

Parity Magic

The world is a complicated and imperfect place, and errors can occur when digital information is stored or transmitted. Data stored on digital devices can be changed if there is a tiny fault in the hardware (and these occur regularly); and data being transmitted over networks can be messed up if there's a problem with the connection (which is bound to happen at some stage). These activities explore how digital devices detect and correct errors in data, and why sometimes computers can detect errors, but don't have enough information to correct them.

What is it?

Not only can most digital systems detect errors, but many can correct them as well, back to what the data should have been. Error correction can appear to be magic, since it involves being able to put data back to how it was originally, even when you don't know what the original data was.

Why?

The first lesson plan presents a technique called "parity error correction" as a magic trick that most audiences find intriguing. In the trick the demonstrator is "magically" able to figure which one out of dozens of cards has been turned over, using the same kind of method that computers use to figure out when and where an error has occurred in a piece of data.

Link to Digital Technologies Curriculum

This activity brings together the first Progress Outcomes in both **Designing and Developing Digital Outcomes** and **Computational Thinking** in a more comprehensive manner. Calculating Parity Bits builds on the earlier Binary Number activities while introducing a practical manipulation of a digital system.

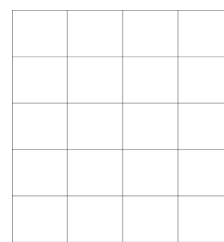


KIA HIHIKO AOTEAROA!

Discovery

Mathematics: Numeracy
Literacy: Speaking
Performing Arts: Drama

Downloadable Resources (One Per Class):



Parity Cards

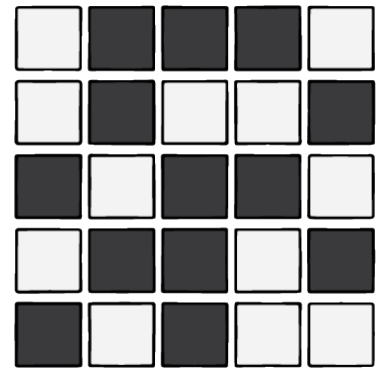
Classroom Resources:

- A set of 36 parity cards
- Whiteboard

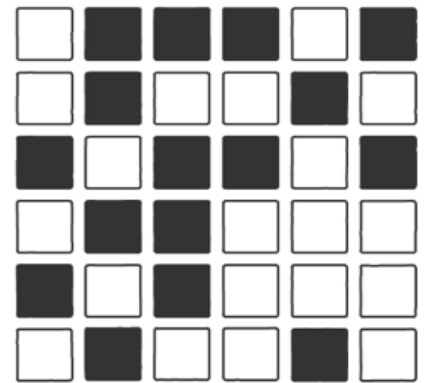
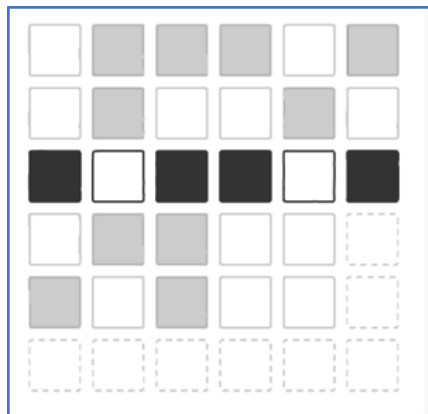
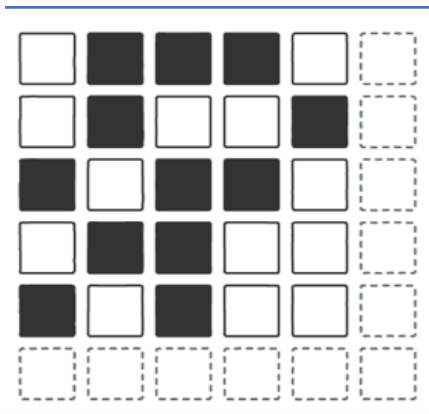
Note: Be sure to print double-sided!

Activity Background

1. Teacher to class: "I've just learnt a magic trick I want to show you".
2. Teacher to class: "So who will be my assistant?"
3. Hand the cards to the student and ask them to put up one row of 5 cards with some cards showing black and the other white. Ask them to add another row, but making sure there isn't a pattern between the 2 rows. Continue to do that until you have a grid of 5 x 5. This is an opportunity to count all the cards, skip count in fives to 25, or to double check there really isn't any patterns happening.
4. Teacher to class: "I'm going to make this a little bit harder by adding another row and another column".



Adding a parity bit to each row and column



In this example, the additional card and row are filled by either a black or a white card, to make the total number of black cards an even number. You can add the parity cards in any order you like.

The last parity bit placed is useful because it will always work for both the column and row; if it doesn't match for both the row and column then you'll have made a mistake with one of the cards, and should go back and check them (try to not make it obvious that you're doing that).

The Activity

After the 6X6 grid above which has the parity row and column has been completed ask a student: "I'd like you flip over one card while I cover my eyes".

Teacher to class: "Keep a close eye on which card it is to check if I have done my magic trick correctly!"

After the class confirms that a single card has been flipped, turn around to look at the cards. Scan the cards looking for the row with an odd number of black squares, and the column that has an odd number of black squares. The card that has been flipped will be at the intersection of these two lines. Turn this card over casually to restore it to the correct colour, saying "it's this one".

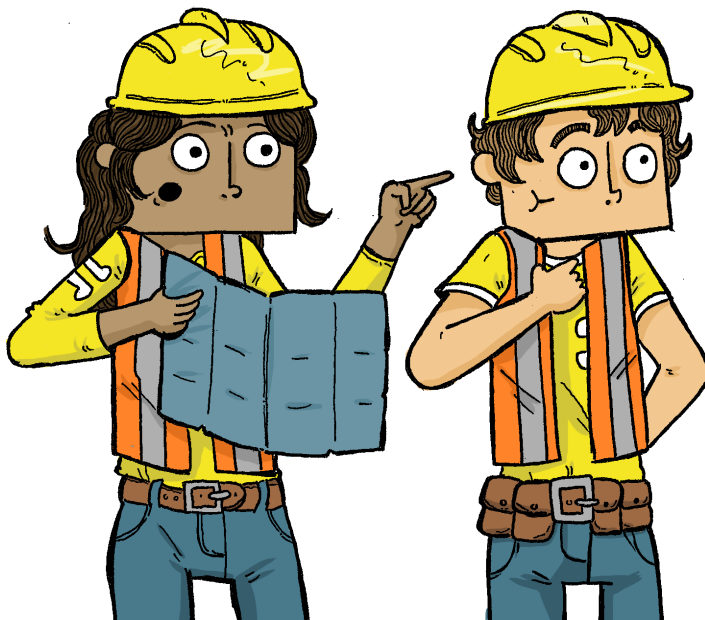
You can make a fuss that it might have been a fluke, so repeat the trick again. (After you put the card back to how it was originally, look away again and ask for another card to be flipped over.)

So is it magic? Or is it a trick?

Teacher to class: "Let's first look at the cards before one was turned over" (make sure you've restored the card that was just flipped). The following steps will help the students to uncover what you've done:

- "Are there any patterns you can see? Think, pair, share."
- "Let's break it down into parts"
- "Let's look at the first row - count the black squares - how many are there?" (4 in the example above).
- "Now the second row - count the black squares - how many are there?" 2
- Note that it could be a row of all white squares - which would be 0 black squares; or it could be a row of all black squares - 6

Teacher to class: "If we group these numbers together, 0, 2, 4, 6, what do we call this group? Even numbers. What about 1, 3, 5? What is the name for this group of numbers? Odd numbers.



Let's now look at the columns:

- "Does the first column have the same rule as the rows?"
- "What about the other columns?"

Teacher to class: "So how did we end up with an even number in every row and column - did the volunteer choose that?" (they didn't!).

Remove your extra row and column, and have them explain what colour to place at the end of the first row to make sure there is an even number of black cards. For example, if there are 3 black cards, ask what colour you need to add to make it into an even number (black)? If there are 4 black cards, they should work out that you need a white card to keep it even.

Continue doing this for each row; then do it for the columns. This is a good exercise for students thinking about even and odd numbers. For the last (corner) card, ask if you should use the row or column to decide it. They should observe that it's the same for both.

Once the extra row and column have been added, ask "So what happens when I turn a card over from black to white?" (It reduces the number of black cards by one, so it's now an odd number). "What if I change a white card to black?" (it adds one, which also gives an odd number).

The students might work out from this how to find the flipped card, but in either case, have a student come up, and ask them to look away while you flip a card. Then, when they look back, ask "Is the first row ok?" (They should notice that it's still even, so hasn't been changed). Carry on for each row until they identify the one with an odd number of black cards. Draw a box around that row, and say "So one of these cards was flipped?" Now do the same with the columns - ask if each one is correct, then draw around the column that they identify.

Now ask "So which card was flipped?" Usually students will identify the one at the intersection.

Extending The Lesson

- This kind of method is applied to almost all data that is stored or transmitted on computers (although usually a more sophisticated method is used that is even more reliable). If we didn't have error detection and correction then unexpected errors in data would be common, and digital devices wouldn't be used to store anything important. The world would be in chaos and people wouldn't trust computers. Computers wouldn't be reliable.
- DVDs and CDs wouldn't work if one fleck of dust was on the disc.
- Backing up wouldn't help much as this would also be unreliable too.
- Transmitting data over long distances (e.g. from space probes) would be particularly unreliable, since it can take minutes, or even days, for data to arrive, and it's not feasible to request it to be retransmitted if it has had interference.