Pixel Colouring

Suggested Age / Grade Level	Curriculum Covered	Duration
Minimum: Grade 3 Maximum: Grade 9	COMPUTER SCIENCE!!!!	1 hour

Learning Outcomes
- An introduction to the fundamentals of computer languages, including the difference between binary, programming and human languages
- Application of these concepts in an art lesson with a pre-coded excel file that allows students to design their own drawing
- Learning computer visualization concepts including resolution, pixels, and HEX codes

Materials
- USB with "Pixel Art" File (also in the Drive Folder in Google Sheets format)
  - Make sure you always COPY the original file so the original file stays properly formatted for future use. Students may save their version on their computers.

Other Requirements
- A projector with computer access (must have either Google Sheets or Microsoft Excel loaded)
- A computer for every student (preferable, students may pair up if necessary)
- Access to google sheets or Microsoft Excel
- The "Pixel Art" file (in Excel or Sheets) loaded onto each computer
- Access to the internet for each computer preferable (access to the internet for the computer connected to the projector is necessary)

Procedure

Introduction (10 mins)
1. Talk about what pixels are and how they make up images.
2. Do a demonstration where one volunteer acts like a computer:
   a. Example 1: you draw a simple image on the chalkboard or whiteboard (I drew a tree). Ask the students to direct the volunteer to colour in the

correct parts (i.e. colour the leaves on the tree green?). Remember, a computer doesn't know what things are until you direct them, so students have to break down each step and give precise instructions about which parts to colour.

b. Example 2: Ask the students to direct the volunteer to do something (pick up a water bottle and place it on a different desk). Remember, a computer doesn't know what things are until you direct them, so students have to break down each step and give precise instructions on which parts of their body to move where.

3. Explain how computers need specific instructions: They do not know anything and need to be told everything.

4. Talk about the three different levels of computers. Human level, programmer level, and machine level. Mention how this relates to colour: There are 0s and 1s (binary code) at computer level, HEX codes at the programming level and as humans we just describe colours with our words.

Black and White Sheet (10-15 mins)

5. Start working with the Excel/Google Sheets file. Have students open the Black and White sheet to work in. This is an example of the machine level. Show students how the Excel sheet works by entering 1's and 0's into one cell at a time.

6. Typing a 1 will make the square black and typing 0 makes it white

7. Give them 5 minutes to play around with the Black and White sheet and draw something using only those two shades.

8. Talk about pixels in reference to Resolution.
   a. Demonstration (if time permits): Draw 2 grids on the board: one grid that is 4x4 and one grid that is 10x10; ask a volunteer to draw a smiley face in each grid by filling in squares one at a time. You can't do it in the 4x4 because there is not enough resolution.
   b. Illustration of resolution:
      https://mymodernmet.com/endangered-species-pixelated-photos-jjsmooth44/

Colour Sheet (20-25 mins)

9. Have students open the Colour Sheet. This is an example of the Programmer Level - remember all computers operate on binary (0's and 1's) code; we have coded this sheet to interpret numbers as different colours - this is an example of a simple programming language.

10. Ask students to google simple images they want to draw. If they want, they can search "_____ pixel art."
11. Give them 10 minutes to start creating their picture on the Colour Sheet.
12. Ask students to pause to introduce the idea of HEX codes - this is how computers interpret colour so we can see colour on all sorts of screens.
13. Go to a HEX Code website like this one: https://htmlcolorcodes.com/
    a. The first demonstration on the page shows various colour languages as you move the small circle to change the colour.
    b. HEX codes are a universal programming language so that different computers can interpret the same colour. Why would this be important? (ex. Using the proper shade of blue for the Ryerson logo on a website, in printed material, etc.)
14. How do HEX Codes work? #FF0000 is red because hex codes are how we store colour. #RRGGBB. The first two numbers are how much red, the second two are green and the third two are blue.
    a. "FF" is the highest amount of a colour that you can get. "00" is the lowest amount of red, green or blue
15. Challenge students to create different colours by dictating the HEX code they think will create that colour. Type the code in to see the result.
16. Once they have a good feel for how to change colours based on the HEX code you can give them some time to finish up their Pixel image.
17. Finish the lesson by mentioning how computer coding, programming and art interact with each other. If you want, you can pull up career profiles like these ones:
    a. Background Artist: "As a background artist, usually you are assigned to one show that you work on with a team. I've worked on a couple different cartoon TV shows like Lion Guard (seasons 1-3) and Tangled (seasons 1-2). My boss will send me a section of backgrounds for an episode. This is the line art and it looks like a colouring book. It is my job to digitally colour in the backgrounds, save them, and send them back."
    https://letstalkscience.ca/careers/rebecca-pilon
    b. Scientific and Medical Illustrator:
    https://letstalkscience.ca/careers/dino-pulera

Important Notes

What are Pixels?
- Tiny little squares that make up all of our digital screens.
- The more pixels, the more details that you can have.

- Computer screens can have pixels like 1920 x 1080 which totals 2,073,600 pixels
- Each pixel can be one colour, and there are millions of colours.

Resolution

The **display resolution** or display modes of a digital television, computer monitor or display device is the number of distinct pixels in each dimension that can be displayed. It can be an ambiguous term especially as the displayed resolution is controlled by different factors in cathode ray tube (CRT) displays, flat-panel displays (including liquid-crystal displays) and projection displays using fixed picture-element (pixel) arrays.

It is usually quoted as **width × height**, with the units in pixels: for example, "1024 × 768" means the width is 1024 pixels and the height is 768 pixels. This example would normally be spoken as "ten twenty-four by seven sixty-eight" or "ten twenty-four by seven six eight".

One use of the term "display resolution" applies to fixed-pixel-array displays such as plasma display panels (PDP), liquid-crystal displays (LCD), Digital Light Processing (DLP) projectors, OLED displays, and similar technologies, and is simply the physical number of columns and rows of pixels creating the display (e.g. 1920 × 1080). A consequence of having a fixed-grid display is that, for multi-format video inputs, all displays need a "scaling engine" (a digital video processor that includes a memory array) to match the incoming picture format to the display.

Televisions are of the following resolutions:

- Standard-definition television (SDTV):
  - 480i (NTSC-compatible digital standard employing two interlaced fields of 243 lines each)
  - 576i (PAL-compatible digital standard employing two interlaced fields of 288 lines each)
- Enhanced-definition television (EDTV):
  - 480p (720 × 480 progressive scan)
  - 576p (720 × 576 progressive scan)
- High-definition television (HDTV):
  - 720p (1280 × 720 progressive scan)
  - 1080i (1920 × 1080 split into two interlaced fields of 540 lines)
  - 1080p (1920 × 1080 progressive scan)
- Ultra-high-definition television (UHDTV):
  - 4K UHD (3840 × 2160 progressive scan)
  - DCI 4K (4096 × 2160)

- 8K UHD (7680 × 4320 progressive scan)

[Wikipedia.org]

3 Levels of Computers
- Human Level
    - We understand things through more than just words.
    - We have past experience that help us to understand things.
    - **For example,** when I tell you to colour in tree leaves, you already know that they would be green.
- Programming Level
    - We made a mix of English and computer language to be able to communicate with computers.
    - It is a mix of words that you would understand and it uses more technical language.
    - **For example,** #FF0000 is red because hex codes are how we store colour. #RRGGBB. The first two numbers are how much red, the second two are green and the third two are blue.
- Computer Level
    - It is all 0s and 1s.
    - Technically, everything a computer does is just a circuit turning on or off.

How the Excel Sheet Works

Black and White Tab - typing a 1 will make the square black and typing 0 makes it white

Colour Tab - the legend at the top describes what colour a square changes when you type a number.

Notes:
- Make sure they only type one number in each "pixel"
- Hit enter after typing the number
- The way it changes colours is through using conditional formatting, so there is no way for them to change the colour that the numbers make (highlighting the number 3 in the legend and making the square light blue won't make number 3's turn to light blue)