CURRICULUM, PEDAGOGY AND BEYOND

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C20: Victorian Curriculum V2.0 Mathematics – an opportunity to expand mathematics culture and understanding

Presenter: Geoffrey Menon
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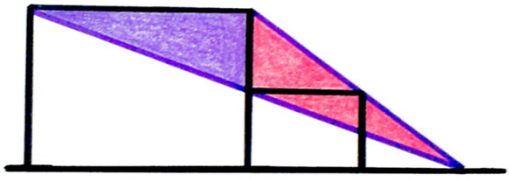
Acknowledgement of Country

Welcome to Latrobe University which, as Camberwell High School, is situated on the land of the Wirundjeri Woi wurrung people and pay our respects to leaders past, present and emerging. Their land is occupied but was never ceded - always was, always will be aboriginal land.

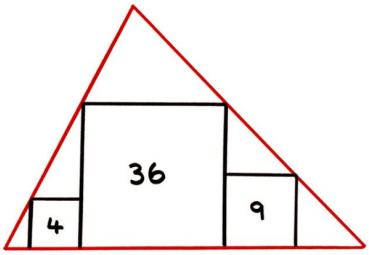
Warm-up

(every good maths class begins with a problem… or two)
[both problems here by Catriona Agg: @CShearer41]

Both coloured regions have area 10. What's the total area of the two rectangles?



The areas of the three squares are given. What's the area of the red triangle?



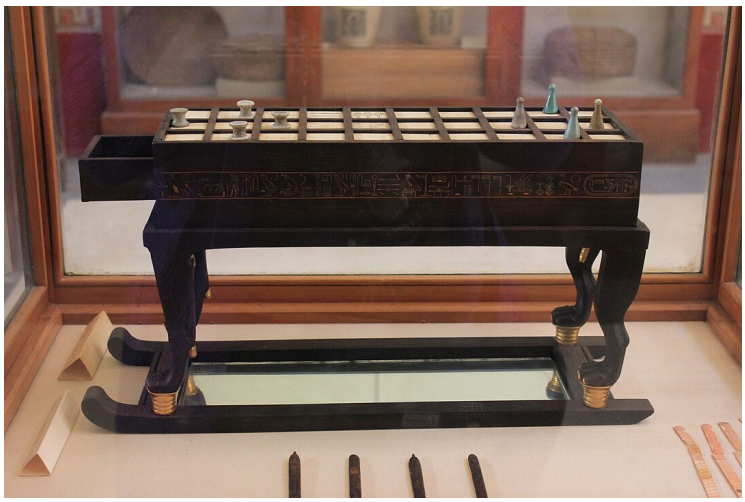
Key change in Victorian Curriculum V2.0 Mathematics

- Geometrical reasoning from year 7 to 10
- This supports mathematical developments and opportunities in the existing senior mathematics curriculum
- This supports the human story of the development of mathematics through time, giving students a direct connection to the past

What mathematical objects do you see in this etching?

(Dürer, 1514)

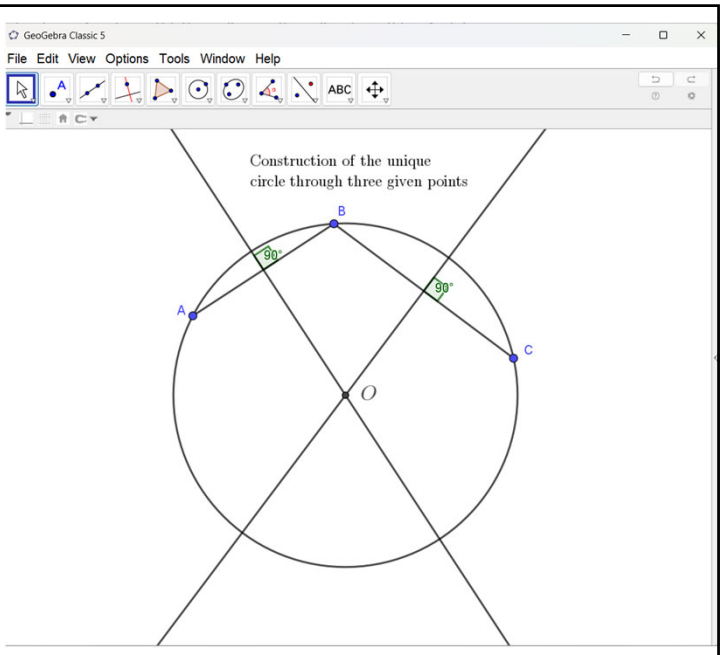
Senet board game *(KV62, c. 1323 B.C.E., image – Wikimedia commons)*



Note the fine cabinet joints, requiring very precise measurement

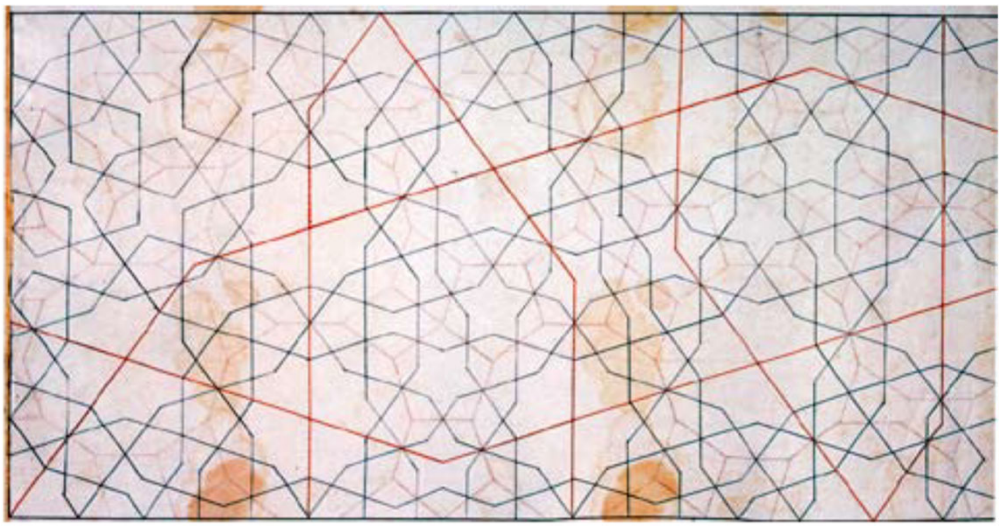
Dynamic Geometry

(rapid exploration of constructible geometries)



Inspiration for this talk…

(I could not figure out how to make a turtle draw this pattern – thanks here to Marj Horne – the image below is from the famous, "Topkapi Scroll", an architects plan to decorate a Madrasa that was never built)



Typical timeline of Mathematics

- Ancient Greek (Thales, Euclid, Archimedes)
- Dark Ages (post Roman Empire nothing happened)
- Medieval Europe (the birth of the modern university)
- Some mention of India (relating number symbols and zero)
- Newton and Leibnitz (Fermat as well perhaps)
- The Enlightenment (Euler)
- Industrial Revolution and modern mathematics

Issues with this view

- Factually inaccurate
- Gender biased *(why are all historical mathematicians men?)*
- Misses the point about mathematical development

  (mathematics costs society a lot – you need to free up a lot of people to spend all day thinking – so mathematical development really shows a map of the wealthiest societies of each time period – where is the centre of the mathematics world today?)
- Why?

  (perhaps not surprisingly this view of history provides just enough history to be useful and support the Imperial viewpoint of the time)

Our Quest Today

- To be more inclusive
- To be open to new ideas
- To learn something and hopefully be inspired to follow-up in our classrooms
- Finally: our content – we will look at the 1 400 year gap in the standard European timeline of mathematics between Ancient Greece and the birth of Calculus

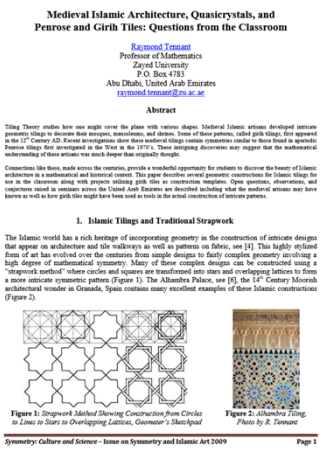
Short timeline of Islamic geometry

(absolutely incomplete - overview)

- Umayyads (661 C.E. onwards by 720 C.E. from Indus valley to Gibraltar)
- Abbasids (Bagdad from about 762 C.E. and the "invention" of algebra)
- Sunni revival (c. 11th Century – Seljuk's and Ghaznavids)
- Mongol Cataclysm (1219 C.E.)
- Ilkhanids and Timurids (Persia, Central Asia – Samarkand, Herat))
- Mamluks (cultural revival 13th to 16th century)
- Ottomans (from about 1340 C.E. onwards until 1919 C.E.)
- Mughals (Persia – India, 16th to 19th Century)

- Take-home:
  - There is a large and complex overlapping history over a period of 1 400 year with which we are not very familiar in Australia
  - Scholars from the Islamic world provided the texts and their own scientific and mathematical texts used to drive the discoveries during the enlightenment in Europe (but notice that there own period was also developed in parallel and at the same time as the enlightenment)

An explanatory revelation



Medieval Islamic Architecture, Quasicrystals, and Penrose and Girih Tiles: Questions from the Classroom

Raymond Tennant
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Abstract

Tiling Theory studies how one might cover the plane with various shapes. Medieval Islamic artisans developed intricate geometric tilings to decorate their mosques, mausoleums, and shrines. Some of these patterns, called girih tilings, first appeared in the 13th Century AD. Recent investigations show these medieval tilings contain symmetries similar to those found in aperiodic Penrose tilings first investigated in the West in the 1970's. These intriguing discoveries may suggest that the mathematical understanding of these artisans was much deeper than originally thought.

Connections like these, made across the centuries, provide a wonderful opportunity for students to discover the beauty of Islamic architecture in a mathematical and historical context. This paper describes several geometric constructions for Islamic tilings for use in the classroom along with projects utilizing girih tiles as construction templates. Open questions, observations, and conjectures raised in seminars across the United Arab Emirates are described including what the medieval artisans may have known as well as how girih tiles might have been used as tools in the actual construction of intricate patterns.

1. Islamic Tilings and Traditional Strapwork

The Islamic world has a rich heritage of incorporating geometry in the construction of intricate designs that appear on architecture and tile walkways as well as patterns on fabric, see [4]. This highly stylized form of art has evolved over the centuries from simple designs to fairly complex geometry involving a high degree of mathematical symmetry. Many of these complex designs can be constructed using a "strapwork method" where circles and squares are transformed into stars and overlapping lattices to form a more intricate symmetric pattern (Figure 1). The Alhambra Palace, see [6], the 14th Century Moorish architectural wonder in Granada, Spain contains many excellent examples of these Islamic constructions (Figure 2).

Figure 1: *Strapwork Method Showing Construction from Circles to Lines to Stars to Overlapping Lattices, Geometer's Sketchpad*

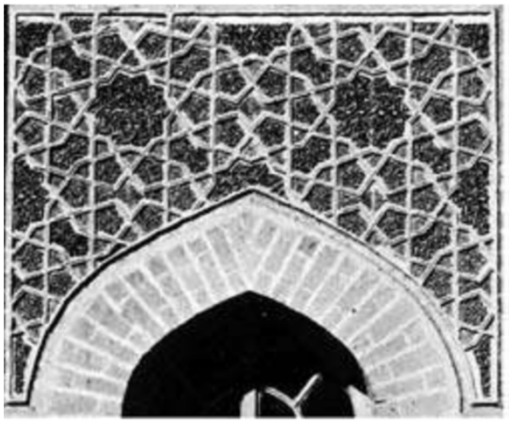
Figure 2: *Alhambra Tiling. Photo by R. Tennant*

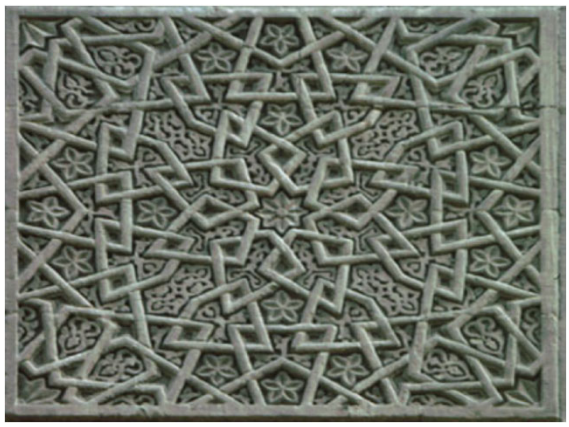
- Short summary – Medieval Islamic Architecture moved from: (1) preserving ancient constructible geometries to (2) developing new constructible geometries to (3) creating new developments including non-constructible geometries

(in our "false" timeline these were largely discovered during the 19th and 20th century by European mathematicians)

12th and 14th century "strapwork"

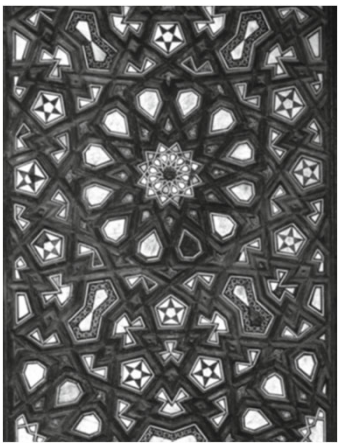
(these are both constructible)





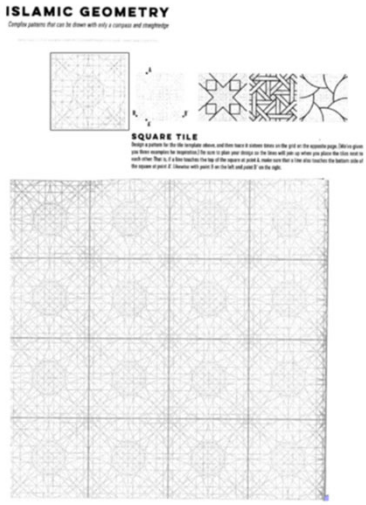
More constructible examples

Detail page from a 10th Centruy Qu'ran



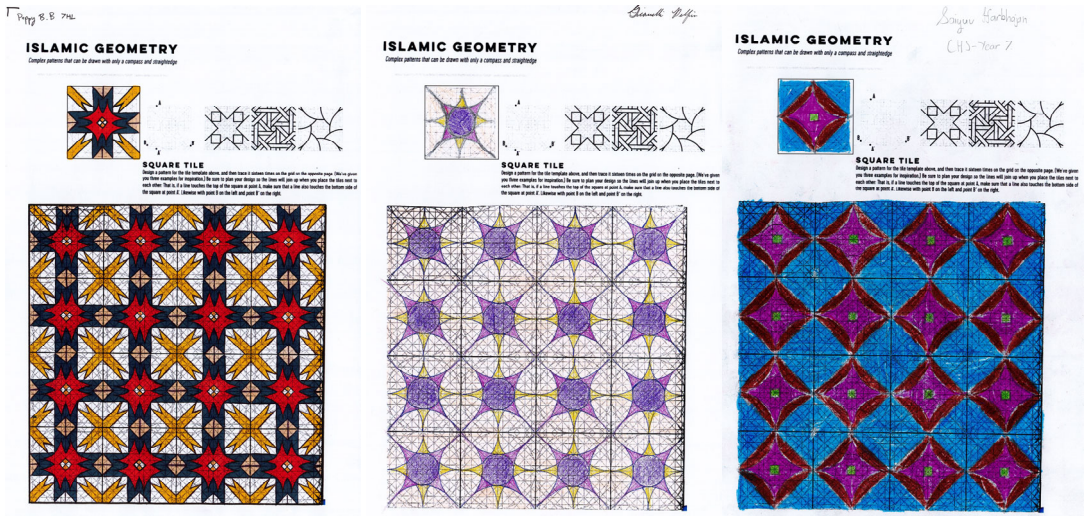
Detail woodwork from an Egyptian mosque

Let's make our own pattern *(handout 1)*

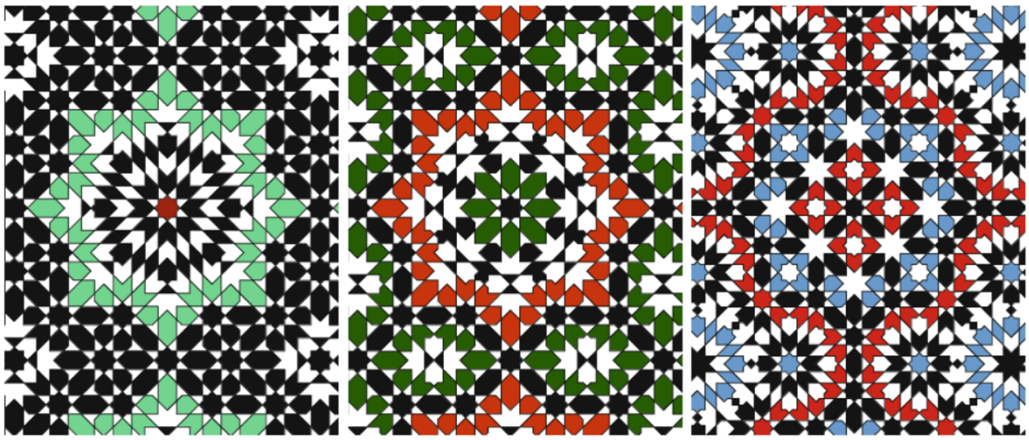


- Make your own design in the square
- Make sure that is has order 1 symmetry *(do ask!)*
- This activity is used in my year 7 class at the end of the geometric transformations unit

Student samples

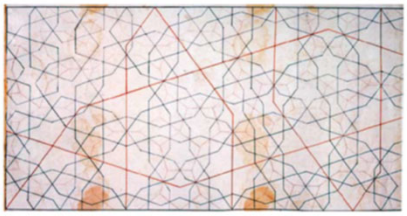


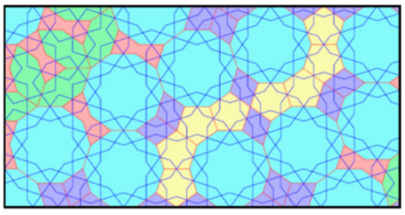
Zillij *(there is really a whole day workshop here)*

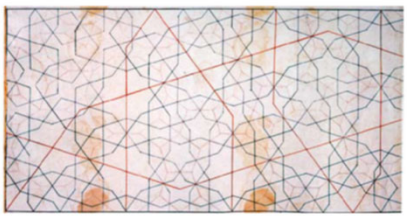


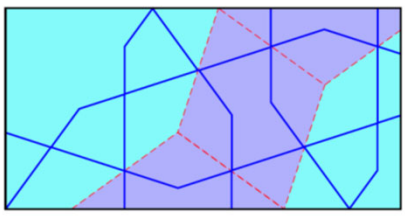
Non-constructible geometries

(Topkapi scroll detail is aperiodic, non-constructible and two scales)

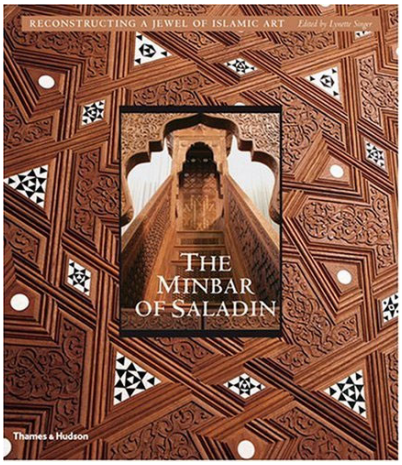








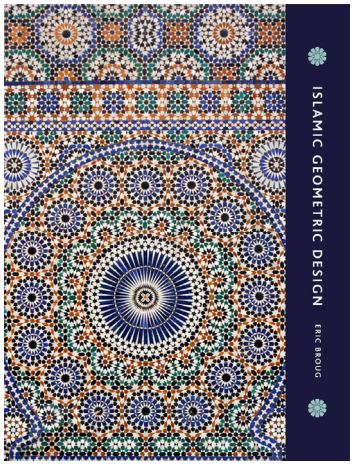
Resources I



Comment:

- Detail of sacred geometry and how it relates to mathematical constants and constructions.

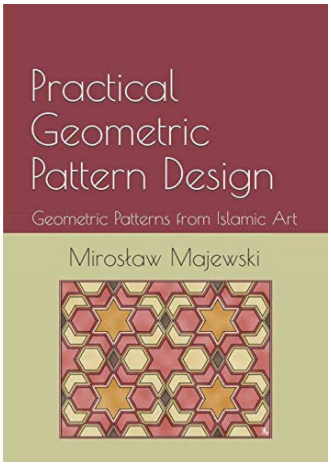
Resources II



Comment:

- Detailed breakdown of fourfold, sixfold, fivefold and combined geometries and how to construct them – some discussion of how to design square tiles for geometries that can make use of them *(labelled, "simple" in the text)*

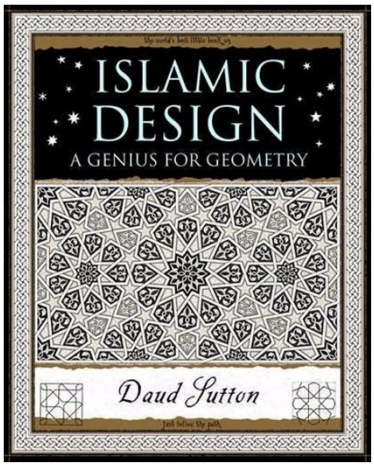
Resources III



Comment:

- Practice book for constructing this sort of geometry – starts from base grids *(square or isometric)* rather than constructible so not particularly traditional or mathematical but lets you get started right away which may be the best starting point

Resources IV



Comment:

- Very small book – presents an interesting framework for understanding many types of Islamic tile mosaic designs and how they relate together, much deeper than it appears on a first reading.

Resources V

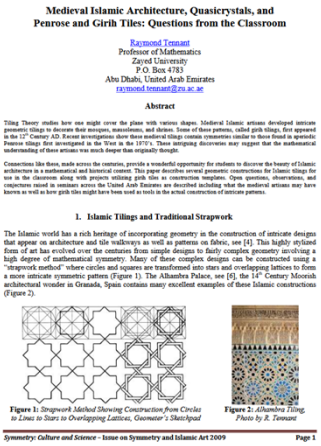


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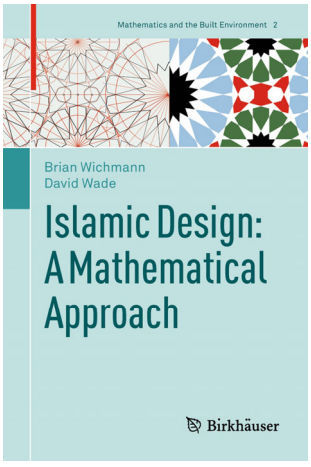
Figure 1: *Strapwork Method Showing Construction from Circles to Lines to Stars to Overlapping Lattices, Geometer's Sketchpad*

Figure 2: *Alhambra Tiling, Photo by R. Tennant*

Comment:

- This is where I started and it is a wonderful article – many of the images on earlier slides were found in the supplemental images part of the paper

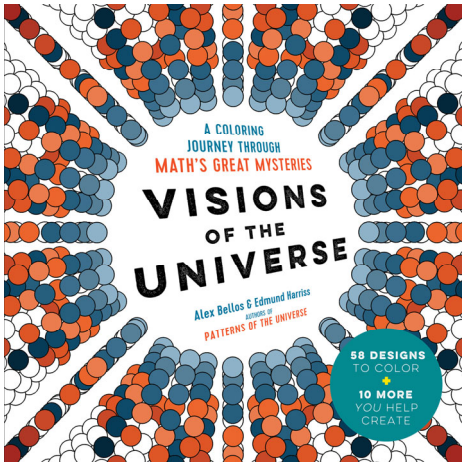
Resources VI



Comment:

- I do not yet understand where this book is coming from – so no real thoughts here as I need more time with this one, even so I have used elements from some parts of it here today

Resources VII



Comment:

- Essentially a colouring book with patterns based upon mathematics – oddly various pages of this find their way into my classroom every year *(the square tiling we did earlier comes from this book)*

Thank you! and a Challenge

(including the worlds oldest cultures in the mathematics classroom)

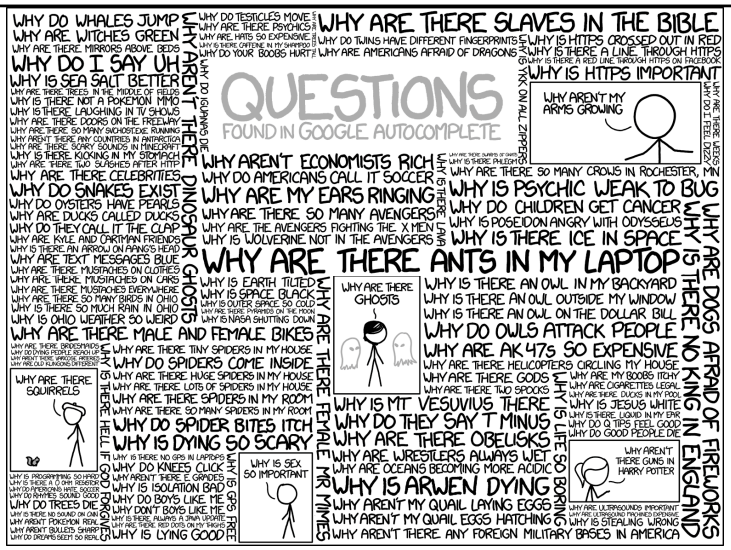
- First Nations mathematics in Australia – where can we find details for use in our classrooms?

  (there are many ideas quoted in the Victorian Curriculum 2.0 Mathematics but no obvious text sources to find out the details)

- How do we make First Nations students feel more comfortable and successful in our classrooms? (ATSIMA?)

Questions?

- Please give your feedback *(app instructions to follow)*



xkcd no. 1256

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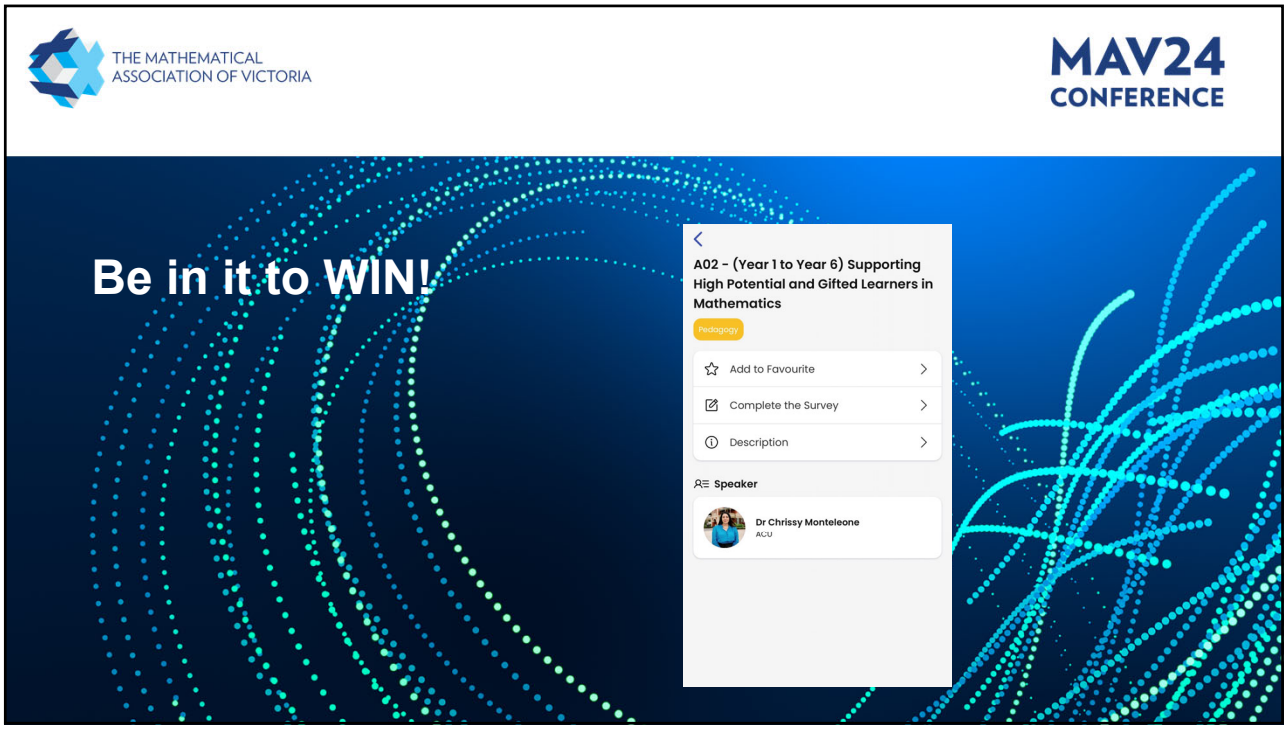
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