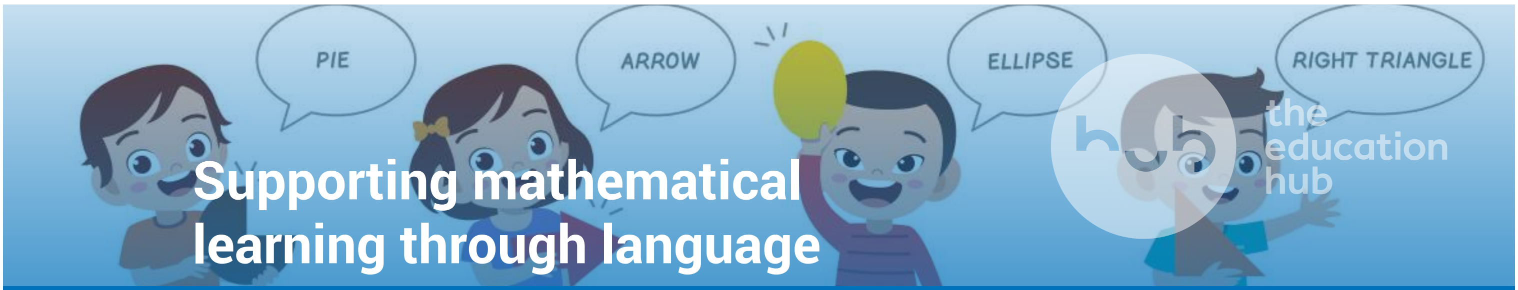

Supporting mathematical learning through language

ECE resources

Beyond understanding basic math facts, children's mathematical knowledge also involves knowing the words used to describe specific mathematical concepts and operations. There are two main types of mathematical language: quantitative words, and words related to spatial and ordinal relations. Research shows that building children's understanding of these types of mathematical language supports their later mathematical learning1. This research review describes the two main types of mathematical language and introduces a range of games and activities that can be used to help children develop their understanding and use of mathematical language.

The first type of mathematical language involves **quantitative words**, and includes terms such as *more, fewer, fewest, least, a lot, a little bit, add, give, combine, take away, same* (number of physical objects or pictures), *similar*, and *different*. These words are critical to understand if children are to more generally (or approximately) describe the size of a set of objects (*a lot*, *a little bit*), compare groups of objects to determine the larger (*more*), smaller (*fewer, fewest, least*), or comparable (*same, similar*) set, and describe the process of changing the set size of quantities of objects (*add*, *give*, *combine*, *take away*). Studies show that children who have better knowledge of quantitative words in early childhood tend to also have better numeracy skills, including rote counting, comparing quantities, and adding simple sums[2]. This is thought to be because children acquire number skills better when they understand the mathematical language behind them. For example, when children are taught the meaning of words to compare quantities such as *more*, *less, many* and *fewer*, they are better able to compare and talk about the size of numbers and groups of objects. Also, when children do not know words to describe quantities such as 'all,' 'most,' and 'some,' they struggle to link number words to their respective sets of objects (cardinality). A recent study showed that when preschool-aged children read books emphasising quantitative words (particularly books from the Little Elephant Series) at home with their parents, their numeracy skills benefited compared to children exposed to similar books that did not emphasise quantitative words[3].

There are many opportunities for children to learn and use quantitative words in free and guided play. For example, using toy balance scales may allow children to apply math language words like 'more, less, and the same' to describe the relative magnitudes of different or the same quantities visually represented using the scale (for example, using the word 'more' when the left side of the scale is positioned lower than the right side, *fewer* when it is higher than the right side, or *same* when the two sides are level with each other). Teachers can also use quantitative language with children while they play with balance scales to describe how the positioning of the scale represents which quantity is fewer or greater. Teachers may also try to encourage children to create situations in which the left or right sides of the scale have *more, fewer,* or *the same* objects. Using playing cards can also allow children to use these same words to compare the quantities of pictured objects on two cards placed side-by-side (for example, 'my 5-card has *more* than your 3-card'). Helping children play the card game *War* by suggesting specific quantitative words to use to generally describe and compare the amounts of objects on each of two cards can help children learn what these words mean.

When children are playing 'shops', they have the opportunity to use words that describe the process of changing the set size of quantities of objects (such as *add*, *give*, *take away*) in response to exchanging play money for store items such as play food (for example, 'give me $5'; 'let me *add* up the total for all of your groceries on my cash register'). In the block play area, when children are playing with a large amount of construction materials, they have the opportunity to use approximate quantitative magnitude language to more generally describe the size of the quantities they have (such as '*a lot* of red Lego blocks' or '*a little bit* of yellow Lego')[4]. Teachers can support this use of language by commenting on the relative amounts of toys, money, or blocks individual children have in relation to others, or using spatial language to describe how food and money are *added to, taken away,* or *given* when children are playing shops. Teachers can also show children different quantities of objects and help them use quantitative language to describe the quantities more generally. A full pot of paint could be described as *a lot*, for example, and a small amount of paint in a cup could be considered *a little bit*. While children have general concepts of quantities, teachers can play the critical role of introducing vocabulary to help give those concepts specific names.

Activities mentioned in these guides on Non-symbolic relations and combinations, Symbolic number skills, Connecting non-symbolic to symbolic representations, and Symbolic relations and combinations provide more opportunities for children to use quantitative mathematical language in free and guided play.

The second type of math language involves words related to **spatial and ordinal relations**. These words include:

- **spatial location and relational terms** such as *nearest, closest, higher, lower, on top, below, above, bottom, far away, away, between, middle, inside, under, behind,* and *in*
- **ordinal terms** such as *first, last, middle, back, front, beginning, end, after,* and *before*
- **spatial features and properties terms** such as *edge, side, angle, corner, round, curved, flat,* and *wide*
- **shape terms** such as *circle, triangle, rectangle, rhombus or diamond, oval, star, heart, trapezoid, pentagon, hexagon,* and *octagon*
- **dimension terms** such as *big, large, long, wide, small,* and *tall*
- **spatial orientation terms** such as *upside down, diagonal, rotated,* and *flipped.*

Knowledge of these words is important for understanding the relations between objects in space. Research studies show when children hear spatial words in infancy and toddlerhood, they develop better spatial skills as preschoolers[5]. Studies show that teaching preschool children spatial vocabulary during playful activities with experimenters involving block, shape, and Lego play (such as this magnetic Geoform shape building activity and this Lego set), origami (such as this whale shape and pig face), and shape matching, composing, matching shape halves, and shape sorting games (such as this set of shape sorting activities) actually leads to improvements in their shape knowledge and spatial thinking. There was less improvement when children played these activities with experimenters without hearing specific spatial language (for example, the experimenter uses only vague shape labels such as *shapes* and vague spatial terms like *here* and *there*)[6].

Construction materials such as blocks and puzzles often include varied spatial forms that children can use to explore and compare spatial properties, such as noting their different *edges* (*round* or *straight*) and *corners*; observing whether the shapes have names based on these properties (like square or triangle); noting their sizes or dimensions (*big*, *small*, *tall*, *wide*), and how they are positioned or moved around in space (for example, *upside down* or *flipped*). Also, having multiple construction materials (such as in construction sets) to play with together allows children to compare and contrast the spatial properties of the same and different pieces within those sets, highlighting the different spatial properties of each. This is especially the case when using construction materials during building, since this involves combining different pieces to create different structures. For example, when building a vertical tower, a child might discover that the edges of a rectangle/rectangular prism block is *longer* than the edge of a square/cube when placed on top of each other. Lego sets in particular allow children to concretely see the number of pips that protrude after placing a smaller Lego block (like a cube shaped block) on top of a larger block, such as a rectangular prism. Magnetic building materials like Magformers, Geoform, and Magnatile blocks have multiple shapes of different sizes represented (including isoceles triangles, small and large equilateral triangles, squares, and other shapes in expansion packs like pentagons and rhombuses). They use magnetic force to encourage children to join individual block shapes along their edges, highlighting the spatial properties they have in common (such as their shared edge lengths).

Teachers can encourage children to learn and use spatial language by engaging them in spatially relevant guided play activities. Research shows that when adults such as parents play with puzzles and blocks with their children, they are naturally encouraged to use more spatial language than during activities that do not involve construction materials, especially when they work to build a specific model structure[7]. This is likely because working in pairs or groups on highly spatial tasks like building requires communication about spatial concepts to complete specific spatial goals. For example, during block building, pairs may want to communicate the types of blocks they are using ('this is a *square/cube*'), where in relation to other blocks they are placing individual blocks ('I'm placing this block *on top* of this one,'), and where they are planning to build components of the model structure ('I'm building the door to my house and it goes in the *middle*').

When completing a puzzle, adults might guide children about how to look at and describe individual pieces (for example, 'this is an *edge* piece because it has a flat side') and how best to turn individual pieces to fit into their designated spots (for example, '*rotate* your piece this way so the picture faces *up*, and so it fits *here*'). Adults and children can also discuss how the puzzle they are working on resembles the model image pictured on the box (for example, 'this piece is part of the tree, and the tree is at the *bottom* of our puzzle'). For younger children, adults can use shape sorter sets to both label the shape names of each piece ('this is a *triangle*'), discuss the locations and characteristics of the specific spaces into which each shape should be placed, and use language to describe how they or the children must *rotate* or *flip* the shape blocks to fit the space available.

Folding paper in specific ways, such as during origami tasks, requires the same types of talk about spatial concepts. For example, adults and children can describe how they are moving the paper in space (for example, *flipping* the paper *over* so that the coloured side is *facing up*), commenting on which aspect of the paper must be folded (for example, 'the *top* of the *square*, goes *down here*'). Spatial ordinal language may also be naturally elicited when playing with string beading sets as children may practice ordering individual beads (*first*, *last*, in the *middle*) in their chosen sequence.

Activities mentioned in these guides on Repeating pattern skills and Spatial skills provide more opportunities for children to use **spatial and ordinal** mathematical language in free and guided play.

Math language type	Vocabulary	Definition/use	Example activity
Quantitative	*more, fewer, fewest, least, a lot, a little bit, add, give, combine, take away, same* (number of physical objects or pictures), *similar*, and *different*	These words are used to: • generally or approximately describe the size of a set of objects (a lot, a little bit) • compare groups of objects to determine the larger (more), smaller (fewer, fewest, least), or comparable (same, similar) set • describe the process of changing the set size of quantities of objects (i.e., add, give, combine, take away)	Playing shops when exchanging items for money (e.g., '*give* me $5') Balance scale play to describe whether the quantities are the *same*, or one side has *more* or *fewer* Playing cards (e.g., *War*) to compare whether one card's quantities are the *same*, *more*, or *fewer* than another card's quantities
Spatial and Ordinal			
Spatial location and relational	*nearest, closest, higher, lower, on top, below, above, bottom, far away, away, between, middle, inside, under, behind*, and *in*	Used to describe the spatial location of objects in relation to other objects	Puzzle play Block play (Tangrams, wooden blocks, Magformers)
Spatial features and properties	*edge, side, angle, corner, round, curved, flat*, and *wide*	Used to describe individual characteristics/ parts of spatial forms	
Shape	*circle, triangle, rectangle, rhombus* or *diamond, oval, star, heart, trapezoid, pentagon, hexagon*, and *octagon*	Used for names of spatial forms	
Dimension	*big, large, long, wide, small*, and *tall*	Used to describe the size of spatial forms	
Spatial orientation	*upside down, diagonal, rotated*, and *flipped*	Used to describe the spatial positioning of objects	
Ordinal	*first, last, middle, back, front, beginning, end, after*, and *before*	Used to describe the positioning of objects, often in a linear arrangement or series	Bead stringing activities to describe the order in which beads are placed in a sequence (e.g., *first/ beginning, end, after, before*)

Endnotes

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