Numbers, shapes and problem solving

A guide to help you think about supporting children's mathematical development in your childcare setting

Supporting members to provide the highest standards of care and learning for children

This practice guidance has been developed for all professionals including childminders, nursery workers and nannies

This guide covers

1. Introduction

It can be daunting thinking about fostering mathematical development in the children you care for, especially if you found maths tricky at school. But as Einstein said,

> *"do not worry too much about your difficulties in mathematics, I can assure you that mine are still greater!"*
>
> *(Einstein archives 42-606)*

Maths in the early years is about so much more than number recognition and adding and taking away. It's also about shape, pattern, space, measurements and solving real-life problems.

We need an understanding of numbers and shapes in all areas of our lives, when shopping, telling the time, budgeting, cooking, doing crafts. And solving problems is enormously satisfying and helps with creativity, cooperation, and real-world skills. All of these things underpin mathematical development.

This guide explores the way songs and rhyme, outdoor play and mark making all help children understand numbers, shapes and problem solving.

2. Learning about numbers, shapes and problem solving

Numbers, shapes and problem solving are important concepts. This is reflected in mathematical development, which is a large part of the framework for children's education in England and numeracy which features in the curriculum in Wales.

The Early years foundation stage statutory frameworks state that

> *"Developing a strong grounding in number is essential so that all children develop the necessary building blocks to excel mathematically. Children should be able to count confidently, develop a deep understanding of the numbers to 10, the relationships between them and the patterns within those numbers. By providing frequent and varied opportunities to build and apply this understanding - such as using manipulatives, including small pebbles and tens frames for organising counting - children will develop a secure base of knowledge and vocabulary from which mastery of mathematics is built. In addition, it is important that the curriculum includes rich opportunities for children to develop their spatial reasoning skills across all areas of mathematics including shape, space and measures. It is important that children develop positive attitudes and interests in mathematics, look for patterns and relationships, spot connections, 'have a go', talk to adults and peers about what they notice and not be afraid to make mistakes.."*
>
> (EYFS statutory framework for childminders p9 and EYFS statutory framework for group and school-based providers p10)

And the ***Curriculum for funded non-maintained nursery settings*** (p22) states that

> *"Children are naturally inquisitive and develop an understanding of mathematical language, concepts and skills through multi-sensory play and authentic experiences. Children should experience daily outdoor play opportunities to encourage their further exploration of mathematical concepts in everyday life. Within the natural world, there are a wealth of opportunities for mathematical development. Open-ended, natural resources offer endless possibilities for mathematical exploration. With our support, and by providing an engaging environment, children can discover and understand that maths is everywhere. Modelling appropriate mathematical language and skills throughout the day will help children develop their strategic competence."*

Maths from the beginning

Babies learn about maths from the beginning – when you play peek-a-boo, they get the idea that something is there one minute then when it's taken away, it's gone. Rolling a ball across the floor or stacking bricks will help them understand shape, height and size. They then start to become aware of number names, through action rhymes and songs, and as they get to two years old, they will start to organise and categorise objects such as teddies and cars.

Between two and three, children will start to experiment with symbols and marks and use language of quantities, such as "more" and "a lot". Then by the time they get to four or five, children will be able to recognise numbers, to count, and start to show an interest in number problems.

3. Role of adult and enabling environment

Being confident with numbers yourself, thinking aloud, and allowing children to work things out and to come to their own conclusions will all help children's mathematical development. As will a number-rich environment where you value mathematical graphics, and provide opportunities to explore shapes, numbers and solve problems in all areas of your setting.

Your environment

Take a quick look around your childcare setting inside and outside. How many numbers can you see? Can you find more ways to display numbers? **Think about** how you can draw the children's attention to the different shapes in your setting.

Julia Sudbury (The Childcare Professional, 2013), suggests displaying numberlines at child height will start and support number discussions. She says, *"children will often find their age or use the line to practice their counting"*.

Think about how you can explore number, shapes and problem solving within the resources you have already.

Role of the adult

Let the children you care for see you using numbers every day. For example, tell them that in five minutes the lunch will be ready, or count aloud when organising shoes in preparation to go out. Or let the children see you using and counting cash when you're at the shops.

Mathematical words

Talk about numbers and shapes and find opportunities to identify and solve a problem when you can. Use mathematical words such as longest, shortest, longer than, more than, fewer than, all gone, and none, heavier, lighter. And describe the properties of shape and space, rather than just naming them. This is an ideal opportunity to use Welsh language too, if you work in Wales.

Children of all abilities

Provide resources that disabled children can access. For example, children with impaired vision will find tactile number cards (Montessori settings use sandpaper) useful, as well as number lines with large print and resources with distinctive shapes or textures. Be aware of dyscalculia which affects a person's ability to understand, recall or manipulate numerical information.

4. Songs and rhyme

Singing action rhymes such as "ten green bottles" or "five currant buns" are probably part of

your everyday work caring for children, knowing that they help with the concept of number, and they are fun for the children.
Jenny Goddard in her article Focus on.. Maths through music, rhythm and rhyme, explains how rhymes help practice and consolidate mathematical concepts. Music helps children, from the very first lullabies they hear as children, to respond to the rhythm and patterns and sequences within. They can also experience the mathematical concepts of beat, meter, duration of sounds, tempo and rhythmic patterns. Taking part in music, songs and rhymes, children can express themselves and interact with each other and adults.

Think about how you use music in your childcare setting. Which rhymes do you sing that reinforce maths? Explore tempo, beat, repetition and duration of sounds with the children, by listening to recorded music and by creating sounds and rhythm with the musical instruments you have available or simply tapping, clapping and dancing.

5. Maths outdoors

So much of maths can be explored in the wider space of outdoors – whether that is out and about on a trip or on the school run, or in the outside space of your childcare setting. There are lots of ways you can explore maths outside, here are just a few ideas to get you started.

Make patterns

Explore repeating patterns with wheeled toys by making tracks or trails. Play games like follow the leader with repeating patterns where children make three hops, three jumps, three hops and so on. Children can make patterns in sand with sticks, shape cutters, and other objects.

Start a collection

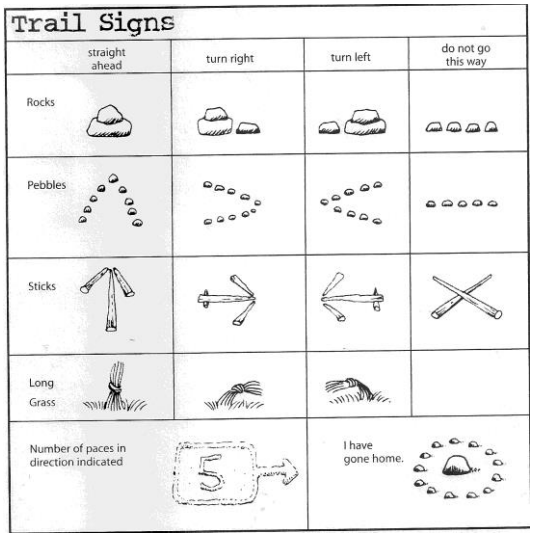
Collecting and sorting all helps with maths. When out and about, get the children to collect interesting things– conkers, acorns, stones, twigs, leaves, shells, seaweed. Then you can talk about what you've found, count them, and sort them into groups depending on the age and stage of development of the children. For example, younger children could sort them into colours, while older children might sort them by types of leaves. Let the children organise the groups themselves and talk about how they've done it. **Talk about** the patterns found in nature and create repeating patterns with the collection. You could also share the leaves (or shells) out, practice counting and order them by size.

Build a tower

Make the most of the larger space outside to make big towers with big cardboard boxes, hollow bricks and crates. Get the children to work together to decide how to make the tallest, sturdiest tower. Block play helps children with mathematical skills "by selecting blocks of different shapes and sizes and comparing surface volumes and areas, for example, they are unwittingly using classification." (Phelps and Stannard)

Follow the trail

This tracking activity inspired by the Scouts is great fun around your outside space or when out and about in your local nature area. Depending on the group of children you're caring for, either lay the trail for them to follow or split them into two smaller groups – one to lay the trail and one to follow it.



[image source: A Canadian Guider]

Patterns and shapes

Look at patterns and shapes when you're outside. Take pre-school children on a shape walk, seeing how many different shapes they can find. Look at paving stones, road signs, drain covers, brick walls, park benches, and lamposts.

Take some photos and make a book of shapes or patterns. Use what you've observed to inspire some mark making or pattern making back at your childcare setting. This BBC film about artist, Cornelia Parker, shows her making a sculpture from the cracks in paving stones.

6. Numbers and Shapes

Part of mathematics in Development Matters in England (p89) states that children will be learning to *'Talk about and explore 2D and 3D shapes (for example, circles, rectangles, triangles and cuboids) using informal and mathematical language: 'sides', 'corners'; 'straight', 'flat', 'round.'*

Children can explore shapes with their whole bodies.

Julia Sudbury (The Childcare Professional, 2013) suggests that you

"provide lots of opportunity to move and manipulate objects, climbing onto or into boxes hiding under tables, jumping off low objects or crawling through tunnels. Support positional development by using words like under, on top, inside and behind to describe their movements".

Explore large and small 2D and 3D shapes such as circles and spheres, squares and cubes, equilateral triangles and pyramids.

Describe shapes

The shapes don't have to be regular, it's more important to talk about what a shape looks like and the characteristics of it. For example, "this cylinder is tall and thin and you can see right through it – it's hollow. What do you think might fit on top of it, under it, inside it? What will happen when we drop this marble (or other sphere) in this hole?" Or this milk carton is oblong but has a sloping top. What else slopes on top? What else has this shape? What can we make out of this carton?"

Junk modelling

Collect a pile of empty food boxes and containers. Talk about the shapes and how they might fit together, and let the children experiment. Give them some flattened boxes so that they can see the relationship between 2D and 3D.

Natural materials are also great for exploring shapes and pattern. Make pictures with leaves, seed pods, conkers, acorns and shells. Create treasure baskets with interesting shapes, patterns and textures for babies. Talk about the shapes with the children and observe the patterns they create. Make posting boxes for younger children so they can see what fits into the hole and talk about where it's gone.

Dice games

Dice games are great for playing with different numbers and ages of children, you can take them anywhere and children learn a lot about numbers from playing them.

Mathematical graphics

It is important that *children have plenty of opportunities to mark make.*

Provide resources for imaginative play that encourage making mathematical graphics, for example, calendars, cheque books, birthday cards, petty cash receipts, raffle tickets, recipes, and maps. Taking a register and looking at clocks also include number recognition.

There are more ideas for mark making in the PACEY Mark Making practice guide and factsheet. And this chart by Elizabeth Carruthers and Maulfry Worthington, founders of the Children's Mathematics Network, shows how children make meaning in pretend play with graphics and symbols.

7. Problem solving

Experimenting and solving problems is something that children do on a daily basis, but creating opportunities for children to solve problems with a particular emphasis on maths either on their own, in pairs or groups, will help build their self-esteem and confidence as well as consolidating their knowledge of mathematical concepts.

Ttime should be given to all children to return to the problem several times to see if they can work out the solution with practitioner support available if the child becomes frustrated.

Link the problem to children's interests, and introduce it with a story or with puppets, allowing children to be the experts. Talking through how children solved the problem will help their understanding of the process and help them approach something similar next time.

A problem-solving table or shelf

Set up a problem-solving table or shelf which is interactive and which the children can come back to if they don't solve it the first time around. There are some great ideas of mathematical problems for all ages of children on the NRICH website which was set up by the University of Cambridge. Make the problem-solving experience multi-sensory with different methods and recording solutions, for example, mark making, drawing, photography or model making or simply using fingers or counting aloud.

Set the children everyday challenges such as thinking about how many plates, cups will be needed for snack time. Estimating and guessing helps us know if we're headed in the right direction, building confidence.

Think about how you encourage problem solving in your childcare setting. You may set the children challenges during the day and usual conversation but **think about** whether conciously setting mathematical challenges is something you can incorporate into your work. **Think about** how you can encourage children to collaborate on these and how you can leave the problem open to be solved and returned to.

8. Supporting home learning

Whether parents feel confident with maths or not, they may come to you to ask how best to help their children at home, since numeracy teaching methods have changed since they were at school. In the early years, remind parents of the ways they use maths every day, for example in cooking, telling the time, with money, and reassure them that reinforcing those skills with children are really important. Point them in the direction of information aimed at parents, for example, on the National Numeracy website.

Why not take part in the National Numeracy Challenge as a whole setting? Encourage the parents of the children you care for to join in too.

9. References

Letter to high school student Barbara Lee Wilson (7 January 1943), Einstein Archives 42-606

Mathematics with the very youngest, Julia Sudbury, The Childcare Professional, Oct/Nov 2013?pp16-17

Focus on…Maths through music, rhythm and rhyme, Jenny Goddard, NCETM early years magazine, issue 6

Block play and maths, Pamela Phelps PhD and Laura Stannard PhD, Community Playthings website article

10. Resources

Nursery World Practice Guide: Mathematics in the EYFS

Children's Mathematics Network

Teachers TV – EYFS Maths

National Centre for Excellence in the Teaching of Mathematics (NCETM)

What do Artists Do All Day? A BBC film of Cornelia Parker

Enabling Environments: collections – take shape, Nursery World, Nicole Weinstein 29 July 2013

NRICH Enriching mathematics

National Numeracy

Maths is Everywhere– Early Education

Open up to Outdoor Mathematics – Learning through Landscapes

Encouraging Quality in Early Childhood Education and Care – Curriculum Matters, OECD

11. Frameworks and Legislation

England

Department for Education ***Early years foundation stage statutory frameworks***.

Department for Education ***Development Matters Non-statutory curriculum guidance for the early years foundation stage***

Wales

Welsh Government (2022) ***Curriculum for funded non-maintained nursery settings***

Welsh Government (2016) ***National Minimum Standards for Regulated Child Care for children up to 12 years of age***

12. Support from PACEY

As a PACEY member you can get more help by visiting the website www.pacey.org.uk or by calling 0300 003 0005.

PACEY is the Professional Association for Childcare and Early Years. Formed in 1977, we are a charity dedicated to supporting everyone involved in childcare and early years to provide high quality services, information and advice to children, their families and carers. We want all children to experience high quality childcare and early education, helping them to have a bright future.

Across England and Wales we provide training, expert advice, help and peer support to practitioners and practical and impartial support and information for families and carers and those advising them. We represent the views and experiences of practitioners and champion their vital role in helping prepare children for a bright future.