FOUR COLOUR THEOREM

LESSON PLAN

GRADE:	SUBJECT:	DATE:

LESSON FOCUS AND GOALS:
To investigate the four colour theorem and learn about the impact of computers in mathematics

MATERIALS NEEDED:
Printed example maps
Colours; Digital device (if possible)
Projector (if possible)
These slides

LEARNING OBJECTIVES:
I can have a systematic approach to my learning
I make links between Computer Science and Maths

STRUCTURE / ACTIVITY:

The Set Up (5-10 minutes):
Start by sharing the 2x2 grid on JSPaint. Download the file from the website (or create your own) and open it using 'File - open'
Colour in each grid with a different colour using the bucket tool. Suggest to the class - "I managed to fill this grid with colour so that no same colour meets at an **edge**. Could I have used less colours?"
Once you establish you can do it with two colours (like a checkerboard), then show the 3x3 grid. Again discuss how this can be covered in just two colours with them never meeting the same colour at an edge. Be sure to explain the difference between meeting at a **point** and at an **edge**. (points are allowed) Now share a more complex map like the one given on the site.

The Investigation (20 - 30 minutes)

"The Guthrie Brothers believed they only needed four colours or less to colour in the map of England - or in fact any map - without same colours touching, but could not prove it"

First ask the students to see if they can colour in the map with just four colours. Have some other complex maps/designs printed (from the site) in case they finish this challenge. If you have access to devices you might want to skip this and move onto the next part of the task)

After a few have managed to successfully colour in the map, then explain that computers were able to prove this theorem and it was the first time that computers were used to create proof - meaning it is always definitely true that you need four colours or less.

The lesson then splits dependent on whether you have access to devices in class

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WITHOUT DEVICES

On the board, show Kleeman's solver for straight line maps. Ask students to come up with a design that their partner cannot solve with four colours. They must only use straight lines and try to limit to only twenty straight lines or so so that it doesn't go to difficult. They then pass the design to their partner or someone else and see if they can solve it.

Follow up:

A challenge for students also is to figure out what sort of drawing requires **four colours** compared to **three?**

WITH DEVICES

There are two great colouring challenges using Mathigon and Transum, which students can start using right away to practice trying to fill in maps. (Links on webpage)
You could ask them to screenshot their finished images and share with you to make a really impressive piece of artwork. If they finish or start to look bored - use JS Paint with them to design their own map problems for their friends to try and solve. They can use the line tool to create a map and then save it to their computer. They can then share it on Google Classroom or similar for other students to try

The Follow Up

Using Kleemans Solver - have students learn about how computers proved that four colours were enough They can draw their own pattern and the algorithm will solve it and colour it in under four colours.

Questions - how complicated can you make it?
Can you beat the computer algorithm?
What changes about the design that makes it jump from 3 - 4 colours?

Why do some patterns need only three colours, whilst some need four?

What changes?

ASSESSMENT:

Have the students create a simple paragraph explaining the Four Colour Theorem, and a small example with a small drawing (or screenshot/printout of previous work.)

Finally ask them to write down the answer to this **in less than 20 words -** why were computers needed to prove the four colour theorem?

This task does not require much assessing, but should be seen as an introduction into the links between computer science and mathematics (and art!)