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Awe and Wonder: Science, Mathematics and the Outdoors

The Woodland Picture



Using the Outdoors to Promote Children's Scientific and Mathematical Thinking

The Outdoor environment provides a meaningful opportunity for young children to develop their scientific and mathematical understanding. Miracle (2025) states that spending time in the outdoors helps to keep children fit and healthy physically, as it encourages them to jump, run and chase which develops good fitness levels. It also helps them gain advanced motor skills. The photograph depicts a natural outdoor area with trees, muddy ground, wooden seating areas, a raised platform, small patches of plants. Tops day nurseries (n.d) states that this is all important for a child to have as it helps to encourage creativity, which is their emotional development, it also increases their brain activities when playing with mud they use all their senses. This all improves their creativity which is one of the four purposes of the Welsh curriculum, as stated by Cilffriw Primary School (n.d). This type of space reflects the principles of the new curriculum for Wales, which has a big emphasise on the holistic development and cross-curricular learning. It allows children to explore scientific concepts such as forces, materials and life cycles, whilst promoting mathematical thinking through comparing sizes and weights, recognising patterns and shapes, and grouping and sorting natural objects. Studies Weekly (2024) states that it is important for children to learn scientific and mathematical concepts as it helps to develop stronger critical thinking skills, problem solving, creativity and curiosity, all of which are important for their development into adults. This section outlines how the environment in the photograph could be used by children in early years to develop different types of concepts and ideas.

The Value of Outdoor Learning in Early Years

The Curriculum for Wales places a strong emphasis on learning through play and active engagement, according to Play Wales (2022). Outdoor environments support this approach by offering an experience that stimulates the child's curiosity and discovery. The outdoor areas encourage a sense of wonder and mystery that motivates children to explore their curiosity and ask questions, becoming active participants. This aligns with the view of theorists like Froebel who invented the term 'kindergarten'. Froebel was an advocate for the importance of nature in education and emphasised that children need contact with nature to develop holistically, according to Froebel Trust (n.d). Similarly, Vygotsky thought that outdoors play creates a zone of proximal development, stated by hello683850 (2025).

Developing Scientific Thinking through Forces, Balance and Movement

The muddy ground in the photograph presents opportunities for children to explore forces and movement. Rupiper (2017) states that muddy puddles provide children with endless possibilities of fun and learning. Walking or running on different surfaces helps them experience different types of frictions, grips and balances. Rolling objects like small balls down the slopes allows children to observe how forces such as gravity affect speed and direction. This is a useful part of learning as stated by Illinois early Learning Project (2025). By encouraging them to predict what will happen before rolling and then discussing the outcomes, adults can introduce early scientific enquiry skills such as hypothesising, observing and evaluating.

The wooden platform can be used to develop an understanding of forces. Children might jump from it onto the ground and feel the impact on their feet, linking this to ideas about energy and motion. Kashin (2021) suggests that wooden planks and other materials can provide a challenge for children to overcome in a fun, educational way. Balancing on the edges of the platform or logs develops coordination. This type of physical exploration supports both scientific and mathematical thinking because it requires estimation, measuring distances and comparing outcomes.

Exploring Properties of Materials

The environment contains a variety of materials such as wood, gravel and soil. These can be used to develop children's understanding of properties and changes. For example, children can compare wet and dry soil, observing how water changes its texture and weight. They can touch the bark of different trees and describe the texture and predict the trees life cycle. This can be linked to scientific language such as rough, smooth, hard or soft. Kayte-Hartland (2025) adds to this by stating that the understanding of materials can improve the creativity and imagination of a children's thinking.

Gravel paths offer opportunities to discuss mathematical terms, such as size and shape. Children can collect stones, sort them by size or colour and create patterns. They might also compare which stones sink or float when placed in a bucket of water, linking to concepts of density and weight. These types of activities make some scientific ideas concrete and accessible to the learners. They also encourage careful observation and the use of

descriptive vocabulary, which supports language development alongside scientific thinking. Early Years Hub (2025) suggests that this is imperative in the ability and chances of employment and in educational achievements.

Investigating Plant and Animal Life

The presence of trees, small plants and patches of greenery provides opportunities to study living things and life cycles. Children can observe seasonal changes. This helps them understand growth and change over time. They can also look for different insects or small animals in the soil or on tree bark, learning about habitats and the needs of living things. White Rose Education (2025) states that learning about plant lifecycles help them develop a better understanding of their own lifecycle.

Adults can support this by providing equipment like magnifying glasses or simple identification charts to help children name what they find. Estyn (2024) states that adults can help to enable learning in a planned environment to encourage more independent and child lead learning. Linking these activities to the Curriculum for Wales encourages children to develop respect for nature and understand their role in caring for the environment. According to Kids Growing City (2024), when children watch a plant grow or see insects in their natural setting, they become more engaged and develop empathy for living things, they develop a stronger sense of responsibility as they realise that plants need to be looked after and cared for, like pets and people. This experience of awe and wonder underpins scientific learning and fosters a lifelong interest in the natural world.

Mathematical Thinking: Size, Weight, Patterns and Grouping

Mathematical concepts arise naturally in the outdoor environment. Wisbey (2018) states that the natural use of mathematical thinking is part of the outdoors experience. Children can compare the sizes of leaves or sticks they collect, learning to use comparative language such as bigger, smaller, heavier or lighter. They can count how many stones they have collected or measure how far an object rolls down a slope. Sorting and grouping materials by size, colour or shape introduces them to classification and pattern recognition, which are fundamental skills in early mathematics. For example, children might create a line of stones from smallest to largest. They might arrange sticks to form shapes like triangles or squares. These activities support spatial awareness and introduce mathematical vocabulary. Adults

can extend this learning by asking open-ended questions. Doing this encourages children to explain their thinking and develop reasoning skills.

Linking to Curriculum for Wales and Cross-Curricular Learning

The activities described above reflect the principles of the Curriculum for Wales which integrates learning across different areas. Exploring the natural environment supports not just the scientific and mathematical areas but also the literacy, as children describe their findings, and personal and social development as they collaborate with peers. Physical development is also enhanced through climbing, balancing and moving on uneven surfaces.

This holistic approach mirrors the ideas of Bruner. McLeod (2024) states that Bruner emphasised the importance of discovery in learning and the spiral curriculum, where children build on their prior knowledge through repeated and progressively deeper experiences. Vygotsky's concept of the Zone of Proximal Development also applies here, according to McLeod (2024) as adults catalyse children's exploration to extend their understanding. By using sustained shared thinking, adults can ask probing questions and model curiosity, which strengthens both their scientific and mathematical reasoning.

Encouraging Curiosity and Open-Ended Play

The photograph shows an environment that lends itself to open-ended play. Sherwood (2025) states that open-ended play fosters problem-solving and critical thinking skills. There are no fixed toys or prescriptive activities, which means children can direct their own learning. This aligns with the Reggio Emilia approach which values the environment as the "third teacher" and the belief that children can control their own learning, according to Worsley (2023), adults can enhance this by providing loose parts such as buckets, ropes or measuring tapes which children can use to investigate forces, weights and distances. For example, a rope tied to a log could become a way of exploring pulling forces or teamwork. Kable (2025) states that loose parts play can also promote positive social interactions and communication skills in children. Measuring tapes can be used to compare the heights of trees or the lengths of sticks. These activities not only support mathematical and scientific concepts but also creativity and problem solving.

Integrating My Own Experience and Reading

In my own experience, children respond enthusiastically to outdoor learning because it feels different from the classroom. They have more freedom to move and explore, which increases their engagement. Reading around this topic has shown me that outdoor learning is not just about having fun outdoors but also about providing authentic contexts for learning. Research highlights that children who regularly engage in outdoor science and mathematics develop stronger enquiry skills and are more confident in applying their knowledge, as stated by Altuntas (2025).

Holistic Benefits of the Environment

This outdoor space also supports the development of social skills and emotional well-being. Weir (2025) states that exposure to nature reduces stress, improves attention and can boost the overall mood. Working together to collect materials or build patterns fosters cooperation and communication. Observing nature can be calming and can support children's mental health, which is an important consideration in the early years. The Curriculum for Wales emphasises the well-being of learners as a key principle, and outdoor learning contributes significantly to this.

Role of Adults in Supporting Learning

While the focus here is on children's experiences, the role of adults is essential in maximising learning opportunities. Education Endowment Foundation (2023) states that adults should model language, ask open-ended questions, provide resources and ensure safety to push the children into self-lead education.

RISK BENEFIT ASSESSMENT

Location / Activity:	Woodlands	Date:	28/09/25
Assessor:	Jack Benney (2104744)	Review date:	28/03/26

The boxes in the table below will expand as you type into them; pre-entered text is simply for illustration. You should delete irrelevant items and replace with text relevant to your circumstances.

Your overall risk rating – Low, medium or high – is based on your judgement about whether the BENEFITS of the activity or opportunity outweigh the RISKS.

Experience exploring outdoor space in photograph	How will young people BENEFIT from this activity?	Hazards and associated risks	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk after precautions RATING: L/M/H
Walking on uneven ground.	This can benefit children as it helps to improve balance and co-ordination as uneven ground makes the brain and muscles constantly adjust posture and foot placement. It helps to boost confidence as learning how to walk on tricky ground can master as sense of achievement.	The children or adults may fall over resulting in a minor injury causing pain.	Children and Practitioners.	Ensure that the children are wearing appropriate footwear and carry first aid kit in case of emergency.	L

Experience exploring outdoor space in photograph	How will young people BENEFIT from this activity?	Hazards and associated risks	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk after precautions RATING: L/M/H
Wooden decking platform and monkey bars.	The wooden stage promotes imaginative play and social interaction with other children. Gross motor skills are also benefited as climbing and moving across the platform strengthens large muscles. The monkey bars encourage peer support and teamwork. Additionally, cognitive skills when deciding how to cross them and when to swing.	The children or adults may slip on the decking especially if it has been raining. The children may fall off the monkey bars if they are not strong enough to hold their weight.	Children and practitioners.	Ensure the children are wearing shoes with grip on the bottom. A member of staff always manning the monkey bars.	L

Experience exploring outdoor space in photograph	How will young people BENEFIT from this activity?	Hazards and associated risks	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk after precautions RATING: L/M/H
Feeling and playing with soil and water.	Playing with both soil and water provides a sensory input allowing the children to feel and work with different textures. This allows for creativity such as digging, moulding, pouring and building. The calming effect of playing with different materials can have a calming effect reducing stress and anxiety.	As a result of soils texture and colour sharp objects could be hidden within it. Additionally, there is the worry that the children may drown in the water if there are large volumes	Children.	No dangerous objects in the water or soil. Ensure only a small, safe amount of water is of access to the children.	L

Experience exploring outdoor space in photograph	How will young people BENEFIT from this activity?	Hazards and associated risks	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk after precautions RATING: L/M/H
Allowing the children to explore by themselves.	This gives children a sense of independence and freedom, allowing them to learn what they are capable of and cannot do. This means that they can make mistakes on their own and learn how to overcome them.	The children may go into an area where an adult cannot see them such as behind the shed.	Children.	A High-Vis must be always worn to ensure visibility. There must be a 1 to 5 staff ratio of children.	L

Experience exploring outdoor space in photograph	How will young people BENEFIT from this activity?	Hazards and associated risks	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk after precautions RATING: L/M/H
Collecting things.	Fine motor skills are benefited from collecting small things, which strengthens hand muscles and co-ordination. The children may sort the objects once they have been collected promoting cognitive development. Finally, memory and recall are benefited as children remember what interesting items they found.	Children could pick up something sharp or wooden causing them harm	Children.	The caretaker or I will do a sweep of the woodlands beforehand, ensuring no harmful objects like glass or spikes are within the surrounding area.	L

Children exploring things they observe e.g. sticks, rocks flowers and minibeasts.	This allows children to ask questions and be curious about living things. They can investigate animal habitats and life cycles which supports their understanding of the world. Additionally, their fine motor skills and needs met by touching and picking up these things. Furthermore, focusing on details in nature can be calming and reduce stress.	Rocks can be small and seen as a choking hazard if picked up and put in a child's mouth. Some of the branches are eye level to the children and therefore could cause injury. Some plant nettles can also cause pain if touched. Some minibeasts can bite or sting potentially causing harm or an allergic reaction.	Children and practitioners.	List of items and objects that they can touch (Check list or scavenger hunt). Depending on the age of the children, they can be taught about the dangers of touching potentially harmful plants/animals.	L
Varying weather conditions.	Children can explore varying temperatures and develop vocabulary such	If the rainfall is heavy children may get wet if not in an	Children and practitioners.	Check MET Office to see if the weather for the day is of extreme conditions. If so, the children will not be taken out.	L

Experience exploring outdoor space in photograph	How will young people BENEFIT from this activity?	Hazards and associated risks	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk after precautions RATING: L/M/H
	as hot, cold, wet and dry to describe weather. They are also able to use some of their five senses to observe how the textures of woodland features change in different weather.	appropriate outfit, causing them to be uncomfortable. If it is too hot or too cold children can overheat or catch hyperthermic in extreme cases. High winds can cause damage to our building or blow trees over.		I can ensure the children will dress appropriately for the weather. For example, wellies and waterproofs when it is raining. Suncream and hats when it is hot and sunny.	

Experience exploring outdoor space in photograph	How will young people BENEFIT from this activity?	Hazards and associated risks	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk after precautions RATING: L/M/H
Bug pots/ magnifying glasses.	Bug pots allow children to observe patterns, colours and the movement of minibeasts close. Magnifying glasses enable child to see small creatures in detail.	Equipment could break. The bug pots are made from plastic and the magnifier glass both materials that could cause injury.	Children and adults.	Children will be taught to look after the equipment and the intended use of the objects.	L

Adults Supporting Science and Mathematics Outdoors

Outdoor learning has become an integral part of early years practice in the UK, reflecting a widespread recognition that children's ability to learn improves through active engagement with and in nature. Farringtons School (2025) backs this by stating that it helps to improve a child's social and emotional development. 50 things to do (2021) states that being outside does not guarantee learning. This is because a child would benefit most when adults help them. Adults will help the child to focus, name and extend their ideas. This section will evaluate how adults working with early years children can support scientific and mathematical thinking in the outdoor environment. It will discuss concepts such as loose parts play, open-ended and child-led play, sustained shared thinking, observation, curiosity and discovery. It also uses theoretical perspectives from the likes of Piaget and Vygotsky and the Reggio Emilia tradition and considers barriers that may prevent adults from supporting scientific and mathematical learning outdoors effectively.

Adults as mediators of outdoor learning

In outdoor environments, Bilton (N.D) states that adults act as mediators rather than simply supervisors. They observe closely, tune in to children's interests and intervene at moments that can deepen understanding. An example of this is when a child rolls a stone down a slope, the supporting adult might gently ask, "What do you think will happen if we roll it from higher up?". This type of leading question encourages predictions, observations and reasoning about the different forces and gradients, making a scientific concept meaningful. This type of interaction is called Sustained shared thinking. Arnerich (2025) further explains this by stating that sustained shared thinking takes the form of conversation with a child. The adults and children work together intellectually to explore and solve problems. Evidence from early years research shows that this approach strengthens conceptual understanding and language development, including in outdoor contexts, as stated by Early Education (2022). By modelling curiosity and verbalising their own thinking, adults show that scientific and mathematical reasoning are not distant academic skills but ways of making sense of the world. Adults also play an important role in providing vocabulary and conceptual labels that enable children to articulate their ideas.

Loose parts, affordances and open-ended play

The Curiosity Approach (2025) states that materials like buckets, ropes, magnifying glasses, measuring tapes, sticks, stones and fabric are endlessly beneficial. The concept of affordances, as

defined by Ralphs (2024), refers to the possibilities for action offered by a space or object. By adding and arranging loose parts, adults enrich the environment and increase the range of investigations available to children. Simon Nicholson's theory of loose parts has been widely adopted in UK early years practice to promote creativity, problem-solving and mathematical reasoning, as given by Inspiring Scotland (2025). Natural materials such as stones, logs and leaves invite grouping, sorting, measuring, comparing and pattern making, which are fundamental mathematical processes. They also provide opportunities for scientific enquiry through observation, prediction and testing. Importantly, adults should resist scripting how materials are used, as suggested by National Library of Medicine (2025) as it is important for children to use their creative intuition. Their role is to create rich environments and respond to children's initiatives, maintaining autonomy while offering intellectual support. Open-ended and child-led play further strengthens this process. Good2Know Network (2024) states that when children lead, they choose what to test, what to compare and how to play with materials, which builds a sense of self-direction and self-confidence. Adults support by asking thoughtful questions like "How many more stones do you need to match this line?" or by introducing tools such as magnifiers or measuring tapes at the right time. These interventions respect children's autonomy while providing scaffolding that extends their scientific and mathematical thinking.

Theoretical foundations

Several learning theories illuminate the adult role outdoors. Piaget argued that children construct knowledge through interaction with their environment, according to soft surfaces (2025). Outdoor settings, with their varied, concrete materials, align with this approach by enabling children to manipulate objects and witness cause and effect directly. Vygotsky (1978) states that Vygotsky's concept of the Zone of Proximal Development shows that children achieve more with guidance than alone. In outdoor science and mathematics, adults can offer prompts, demonstrations and new vocabulary when needed. Bruner highlighted discovery learning and the spiral curriculum. McLeod (2024) states that discovery learning allows children to explore and experiment, while the spiral curriculum encourages revisiting concepts at deeper levels over time. Adults who plan repeated outdoor encounters like measuring plant growth over weeks, comparing how quickly different objects roll down slopes, observing shadows at different times of day, can help children build a secure and growing understanding. Tovey (2025) states that Froebel emphasised nature as the main orchestrator to the holistic development of children. This is because it can integrate physical, social, emotional and cognitive growth. My Teaching Cupboard (2025) states that Reggio

Emilia believes the environment is the “third teacher”. This means that the adults design the spaces to invite investigation and mathematical thinking rather than relying on pre-set lessons.

Evidence from UK research

Research by GOV (2016) demonstrates that an adult’s influence can turn outdoor potential into learning. Natural England (2016) shows that the Natural Connections Demonstration Project, which involved more than 125 schools, found that when teachers embedded outdoor learning into the curriculum, 92% reported that the children became more engaged. This indicates that adult planning is crucial for converting outdoor time into meaningful scientific and mathematical learning. Evaluations of Forest School programmes, according to O’Brien (2025) also highlight the role of trained adults. Studies show that an adult’s ability to guide reflection and link experiences to concepts enhances outcomes such as confidence, problem-solving and communication. Policy frameworks support this approach. The Early Years Foundation Stage (EYFS) in England stresses the importance of outdoor learning as part of a balanced provision, as stated GOV (N.D). In Wales, the Foundation Phase Outdoor Learning Handbook offers practical strategies for practitioners to plan, observe and extend children’s learning outdoors, as stated by GOV.Wales (N.D).

Challenges and barriers

Learning Through Landscape (N.D) suggests that, despite the strong evidence base, significant barriers remain. Practitioner confidence is a notable challenge. Learning Through Landscape (N.D) continues by stating that research shows that a lack of teacher confidence and training is a key obstacle to outdoor learning. Without sufficient subject knowledge or practical strategies, adults may miss opportunities to orchestrate children’s thinking. Curriculum pressures also marginalise outdoor provision. Where assessment and inspection emphasise measurable indoor outcomes, practitioners may prioritise classroom tasks. Recent research notes by Parliament (2004) states that outdoor learning is often undervalued in inspection cycles. Risk perception and weather are persistent issues in the UK. Guidance from organisations such as Learning Through Landscapes (N.D) advocates a risk–benefit approach. Adults need training and institutional backing to adopt this balanced mindset. Lack of access to outdoor spaces further limits what adults can do. Schools in urban or deprived areas may lack high-quality natural spaces, constraining opportunities for scientific and mathematical learning. National reports show significant variation in access to green space for children across socio-economic contexts, as stated by McKinlay (2025). Finally, there is a

pedagogical tension between child-led exploration and adult intervention. Too much adult direction risks turning outdoor play into a rigid lesson. However, too little would risk causing a missed learning experience. According to National Library of Medicine (2013), the most effective adult practice is responsive, combining sensitive observation with well-timed prompts.

Strengthening adult practice

Addressing these barriers requires deliberate action. Professional development focused on outdoor science and mathematics builds practitioners' confidence and subject knowledge. Integrating outdoor learning into curriculum planning ensures that science and mathematics are not seen as optional. A risk–benefit approach allows adults to manage safety while preserving challenge. Curating rich environments with loose parts and open-ended provocations increases the likelihood that children will encounter mathematical and scientific affordances naturally. Family and community engagement can extend learning beyond the original setting. These strategies reflect the best practices and ideas from Forest School and Reggio-inspired approaches, where adult facilitation is seen as a catalyst rather than a constraint, as stated by Forest School (N.D). Applying theories in practice is not always straightforward. For example, Piaget discovered that learning may lead some practitioners to believe that adults should stand back entirely, according to Gowrie (2025). However, research by Taking Learning Seriously (2025) suggests that without guidance children may miss key ideas or develop misconceptions, thus it is important for practitioners to revisit their misconceptions and help them better their understanding. Vygotsky's theory, as given by McLeod (2025), reminds practitioners that learning is social. Outdoor environments often provide rich social contexts, like when children build a den together or compare who has collected more leaves, but adults must help articulate mathematical and scientific thinking. Similarly, Bruner's spiral curriculum, which Structural learning (2022) describes as the form of encouraging the idea of revisiting topics and key concepts, requires planning. Repeated visits to the same outdoor area with slightly different tasks, like measuring shadows at different times of day, allow children to build on their prior knowledge. Froebel's emphasis on nature supports holistic development but can be misunderstood as simply "being outside.". Reggio Emilia's idea of the environment as a third teacher also calls for adults to intentionally design the outdoor spaces. This shows that the adult's role of facilitating the outdoors is an active, ongoing process. It highlights the importance of balancing the risk and safety, naturality and planning, individuality and co-operation. Practitioners who can find the right balance can make decisions that support children's learning while maintaining the joy and authenticity of outdoor exploration,

which is the key as suggested by The Woods Academy (2025) as it improves a child's creativity, resilience and problem-solving skills.

To conclude, adults are vital in turning outdoor spaces into a place where children can develop strong scientific and mathematical thinking. UK evidence, combined with educational Theory show that when adults observe, orchestrate, question and model curiosity, children can develop a deeper understanding and improved engagement. Overcoming barriers such as teacher confidence and risk versus reward allows outdoor learning to fulfil its potential and helps children to experience both the awe and wonder of the outdoors with the added learning outcomes in their scientific and mathematical skills

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