Idea from: https://www.csunplugged.org/en/at-home/binary-challenge/challenges/

Binary Numbers by Hand

In this activity students will explore how binary numbers are used to represent standard numbers. They will do so by creating cards similar to a playing card and manipulating those cards to create binary representations of standard numbers. Each card will have dots on them representing the different binary number values. Once students get the basic idea of binary numbers and follow along with examples from the teacher, they can complete their own conversions using the cards they created.

Binary numbers are basically a sequence of 0's and 1's that, based on the order, equate to a typical number we see everyday. This can be achieved because the positioning of the 1's in the sequence is worth a certain value that follows the base 2 system. Essentially we can think of each 1 in the sequence to have a specific "weight", and when we add up the "weights" all 1's in the sequence we have our conversion to the standard number.

The weights of each position in binary in all of the first 6 positions are demonstrated below. For the purposes of this assignment students will only need to utilize the first 5 positions however. The numbers in the boxes represent the binary sequence and the values above each respective box corresponds to that position's "weight".

$2^5=32$	$2^4=16$	$2^3=8$	$2^2=4$	$2^1=2$	$2^0=1$
0	1	1	0	1	0

A 1 in any position of the sequence can be thought of as a yes and a 0 can be thought of as a no. Based on the example above we have three boxes containing 1's which means we will add the weights from those boxes to our sum to find out which number the above sequence is representing in binary. 2 + 8 + 16 = 26. Therefore, the binary sequence 011010 equates to the number 26. Students will now create these conversions using their own cards; the weights however will be represented by dots for simplicity. Please follow steps below:

1. Have students cut out 5 rectangles of similar sizes (similar to standard playing cards)
2. Lay all 5 cards in a horizontal line across the table
3. Place colored dots on each card starting with 1 on the rightmost card, then doubling that number for each card moving left until all five cards are filled in. It should look like this

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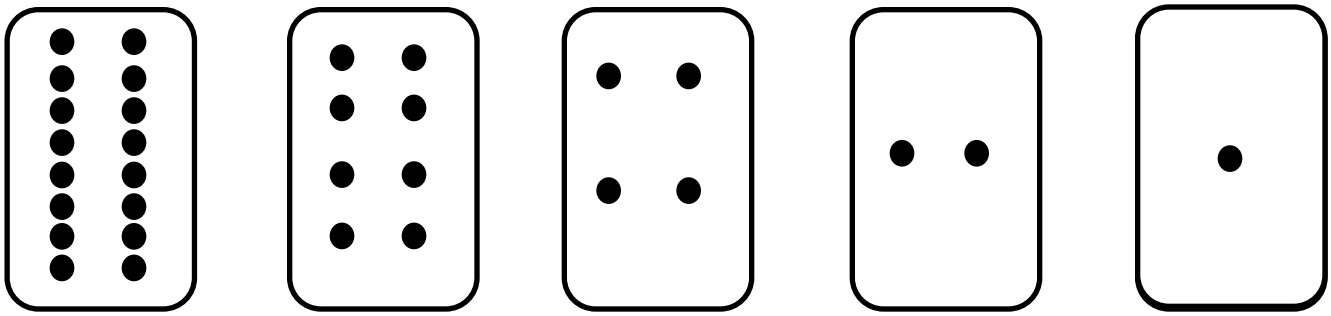
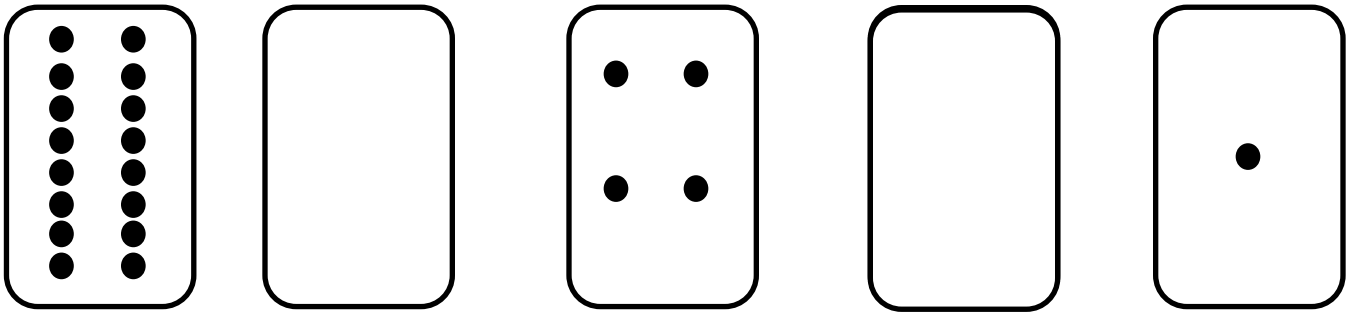


4. Ask students to answer Question 1 on the worksheet at this point
5. Using the cards they have created, students will not turn them either face down (denotes 0 or false) or leave them face up (denotes 1 or true) to create the proper sequences representing the standard numbers listed on the student worksheet

Students will input their answers on the worksheet as a series of binary numbers which will be checked by the teacher using the answer key. A quick example to aid in helping students who may get stuck is given below:

Create the number 21 using the cards:



If we count up the number of dots remaining on the cards that are face up we will see it equals 21. With this, we will put a 1 in each position that is still face up.

1	0	1	0	1

The binary number representing 21 is 10101.