# Understanding Zero

Zero is not to be understood as only a concrete digit or number, but rather, zero is a dynamic and complex concept. Zero's role changes depending on the context in which it is used. As such, reducing or simplifying zero to be represented as merely "nothing," causes numerous misconceptions.

History of Zero

The historical significance of zero is that its beginnings have always been contested. Various ancients civilizations have attempted to use zero, but have struggled to reconcile zero's abstract nature. It was not until 628 A.D., when an Indian mathematician named Brahmagupta started using it in computational math.
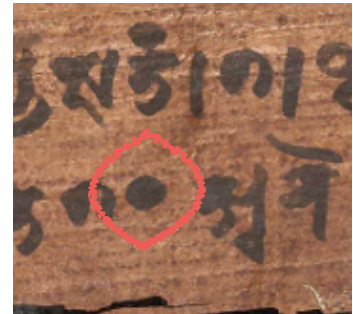
Common Misconceptions

- Zero is merely "nothing"
- Counting starts at 1
- Zero is an integer

- Zero is a rational number
- Numbers can be divided by zero

Four Grounding Metaphors

Metaphor	Description
Collection Metaphor	Zero is the empty collection (i.e. an absence of value)
Object Construction Metaphor	It's either the lack of an object <u>or</u> the destruction of an object as a result of an operation • ex. 4x0=0, so it's (0) the destruction of 4
Measuring Metaphor	Zero stands for the ultimate in smallness, the lack of a *physical* entity
Motion Metaphor	Zero is the origin of motion • Think integers - magnitude, temperature, etc. Lakoff and Nunez as cited in Cockburn and Parslow-Williams (2008, pg. 20)

anisha.malik@mail.utoronto.ca | katie.kovacs@mail.utoronto.ca | sukanya.rastogi@mail.utoronto.ca | breanna.wu@mail.utoronto.ca

Suggestions for Practice

| 0	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59
60	61	62	63	64	65	66	67	68	69
70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89
90	91	92	93	94	95	96	97	98	99
100	101	102	103	104	105	106	107	108	109

In adding '0' to the number chart, we are priming students to better understand place value in higher grades.

Early Years (counting):

- *Fist of zero* - use a fist to represent a zero; an absence of a unit
- *0-9 counting* - start counting from 0-9 instead of 1-10
  - Priming students' understanding for place value in recognizing the role of 0 in multi-digit numbers
 - Using a *0-109 chart*, rather than a 100's chart

Primary:

- *Benchmark:* using number lines and integers to teach cardinality in relation to magnitude (showing how numbers grow and reduce in relation to zero's)
- *Temperature* - thermometers as a visual representation of numbers smaller than 0 and reinforcing 0's value as not "nothing"
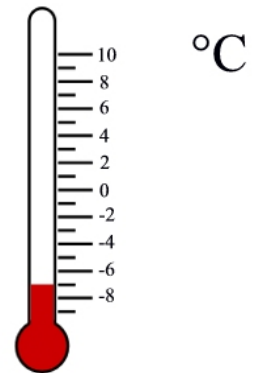
Junior:

- *Zero inquiry* - exploring division with 0
  - x/0=?
  - 0/x=?
  - 0/0=?
- *Zero box* - encouraging students to move away from using manipulative to honour the presence of 0 in relation to adding and subtracting positive and negative numbers
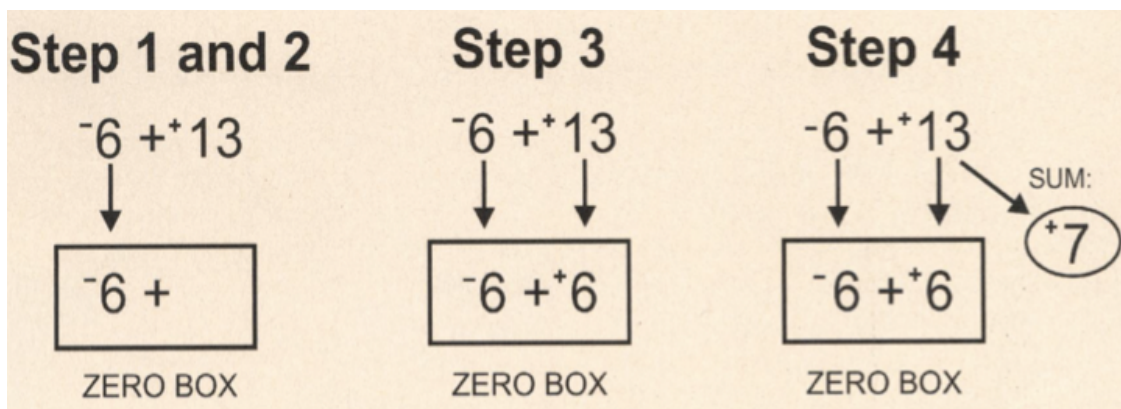
As the sum of two opposite numbers is zero, using the zero box provides a reference point to show students why they need to subtract when adding a negative number rather than having them just remember the rule.

Takeaways

- The language of zero - as educators, we need to be mindful of the language we use to describe and explain zero
- Providing students with various visual representations of zero to foster an nuanced conceptualization of zero
- Begin instruction of zero in the early years to lay the foundation for later learning

anisha.malik@mail.utoronto.ca | katie.kovacs@mail.utoronto.ca | sukanya.rastogi@mail.utoronto.ca | breanna.wu@mail.utoronto.ca