MODULE 1 - CS INTRO

LESSON 1.2 - ZEROS AND ONES

Summary

This lesson introduces students to the Binary System. All of the information that a computer holds is encoded by using 0s and 1s, starting with the rest of the numbers. Students will practise converting 5-digit binary numbers to decimal notation and vice versa, allowing them to count from 0 to 31– ultimately, using the fingers in only one hand.

Duration

60 minutes.

Materials

- Writing board;
- Teacher's computer;
- Projector;
- '1.2 - Zeros and Ones' powerpoint;
- 'Binary Cards', five in all, each with a different number of dots (1, 2, 4, 8 and 16 dots);
- Adhesive (on both sides of each 'Binary Card' to stick them on the writing board);
- Pens;
- 'Binary-Decimal Conversion Exercises', each copy will have two sets of exercises that the teacher can then cut in two, one for each student.

Preparation

1. Traditional seating arrangements, either in rows or in groups.
2. Set up the projector with the '1.2 - Zeros and Ones' powerpoint.
3. Prepare a table at the front of the classroom where the 'Binary cards' will later be displayed (the table should be slightly tilted towards the students so that they can see them from where they are seated).

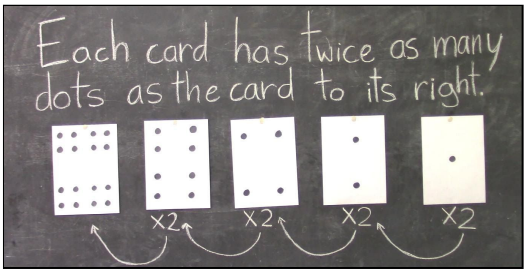
Procedure

1. Quickly review the last lesson. First, bring up the "Which of these are computers?" slide, making sure that the students remember that a smartphone is also a computing device. Follow this with the next slide, which shows the usual contents of a computer, and see if the students understand that all the categories are considered to be "Information". Next, try and elicit the elements that a computer uses to store that same information: 0s and 1s.

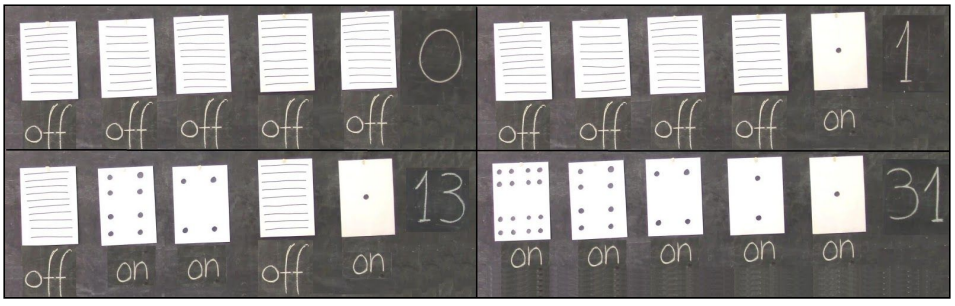
2. Using 0s and 1s a computer manages to store all of that information: numbers, letters, text, images, etc. Tell students that the first step will be to understand how we can get to the rest of the numbers with only 0 and 1. Start by writing 'Binary System' on the board and underline the prefix "bi-". Try to elicit the meaning of the prefix by giving examples of words containing it (e.g.: "bilateral", "binoculars", "bicycle", etc.) and, if necessary, hinting at the fact that it denotes quantity. Having reached its meaning, tell the students that the 'Binary System' works with two things and see if the students connect it to the 0s and 1s, which are shown on the last slide.

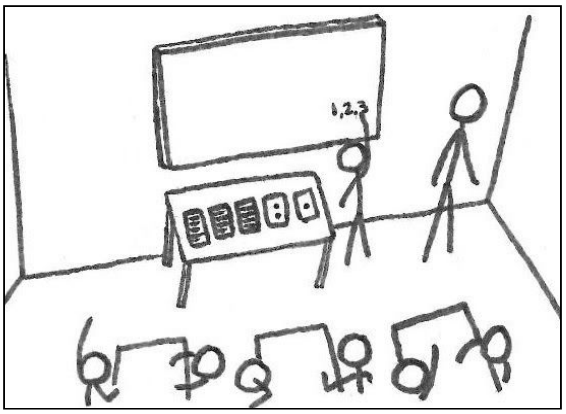
3. Start sticking the 'Binary Cards' on to the board with the dots facing up, from right to left, starting with '1'. After placing '1' and '2', ask what the students think will be next. The answer will most certainly be "It's 3!", so place '4', '8' and '16', each time giving the students a chance to guess what the next one is.

   After they understand that the dots double in number with each new card, ask what the next two or three cards would be after '16' – although making sure to explain that for now they will only be working with 5 cards.



4. Tell students that the cards can be turned 'on' and 'off'. Turn 'off' all of the cards by flipping them over and see if the students can remember how many dots each card has. Ask students which cards would have to be turned 'on' to get numbers 8 or 2, for example. Then ask for numbers that do not correspond to the number of dots on any one card, such as 13 or 10. Explain that, depending on the number we want to express, it might be necessary to turn 'on' more than one card. When wanting to express any number with the cards, one should start turning the cards 'on' or 'off' from left to right, biggest to smallest. If the number of dots in a card is higher than the number you want to express then skip ahead to the next card. If the number of dots is equal or lower, it should be turned 'on'. In case the number of dots is lower than the number we want to express, it will be necessary to turn 'on' more cards – and the process should be repeated until the sum of the dots is equal to the number they want.

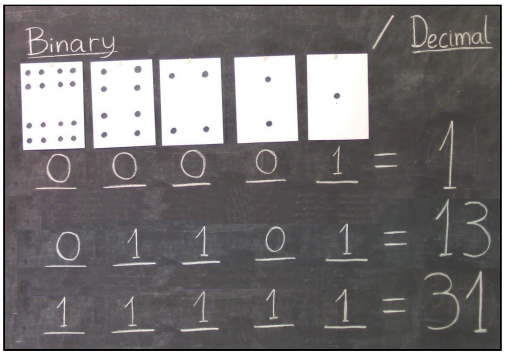


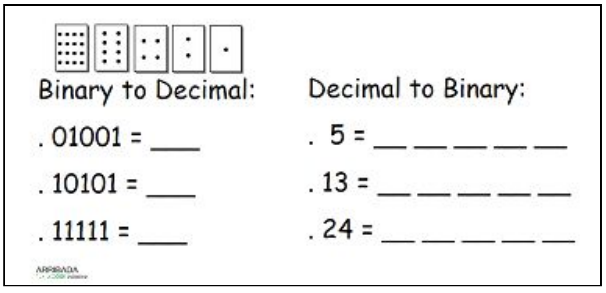


5. After a few examples, set the cards on the table and flip them so that they are all turned ‘off’. The students will come to the table, one at a time, and will be counting up from 1, flipping the necessary cards to show the number they want, and then writing it up on the board.
Once the exercise is done, ask what is the lowest number that the 5 cards can express (making sure to mention 0) and then the highest (31). Also ask how many numbers in total can be shown, i.e., 32.

6. Stick the cards back on the board with the dots showing. Next, tell the students that there is another way of turning the cards ‘on’ and ‘off’ without having to flip them. Mention the binary system and see if the students make the connection between ‘0’ and ‘off’, and ‘1’ and ‘on’.

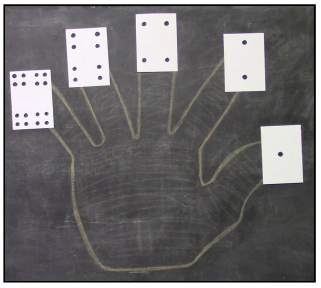
   Then write sequences of 0s and 1s, one under each card, followed by an equals sign and get the students to make the conversion between binary and decimal. Give them a couple of examples and explain that they are now using two notation systems, binary and decimal.





7. Handout the ‘Binary-Decimal Conversion Exercises’. Make sure that the students understand that each digit on the first exercise corresponds to one of the ‘Binary Cards’ that are still up on the board. Also, emphasize that on the second exercise they can only write 0s and 1s.

8. Introduce students to ‘finger binary’, in which each finger in one of their hands corresponds to the binary notation system. Test them first by showing a hand, and lifting up the fingers that correspond to the cards you want to turn ‘on’. Then have the students gesture some numbers themselves. And, be careful with 4. It’s a tricky number…



SOURCES

- "CS Unplugged - An enrichment and extension programme for primary-aged students", Tim Bell, Ian H. Witten and Mike Fellows, 2015.