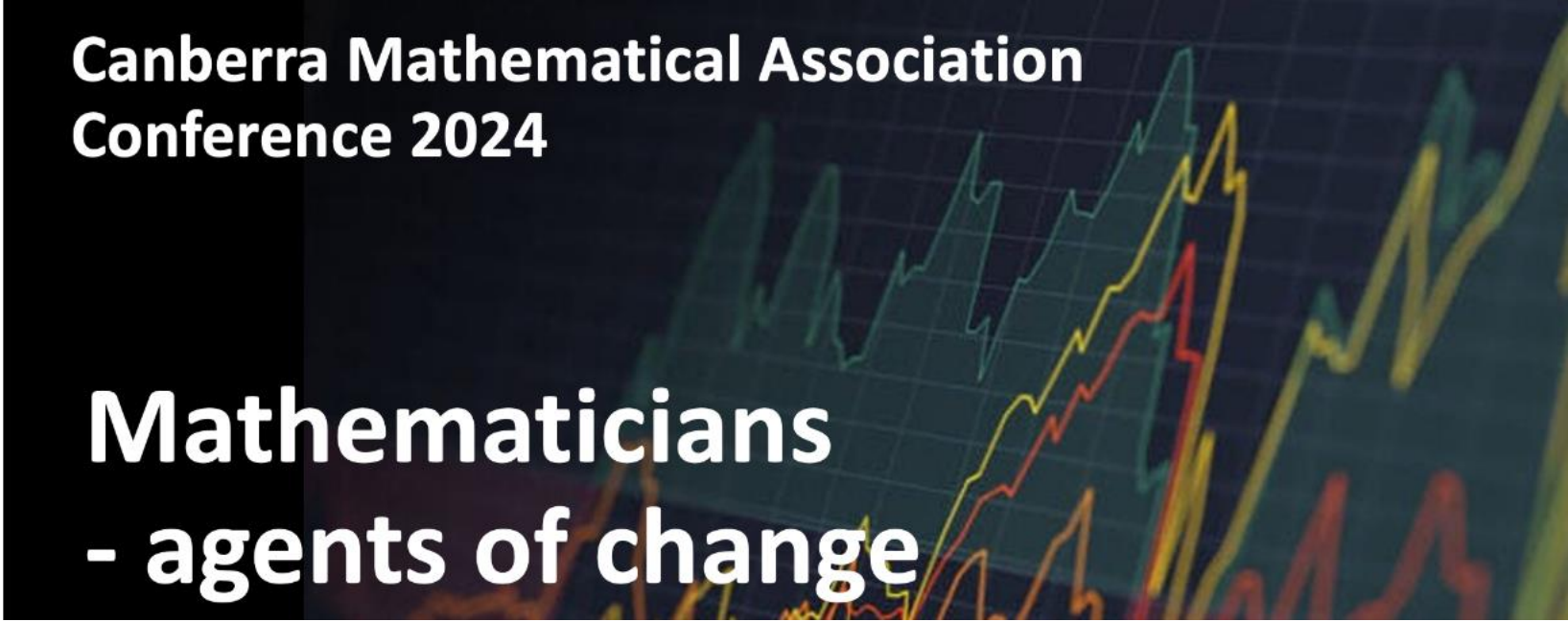


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**Mathematicians  
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**Changing maths tasks and problems – Developing rich  
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