Episode 5

The main character here is Dr Francesca Iezzi (Mathematics Engagement Officer at the University of Edinburgh). The puzzle comes from Topology, the area of Mathematics Francesca focused on during her PhD. This area has applications to physics (e g studying the shape of the Universe), Chemistry (e g the study of molecular structures) and biology (e g the study of DNA)

The puzzle

Question

We have a necklace, and a magnetic board with two supports: a white support on the left, and a blue support on the right. Hang the necklace in such a way all three of the following are true simultaneously:

1) If both supports are there, the necklace will hang

2) If we remove the blue support the necklace will fall

3) If we remove the white support the necklace will fall

Aims of this puzzle

- Generating a sense of surprise, by showing an area of Maths which is not in the school curriculum.
- Developing some skills in Topology. This is the area of Mathematics concerned with the study of shapes; it also includes the study of knots.

Prompts (should you get stuck)

- As a first hint, keep in mind that the solution is <u>not</u> related to balancing or creating friction. You should imagine that the chain is perfectly smooth and there is no friction. The trick only relies on how you hook the chain around the two supports. The chain would be tangled if both supports are there, but as soon as you remove either one of the two supports it will untangle.
- As a starting point, try first to make conditions 1) and 2) true simultaneously.
  What is key here? Why does the necklace fall if we remove the support on the right?
- Now, try to make this symmetrical.

If you or your students are at the point of giving up…

We recognise that this puzzle is really challenging. We recommend that you watch the solution video before posing the puzzle to your students.

If your students feel stuck we advise that you show the solution to them, and you ask them to imitate it. Then ask them to draw the solution on a piece of paper, and understand the reasons why the chain untangles if we remove either of the two nails. In this case, even understanding a given solution is a huge achievement.

Material

It would be ideal to use a necklace or a piece of string, and hang it on magnetic supports or pegs on a notice board. If that is not possible, drawing the chain on a piece of paper would be sufficient.

As mentioned, after solving the puzzle, students should draw the solution on a piece of paper. In this way they can get a better idea of why the chain untangles. They would also get familiar with some very advanced concepts in mathematics.

Further details

This puzzle is related to an important discovery in pure Mathematics known as the "Pochhammer Contour"

A possible extension

After solving the necklace puzzle, you can try solving the following problem.

Magic Bracelet

The bracelet in the picture below has the following characteristics:

- It is made of three loops

- The three loops are all linked together

- If we cut any of the three loops, then the bracelet will fall apart (i. e. the other two loops will not be linked together anymore).

Questions

- Use the pieces of string to make yourself a bracelet like this.
- Why does the bracelet fall apart if you cut any of the three pieces of string?
- This puzzle is closely related to the necklace puzzle that we just solved. Can you see why?

Material

You will need three pieces of string and some sellotape. It would be useful to also draw the solution on paper.

Further details

This puzzle is related to an important discovery in pure Mathematics known as the "Borromean Rings"