Lesson Title	Binary Art
Length of Lesson	1 50-minute lesson
Created By	Sean Owens
Subject	Mathematics, Geometry
Grade Level	9^{th} – 12^{th}
State Standards	9^{th} - 12^{th} Pre-Algebra: 1 b; 1 e
DOK Level	DOK 2 – Pre-Algebra
DOK Application	2 – Identify Patterns, Organize, Cause/Effect, Interpret, Show
National Standards	9-12: A: Number and Operations H: Connections I: Representation
Graduate Research Element	This lesson provides an introduction to the binary number system. My research uses binary and hexadecimal values throughout to represent certain values including audio samples, math results, and chip layout information that must be interpreted.

Student Learning Goal:
After performing this lesson, students will be able to represent decimal numbers using the binary number system.

This lesson addresses Mississippi 9-12 Mathematics standards: Pre-Algebra 1b and 1e. It also addresses National 9-12 Mathematics standards B, C, and D.

State Standards: 9^{th} – 12^{th} Mathematics

Pre-Algebra – 1b: Formulate and solve standard and real-life problems involving addition, subtraction, multiplication, and division of rational numbers.

Pre-Algebra – 1e: Explain the rules of exponents related to multiplication and division of terms with exponents.

National Standards: 9^{th} – 12^{th} Mathematics

A (Number and Operations):

- Understand numbers, ways of representing numbers, relationships among numbers, and number systems.

H (Connections):

- Recognize and use connections among mathematical ideas.
- Understand how mathematical ideas interconnect and build on one another to produce a coherent whole.

I (Representation)

- Create and use representations to organize, record, and communicate mathematical ideas.

Materials Needed (supplies, hand-outs, resources):

- Thick Paper (e.g. construction paper, cardstock, etc.)
- Coffee straws, florists wire, yarn
- Washers or other round objects
- Glue

Lesson Performance Task/Assessment:
Students will actively participate in the guided practice portion of the lesson. Also, students will create artwork using provided materials to represent a chosen number in binary.

Lesson Relevance to Performance Task and Students:
The students will assist the teacher in the guided portion of the lesson providing hands-on learning of the basics of counting in binary. The students will choose a decimal number and demonstrate their understanding of the binary number system by converting it to binary and artistically representing it on paper.

Anticipatory Set/Capture Interest:
The lesson will begin with the instructor writing the following on the board:
01010111 01100101 01101100 01100011 01101111 01101101 01100101 01010100 01101111
10000110 11011000 11000010 11100110 11100110 0100001
The instructor will then ask the students if they can read what's on the board. After, the instructor can lead into a discussion of number systems. The instructor will explain how the number system we use (decimal) is just one possible number system that can be used. The instructor will then explain how number systems are based on a single number (decimal = 10; binary = 2) and lead into a discussion of the binary number system. The instructor will then lead into the guided practice section of the lesson.

Guided Practice:
In the guided practice section of this lesson, the instructor will ask for four to eight volunteers to come to the front of the room. The instructor can then have the students represent the different digits of a number by either crouching and standing up or lowering and raising their arms to represent being a zero or one respectively. The instructor can then walk through counting up to however high a number can be made with the number of volunteers used and continuously ask the students to point out any patterns that they can detect. Next, the instructor can have the students choose a number and have the class work together to get the volunteers to show the correct bit sequence. After this, the instructor will explain the instructions for the independent practice section of the lesson.

Independent Practice:
To begin the independent practice section, the instructor will ask each student to choose a number between 16 and 63 (5 – 6 bits). Afterwards, each student will be given a piece of thick paper and coffee straws and washers and instructed to artistically represent their chosen number in binary. The students will confirm their binary number then use glue to attach their materials to the paper.

Remediation and/or Enrichment:
Remediation: Individual IEP, Have the student complete the activity with a smaller number.
Enrichment: Have the student complete the assignment with a larger number.

Check(s) for Understanding:
What is the base number in the decimal system? binary system? What is the largest binary digit? How is the number two represented in binary?

Closure:
To close this lesson, the instructor will explain how binary is the basis for all computing and how computers store information in a binary fashion. Then, the instructor will explain that this allows us to encode anything as a binary string and finally reveal the message written on the board:
Welcome
To
Class!

Possible Alternate Subject Integrations:
Pre-Algebra, Algebra, Physics, Introductory Computer courses

Teacher Notes: