Inspiring Mathematical and Scientific Curiosity Through Outdoor Investigation!

(Source: James, 2024a)

I acknowledge the use of Microsoft Editor on 25 September 2024 to check my work.

Investigating Nature by Promoting Children's Scientific and Mathematical Concepts

A dedicated teacher and an experienced practitioner lead a group of six children between the ages four to five, to an outdoor area where children can explore, play and develop, taking part in a variety of mathematics and science activities together.

On the walk over to the forest area the teacher decided to sing a song with the children “walking to the forest what can we see?” Ariella could see birds and counted “one two three birds singing in a tree.” Buddy could see aeroplanes in the sky “one two aeroplanes flying in the sky” Cole could see leaves “one two three four five leaves falling to the floor.” The teacher and children approached a road stopping to look and listen to see if any vehicles were approaching, Cole alerted everyone shouting, “Stop there is a car coming.” There were no other vehicles on the road, therefore everyone crossed safely to the outdoor area.

The children quickly started exploring the forest soon after they arrived. "Wow, look at all of this!" said Buddy. "I wonder what lives here?" asked the teacher, "I can see bugs inside," Cole replied. The practitioner asked, “what shape is it? Buddy yelled, "rectangle” Ariella said, "circle, triangle and look there's a pattern." The children yelled, "Ladybirds, woodlice, bees, frogs and hedgehogs!" with excitement as the teacher asked about what kinds of insects might live in the bug hotel.

Ariella shouted, "Look everyone, a butterfly!" as she saw a butterfly while investigating the bug hotel. The practitioner decided to discuss the life cycle of the butterfly by asking each child to represent each part of the lifecycle. it begins as an egg, grows into a caterpillar, becomes a chrysalis and then, after two weeks, becomes a butterfly. The children gathered with interest to act out the transformation from an egg to a caterpillar to a chrysalis and finally to a butterfly.

The teacher questioned the children “I am curious what other insects can we see?” Ariella cheered “I can see a spider,” the practitioner asked, “I wonder how many legs the spider has, let us count together.” Everyone started counting “one two three four five six seven eight.” Cole shouted, “I can see a frog jumping on the floor” the children started to jump around, Cole questioned the practitioner “what is the life

cycle of a frog?" the practitioner replied "Eggs, Tadpole, Froglet and then a Frog. I wonder how high we can jump?" The children started to jump to see who jumped the highest and who jumped the lowest. The teacher questioned the children "I wonder who jumped the highest?" the children replied, "all of us." The practitioner then questioned "who jumped the lowest?" Buddy replied "You."

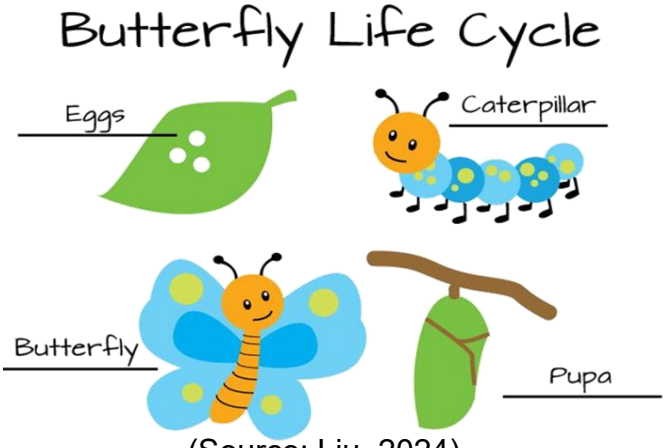
Links to the Curriculum

Mathematics

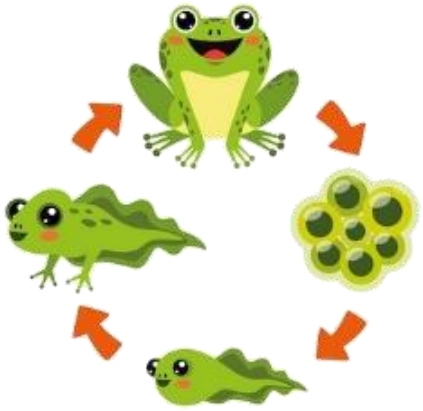
In the outdoor setting rich in mathematical experiences, the children explored a variety of numbers, including cardinal, ordinal and nominal numbers. With the understanding of the counting sequence and one-to-one relationship, the children counted sets with accuracy. Children can count both actual objects and those that are only perceived. The children have also explored, contrasted and used the general vocabulary associated with forms through exploratory play. The children can keep estimating and comparing using measurements such as "shorter than" and "heavier than" (Welsh Government, 2020a).

Science

The children can recognise both plants and animals as growing living things. Children can look around, pay attention to different details and communicate their ideas clearly. Children can recognise, adhere to and start forming patterns and sequences in daily tasks (Welsh Government, 2020b).



(Source: Liu, 2024)



(Source: Yusufdemirci, 2024)

(Source: James, 2024b)

Tyres

As the teacher looked over to the tyres on the floor, she could see three children admiring them. The teacher asked, "I wonder what we can use these for." Delilah asked, "What if we roll them?" Freddie said, "This is heavy, I need help!" as he picked up the tyres. After sprinting over, Ezra and Freddie then pushed one to test how far it would roll. Ezra asked the practitioner, "Why did the tyre stop?" when it came to a stop at a concrete stone. The stone was higher than the muddy floor, the practitioner explained. When Freddie compared the heights and textures, he stated "The stone is higher." The practitioner asked, "What if we change the direction or find something else to help us push the tyres." Delilah spotted some wood and rope and asked if they could be used. Ezra suggested, “What if we build a ramp with the wood?” The teacher encouraged the children, “Let’s see who can push the tyres further.”

The children were engrossed in this activity wrapping the rope around the tyres and building a ramp while checking the ground to see if any items would stop the tyres moving. The practitioner questioned “How will we know whose tyres have travelled the most distance?” Ezra said, “we will have to measure with our feet to see which has the highest number.” Delilah was the first child to push her tyre down the ramp. The teacher asked, “I wonder how it travelled so far this time?” Ezra said, “it is because of the ramp.” The practitioner said, “it is the force of gravity making it travel faster. I wonder if we change the ramp height to smaller or taller, what will happen?” the children started to look for extra things they could add to the ramp to see if it would have an influence on the speed and distance the tyre could travel.

Ezra was next to push his tyre on the ramp “Wow it went further than Delilah’s” the teacher asked, “what if we made the ramp lower what would happen?” The children ran over to the ramp and made it shorter than before; Freddie pulled a tyre up to the top of the ramp then pushed it down. Freddie watched the tyre roll and waited for it to stop, it stopped right in the middle between Delilah’s and Ezra’s tyres. Freddie said, “the height of the ramp affects the speed the tyre goes, I wonder if we all push our tyres down the ramp at the same height, would they all be in the same area?” Ezra said, “Good idea.” Ezra went to get the tyres and put them all in a line ready for everyone, Freddie went first then Delilah and finally Ezra. They all observed the tyres and where they had stopped, Ezra shouted, “let’s see whose tyre travelled the most.” The children asked the practitioner to help them count. The teacher arrived and

started to count together, Ezra's tyre went fifteen feet away, Delilah's tyre went sixteen feet and Freddie's tyre went fourteen feet away. The practitioner questioned "who has got the biggest number?" Delilah was jumping up and down shouting "Me, Me, Me, it is more than Ezra and Freddie's number."

Links to the Curriculum

Mathematics

The children are developing their ability to use mathematical language to describe quantities and make estimates and comparisons, such as identifying when one quantity is 'more than,' 'less than' or 'equal to' another. Children have utilized a variety of objects for measurement and are beginning to grasp the importance of consistently using the same physical unit without any gaps during the measuring process. Children have explored different movements and directions and can start applying mathematical language to describe positions accurately (Welsh Government, 2020a).

Science

Children act inquisitively and actively to explore the mechanisms of objects. Students take in their surroundings, notice things, and express themselves well. Children communicate about their design process and the objects. Children use basic tools, supplies and machinery for both construction and demolition in a safe manner. Children also investigate the characteristics of varied materials, choosing the right items for certain uses (Welsh Government, 2020b).

(Source: Sasek, 2018)

Risk Benefit Assessment

Location:	Forest	Date:	18 September 2024
Assessor:	N James	Review date:	18 September 2025

Table

High	Medium	Low

Experience Type	Benefit from this activity	Hazards and Risks	Who is at risk?	Measures to minimize the risk	Overall risk after precautions
Tyres	Children benefit from rolling tyres down a ramp by improving their social, mental and physical abilities. It emphasises fundamental physics ideas such as gravity and motion while also strengthening muscles and enhancing balance and coordination. Experimenting with ramp designs stimulates critical thinking, imaginative play and problem-solving.	Tyres toppling over when climbed onto, bumps and falls from shaky ramps and strains from pulling or dragging tyres.	Children and Adults.	Constant supervision. Use the correct size tyres, keep the number of children to a minimum, check the equipment frequently and conduct the activities on flat terrain.	
Wooden climbing frame	Improves balance, coordination, motor abilities, which benefits children's physical, mental and social development. Through route planning, it enhances spatial awareness and fosters critical thinking and collaborative play.	The absence of safety barriers in the structure raises the possibility of falls. Because it is made of wood, inappropriate maintenance could cause it to crack or splinter.	Children.	Observation of the children while using it. To avoid damage, regularly check the wooden frame for maintenance and report any defects.	
Ground surfaces	Children's physical, social, emotional, cognitive and creative development are all aided by exploring various surface levels. While walking and climbing help	Uneven ground surfaces, tripping, ankle sprains and balance problems. While navigating these terrains,	Children and Adults.	Practitioners can observe play, ensure the use of appropriate footwear and teach children about their surroundings. Selecting safe	

	to build gross and fine motor skills as well as balance and gravity awareness of different terrains.	tiredness may cause accidents and health problems may arise from hidden hazards.		play locations, establishing limits and encouraging cautious movement are all part of minimising dangers.	
Trees	Children can learn to identify various types of trees while being creatively stimulated by building dens out of fallen branches. Children can make items out of sticks and leaves and hide behind trees.	When handled inappropriately, sticks may poke children in the eyes and in windy conditions, falling branches can be dangerous. Children may have allergies caused by pollen.	Children and Adults.	When pollen counts are high take extra care with allergic children. By removing ground branches to avoid tripping hazards and inspect trees for weakened or dead branches.	
Wooden hut	Encourages imaginative play and creativity. It helps children develop their problem-solving, emotional intelligence and cognitive abilities while also building friendships and teamwork.	Potential of protruding nails in the wooden cabin or in locations that are unstable. Children may trap their fingers in the wooden hut's door.	Children and Adults.	Make sure there are no nails sticking out and that it is stable. Make sure children know how to climb the stairs to the cabin and use a hook to keep the entrance open.	
Fence	Children can drag sticks against the fence to hear different sounds it creates. The fence will provide the children security and protection from harm from the outside.	In addition to the possibility for distraction posed by people talking to children outside the fence, there is a chance of damage due to faults and sharp spots.	Children and Adults.	Before allowing children to participate in any activities, check the area for safety. Make sure the metal fence is secure and free of sharp edges.	
Cable reels	Children may build dens for hide-and-seek games, roll objects down ramps to measure their speed and use cable reels as drums.	The cable reels weigh considerably. Things that fly or tumble down the ramp could fall into a child who could be struck with the items.	Children And Adults.	Children should be watched closely, take caution while moving wood, ask for help when handling large cable reels and survey their surroundings before using the ramp.	

Bug hotel	After studying the life cycles of the insects that reside within the hotel and observing its assortment of shapes. Acquiring knowledge about the many environments that animals prefer to inhabit.	There could be splinters in the wood and the children could get wounded if the insect hotel falls. There is also the risk of harm caused to the children by certain insects.	Children And Adults.	Ensuring that the bug hotel is maintained and clear of splinters, as well as that it is stable and fastened to the fence. Make sure there is enough first aid supplies on hand in case someone gets hurt.	
Rope swing	Stimulation of brain regions responsible for balance, rhythm and muscular control. This activity improves children's general and fine motor abilities, coordination, balance, and sensory development.	Falling off the swing, the rope coming loose from the tree, branches of the tree falling onto a child's head.	Children	Examine the tree for lumps and cracks, trim off any hanging or dead branches and make sure children are swinging on the right type of rope.	
Road beside the area	Learn the skills to stop, look, listen, and think before crossing the road safely. Pointing out to the children where the path ends and the road begins, as well as how to cross at the crossing.	Children are more vulnerable to serious injuries from cars because of their small stature, poor visibility to drivers.	Children And Adults.	Ensuring that there are sufficient staff members to assist children in crossing the road, make sure the entrance is observed to prevent children from getting out unattended.	
Rope and ribbon	To connect tyres or different objects for pulling. Children can make a trail by laying the rope on the ground as well as attach objects to make designs or a den.	The hazards associated with rope and ribbon include tripping, burns from ropes, entanglements that cause falls and stumbles, as well as rope strangulation.	Children And Adults.	Ensuring the rope and ribbon are bright colours for easier detection and having practitioners keep an eye on the children. Check for trip hazards, maintain and inspect ropes.	

Encouraging Outdoor Mathematics and Science Learning for Early Childhood Learners

Practitioners play a key role in providing hands-on learning opportunities and creating a welcoming atmosphere where children can freely engage with these materials. Children learn science and mathematics in a natural way by completing activities using natural materials such as water, leaves and stones and playing outside provides children the flexibility to enjoy themselves. A place of freedom, chaotic and outrageous movement and interaction with the elements, the outdoors might be characterised as an open and ever-changing environment (Bento and Dias, 2017).

Loose Parts to Enhance Mathematics and Scientific Learning

According to Casey and Robertson (2019) children's environments are richer when there are loose parts available to pursue their interests and explore their curiosity. An outdoor setting with several loose elements encourages children to experiment, enjoy themselves and figure things out on their own, blurring the lines between learning and play. Moreover, materials that are known as loose parts can be rearranged, carried, combined, lined up, deconstructed and reassembled in a variety of ways (Cumbria County Council, no date). Also, Nicholson theory uses the term "variables" to describe loose parts with a range of elements, such as materials, forms, physical phenomena such as gravity and electricity, gases, noises and even ideas and words. These varied components provide children with the chance to explore, experiment, learn and create, which makes learning enjoyable and interesting (Casey and Roberson, 2019). In addition, Play Wales (2023) claims that the practitioner’s role is knowing their place and to help children play freely with loose parts with little involvement.

Brodie (2024b) claims that loose parts offer many chances for mathematical learning. Children instinctively sort, classify, create patterns and count during play. Children investigate ideas related to shape, size and spatial relationships without even realizing mathematical engagement. Practitioners can demonstrate the use of various materials as well as provide clear explanations for activities and items. Also, Ranheim (2020) suggests that stones, pinecones and leaves can be utilised for weighing, sorting, counting and analysing forms. When adults assist children in gathering natural objects, children can practice mathematical abilities while engaging in connections and broadening their understanding of mathematics. In this case, many opportunities emerge with loose parts to study size, form, classification and to teach mathematical vocabulary (Early Years Stronger Practice Hubs, 2023).

The loose parts approach involves fostering relationships through candid discussion; considering the audience's particular context and needs; communicate goals clearly and promoting

experiential learning through hands-on activities by encouraging reflective practice. These elements, which highlight practical participation, effective communication, audience awareness, community building and reflection in the learning process, are in line with studies on facilitation and professional development (Xavier, Morrison and Sulz, 2023).

Early Years Alliance (2023) claims participating in outdoor education could create a rich environment for improving scientific and mathematic abilities. Children may practice measuring, pulling and lifting with loose components as well as understanding weight and balance. Working together promotes the exchange of innovative terms and concepts, which enhances communication skills.

Tovey (2017) claims that Froebel theory allows children to utilise basic, unrestricted materials to help with communicating their thoughts, emotions and experiences. These investigations were described as “forms of knowledge,” “forms of life,” and “forms of beauty.” This implies that the work children produce can highlight their knowledge of mathematics and science as well as elements of art such as symmetry, patterns, shapes in addition to individual experiences.

Fostering Curiosity and Discovery

The investigation of curiosity-driven learning holds significance as it provides insights into how children acquire knowledge outside of carefully planned experiments (Twomey, 2016). Furthermore, children could be more interested in the surroundings and have an exciting time as active learners which makes decisions based on their own interests and oversee their own growth (Learning Journals, 2024). Additionally, children raised in environments with a curiosity approach have shown signs of an increased motivation to learn new things and develop a sincere appreciation of nature and respect for the outer world and for others who share it is at the heart of this education for children (Learning Journals, 2024). Moreover, Moorhouse (2021) claims that curiosity fuels children’s urge to explore, enquire and play throughout their early years. Since it places children at the centre of their learning, children have shown to learn best during the pursuit of their natural curiosity. Intellectual curiosity develops the cognitive state in which individuals are open to examining ideas and their initial interest in curiosity leads to inquiry.

Children’s curiosity and creativity are sparked by interesting things found in the outdoors, such as sticks, rocks and water. Compared to plastic toys, using readily available and affordable resources improves sustainability. In addition to providing children with a wealth of educational possibilities, outdoor play helps children acquire language, scientific and mathematical ideas. Children can learn a new language through discussion when exploring concepts such as weight and volume for instance when playing in soil and water (Bento and Dias, 2017). In addition to their adaptability and ability to change into many objects, these natural elements promote imaginative play (White,

2008, cited in Bento and Dias, 2017). Furthermore, Thomas and Boulton (2021) suggest that children can obtain several opportunities to expand their brains, sharpen their thinking abilities and gain confidence when exposed to the outdoors. Children can learn more about how the world functions as a result. The advantages of this play reflect on what the practitioner offers in a nurturing setting such as the tools and resources at their fingertips. Practitioners can promote careful observation by asking questions such as “What does this remind you of?" and "What does it feel and smell like?" and encourage children to draw connections between different plant families with statements like "this one smells a bit like mint" or "this has five petals just like the apple blossom." Teachers can share their interest, observations and love of nature with students during key learning stages (D'Ascoli and Hunter, 2022).

Axelesson (2024) identifies the Reggio Emilia method which encourages inquiry and exploration. It places a high priority on developing solid bonds between parents, teachers and students to promote lifelong learning and holistic development. Furthermore, Education Scotland (2020) explains the philosophy of Reggio has its origins in constructivist and sociocultural theory, which indicates that learning requires adult intervention. Researchers say that children possess boundless curiosity, always seeking explanations and resolving issues and the capability of creating their own knowledge, abilities and capacities.

Importance of Open-Ended and Child-Led Play

Early Years Alliance (2023) suggests telling stories and posing open-ended questions, such as "I wonder how far we can push this," encourage inquisitiveness and critical thinking about the natural world. In addition to making learning more fun, this experiential approach helps learners grasp scientific and mathematical concepts in a real-world setting.

Children can engage in a variety of interactions with their surroundings through unstructured or child-led play (Houser *et al.*, 2016). In these situations, children can observe the beauty of nature in a variety of enjoyable ways, such as observing woodlice, examining leaves close up or splattering water in puddles. These actions can promote play and aid in learning across a variety of areas. Connecting with nature is facilitated by creating areas such as gardens, flower beds and natural habitats. There are countless play opportunities when using items like wood, logs, stones, sand, water and dirt, which are also typically inexpensive and simple to locate (Moorhouse, 2020). Furthermore, Early Years Alliance (2023) has indicated that the child's imagination is their only restriction and as practitioners know, children have an open mind and are naturally curious about the world around them. This could be displayed in many forms, children may push, pull, rotate and balance on a horizontal tree trunk, while observing the environment from various perspectives on a tyre swing.

According to Wisbey (2018) the Montessori method provides children a natural ability for organising and comprehending patterns in things during encounters. Furthermore, Montessori theory believes that mathematical capacity is marked by order, observation, precision and imagination which can be developed with careful instruction. Similarly, Dewey theory has recommended that rather than focussing on whether children will like an activity, teachers should consider how it will advance the education of children, foster their development, help children acquire abilities, broaden their perspective of the world and to prepare children for a richer life (Wisbey, 2018).

Children have shown to learn best through engagement and raised interest in the process. This is achieved when the learner is intensely motivated by the experience because it is relevant and important in that moment (White, 2024). Moreover, teachers can function as facilitators, by encouraging open-ended exploration and creative expression, while also valuing the importance of art, documentation and collaboration in the learning process. To aid the learning process, practitioners could take on the role of a facilitator, fostering free-form inquiry and artistic expression while appreciating the value of art, documentation and group projects in the educational process (Axelsson, 2024). To support the facilitation of children's learning, the practitioner could communicate with the children about their activities and employ terms such as "same as," "fewer," and "less." Before posing questions on sequences, the educator should make sure that the children comprehend number order and to encourage the children to solve problems. promote the interest of the children with outdoor items by talking about the similarities and contrasts between them and by placing them on display to appreciate how items are arranged. Encourage children to recognise and pair up shapes in their surroundings by introducing them to the concept of shape language. Additionally, design trails with them using descriptive language, encouraging children to experiment with various paths and options (Richardson, 2019).

To establish a connection with children, practitioners should pay attention to their needs without being overbearing, keep eye contact, observe their emotions, and body language. Questions can be improved by using complex phrases and maintaining an open mind, as well as respecting the child's perception, enquiries with predetermined responses should be avoided. Communication can be enhanced by speaking to children on their emotional level and by sharing relevant individual experiences. When communication is challenging, asking simpler questions might be helpful (Shannon, 2023). According to Department for Education (2023), providing children easier access to resources and tools encourages collaboration and making decisions. Allowing complex tasks enough time and considering their rationale, such as selecting a paintbrush over a pencil. Include activities that correspond with the chidlrens interests and offer stimulating materials for individual and group play. Speak to children about insights to better grasp their learning subject.

Promote interactive investigation using organic items like shells, rocks and leaves, complemented by tools for example magnifying glasses. Creating interest by teaching relevant vocabulary for expressing what has been discovered and practicing observation skills.

Malaguzzi's Reggio Emilia method of teaching places a strong emphasis on the idea that children are curiosity-driven and capable of leading an independent education. It sees the environment often referred to as the “third teacher” as a key part of education that is purposefully created to encourage children to explore and work together (Malaguzzi, 1993; Strong-Wilson and Ellis, 2007, cited in Brodie, 2024a).

In addition to encouraging wonder, being outside provides students a sense of freedom and ease in fascinating surroundings. Children who have a connection to nature grow to have empathy for the environment and realise the impact of their activities on the planet. Children can also learn about sustainability personally through this experience (Williams, 2022). Moreover, Tinney (2023) claims that the value of outdoor learning in early childhood education is emphasised in the Wales 2022 Curriculum. By fostering children's innate curiosity and exploration instinct, this method supports their learning and general development in a comprehensive manner.

In conclusion, integrating loose parts into outdoor education improves children's learning chances by promoting curiosity, exploration and hands-on engagement with the natural world. Working with flexible materials encourages children to spontaneously engage in mathematical and scientific concepts through play, which supports both cognitive and emotional development. Practitioners provide an integral part in helping children develop meaningful relationships with the environment by providing support and facilitating unstructured exploration. Practical learning not only helps children understand fundamental concepts better, but also promotes a lifelong appreciation for the natural world and the value of sustainability.

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