UNIVERSITY OF JOHANNESBURG

Centre for Social Development in Africa

Hierarchical Development of Early Number Concepts

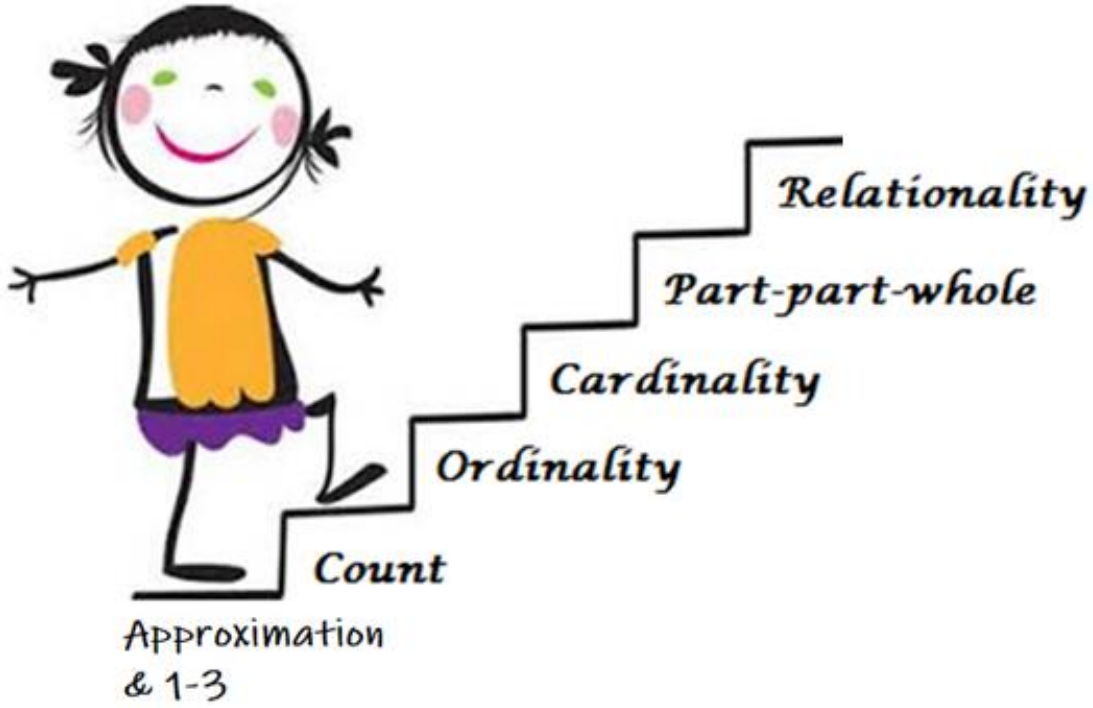
HANRIE BEZUIDENHOUT

DEPARTMENT OF CHILDHOOD EDUCATION

The Future Reimagined

How do children develop number concepts?

Children learn number concepts step by step. If the foundation is cracked, a child may struggle to learn. This is why teachers must know which concepts develop first and how concepts build on previous concepts.

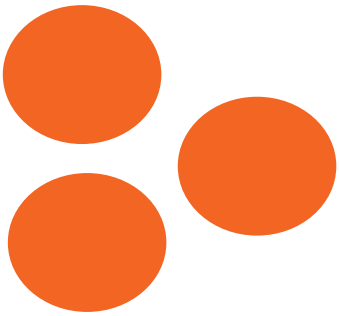


Children are born with an intuitive 'feeling' for numbers. Even before they can count, they can distinguish between a container with one sweet and a container with four sweets. It is very likely that two-year-olds will choose a container with more sweets – if they are not yet able to count the number of sweets. Just because most two-year-old children can recite the counting rhyme up to ten, it doesn't mean that they can use one-to-one correspondence to count. What numbers can a two-year-old compare? Research tells us that they can accurately distinguish between sets of one, two, three and four items without counting. They can also compare larger sets if there is a clear difference between the two sets. For instance, they can distinguish between eight and fifteen objects, but not between eight and nine objects.

ACTIVITY IDEAS FOR APPROXIMATION

Teachers can strengthen children's ability to approximate and compare objects by showing them containers with objects and asking them to choose the container with more items (or the one with less items).

Teachers can also show children cards with dots and ask them to choose the card with more dots (or less dots). To increase the difficulty of this task, enlarge the dots on the card with the fewest dots. Remind them to look at the number of dots and not the size of the dots.

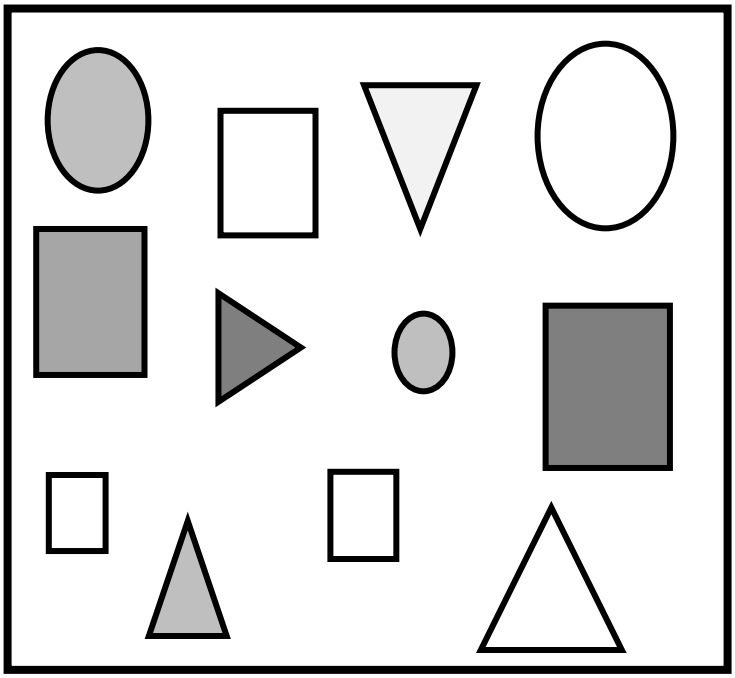


Building on the foundation of approximation, children's number concepts develop in five steps or levels:

Level one: Counting

At the age of two children's language development begins to flourish. Together with their language development, they build on their innate 'feeling' or sense for numbers and begin to learn how to count. They learn the rhyme or learn how to sing the counting song. At this age, they do not know the meaning of the words. This "list of meaningless lexical items" is not always recited in the correct order. Gradually, they begin to assign objects to number words by way of one-to-one correspondence. When counting out objects, remind children that counting actually means that we *add one* each time we count.

ACTIVITY IDEAS FOR COUNTING



How many circles are there?

How many triangles are there?

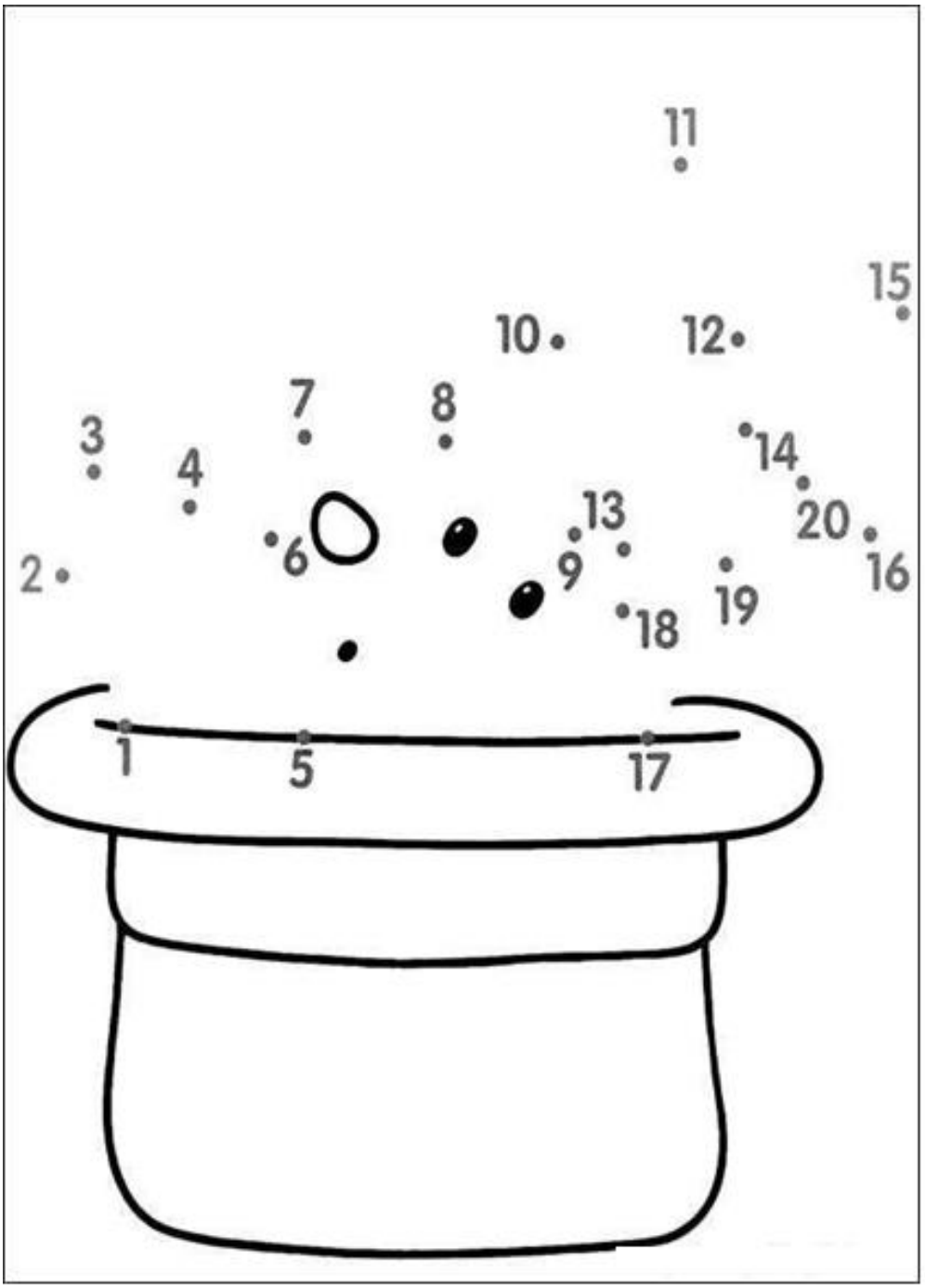
How many squares are there?

Are there more triangles or more squares?

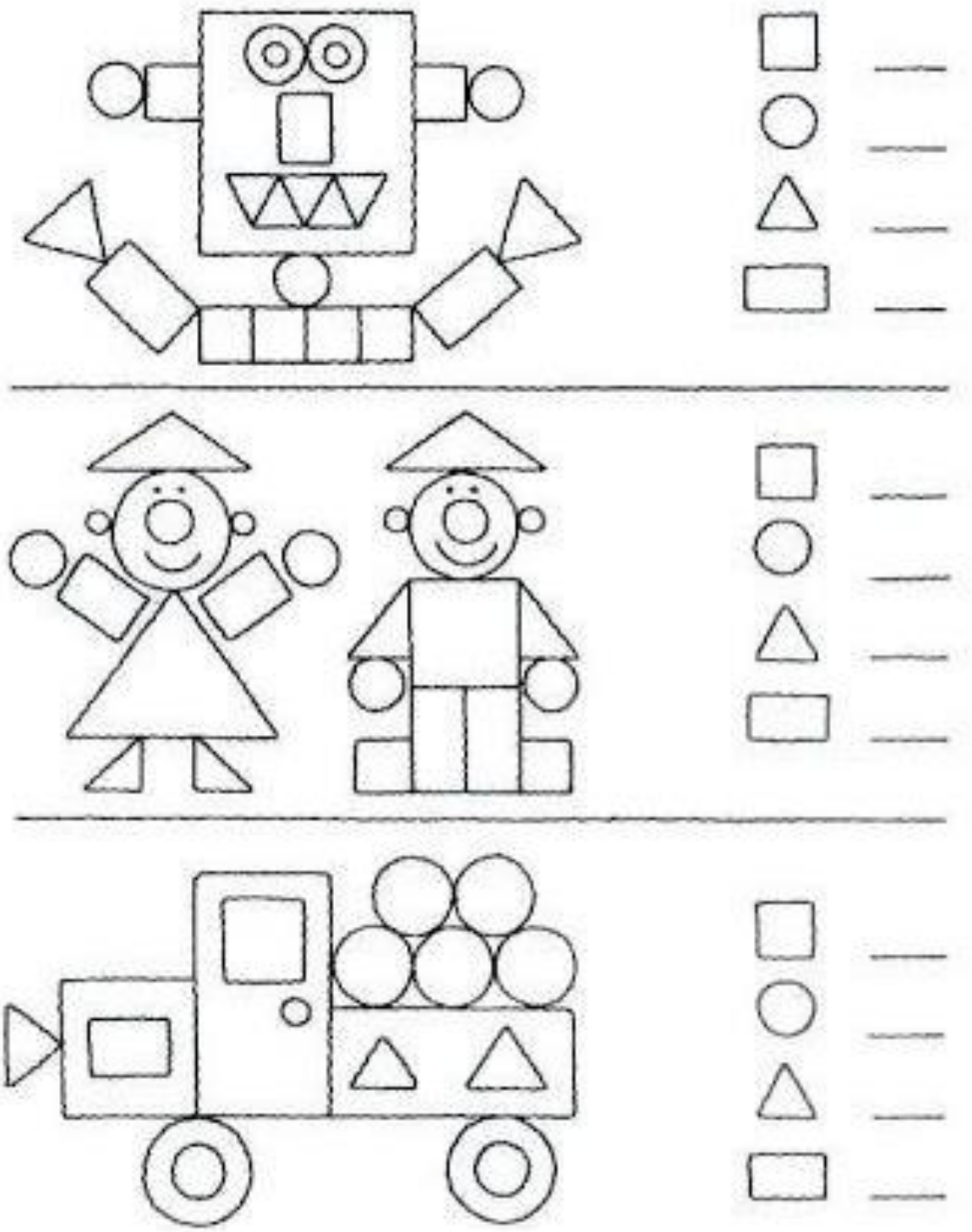
How many more squares are there than triangles?

How many fewer circles are there than squares?

Connect the numbers: Try to avoid pictures with ‘obvious’ sequence of numbers. Try to find ones where the child actually has to think of which dot comes next. See for instance numbers 9, 10, 11, 12, 13, 14, etc. in the picture below. There is no obvious next number. They have to know which number comes next.



Count the shapes

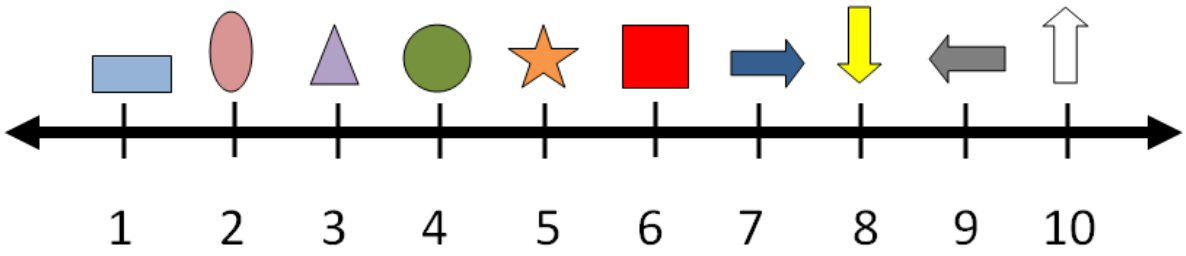


Level two: Ordinality

Next, children discover the order of numbers and they learn how numbers are represented a number line. They learn to find out which number comes before or after a number and can identify which number comes between two numbers.

ACTIVITY IDEAS FOR ORDINALITY

Teachers can use a number line like the one below to develop children's knowledge of the concepts *before*, *after* and *in between*. This activity can easily be combined with revision of shapes, sizes, direction and colour.



Begin to ask questions about the shapes:

What shape is after the oval?

What shape is before the triangle?

What shape is between the triangle and star?

What number comes after 3?

What number comes before 5?

Then move on to questions about the numbers:

What number comes between 4 and 6?

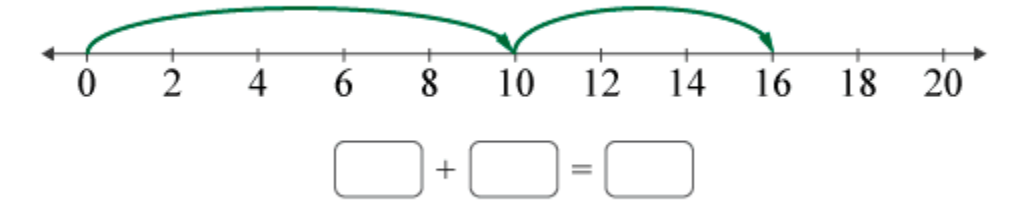
Which direction does the blue arrow point?

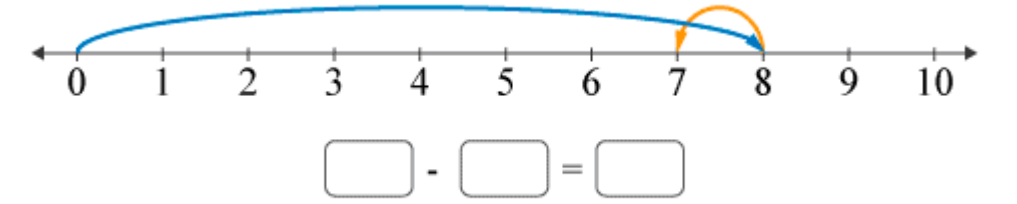
What color is the square?

Put your finger on the arrow that points to the left.

Put your finger on the arrow that points down.

By using the number line, they can do simple addition and subtraction sums.





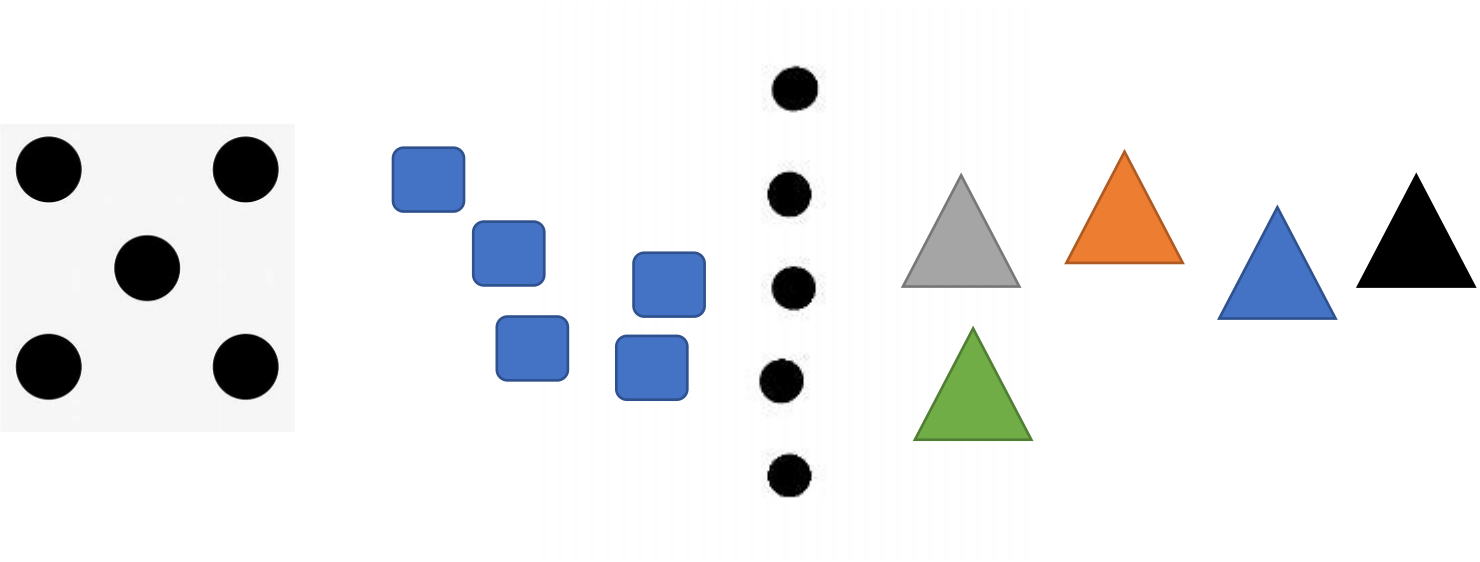
Please remember: DON'T GET STUCK ON THE NUMBER LINE!

Although we should teach counting strategies, including "*counting from the biggest number*", "*hop on the number line*", and so forth, children must learn the next steps in number concept development. Therefore, *DO NOT FORCE A CHILD TO USE A NUMBER LINE IF THE CHILD DOESN'T NEED THE NUMBER LINE TO CALCULATE*.

If a child can solve 8 + 5 by arguing that 8 is also 5 + 3 and that is why 5 + 5 + 3 = 13, do not force the child to use the number line to calculate 8 + 5. Please allow the child to use a strategy that works for him.

Level three: Cardinality

Cardinality is the *manyness* of a number, the *fiveness* of five and the *eightness* of eight. It means that a child doesn't need to count to find out which number comes after four, but he knows that five is one more than four. Children should know that all of these are representations of the number *five*:

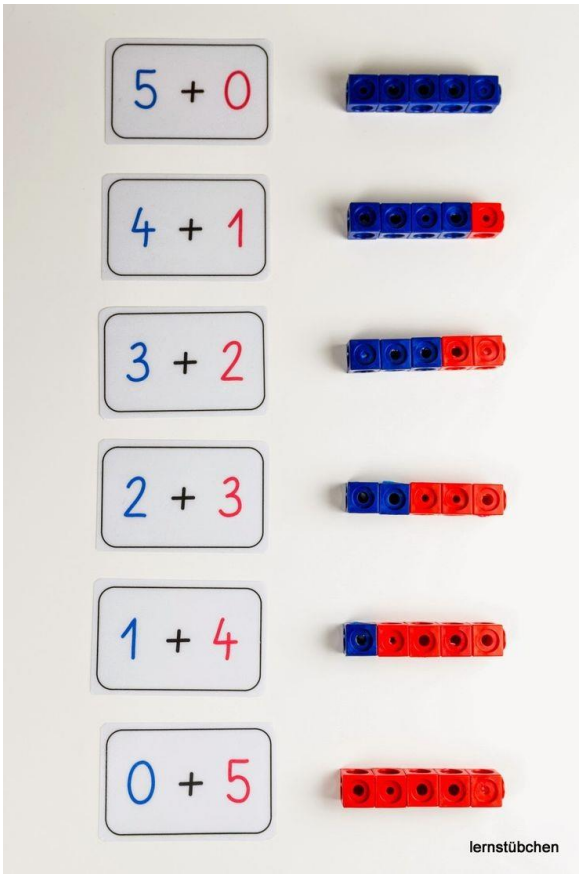


ACTIVITY IDEAS FOR CARDINALITY

Ask children to use their fingers to show numbers. Ask them to use different representations of numbers. For instance: "Show me four fingers. Show me four fingers again, but use different fingers."

For example:

Build the number *five*:



Flip a number, make the number with counters and build it with blocks:

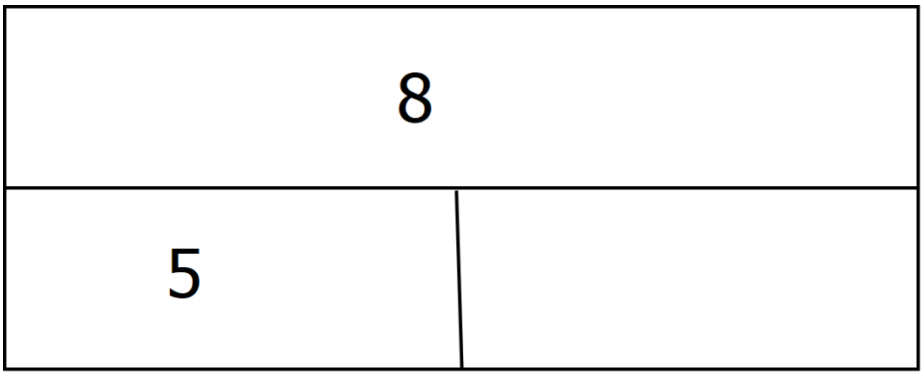
Level four: Part-part-whole

As children learn how to decompose numbers, they realise that each number can be divided into various combinations of smaller parts of numbers and that each number also forms part of larger numbers/quantities. For example, 8 can be decomposed into 3 and 5 or 6 and 2 but it also forms part of 9 and 10, and so forth.

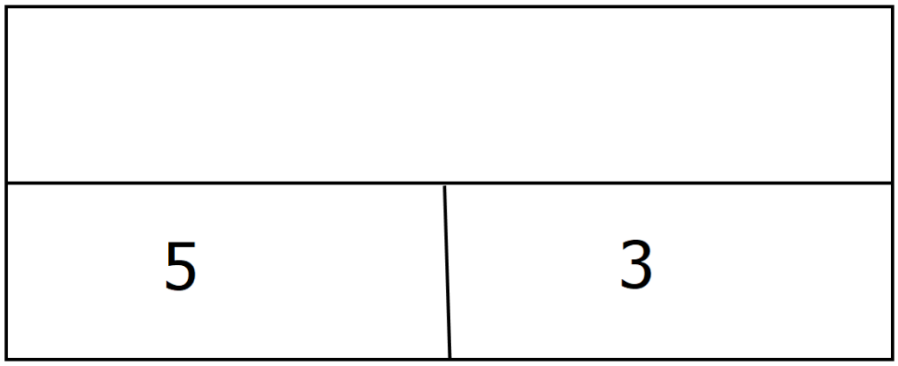
ACTIVITY IDEAS FOR PART-PART-WHOLE

If two quantities in an equation are known, the third one can be determined, no matter which part is missing.

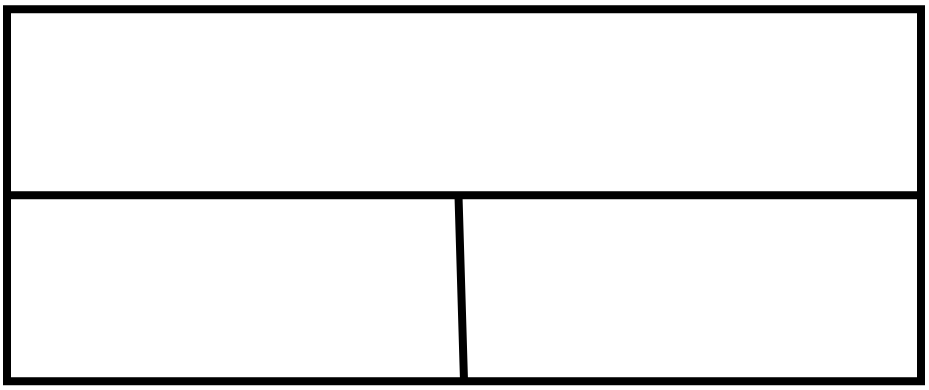
For instance, I can show a whole and one part and ask a child which number should be added to five to get eight. This is actually a subtraction task. Now, children don't need to use counting strategies or a number line to find the answer. They can use their knowledge of cardinality.



I can also show two parts and ask what is the whole (3 + 5):



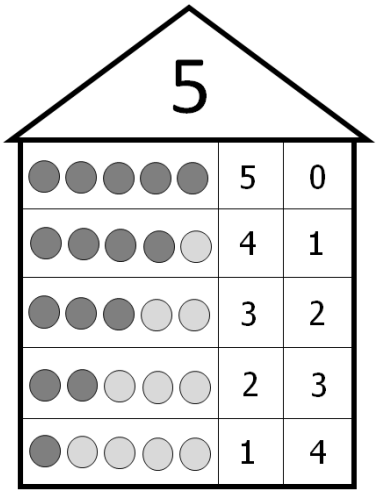
A useful idea is to laminate an A4 page with this diagram for each child:

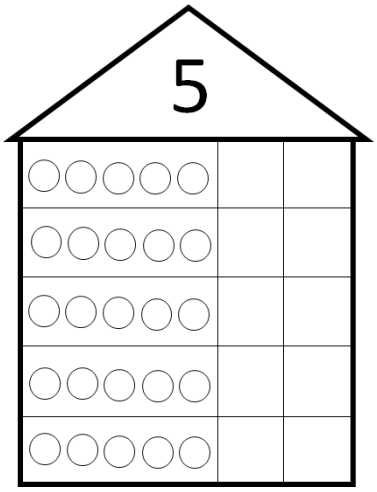


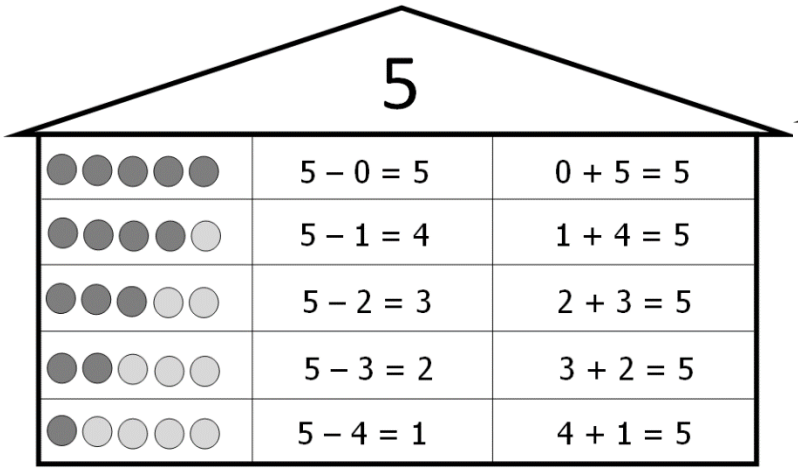
It can be used to teach many things, for example:

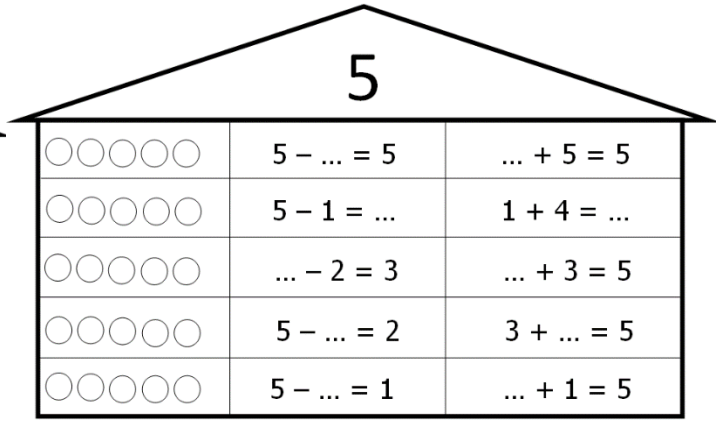
- doubling and halving (8 = 4 + 4)
- place value (15 = 10 + 5)
- money (R5,40 = R5 + 40c)

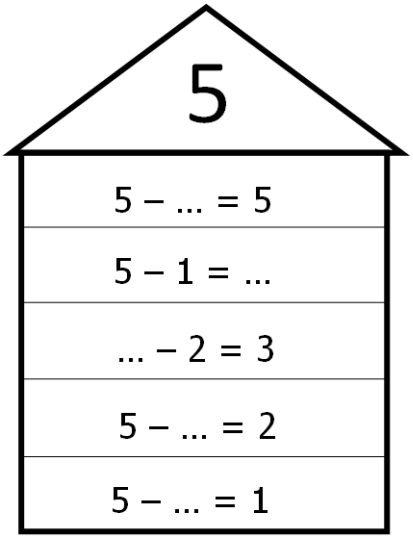
Different variations of the house activity can also be used to teach the principles of part-part-whole:

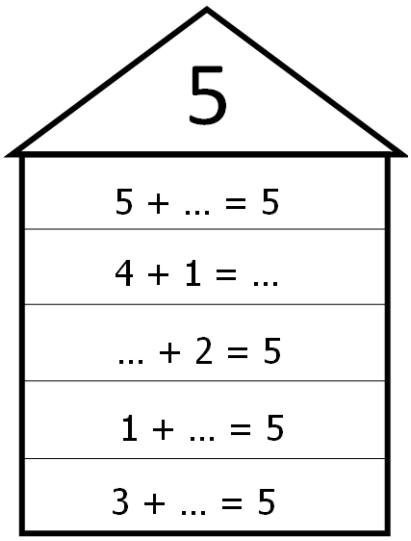












Level five: Relationality

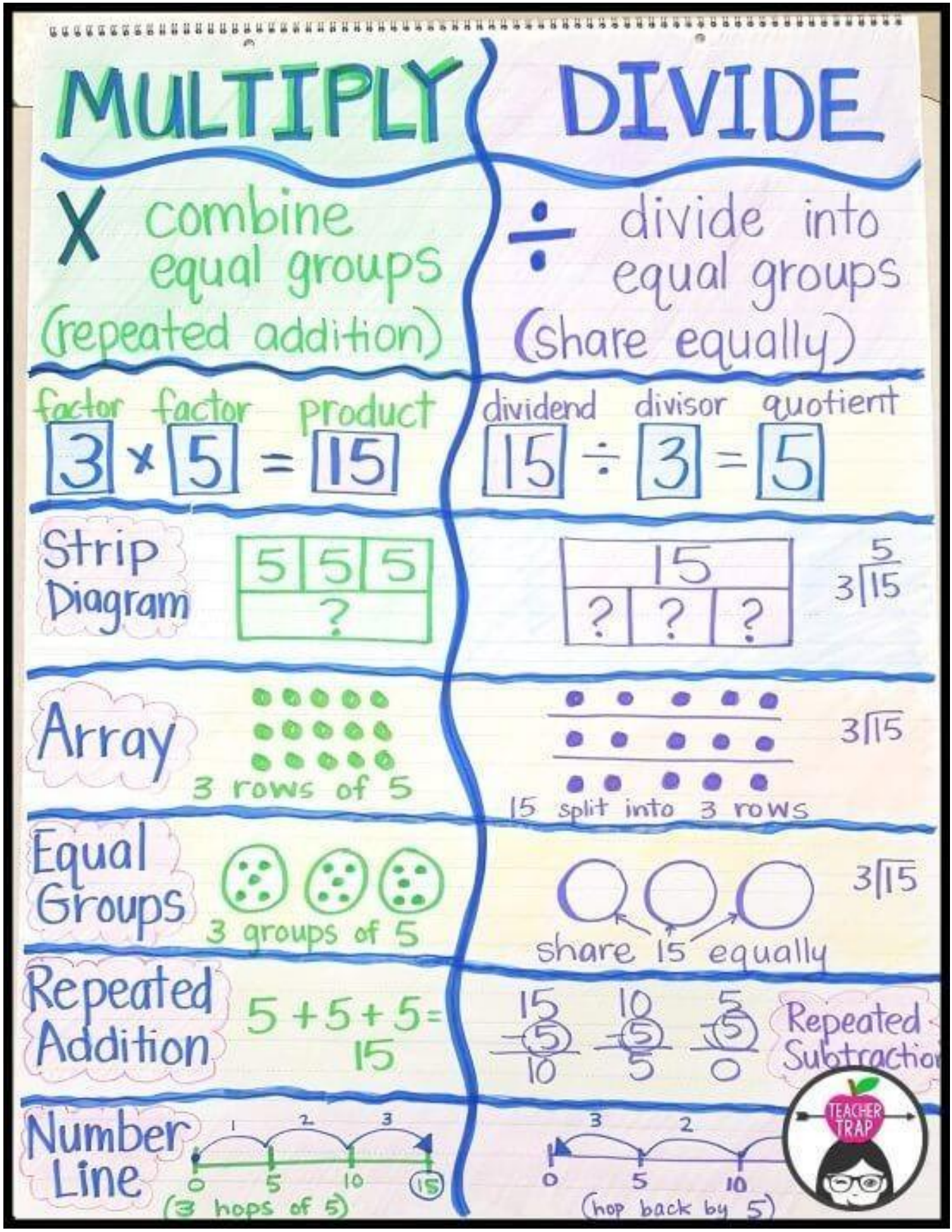
Lastly, children discover that each number is made by adding a constant of one (+1) to the previous number and that all numbers are related: the distance between two consecutive numbers is always an equal distance. This idea is a prerequisite for understanding multiplicative relationships and the place value system.

ACTIVITY IDEAS FOR PART-PART-WHOLE

Questions that assess children's knowledge of relationality include:

- Give me 9 apples, 4 of them must be blue.
- Give me 6 apples, there must be more blue ones than red ones.
- Give me 8 apples, there must be 2 more blue apples than red ones.

We can also help them learn relationality by tasks such as these:


MULTIPLY
DIVIDE
X combine equal groups (repeated addition)
÷ divide into equal groups (share equally)
factor factor product
3 x 5 = 15
dividend divisor quotient
15 ÷ 3 = 5
Strip Diagram
5 5 5
?
15
? ? ?
3⟌15
Array
3 rows of 5
15 split into 3 rows
3⟌15
Equal Groups
3 groups of 5
share 15 equally
3⟌15
Repeated Addition
5 + 5 + 5 = 15
15 10 5
-5 -5 -5
10 5 0
Repeated Subtraction
Number Line
1 2 3
0 5 10 15
(3 hops of 5)
3 2
0 5 10
(hop back by 5)
TEACHER TRAP

In conclusion

Teachers should know the levels of conceptual development so that they know where to look for 'cracks' in the foundation when children struggle. For instance, if a child cannot add or subtract, ask yourself what are the building block for addition? It is senseless to keep practicing addition if the child cannot count, doesn't understand ordinality, cardinality and doesn't know how to decompose numbers.

If the child cannot add...

- Does he understand how to count?
- Does he understand ordinality?
- Does he understand cardinality?
- Does he understand part-part-whole?

Number concepts develop step by step. This doesn't mean if children can count, teachers should stop improving their counting skills. Keep on practicing the skills of all levels and build strong foundations by using the tasks outlined in this manual.