THE OUTDOOR MATHS PLANNING FRAMEWORK

Use the suggestions below to help you plan your outdoor maths lesson. Not every session needs to have every aspect. Not every lesson needs to be entirely outdoors. You may meet your class outside for 10 minutes of interactive mental maths stick work before going back inside to continue a maths session.

Getting ready • Timing class to get ready • Lining up in different ways (human graphs/data handling). • Weather check: chance & probability • Resource organisation	**Moving through the school** • Observation challenges – finding and commenting about things your see on your way outside. • Count steps, stop and point. • Different ways of moving: making shapes, partner work.	**Gathering circles** • Use "sticky feet/elbows/shoulder" to create gathering circle • Adapt well-known games to the lesson focus, e.g. *duck duck goose, fruit salad*, etc. • Where possible, go for random turns rather than round the circle, unless it's a quick sweep.
Run and touch • Useful for ensuring children know boundaries for work • Tell them to stay put so you can assess who has touched the right object, e.g. an example of an array. • Teach children to come back to gathering circle "Quick Circle" and to form this wherever you are.	**Physically active maths** • Highly physical for children who need to let off steam • Adapt PE games – good for maths, spelling, reinforcing key facts, modern languages, etc. • Look at Maths in Your Feet and Tagtiv8 ideas	**White sheet activities** • Find something interesting – remind/establish collecting ethics • Use to play whole class games or small group games • Remember to weigh down sheet in windy weather - use bags, sticks, stones, feet
Small group work nearby • Ideal for problem solving or team challenges. • Look and direct children where to work to avoid group spreading out too much, e.g. take 3 steps back from the gathering circle • Encourage children to invent games to learn a concept.	**Finishing off** • Send children to assist other groups • Teach children simple games that they can play, e.g. Nim, Your Turn, My Turn • Invent a maths game using a resource	**Reviewing (outside or in)** • De Bono's Thinking Skills: plus, minus, interesting • What worked well, even better if… • Encourage older children to find the curriculum links • Journaling: recall, creative, evaluative, investigate – plan and model this carefully.

Introduction

Maths is a broad subject and requires effort on the part of any teacher to learn the elements of maths and be able to teach them effectively. It is useful assess what is working well in your maths lessons and what could be better taught, more effectively through the use of the outdoors. The aim is for your outdoor elements to complement and extend the indoor aspects of your maths lessons and vice versa.

From the previous two years in Dundee, we know:

- A substantial number of children find working outside beneficial and that this can have a knock-on impact inside. Part of this is a focus on developing conceptual understanding of different aspects of maths.
- Many teachers find a new enthusiasm and excitement when working outside with maths. The first few weeks and months can be a bit nerve-wracking as you find your outdoor feet but the effort pays off.
- We shouldn't force a maths session outside for the sake of ticking the outdoor box. Sitting outside on a picnic bench completing a few pages of workbook is unlikely to be a high-quality maths experience.

Making the maths visible
When working outside, some children do not perceive what they are doing as real work because it is not inside in a classroom. This can be a definite bonus in some situations. For example, when working with an exceptionally challenging class where the "L" word creates a riot or an outright refusal to even try a task. Making the learning connection after the event is the way to go.

However, for almost all classes, there is a risk that the maths gets lost in the session and the point of learning is missed. You need to be very clear about the purpose of being outside for the maths in your own head.

Planning outdoor maths – the basics

1. Use the outdoor maths lesson framework to help you put together maths sessions outside. Also look at *Dirty Teaching Chapter 3*. There's lots of practical generic advice for getting going that's relevant.

2. Plan a clear series of linked experiences on a specific aspect of teaching. Remember that practice is about "*variation not repetition*" according to Yeap Ban Har, so tweak the learning each time you go out. It's best to plan whole class approaches rather than differentiate into ability groups.

3. Minimise dead time without hurrying children - every moment is a learning moment!

4. Use your best teaching skills! It can be so easy to forget these outside, especially when new to getting out. In my experience, we need to re-learn to remember things like the correct labelling of a graph when we go outside.

5. Think about the learning intention and success criteria and how these will be introduced or co-created with your class. If it is a lesson where the emphasis could be on multiple areas of the curriculum, decide what is the overarching learning intention but use higher order thinking

questions to tease out the links to other curriculum areas throughout or at the end of the lesson. In this instance, introducing new maths concepts probably isn't a good idea.

6. Your questioning techniques will impede or improve the learning - so framing these well matters. Try and create investigations or problems to solve and the strategies that could be used.

7. Feedback. This is crux, plan your feedback sessions well. Outside, it's common to find that many of the activities involve focussed discussions and conversations so there's a lot of learning going on.

8. Review and follow-up. Try to avoid isolated outdoor sessions. Make connections between the indoor and outdoor experiences. Finishing or following up on the maths session outside with a journal entry or continuing the same theme back inside, be this straightaway or the next day. Remember digital approaches can be more effective with some children.

9. Treat your environment with love and care. Place value (in every sense) matters.

10. Chalk... use manipulatives for practical work and scrap paper/pencil for working out or a digital device for those who need this. Some playgrounds eat chalk and it can be expensive to keep on having to top up. Manipulatives are more forgiving of errors in the eyes of a child. Furthermore, manipulatives can be quicker to layout and move around outside. Outside the manipulatives could be:
    - Found objects in the playground, woodland or wherever you are working
    - Items you have brought outside: sticks, stones, shells, pebbles. This is very handy if you are in a concrete jungle. Collect bags of resources
    - Homemade or bought outdoor maths items, e.g. number pebbles, cut sticks, tagged rope

11. Don't force a lesson outside. If there's no obvious connection, then do a recap lesson or run a series of outdoor sessions on a theme separate to the rest of the ongoing maths work. Shape and measurement work are particularly well-suited to the outdoors. There is a handout created by Dundee teachers which shows lessons in their entirety which could be helpful to see what this looks like.

12. Develop an approach to all your work that enables you to revisit and embed the learning through careful spacing through the year. The concepts need to be put into long term memory make the most of outdoor maths to do this as well. It is another way of using the outdoors.

Exploring symmetry outside with sticks

Getting ready

This is before you leave the classroom. Make it short and snappy.

1. Weather check: probability and chance discussions.
Encourage your class to come up with questions as well as the likelihood - create a line chart for this purpose. A lot of fun with purpose and an opportunity to get children thinking about what they need to wear and how we will all keep safe and well.

2. Resource organisation
This is about ensuring your class know:

- What personal resources they need, e.g. seat, pencil, scrap paper, clipboard, digital device (with robust cover, fully charged and sufficient memory)
- Maths resources – where they are, what to take out, how to care for them

3. Timing your class
Making a swift 'getting ready' transition an ongoing problem-solving activity. Encourage your children to brainstorm ways of doing this efficiently and to review their progress. I have managed to get classes to aim for 2-minute "Get Ready" time over the course of a term of weekly outdoor sessions.

4. Keeping a graph
This notes how many minutes you and your class spends outside each week. Ideally you are best committing to at least one outdoor maths session per week. Build up from here. Remember to focus on quality. The documenting of time is to give you and your class a visible incentive to get outside and capture the data and use it as a discussion tool.

5. Human graph line ups.
We choose an attribute and line up in accordance with this attribute, e.g. who has a pet, who does not have a pet.

- We talk about how many people were in each line and which had more. We estimate first and then count in ways linked to our ability/level

This can be extended to introduce histograms by calculations such as:

- The *p*et line has 8 people. Each person has 2 arms, so how many arms in this line? Have a chat with your partner and then let's share our thoughts.
- The *no pet* line has 12 people, how many fingers and thumbs are in this line? Have a chat with your partner and then let's share our thoughts. What methods did we use to calculate our answer?

Line ups can also happen in order of height, shoe size, birthday month, etc. Do this silently for more challenge.

Moving through the school

Getting outside could be part of the maths experience. Link this tightly to your lesson, either to recap previous learning or as part of the introduction to your outdoor session.

Observation challenges
This is about finding and commenting on things you see on your way outside?

- How many different quadrilaterals will we find on our way out?
- How many right-angled turns did we take to get outside?
- How many doors do you think we will pass? Write down your estimation. Let's now check as we go outside. We will use this information for exploring the mean, median and mode responses to both our estimates and what we count. (This can also be a group challenge with other groups having to estimate and count windows, fire exit signs, ceiling lights, etc.)

Counting challenges
This is using the time to practice counting sequences of numbers. Be mindful of your children's ability to work on their own, especially to begin with and for younger children, simply not knowing! Also be aware of children getting excited, shouting and disturbing other classes in open plan settings.

- How many steps did we estimate it took us to get outside? Did we over or underestimate? For younger children, chunk this activity, e.g. number of steps along a corridor. Stop, check then estimate the next section of the walk outside. Remember you can move in tiny steps, big strides, sideways walking, etc.
- The Stepping Game: Pick a multiple and walk outside skip counting. Every time you come to that multiple, you have to say it aloud and whisper the numbers in between, e.g. *1, 2*, **3**, *4, 5*, **6**, *7, 8*, ***9***, *10*, etc. This can be extended to skip counting in decimals, fractions etc. Just pick what counting patterns your children need to know and remember.

Other ambulatory possibilities (activities on the go)

- Taking 5 steps, pause and look for 2D shapes. Prior to this, predict which shape is likely to be the most common and look out for any unusual 2D shapes. This can easily be modified
- Taking 10 steps and making a symmetrical step your partner needs to copy. This can be undertaken by making 2D shapes or different angles using body parts.
- Taking 10 steps, calling out a number, e.g. "25 metres" and call out "Convert to Centimetres" and the children. If correct the children move on. If wrong, the children have to convert to millimetres or complete another challenge, e.g. "*Convert 15 metres to centimetres*."
- Providing 'robot' instructions for a partner, e.g. "Take 2x3 steps forward".

Gathering circles

Just like indoors, it is good to have a place to come together as a class. A gathering circle is a lovely way of building a collaborative, shared learning experience. A circle lends itself naturally to discussions, reflections and reviewing tasks, as well as games and action activities.

Making a circle is a mathematical opportunity.

- Create a circle in order of height, shoe size, birthday month, etc. Do this silently for more challenge.
- Practice making sticky elbows, feet, knees, tips of fingers, shoulders: good for understanding scale in relation to the body. Often children have no concept of how wide their armspan is or how small a group huddle circle is (sticky shoulders)
- Use a rope tagged with electrical tape to indicate each metre. Have ones available in lengths such as 5m, 10m, 15m to help children see the differences in scale. Whilst children can stand one metre apart with the help of tags, usually 2 children per metre is easier for group cohesiveness and children being able to share ideas, and hear each other.
- Using one metre sticks form a circle. Then your class can count off and work out the circumference of their circle. To increase the challenge, substitute some of the sticks for 1/2 m. Then introduce 1/4 m sticks and so on. Switch to counting in decimals. Flip to using centimetres or millimetres and so on so that children get used to converting between the scales.

The first time you take a class outside, it is worthwhile spending time getting children used to gathering and doing circle-based activities. This helps children understand that it is different to playtime. It is also an opportunity to review ground rules and behaviour expectations. The circle can become a unique and special part of being outside

Social distancing spaces

Think about the most efficient system for social distance gathering. Would it be circles, squares or equilateral triangles? Discuss this with your partner and be prepared to explain your thoughts. How could this be marked out or remembered by classes?

Play circle games to embed maths concepts
Adapt games you know well. Many games from PE and circle time can be adapted for outdoor math, e.g. *duck duck goose, fruit salad*, etc. Where possible, go for random turns rather than round the circle, unless it's a quick sweep. It avoids children loosing concentration.

Other examples of circle experiences include:

- **Tapping activities** - counting forwards, backwards, listening to the number of taps, using them for addition and subtraction work - moving into place value. See the primary maths handouts for the details. This works best with big one metre sticks.
- **Introductory whole class activities**: bounce passing a ball as skip counting takes place, discussions about a maths problem that has been presented with a partner.
- **White sheet activities with a large white sheet in the centre**. This can be useful as part of a recap or introduction to group work.
- **Coming together to review a problem and share findings**.

Run and touch games

This is handy when starting out for creating clear boundaries about where it is okay to be outside. You can reinforce positive actions of those staying within the defined boundary. In terms of touching, you may prefer children to point in these COVID-19 times.

The aim is to frame the commands around your learning, e.g. symmetry, angles, measurement, etc.

Call out instructions such as 'Run and touch …

- Double objects, e.g. two daisies on the ground beside each other, double doors, two sides to a picnic bench
- An example of an array
- A 2x4 array
- An illustration of ½
- Something you can count in twos
- A quadrilateral.
- A right angle
- A feature which has more than 8 right angles
- Something that has too many parts to count (good introduction to estimation)

It is important your children stay at the object they have run to. Then you can do a quick sweep and check that everyone is on task. After each instruction, call the class back to the gathering circle. Time them, if necessary, to see how quickly they can return. Ask the children to call out their "run and touch" maths ideas too.

It is helpful to have your list of "run and touch" linked to your lesson theme created in advance. Then it's a lot less stressful. Essentially it's a mathematical scavenger hunt but done en masse.

The blue mats making sitting outside anywhere more comfortable – portable seating can be a bonus.

Physically active maths (whole class group games)

In cold or inclement weather, it's important to keep children moving when working outside. Run around or moving activities are incredibly useful. If you have a very energetic class then moving around can be helpful.

Adapt PE games
There are lots of mathematical PE games that can be quickly adapted to meet a maths outcome. For examples, have a look at the Tagtiv8 website https://tagtiv8.com

For work on position, movement, direction and symmetry, the Math in Your Feet website and videos are inspiring http://www.malkerosenfeld.com This approach can easily be adapted for using outside using chalked or painted squares.

The cone grab game
This involves splitting the class into groups. Each has their own base - a hoop or chalked out shape at the end of a ½ a netball or similar court. When the whistle blows, each person collects one cone at a time to put in their hoop. When the whistle blows again, everyone stops. Each cone is worth a different value, e.g. Scots pine cones = ones, stone pine cones = tens, *Wellingtonia* cones = hundreds. The group totals the value of the cones. The game continues. If you wish, you can vary the value of each cone.

Other alternatives include each cone representing a different number for addition or multiplication or for working out fractions of the total set, e.g. 8 Scots pine cones out of 24 collected = 1/3. This game can be adapted to any age and many different areas of maths.

Using playground markings
In my experience most playground markings have limited value, but it's easy to chalk out a hopscotch, blank number line or look for flagstones that can be used for grid work. A lot of children will invent maths games that use markings.

White sheet activities

White sheets are useful for whole class and group activities as a focal point for work that involves using natural materials such as found materials, cones, stones, sticks and so on. Just use an old sheet.

Within many approaches to maths there's a focus on use of concrete materials moving to pictorial representations and eventually onto abstract thinking, sometimes referred to as CPA originally advocated by Bruner[1]. The use of a white sheet helps make this link between the use of manipulatives and a visual representation of this. Unlike paper, chalk or whiteboards, it's quick and easy to move the materials around on the sheet to explain thinking.

There is also a range of layouts you can use, by carefully drawing these with permanent marker pens. Having different layouts and sizes for different purposes can be very helpful.

This is a one-metre cloth which is handy for small group work. It gives children a sense of what one-square metre looks and feels like too.

This design encourages creative thinking. I've used it for place value work, multiplication and symmetry with a range of ages. The photo shows an example of halves and doubles where the large cones represent 100.

This is a Hungarian tens frame and can be a useful addition to a standard tens frame to add variation rather than repetition. It is helpful for understanding how numbers can be broken into smaller amounts.

This is a plastic A1 sized sheet with grid lines, which is from Magic Whiteboard https://www.magicwhiteboard.co.uk
It is useful for upper primary classes where more accuracy is needed, e.g. for coordinates work, angles, scale and symmetry.

This is large sheet for group or whole class work and has a 10x10 grid. Each square is 12x12cm and comfortably fits Dienes place value 100cm² blocks.

[1] https://mathsnoproblem.com/jerome-bruner-theories-put-into-practice/

Small group work

Group work is exciting outside. Children enjoy the opportunity to investigate or explore a maths problem. Here's some useful tips:

- **Think about the organisation of materials in advance**. Sometimes it can be less faff if a group takes a bag of grab-n-go resources. Or have a system for collecting and returning resources that is easy to manage. I tend to put my resources along a fence or wall and spaced out.
- **Define the working area**. From your gathering circle, take 3-5 steps back. Your groups work near each other but still within quick reach of the gathering circle for discussions.
- If your children need to move about to explore the environment, **stick within one playground** to begin with. If necessary use cones or a chalk line or ribbons as boundary markers.
- Some classes and groups can work anywhere well. Others need more direct supervision. **Experiment until you have effective working groups**. Avoid differentiation by ability. It is common that children who demonstrate less interest or ability inside show a positive difference outside.

Team problem solving

If you have a really challenging class, then looking at problem solving team games and strategy games can be a useful entry point. This can help children acclimatise to working outside with others and develop the skills of "productive struggle" that can then be applied to maths work outside.

A games-based approach (small group work)

To develop maths ideas from the children, this is the approach I take. They can be useful for:

- Early finishers to play some of the games that have been developed.
- Exploring new resources
- As part of a wider assessment to ensure they can apply new thinking to a different context.
- To develop collaborative approaches to learning maths. For example, when an older class creates a series of maths activities for a younger class around a theme. A good example, using time, can be seen in this Middleton Park video: https://vimeo.com/165466148

The approach

- We go outside. This is really important. The children are not as creative inside and do not think about using the environment for inspiration and to make a game or challenge come alive.
- Children work in groups of 4. If a child needs to work on their own or in a smaller group, this is okay. Use co-operative learning techniques or similar if your class is used to this approach.
- Each group is given the resource and/or makes it.
- For two minutes the group discusses what is mathematical about the resource.
- There is a quick share of thinking. If a challenge naturally arises, every group has a go and shares how they got on.
- Each group devises a maths challenge or game using the materials. This normally takes 10-15 mins
- Each group shares their idea. The teacher takes notes, videos etc.
- The group then look at the CfE experiences and outcomes and considers whether their game or challenge is sufficiently challenging in terms of meeting the standard. If not, then everyone brainstorms how to increase the challenge. This may need the help of others in the class and works best with P5-7 classes.
- The game or challenge is written up back inside. Alternatively, it can be videoed. This will take a few practice runs. This is then kept and used by the class later in the term, or, shared with another class.

Finishing off

Just like inside, children need an activity to keep them engaged if they finish early and are waiting for others. Possibilities include:

- Send children to assist other groups or children
- Providing a role such as taking photos, videos or organising resources
- Teach children simple games that they can play, e.g. Nim, Your Turn, My Turn. There are lots in the handouts.
- Invent a maths game using a resource. Also having a bank of games on relevant maths themes can also make a difference, especially if your class have created these from their own suggestions.

Mazes can be an ongoing investigation – more information in the Outdoor Maths Games handout

Reviewing (outside or in)

Making time to reflect on the value of the outdoor session matters. Make the most of your teaching skills and techniques that you already use. Outdoor approaches include

De Bono's Thinking Skills: plus, minus, interesting
Create a semi-circle of children around a +, - and squiggle symbol drawn on the ground. One at a time, children step forward to give their opinion. Just a plus OR a minus OR an interesting is needed, not all three.

What worked well, even better if… (www/ebi)
This reflection can be simple line up graph. Draw a T-bar on the ground, labelling one side WWW and the other EBI. Children state their thought and then step back on the graph, making room for another person to come up and state their thoughts. Back inside, each statement can be written up the child that suggested it so that the following week the class can take action to improve on the "Even Better If's…"

Journaling
This is covered in more detail in a separate download.