

Developing mathematics

Mathematics in the early years should be approached primarily through practical activities that children will be able to relate to and understand. Children who ‘do’ mathematics through first-hand experiences (i.e. use real objects and real-life situations to explore and develop mathematical understanding) are most likely to develop confidence and understanding in the subject. The teacher/adult needs to be aware of the mathematical potential of any situation and be prepared to extend and develop this through interaction with the children.

What is mathematics?

Mathematics is all around us, and children have many mathematical experiences in their everyday lives before they begin the formal study of mathematics. Mathematics is much more than figures and formulae.

Mathematics is contained in children’s everyday activities. For example:

- Waking up. Is it still dark? (Time; making logical deductions)
- Getting dressed; putting clothes on in the right order. Are these socks a pair? (Sorting, sequencing, matching)
- Having breakfast; putting breakfast food in a bowl, pouring drink into a cup without spilling. (Estimating quantity, volume)
- Going shopping. How many oranges? A large packet or a small packet? How much does it cost? (Counting, size, money)
- Unpacking the shopping bags. Where will these boxes fit? What goes in the fridge? (Sorting, shape, size)
- Laying the table for lunch or dinner. How many places? Are there enough plates? How long before we eat? (Matching, counting, time)
- Out for a walk. How far is it? Have I seen more buses or more lorries? How many boats can I see in the lake? (Estimating, comparing, counting)
- Bedtime. Can I have one more story? Can we read the big book? How long is it till morning? (Number, size, time)

Early mathematics is:

- Numeracy
- Shape
- Sets and sorting
- Pattern
- Measuring (length and area; weight; volume; capacity; time; money)

Numeracy

Numeracy includes counting, estimating, recording numbers and the four rules of number – addition, subtraction, multiplication, and division – and, later, the understanding of fractions and decimals.

- *Activities* – taking every opportunity to count, for example children in the class, coats on the pegs, bottles in the crate; matching one thing to another, children to chairs, saucers to cups; linking number symbols to groups of objects; dividing apples into halves, quarters and sharing them out; using real objects to add to, take away, share. As they develop an understanding of

number, children will begin to recognise numerals and use symbols to record their work.

Shape

Children need to be able to recognise shapes in both two- and three-dimensions. They need to learn about the properties of shapes, for example that cylinders roll, cubes have right angles, how they fit together and the space that they occupy.

- *Activities* – identifying shapes in the environment; drawing around shapes; sorting junk and modelling with it; making shapes with clay; building with bricks.

Sets and sorting

Children need to be able to sort objects into sets and explain why they belong there. This contributes to the development of their logical abilities.

- *Activities* – sorting with structured sorting apparatus and with collections of beads, blocks, etc.; sorting for colour, for shape, for more complex attributes, for example, making a set of animals that live on farms. Older children will begin to record their findings on diagrams and in other ways.

Pattern

Pattern occurs both in number and in shape. It is an important mathematical concept that lays the foundation for algebra. The essential features of a pattern are that it is regular and predictable.

- *Activities* – looking for pattern in the environment, for example in brick walls, on floor tiles, on fabrics, and also in nature, in animal markings and in plant life; making patterns with beads, blocks, and other materials including painting, printing, and collage; copying and continuing patterns with blocks, beads and peg boards and also using computer software.

Money

As for numeracy, but additionally children will become familiar with coins and notes and understand about equivalence, that is that one coin/note may be worth the same as, say, ten other coins/notes.

- *Activities* – making shops in the classroom/home and buying and selling; counting real money and sorting; making a collection of price tags, receipts, etc.

Time

Children need to understand that time can be measured and to be familiar with how we measure time. At about 7 years, we expect children to be able to read the time from both analogue and digital clock faces. They also need to be able to sort events into past, present, and future.

- *Activities* – talking about daily routines; filling in daily calendars; using all kinds of timers to measure, for example, how many jumps in a minute, etc.; using movable clock faces. Stories dealing with the passing of time can be helpful to children's understanding of this concept.

Weight

Children need to be able to use non-standard (e.g. a book weighs as much as three apples) and standard (e.g. grams and kilograms) measures. They need to be able to

apply the concept of equivalence (equal weight) and be able to make comparisons based on weight.

- *Activities* – practical experience of holding things and talking about *heavy* and *light*, then *heavier than*, *lighter than*; cooking activities using non-standard (cups or spoons) or standard measures; using balance scales to weigh first with non-standard, then with standard measures (balance scales provide clear evidence of equivalence that children can see); investigation of other types of scale.

Length and area

Children need to be able to estimate and measure length and area using non-standard as well as standard measures. They need to be able to select the most appropriate unit of measurement for the task.

- *Activities* – measuring with hand-spans, strides, pencils, etc.; measuring using standard measures, rules, tapes; measuring and making charts of height – who is tallest? who is smallest? – ordering: smallest to tallest, tallest to smallest; drawing around hands, feet, and children on squared paper and counting the squares; covering box models with paper and estimating how much is needed.

Capacity and volume

This is a difficult concept for young children to understand. They need to understand that capacity and volume can be measured using non-standard as well as standard measures. They need to be able to compare containers of different sizes and shapes and to make comparisons about their capacity.

- *Activities* – filling buckets, beakers, containers with sand or water. Posing problems – how many cups to fill a bucket? Using standard measures to compare the capacity of other containers; ‘real-life’ questions – how many beakers can you fill from a large bottle?

Early mathematicians need lots of practice. You can help them by:

- Encourage and explain. Many children take a while to understand new ideas.
- Talk to the children about their work. Introduce mathematical language, *more than*, *less than*, etc. Name shapes accurately.
- Use everyday experiences to reinforce mathematical learning, for example counting stairs, sharing biscuits, laying the table.
- Be aware of the mathematical potential of activities and experiences and develop children’s understanding.
- Observe progress on an individual level and use this to plan the next step.

The language of mathematics

Difficulties in understanding mathematical concepts may arise because of the abstract language of mathematics, the use of symbols to represent numbers, and the need to recall and use many steps, rules and number facts which require language. This means that the language of mathematics needs also to be taught alongside the practical activity. Mathematics vocabulary includes:

Number and algebra:

A lot, all, some, both, another, not any, many, same, more, less, every, enough, as many as, first, second, third... last, add, subtract, guess, estimate, two times, multiply, units, tens, hundreds, odd, even.

Fractions:

Same, different, as big as, smaller than, larger than, greater than, whole, piece (of the...), part, complete, halves, equal, unequal, quarters, one quarter, two quarters, three quarters, one half.

Time:

Again, now, after, soon, today, before, later, yesterday, early, late, once, tomorrow, twice, quick, slow, first, next, last, days of the week, months of the year, o'clock, half-past, quarter-past, quarter-to, seconds, minutes, hours, days, weeks, months, years.

Size, width, height, length:

Big, small, little, fat, thin, long, short, thick, wide, narrow, order, compare, all units of measure, comparative and superlative forms of words: as big as, longer than, shorter than.

Area, volume, capacity:

A lot, lots, a little, a bit, a small bit, empty, full, much, most, more, more than, less than, same, and all units of measure.

Weight:

Heavy, light, heavier than, lighter than, heaviest, lightest.

Money:

Coins, notes, how much, how much altogether, cost, price, change.

Shape:

Round, dot, spot, line, circle, rectangle, square, hexagon, pentagon, oval, triangle, diamond, sphere, cylinder, cuboid, pyramid.

Spatial relationships:

In, on, under, by, beside, behind, in front of, next to, over, through, inside, outside, out, to, off, above, below, round, up, down, front, back, left, right, forwards, backwards, top, bottom, middle, first, last, next.

Difficulties associated with learning mathematics

- Difficulties that arise from visual-spatial impairment in some children may mean that they will encounter difficulty when differentiating between numbers, e.g. 6 and 9, 2 and 5, 17 and 71, and between operation symbols, e.g. + and x, - and =, < and >.
- The directional aspect of mathematics may be problematic, e.g. using a number line, vertical addition, left-right regrouping, and alignment of numbers or writing across the paper in a straight line. The recognition and understanding of the associated vocabulary should be taught alongside each, to help reduce confusion.
- Opportunities need to be created to encourage children to manipulate, investigate, and use concrete materials. The adult needs to give the child sufficient time to use and practice using materials in order to consolidate their learning.
- In order to count efficiently past a given number help the child do so by using a visual prompt to help the child stop at the correct number. For example,

ensure the child touches each item and says the number as they count. Teach that two items are counted as 'two' and count 'one, two', emphasising the 'two'. Introduce three items and then four.

- Teach children to count on and back from numbers other than 1.
- Help children to solve mathematical problems by demonstrating and providing a model of how to complete the task. Instruct the child to complete each step while saying the key words out loud. Finally, allow the child to complete the subsequent problems on his or her own, with the adult's model still available for reference.
- Provide adequate experience with real life materials, time for exploration and situations where the 'right' answer is not important. Use careful, accurate, and appropriate language. Convey to the child that getting it wrong is a necessary part of learning.

Acquiring basic skills

- Developing attention skills is a crucial area of development. Support the child in regularly practising mathematical skills and knowledge, for example two ten minute sessions per day are likely to be better than a two hour session once per week.
- Initially children will need to learn that counting involves pointing to objects individually and giving each a specific and different number name. The 'conservation of number' principle involves the realisation that counting the same set of objects several times will always give the same result.
- The child needs to become aware that the final number of a count represents the total number of objects present in that group.
- Practical activities to develop these principles should be devised progressing along the ideas in the following list:
 1. Sorting and matching like objects by colour, size, and shape.
 2. Rote counting objects from 1-10.
 3. Counting up to 10 objects in a row.
 4. Associating numerals with the written words, spoken words, and appropriate amounts.
 5. Selecting up to 5 objects from a set of 10.
 6. Matching numerals 1-5.
 7. Selecting numerals 1-5 on request.
 8. Sequencing numerals 1-5 in correct order.
 9. Sequencing amounts 1-5 in correct order.
 10. Identifying and selecting correct numeral on request.
 11. Labelling amounts 1-5 with correct numeral.
 12. Copying numerals 1-5 on request.
 13. Repeating items 5.-12. using numerals 1-10.
 14. Organising materials so they can be counted accurately.
 15. Adding 'one more' to a group of objects and counting.
 16. Subtracting 'one less' from a group of objects and counting.
 17. One digit addition, e.g. $3 + 4$.
 18. Counting objects to 20.
 19. Subtracting one digit, e.g. $4 - 2$.

Further reading:

Beaver, M., Brewster, J., Jones, P., Keene, A., Neaum, S., & Tallack, J. (2001). *Babies and young children: diploma in child care and education*. Cheltenham, UK: Nelson Thornes Ltd.