

Teaching students to work  
mathematically:  
An Australian perspective

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# Australian curriculum framework

- Number
- Algebra (age 12 +)
- Measurement
- Space (Geometry)
- Chance and Data (Statistics)
- WORKING MATHEMATICALLY
  - with a variety of names in different places

# Working Mathematically

- Reasoning
- General strategies for problem solving
- Communication
- Contexts and Uses for Mathematics
- Using Mathematical Tools

# PLAN

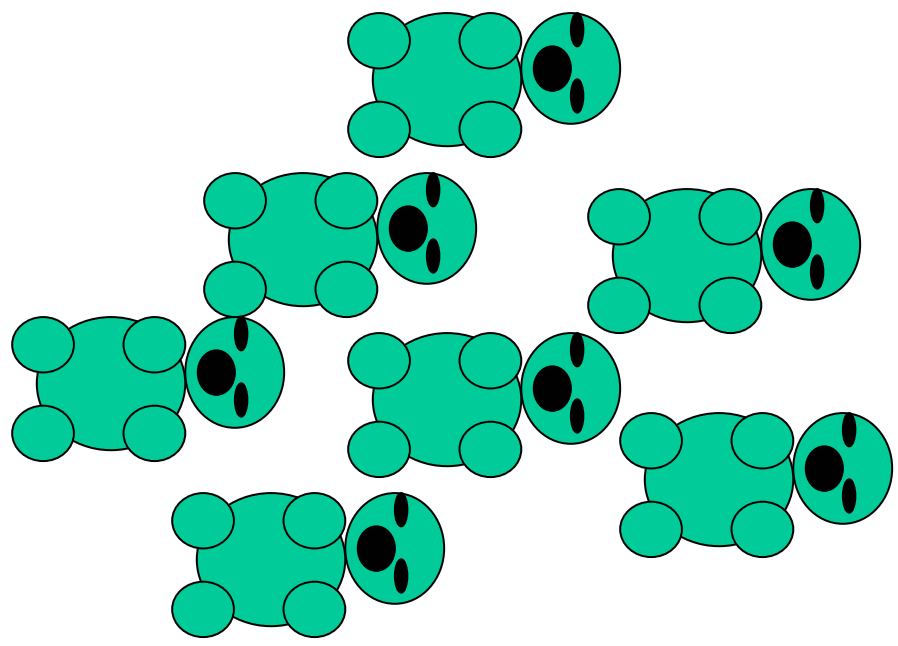
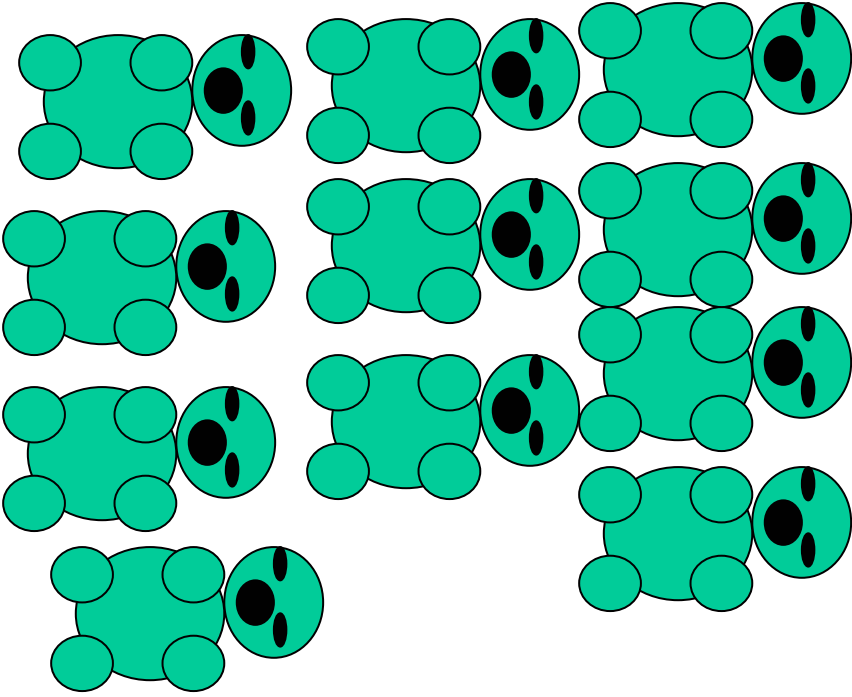
- Teaching from integrated “theme”
  - 5 year olds
- A mathematical project
  - 17 year olds
- An investigation lesson in geometry
  - 11 year olds

# Teddy Bears - a theme for integrated work

- possibly one week, ending in picnic (making healthy food, sports etc)
- several maths topics
- other subjects (story writing, care for others, families, going shopping, .....
- teachers together decide theme
- teacher constructs activity herself or together

# Counting teddy bears with 5 year olds (+ calculators)

- **STIMULUS** Sort bears by colour
  - 7 brown, 4 white, 3 grey, 4 other colours
- **TASK** Find out how many there are:
  - count all again by ones or twos
  - count using calculator constant function
  - use addition function
- **RECORD** Write what you have found out
- **SHARE** Whole class discussion



# Byron discovers $6+6+6 = 18$

- $7+4+3+4 = 18$ 
  - calculator addition
- $9 + 8 + 1 = 18$
- $9 + 9 = 18$
- $6 + 6 + 6 = 18$ 
  - mental problem solving on a self-directed task

# Teddy Bears - Aims of whole class discussion

- consolidating (e.g. count by 2 together)
- sharing ideas “awareness raising”
- showing there are many ways possible (promote confidence and flexibility)
- introducing and extending ideas (e.g. count on, not count all)
- feedback for teacher to decide what next

# Later in the week.....

- Teddy bears having picnic
- Share the biscuits
- Use cut-out bears
  - motor skills
  - concrete aid for maths
- Girls learn about 0.5
  - used calculator
  - introductory knowledge only

# Recording is a high priority for

- teacher monitoring and assessment
- consolidating knowledge, reflecting and reviewing
- written mathematics (e.g. number sentences)
- develop language skills, forming letters etc

# Working Mathematically?

- Reasoning \*\*\*
- Strategies \*\*\*
- Communication \*\*\*\*\*
- Contexts for Mathematics \*\*\*\*
- Using Mathematical Tools \*\*\*\*\*

# Art Gallery Problem: Year 12

- Find where to stand for greatest viewing angle for one picture
- Find where to stand for another picture
- Would a taller person have an advantage?
- Where to place a viewing stand
  - for the maximum sum of viewing angles?
  - for the minimum difference of viewing angles?

# Features

- Assessment task; similar tasks common now in earlier grades
- State assessment too difficult - now abandoned and replaced by teacher assessment
- Individual work with discussion with teachers and class mates
- Emphasis on writing a clear report

# Features (2)

- Real world setting
  - teachers see this as crucial to problem solving
  - demonstrates usefulness and limitations of maths
- Involves formulating model, using current maths and interpreting results
- Evaluating overall approach more difficult

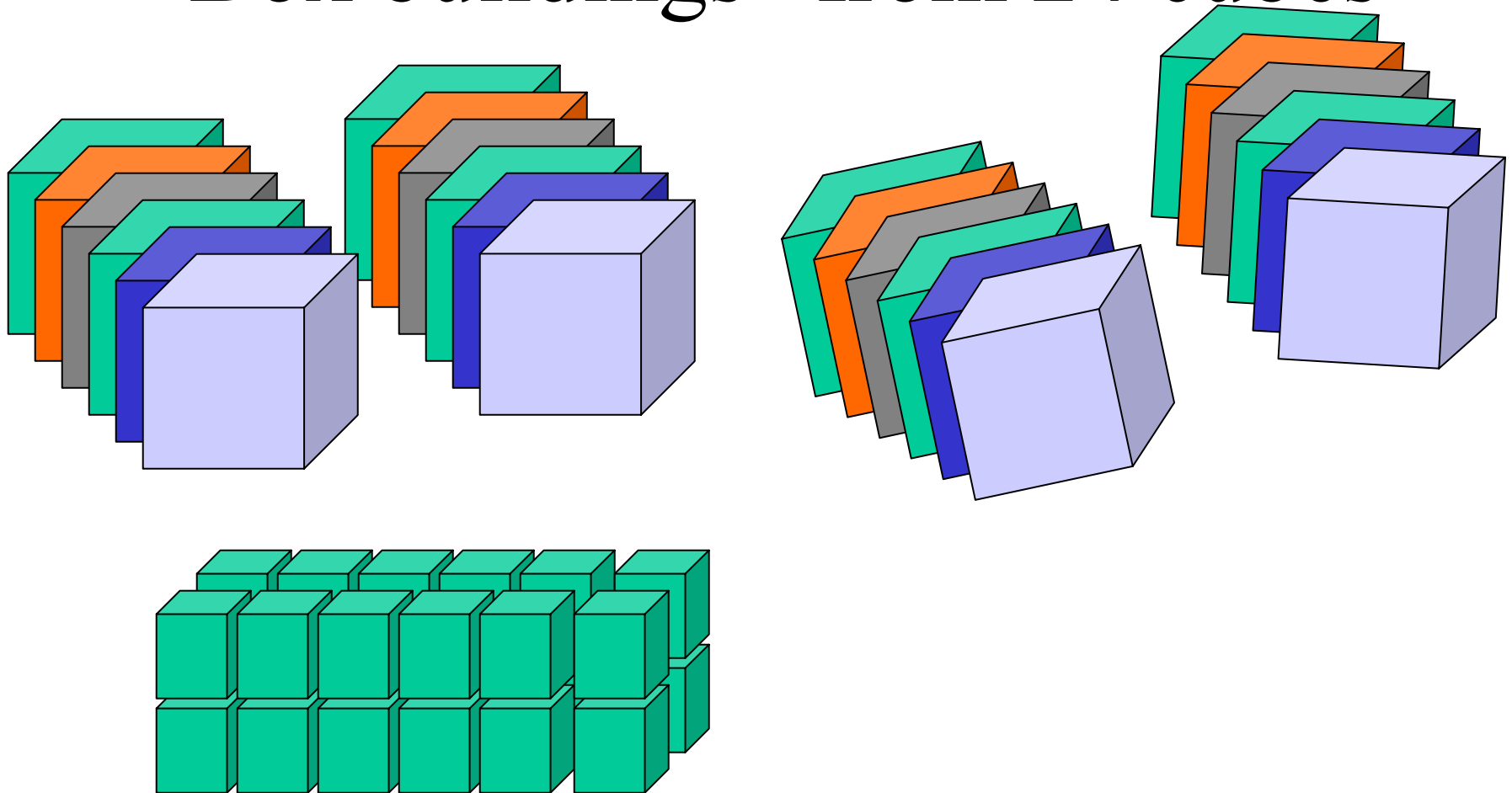
*“I have never seen such intense, creative and co-operative work in mathematics. In class there was a great deal of discussion, yet they were all working on their own problems.”*

Year 12 teacher reporting on students engaged in assessed investigative project (1990)

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# “Box buildings” from 24 cubes

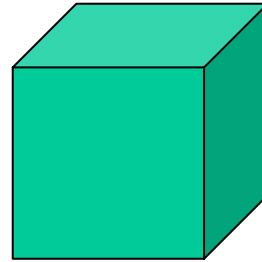


# Box buildings from 24 cubes

- From “Learning about Teaching” (Mousley & Sullivan)
- INTRODUCTION - everything you know about this cube
- PROBLEM POSING - make box-shaped buildings from 24 cubes
- INDIVIDUAL then GROUP work
- REPORTING BACK

# INTRODUCTION - class discussion on “everything you know about this cube”.

- Teacher finding out what children know
  - for this lesson
  - for subsequent teaching
- Establishing vocabulary (e.g. cube, 3-D)
- Opportunity for some initial teaching e.g. dimensions of length, width and height
- Drawing attention to important features



# PROBLEM POSING - make box-shaped buildings from 24 cubes and record them

- Looks a real problem but not actually
- Negotiate problem conditions
  - not hollow, box shaped, front and side different
- Open-ended - teacher has no central goal
  - explore ideas of volume
  - explore different ways of recording blocks
- Some teaching during problem posing

# INDIVIDUAL then GROUP work

- Many things to learn
  - drawing shapes, dimensions, interpreting size
  - Teacher works with individuals.
- Child-child discussion important
  - increasing number of good ideas per group
  - checking, monitoring, conjecturing
  - reduces calls upon teacher
  - keeps children active

# Samples of work reported

- draw top, bottom and side
- draw 3-D view
- record dimensions and use LBW=24

# REPORTING BACK

- Three recording systems presented:
  - draw top, bottom and side
  - draw 3-D view
  - record length, width, height and use  $LBW=24$
- Teacher makes no value judgement on solutions - “they serve different purposes”, “use a strategy you understand”
- Recording took over from volume aim.

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Thank you

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*Balanced* mathematical activity  
at *every* level for *all* students

- Knowledge of facts and technical skills
- Depth of conceptual understanding
- Communicate clearly, precisely
- Tackle non-routine problems systematically
- Use maths to solve real problems
- Logical reasoning and proof
- Practical ability in measuring, estimating  
Sensible use of calculators and computers.

# Goals of School Mathematics

- To acquire mathematical skills and knowledge so that they can deal competently and confidently with everyday life
- To develop knowledge and skills in using mathematics for employment, further study and interest
- To be able to interpret and communicate quantitative and logical ideas accurately
- To be aware of the fundamental importance of mathematics to the functioning of society
- To understand and appreciate the nature of mathematical thinking , the processes by which it changes and its role in different cultures
- To understand the dynamic role of mathematics in social and technological change
- To use technology to support learning of mathematics and in carrying out mathematical activities in context.

Fulfilment of these goals requires that mathematics at school is a positive experience in which students develop confidence and a sense of achievement from what they learn.

# Principles:

- Teaching from base of concrete experience
- Recognizing mathematics as abstract and general
- Variety of modes of classroom activity
- An emphasis on applications
- Recognizing individual differences
- Sensible use of mathematics at every stage
- Allowing time for growth

# Teaching problem solving

- Teach mathematics content well
- Experience of solving non-routine problems
- Teach strategies and good habits
- Reflection - learning from experience
- Build good attitudes - flexible, willing to try
- Strengthen intuitive methods, teach formal methods

# Timeline

- 1970's Applications and modelling
- 1980-1984 Fashionable fringe activity
- 1984 - 1988 Institutionalised in K - 10
- 1988 Assessment needed for year 12 - attempting to drive curriculum from above
- 1990 - 1999 Year 12 assessment modified

# Japanese lessons

- Teacher presents problem
- Students work individually
  - Private knowledge 1
- Whole class discussion
  - about mathematics of solution
  - public knowledge
  - Private knowledge II