Name: Anthony Pieper

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Unit: Digital Information

Grade: 9

Lesson Topic: Digital Images and Bitmaps *(Developmental lesson)*

Time Allotted: 85 minutes (1 class period)

Context for Learning:

This lesson is the second lesson in the third unit of the class, which focuses on abstraction and how computers encode and store data. The previous lesson introduced students to the two main types of files (*plain-text and binary*), and re-introduced the ASCII encoding scheme used for storing text messages, but this time in the context of plain-text and binary files. The previous lesson also introduced students to a tool called a "***Hex Editor***," and allowed students to use this tool to modify both plain-text and binary files.

This lesson will expand upon topics that were previously covered by showing students how more complicated objects are encoded as data, which should help students reinforce the concept of abstraction in computer systems. This lesson will introduce students to the concept of a "***pixel***," which is a combination of red, green, and blue elements that a computer can use to display images. This lesson will then introduce students to the concept of "***bitmap images***," which digital images composed of red, green, and blue elements that can be easily displayed through pixels.

Students will practice encoding images initially using a worksheet consisting of black and white images, since these images are more easily represented using binary (*1 for white, 0 for black*). By the end of the lesson, students will be allowed to experiment with the Hex Editor tool in an attempt to create real bitmap images, which should help reinforce the previous activity with black and white images. This will also reinforce the concept of "***metadata***," which was discussed in previous lessons.

Curriculum Standards:

CSTA K-12 Computer Science Standards

- **3A-CS-02**   **Compare levels of abstraction and interactions between application software, system software, and hardware layers.**

- **3A-DA-09**   **Translate between different bit representations of real-world phenomena, such as characters, numbers, and images.**

ISTE Standards for Computer Science Educators

- **1-C-I**   **Demonstrate an understanding of data representation at the machine level.**

Objectives:

- Students will demonstrate their understanding of the concept of a pixel by explaining how computers use binary encoding to store a pixel *(ISTE 1-C-I)*

- Students will demonstrate their understanding of the relationship between pixel data and metadata by creating a simple encoding scheme that stores black-and-white images *(CSTA 3A-DA-09)*

- Students will demonstrate their understanding of how application software simplifies the abstraction process by using the Hex Editor to manipulate bitmap images *(CSTA 3A-CS-02)*

Materials:

- Everyone will require a computer with Internet access
    - Code.org Pixelation Widget (studio.code.org)
    - Web-based Hex Editor (hexed.it)
- Worksheets for students
    - Invent a B&W Image Encoding Scheme (*classwork*)
    - B&W Pixelation Widget Activity Guide (*classwork*)
    - Bitmap Hex Exercise Handout (*classwork*)
    - Personal Favicon Project (*homework*)
- Student Notebooks
- Whiteboard with dry erase markers (*at least 4 different colors*)

Procedures:

- **Warm-up** (*5-10 minutes*)

    - *Pre-bell:* Teacher will write the vocabulary list on the white board: ***Pixel, Bitmap, Metadata.***

        - Only the words will be written, not the actual definitions.

    - *Post-bell:* Students will be asked to write down the definitions in their notebooks. The teacher will remind students that ***metadata*** was discussed in previous lessons, but that the terms ***bitmap*** and ***pixel*** may be new. <u>After 3-5 minutes, the teacher will call on 3 students to provide the definitions.</u> The teacher will ask if there are any different definitions that students came up with, and then discuss possible reasons for the differences.

        - These terms may not have been explicitly defined in previous lessons, so there may be some variety in student responses.

- **Motivator/Bridge** (*5-10 minutes*) – <u>ASCII Review and Pixel Introduction</u>

    - The teacher will ask students about the previous lesson's topic, and try to get students to talk about how ASCII uses 8 bits to represent a single letter of text. The teacher will then ask students how we could represent something more complicated, like an image or picture.

- **Group Task** (*10-15 minutes*) – <u>Pairs Invent an Encoding Scheme</u>

  o The teacher will pass out the Encoding Activity Worksheet, and students will work in pairs to come up with an encoding scheme to store black and white images as binary numbers. This will allow students to see the relationship between metadata and pixel data, since part of the encoding scheme will have to account for the actual size of the image (*width and height*) which is separate from the actual black and white pixels.

- **Individual Task 1** (15-25 minutes) – <u>Use the Pixelation Widget</u>

  o The teacher will pass out the Pixelation Widget Worksheet, and students will work individually to create actual images using binary numbers in the Pixelation Widget. Part of this activity will also test whether or not the encoding scheme developed in the previous activity will actually work or not. Students will also be required to fill out the worksheet as they use the Pixelation Widget, and the worksheet will be turned in at the end of class.

- **Guided Activity** (5-15 minutes) – <u>Use the Hex Editor to Create a Bitmap Image</u>

  o The teacher will pass out the Bitmap Hex Editor Worksheet, and walk the students through the creation of a small bitmap image in the Hex Editor. This will help provide a real-world example of the use of binary numbers in the creation of images, as well as demonstrate the utility of using software applications to create images as opposed to creating them manually.

- **Summary / Closure** (*5-10 minutes*)

  o The teacher will recap the definition of key terms by asking students to explain them, and then ask them to think about how using binary numbers to represent images could get very large if 24 bits is used for each pixel. The teacher will then foreshadow that the following lesson will cover ways to reduce file size without reducing quality, and that it will include reducing text size as well as image size.

  o The teacher will pass out the *Favicon Project Worksheet* and instruct students to do Lesson 4 on the Code.org website for homework. The teacher will explain that this lesson covers a version of the Pixelation Widget that uses color, and that this tool should be much easier to use than the Hex Editor they used in class.

  o The teacher will collect the Pixelation Widget Worksheets prior to the students leaving the classroom.

Assessments:
Students will be provided a worksheet that contains simple images, and they will be required to create those images using binary numbers and the Pixelation Widget. This worksheet will be turned in at the end of class, and will function as a **Minor Summative Assessment** on whether or not students understood the differences between metadata and pixel data.

Students will also be assigned homework that requires them to create a larger color image, which will be submitted the following class period. Submission of this image will also serve as a **Minor Summative Assessment** on whether or not students understand the concept of pixels and the storage of binary data, because this image will require the use of each of the pixel elements (*red, green, and blue*).

There will also be **formative assessments** done throughout the lesson, as the teacher will walk about the room, checking student performance during each of the activities.

Extension Activities:
The primary focus of this lesson covers pixels, and how binary numbers can be used to represent red, green, and blue elements to create a picture. If time permits, or if certain students manage to complete the activities well in advance, I will ask the students to conduct research on the topic of "***Steganography***," which is the means of storing hidden data in images files by manipulating certain parts of the binary data. Although this topic can be quite detailed, students should be able to discover the basics of simple Steganography, and see how it relates to the current lesson topic of binary pixel data.

Review / Reinforcement:
- Homework
  - **Personal Favicon Project** – Students will be required to complete the Lesson 4 activities on Code.org, which includes additional videos and activities relating to color bitmap images. The main activity requires students to create a small image from scratch using the Pixelation Widget, which is more user-friendly than the Hex Editor tool used in class. This activity will help reinforce the concepts covered in the lesson, including the red, green, and blue encoding schemes used by bitmap files.