**Magic Squares Masterclass**

**Thanks for helping with this Masterclass session! Your support is much appreciated.**

The session leader should be able to tell you more about the content of the session, and exactly how they’d like you to help, but this sheet should give you some basic information you may find useful. If any of this seems obvious to you, that’s great!

In general, for Masterclass sessions:

* While the session leader is talking to the group, don’t interrupt them or distract the students unless something is wrong that needs fixing urgently. You should also watch and pay attention to what they’re saying, to set a good example.
* If things need handing out to the students, wait for the session leader to signal you to do this, as it can distract the students if you start to hand things out before they’re ready.
* If the students are given a task to work on, you should circulate the room to talk to the students. Wait until they’ve had a chance to tackle the problem before you interrupt them, and encourage anyone who looks like they haven’t started yet.
* Try not to give away the answers to the students, especially if they’re working on the problem and about to discover it for themselves - if they are really struggling, you can give them a hint or suggest where they might start looking.

**In this session:**

This workshop is an exploration of number bonds and symmetry. Magic squares capture something of the beauty and joy of manipulating numbers. Magic squares have an interesting history; the first part of this Masterclass focuses on three specific examples:

1. The square carved into the façade of the Sagrada Familia in Barcelona
2. The square depicted in the Durer painting “Melancholia”
3. The ancient Lo Shu Square from China

The second part of the Masterclass encourages the children to play with the concept of magic squares, and to understand how they are constructed.

The main activities are:

**1. Construct a 3x3 magic square using the numbers 1-9 before extending to other sets of consecutive numbers.**

This is just to start setting the scene, the purpose is to encourage familiarity with magic squares.

Working in pairs, students make a magic square (3x3) using the numbers 1-9. The magic total of columns, rows and diagonals are all 15. How many different squares can they make? (Essentially 1, but others are transformations of one another; discussion of rotation and reflection) There are 8 versions of this unique solution, obtained by rotating and reflecting.

Then encourage them to work on 2-10 square. Think about other challenges.

**2. Durer’s painting Melancolia**

Magic squares can be larger, 4x4. Look at some larger examples of magic squares occurring in art and history. The students may have a copy of Melancolia, or may skip straight to the detail of the 4x4 magic square.

If they have a copy of the picture then encourage them to discuss any mathematical things of interest that they can see.

Look at the detail of the magic square in the Durer painting. What do you notice? What is the magic total (answer: 34) Find pairs which sum to 17. Then look for patterns of 4 numbers which sum to 34

What year do you think this painting was painted in? (Remind them of Durer’s dates)(Answer: 1514, at bottom centre!)

**3. Magic Square on Sagrada Familia**

The students should compare the new magic square with the Durer one. There are a couple of major changes… four numbers have been altered to make total 33, so no longer consecutive numbers. The square has then been rotated through 180 degrees…but otherwise these are the same solution to the 4x4 magic square problem.

**4. Constructing a magic square with a random total**

The numberphile video shows how this magic “trick” is done. The children can then try to make one themselves. 12 numbers are always the same….some of them will need help with the concept of substituting for n, their number of choice.

**5. Constructing a magic square for a special date**

Finish by making a special magic square for today’s date. The children can complete this if they follow the instructions carefully. They may end up having to use negative numbers…this is OK, but may freak them out!

The children then make one for their birthday, or another special day of their choice.

*There is a great deal more background information available on a separate sheet, if you would like more detail. Please ask the session leader if you’d like to see it.*

**Thanks again for your help with this session! If you have any other questions, please ask the session leader.**