THE BIRTHDAY MIND-READING TRICK

This classic puzzler serves as a super—and fun!—activity to conduct with students at the beginning of the year or at the start of a new semester.

We learn the following from it.

There is something magical about the doubling numbers: 1, 2, 4, 8, 16, 32, 64, … .

As such, this puzzler beautifully motivates wanting to look at the $1 \leftarrow 2$ machine, which is the first machine described in the *Exploding Dots* story.

Pre-requisites: None!

GLOBALMATHPROJECT

THE BIRTHDAY MIND-READING TRICK

Present the following five groups of numbers on a board or on a Power-Point slide or write out the groups of numbers on big cards.

GROUP A	GROUP B	GROUP C	GROUP D	GROUP E
16 20 24 28	8 12 24 28	4 12 20 28	2 10 18 26	1 9 17 25
17 21 25 29	9 13 25 29	5 13 21 29	3 11 19 27	3 11 19 27
18 22 26 30	10 14 26 30	6 14 22 30	6 14 22 30	5 13 21 29
19 23 27 31	11 15 27 31	7 15 23 31	7 15 23 31	7 15 23 31

The numbers 1 through 31 appear throughout these five groups, numbers that match the days of a month. (The short months and long months are both covered.)

Ask your students to each silently think of the day of the month they were born and look for their birthday among each of the five groups. Now have the following conversation with individual students.

"Suzzy: In which groups does your birthday appear?"
"In groups A, B, and E."
"Ahh. You were born on the 25th."
"Yes, I was!"

"Terell: In which groups does your birthday appear?"
"Just in group C."
"Ahh. You were born on the 4th."
"Yes, I was!"

"Wonhi: In which groups does your birthday appear?"
"Groups B and C."
"Ahh. You were born on the 12th."
"Yes, I was!"

Record each set of group numbers and the birthday number on the board as the conversations occur.

Have this conversation at least a dozen times. Hopefully a few students, like Terell, find their birthday in only one group.

Question: Examine each of the cards. What do you notice about the numbers in each group? What do you wonder about them?

Students often notice the following:

- Group E contains all the odd numbers.
- Group A contains all the numbers 16 and above.
- The top left corner numbers of these groups are 1, 2, 4, 8, and 16. These numbers are doubling.

This last observation usually occurs after a several students happen to have birthdays appear in a single group (and these results are still displayed on the board). These special cases draw student attention to the top left number in each group.

HOW TO SECRETLY CONDUCT THE MAGIC

Simply sum the top left numbers in each group the student's number appears. This sum matches the student's birthday.

Suzzy mentioned groups A, B, E, with top left numbers 16, 8 and 1. Her birthday is $16 + 8 + 1 = 25$.
Terell mentioned just group C with top left number 4. His birthday is 4.
Wonhi mentioned groups B and C with top-left numbers 8 and 4. His birthday is $8 + 4 = 12$.

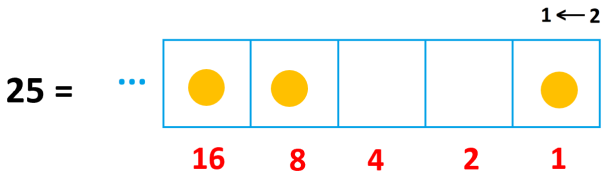
Practice: If Anu says her birthday appears in groups A, C, D, and E, can you see that her birthday is 23?

Practice: If Pricilla says her birthday appears in all the groups, can you see that her birthday is 31?

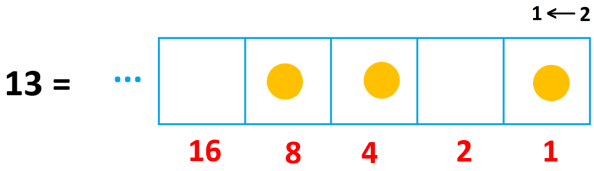
EXPLAINING THE MAGIC

The $1 \leftarrow 2$ machine in the dots-and-boxes story reveals all. (So, come back to this magic trick once students understand the $1 \leftarrow 2$ machine).

For example, computing the $1 \leftarrow 2$ machine code for the number 25 shows that $16 + 8 + 1 = 25$. Consequently, in constructing these groups, we were sure to put "25" in the groups with 16, 8, and 1 in their top left corners.



Here's the $1 \leftarrow 2$ machine code for 13.



It shows that "13" should appear in the groups with 8, 4, and 1 in their top left corners, namely, groups B, C, and E. And, indeed, we made that so!

The$1 \leftarrow 2$ machine code of any given number tells us which of the doubling numbers 1, 2, 4, 8, 16 we need to create that number, and thus into which groups to place that number in the set-up of this magic trick.

The largest number that this mind-reading trick allows with five groups of numbers is $16+8+4+2+1=31$. It is a happy coincidence that this corresponds to the number of days in the longer months of the year!

Extension

Could you design a six-group mind-reading trick?

What's the highest number that would appear among your six groups?

What are the six groups of numbers?