

Awe and Wonder – Science, Mathematics and the Outdoors

ECEY5005

Amy Cox (2412700)

Contents sheet

AI Cover Sheet

Section 1: Photograph of an outdoor environment

Section 2: Discussion for developing science and maths concepts through woodland learning (Word count: 1421)

Section 3: Risk-benefit assessment (Word count: 1971)

Section 4: Evaluation of how adults support children's scientific and mathematical thinking outdoors (Word count: 1983)

Reference list

AI Acknowledgement

I acknowledge the use of Grammarly (<https://www.grammarly.com/>) on multiple dates throughout the assignment to check my work using the prompts:

1. Check the text for readability, grammar, and syntax.

I acknowledge the use of Microsoft Copilot (<https://www.microsoftcopilot.com/>) on multiple dates throughout the assignment to help find and summarise relevant journal articles, using prompts such as:

1. Find me academic journal articles dated within the past 10 years on outdoor STEM in the early years.
2. Summarise the article into an easy-to-read format.

I confirm that I have not presented any AI generated text as my own work. I confirm I have copies of my drafts, notes and other resources I used before, and after the use of AI tools which I may be asked to provide as evidence.

Section 1: Photograph of outdoor environment

Figure 1: Woodland area (Personal collection, 2025).

Section 2: Discussion for developing science and maths concepts through woodland learning.

Introduction

Many outdoor environments offer rich and authentic opportunities for young children to explore foundational scientific and mathematical concepts through sensory exploration and engagement, physical activity and inquiry-led play. In the woodland setting illustrated in section one, twenty children between the ages of four and seven, accompanied by two practitioners, engaged in learning that is social, physical, and deeply connected to their well-being. In such natural settings, the learning becomes profoundly experiential, allowing children to interact with materials, phenomena and living things in ways that are not only developmentally appropriate but also meaningful.

This discussion emphasises a focus on three key concepts of learning that the woodland environment affords: pattern and sorting, measurement and comparison and living things and habitats. Each concept is explored through practical, inquiry-led activities that reflect the principles of the Curriculum for Wales (CfW) (Welsh Government, 2022a), and are immersed within holistic, cross-curricular practice. These experiences also naturally integrate other Areas of Learning and Experience (AoLE), including language, literacy and communication, health and wellbeing and expressive arts. By embedding mathematical and scientific thinking into outdoor play and exploration, practitioners can foster the development of ambitious, capable learners who are also healthy, confident individuals, thus aligning with the Four Purposes and the ethos of authentic, child-centred education.

Pattern and Sorting

Children explored the natural environment with eagerness, collecting leaves, sticks and stones. They were encouraged to sort their collections by observable attributes- colour, size and shape. Engagement varied: some sorted directly onto the ground, while others used buckets first. Both approaches were supported by the practitioner.

This inquiry-led activity aligns with the CfW, Mathematics and Numeracy AoLE, which emphasises reasoning, problem-solving and classification using multiple criteria (Welsh Government, 2022b). Sorting objects by shape, size and colour

fosters logical reasoning. For instance, a stick may resemble another in shape but better match the size category due to its similarity to a leaf or stone.

Children justified their choices:

Child one: “This stick is a very skinny shape. I am putting it in this pile with all the other skinny sticks.”

Child two: “But it is the same length as this big leaf and should go in that pile.”

Following this exchange, children placed items into their chosen pile (see Figure 2).



Figure 2: Piles of sorted natural materials (A little learning for two, 2022).

These conversations, which use comparative language such as, same, different, bigger and smaller, support early data handling and statistical thinking.

This aligns with the progression steps in Mathematics and Numeracy AoLE, where learners develop comparative language and statistical awareness through play (Welsh Government, 2022c).

Later, children explored pattern creation with sticks and stones, taking turns and forming sequences. Each turn deepened their understanding, anticipating whether stone or stick would come next. Such experiences help children spot relationships, make predictions and transfer pattern knowledge to domains such as music and daily routines. This supports pattern recognition and prediction as outlined in the Science and Technology AoLE, fostering transferable skills (Welsh Government, 2022d).

The woodland setting offered abundant opportunities for pattern-making, enhancing mathematical fluency, flexible thinking, problem-solving and creativity, key traits of ambitious, capable learners (Welsh Government, 2022e).

Collecting, sorting and pattern-making also support emotional regulation and mindfulness. The repetitive, tactile nature of the tasks encourages children's focus and deep engagement. Working in pairs or small groups fosters cooperation, turn-taking and decision-making. Children took pride in their creations, inviting peers to "come and see what we did," reinforcing self-esteem and belonging. These outcomes reflect the Health and Well-being AoLE, which promotes emotional literacy, self-regulation and positive relationships through experiential learning (Welsh Government, 2022f).

Measurement and Comparison

The fire pit area of the woodland environment is ideal for measurements and comparisons, supporting mathematical development as outlined in the CfW (Welsh Government, 2022g). Children observed the fire pit inquiringly, saying, "I wonder if I am as long as that log!" The practitioner scaffolded this by suggesting they lie down beside the log and compare lengths. The children responded eagerly, taking turns to see who was longer. Older children expressed glee when they were bigger; younger ones groaned when they did not reach the end.

This inquiry-led activity, using only what the environment affords and their bodies, reflects experiential learning and child-led inquiry central to the CfW (Welsh Government, 2022h), particularly within the Mathematics and Numeracy AoLE. Descriptive language such as, next to, first, and last, supported by spatial awareness, while phrases like "I am longer" or "I am shorter" reinforced quantitative learning and estimation.

While lying beside the logs, children noticed the ones outside felt wet compared to those in the den. They observed colour differences and found wet logs heavier. These reflections support scientific thinking and align with the Science and Technology AoLE, where observation, questioning and explanation are key components of progression (Welsh Government, 2022i). Questions such as "Why is this log darker?" allow practitioners to explain material properties, transformation and why wet logs change in colour and weight.

Afterwards, children walked and balanced along the fire pit logs (see Figure 3). This physical play promotes gross motor development, coordination and confidence, supporting health and well-being in line with CfW (Welsh Government, 2022j).



Figure 3: Fire pit logs used for balancing (Personal Collection, 2025).

The uneven surface and natural instability of the logs offered a meaningful challenge, prompting children to assess their own risk, adjust movements and persevere. They experienced cause and effect; when a log shifted, they learned to reposition or risk falling.

Practitioners scaffolded these moments with open-ended questions like “What do you think will happen if you step on there?” and “Why do you think the log moved?,” encouraging critical thinking and reflection. This approach supports both physical and cognitive development, further aligning with the Four Purposes of the CfW (Welsh Government, 2022k), which aim to develop healthy, confident individuals and ambitious, capable learners.

Living Things and Habitats

Through direct engagement with the natural environment, children begin to develop foundational ecological awareness and scientific understanding (Welsh Government, 2022l). Their encounters with living organisms in a woodland setting are often spontaneous yet deeply engaging.

Referring back to Figure 1, this environment is exemplary for prompting inquiry into what is living, what is not, and why particular creatures and mini beasts inhabit specific areas. Such investigations frequently involve lifting or sifting through leaf litter, as illustrated in Figure 4, eliciting questions and



Figure 4: Dry leaves, sticks and stones (Greyling, n.d.)

metacognitive dialogue, such as “why is it hiding?” or “why does it live here, I wonder?”. These inquiries provide opportunities for practitioners to pose open-ended questions such as “Why do you think the insect chooses to live there?”, thereby further supporting the child's metacognitive development (Welsh Government, 2022m).

The scientific learning that is offered in this context is both experiential and dialogic, aligning with the Science and Technology AoLE which encourages inquiry-based exploration of living things (Welsh Government, 2022n). For instance, a child was observed lifting a log and discovering beetles hiding under the bark. This encounter led to discussions about shelter and food sources, which in turn led to further inquiries. It is this kind of curiosity that forms the basis of their early biological thinking, enabling children to distinguish between living and non-living things and begin to understand how our ecosystems work.

Mathematical thinking was also embedded throughout this exploration. The children were encouraged to count sightings for three different mini-beats: worm, spider and ant. For each ant observed, they added a stone to the bucket, a leaf represented a spider, and a stick signified a worm. These natural items were sorted into piles to determine which creature they saw most frequently. Such explorations support their handling and classification skills within a meaningful and context-rich environment, thereby contributing to progression in the Mathematics and Numeracy AoLE (Welsh Government, 2022o).

Going beyond cognitive development, woodland environments that facilitate encounters with living things also nurture emotional growth and well-being. Children often demonstrate empathy and care when gently handling the insects, expressing concern for their safety and relocating them safely. These responses reflect a growing sense of responsibility and ethical awareness. This is particularly aligned to the progression statement “I can show care and concern for living things,” as outlined in CfW Health and Well-being Guidance (Welsh Government, 2022p).

In summary, the woodland environment serves not only as a backdrop for play but as a dynamic, pedagogically rich space where scientific and mathematical thinking emerge organically through child-led exploration. By grounding learning in real-world, multisensory experiences, practitioners can nurture curiosity, resilience and reflective

thinking, qualities that form the basis for holistic development. This approach reinforces the CfWs' commitment to integrated, purposeful learning and highlights the potential of outdoor education in nurturing lifelong learners who think critically, act ethically and engage meaningfully in the world around them.

Section 3: Risk-benefit assessment

Name of activity:	Exploring woodland materials
Description of activity	Children explore the woodland environment by collecting small sticks, twigs and materials for use in inquiry and play-based learning.
Appropriate for which ages and abilities	• Ages 3-7. • EYFS, Foundation phase and Key stage 1. • Adaptable for mixed ability groups.
Equipment or resources needed.	• Natural materials. • Optional gloves. • Buckets and baskets for collection.
Any special adaptations for different needs	• Visual prompts and adult modelling for safe handling. • Buddy system for children with mobility or sensory needs. • Gloves for children with tactile sensitivity or skin conditions. • Social stories to prepare children with anxiety or ASD. • Emotion check-ins or a visual feelings chart to support emotional regulation before and after.

	• Sensory breaks or quiet zones identified within the woodland for children who may become overwhelmed. • Pre-identified accessible routes or flat terrain options for children with mobility aids. • Raised collection trays or adapted buckets for children unable to bend or reach ground level.
Benefits e.g. Soft/Hard outcomes, Early learning outcomes, Key stage outcomes	Soft outcomes: • builds independence, responsibility and hazard awareness. • Enhances fine motor skills and spatial awareness. • Promotes hygiene awareness and critical thinking. • Encourages creativity and environmental respect. Hard outcomes: • EYFS: physical development, understanding the world. • CfW: progressions steps in health, wellbeing, science, and technology. • Supports four purposes.
Overall risk (refer to separate risk assessment)	• Medium
Other comments	All children will have the opportunity to use the toilet before leaving.

	• At least one staff member who attends will need to hold relevant Paediatric first aid training. • EpiPens to be carried by first aider. • Transport arrangements to and from the woodland will be confirmed in advance, with appropriate child-to-adult ratios maintained during transit. • A register will be taken before departure and upon arrival. • Emergency contact details and medical information will be carried securely by the lead practitioner. • Hand washing facilities or hand sanitiser will be available after material collection. • Spare clothing and wipes will be carried for children who may get wet or muddy. • Mobile phones will be carried by staff for emergency communication. • A contingency plan is in place for adverse weather or unexpected site closure.
--	--

likelihood	x	severity	risk level and acceptability		
			Low - L	Medium - M	High - H
1-5	x	1-5	1-5 acceptable risk level	5-12 acceptable with precautions	12+ unacceptable risk level - find ways to reduce risk.

Activity	Hazard	Risk	Likelihood X Severity	Benefit	Action to remove or reduce risk	Who?	When?	Risk Level (when actions observed)
Collecting small sticks and natural materials	- Children carrying sticks and twigs. - Sticks may be pointed, sharp or	- Trips or slips while carrying sticks. - Eye Injuries if sticks are	2 x 2	- Builds independence, responsibility and fine motor skills. - Enhances balance and spatial awareness	- Teach and remind children to carry sticks pointing downwards.	- Children and Practitioner	- Start and during collection.	Low

	awkward to hold. - Contaminated materials from animal droppings or Mold. - Hidden debris (glass, metal, sharp objects).	carried upright. - Small scratches or splinters - Illness. - Cuts or infection.		- Encourages creativity when using natural materials in play. - Promotes hygiene awareness and critical thinking. - Builds hazard awareness and responsibility	- Only collect sticks they can lift and carry safely. - Provide clear rules (no running). - Clear path, supervise movement, check footwear. - Adult to monitor and check sticks for safety. - Visual checks, hygiene reminders, avoid			
--	---	--	--	--	---	--	--	--

					suspicious items. - Site sweep beforehand, continuous visual checks.			
Building small dens or shelters	- Branches, sticks or logs stacked into dens may be unstable. - Children may climb onto dens. - Sharp edges on sticks or tools - Trips due to uneven ground.	- Den collapse causing bumps or scratches. - Fingers pinched between sticks or logs. - Branches, logs or sticks falling on child.	3 x 3	- Children develop creativity, engineering skills and resilience through trial and error. Encourages teamwork, problem-solving and imaginative play. - Develops fine motor skills.	- Children work in groups with adult guidance. - Use lighter branches only. - Practitioner to check den stability before play. - Clear rules (no climbing on den).	- Children - Practitioner	-before and during.	Medium

		- Cuts or splinters - Falls or minor injuries.		- Enhances coordination and hazards awareness.	- Pre-check materials, offer gloves and tool safety briefing. - Clear ground and supervise movement.			
Climbing on low trees, stumps and fallen logs	- Low level climbing on logs or branches. - Unstable logs or branches. - Overcrowding on	- Small falls causing bruises or grazes. - Scratches from bark. - Sprains or breaks from falls.	3 x 3	- Develops gross motor skills, strength, balance and coordination. - Supports safe risk-taking and judgment skills. - Fosters turn taking and social negotiations.	- Limit climbing to lower height. - Practitioner to check logs and branches first for stability. - Ensure clear ground	- Practitioner	- Before climbing and play commences.	Medium

	climbing structures.	- Collisions and falls			underneath climbing area. - Limit group size, encourage communications and cooperation.			
Carrying and rolling small logs for seating and/or play.	- Children lifting or rolling logs that may be heavy or too big for them. - Logs rolling unpredictably. - Splintered, rough logs.	- Log dropped on toes or fingers. - Back strain from poor lifting. - Trips if logs left scattered. - Impact injuries.	3 x 3	- Encourages teamwork, strength and awareness of safe movement. - Provides opportunities for imaginative play and building. - Enhances spatial awareness and risk assessment.	- Use small, manageable logs only. - Teach children to roll instead of lift where possible. - Always carry logs with two hands.	- Children - Practitioner	- At the start and during the activity.	Medium

		- Cuts, scrapes		- Develops tactile awareness and safe handling skills.	- Stack logs neatly after use. - Supervise rolling, use controlled areas. - Inspect logs beforehand, teach safe grip, offer gloves.			
Using sticks in imaginative play.	- Children pretending sticks are wands, fishing rods or tools. - Unsafe play may occur.	- Eye injuries from waving sticks. - Cuts and bruises from contact with sticks.	3 x 2	- Sparks creativity, imagination and role play. - Develops social skills and cooperation. - Encourages physical	- Set clear rules: no sword fighting, no running with sticks, keep sticks below	- Children. - Practitioner .	- Before and during play.	Medium

	- Using large or heavy sticks. - Conflict during play.	- Trips when running with sticks. - Dropped sticks causing an injury. - Emotional distress, unsafe behaviour.		engagement and decision making. - Supports social development and negotiation skills	shoulder height. - Encourage creative uses like fishing rods, wands or drawing tools for soil. - Encourage manageable size sticks and model safe selection. - Adult facilitation, encourage cooperation.			
--	---	---	--	---	---	--	--	--

Exploring woodland trails and paths.	- Uneven ground. - Protruding tree roots. - Mud. - Slippery leaves. - Getting lost or separated. - Sudden weather changes. - Insect bites or stings.	- Trips or slips on wet or uneven ground, leading to grazes, bruises and twisted ankles. - Collisions if running. - Emotional distress and safety risk. - Cold, wet and discomfort. - Mild allergic reactions.	3 x 2	- Builds curiosity, independence and observation skills. - Encourages physical confidence and stamina. - Builds independence and trust in boundaries. - Teaches preparedness and resilience. - Encourages curiosity and respect for nature.	- Encourage appropriate footwear. - Walk slowly and carefully. - Practitioner to highlight slippery or tricky areas. - Children reminded to watch their step. - Use buddy system, clear boundaries, high visibility clothing. - Check forecast, bring	- Practitioner . - Children.	- At the start and during exploration.	Medium
--------------------------------------	--	--	-------------	---	--	---	--	--------

					layers and waterproofs. - First aid kit, avoid disturbing nests and educate.			
Sitting safely around firepit.	- Fire with open flames or hot embers. - Children not aware of safe distance. - Smoke inhalation.	- Minor burns if too close to fire. - Clothing singes by sparks or embers. - Falls or trips into fire if rules not followed. - Coughing.	2 x 3	- Teaches respect for fire, patience and listening skills. - Builds group community. - Enables calm focus. - Promotes sensory awareness and understanding of natural elements.	- Establish clear fire zone with safe seating spots. - Children only enter/exit when invited. - No running near fire. - Long hair tied back. - Loose clothing i.e.	- Practitioner .	- Before and during fire time activity.	Medium

					scarfs, secured properly. - Monitor smoke direction and allow movement.			
Cooking simple foods over fire: toasting marshmallows.	- Hot sticks that are used as skewers. - Hot food. - Children eager to taste/eat too soon. - Direct contact with flames or embers.	- Burns from hot sticks or pans. - Scalds from hot food. - Smoke causing coughing. - Burns or singeing.	2 x 4	- Cooking boots independence, confidence and enjoyment. - Provides sensory experiences and life skills. - Teaches respect for boundaries and fire safety. - Develops spatial awareness.	- Adults supervise 1:1 when cooking. - use long sticks/skewer s. - Remind children to blow on food before eating.	- Practitioner . - Assisting practitioner.	- During cooking.	Medium

	- Tripping into firepit. - Overcrowding or pushing.	- Serious burns and injuries. - Falls, emotional distress.		- Fosters cooperation and group awareness.	- Practitioner handles hot pans. - Water bucket kept close. - Children with asthma to be monitored closely and removed from activity if necessary. - Establish a clear fire circle with seating boundaries. - Use fire gloves. - Teach a fire respect			
--	--	---	--	--	--	--	--	--

					position; one knee down. - Limit group size, assign seating spots, reinforce calm behaviour.			
Weather exposure during woodland session	- Cold, wet, windy or very hot weather conditions. - Children may underdress or overdressed.	- Hypothermia if wet or cold for prolonged periods. - Sunburn in hot weather. - Dehydration without adequate water. - Wind chill causing discomfort.	3 x 1	- Outdoor exposure teaches resilience, adaptability and preparation skills. - Children learn to dress appropriately	- Ensure waterproofs, warm layers, hats and sunscreen as appropriate. - Carry spare kit. - Provide drinking water. - Shorten sessions if weather is extreme.	- Practitioner - Children	- Start and throughout session.	Low

- Interacting with the natural environment while Investigating plants, insects and mini beats.	- Insects (bees, wasps, ants, ticks). - Stinging plants (nettles, brambles, thistles). - Poisonous plants or fungi (foxglove, mushrooms). - Hidden debris such as glass, wire, rope, litter. - Overturning logs or stones. - Fear or distress from unexpected encounters with bugs, spiders.	- Insect stings causing swelling, allergic reaction or distress. - Scratches and stings from plants causing discomfort. - Ingestion of poisonous plants or fungi leading to illness. - Cuts or puncture wounds from hidden sharp objects. - Falls or trips from hidden debris such as wire or rope. - Finger injuries and disruption of habitats.	3 x 3	- Spending time in woodland builds resilience, adaptability and nature awareness. - Children develop respect for the environment. - build knowledge, curiosity and care for living things. - Supports science learning through exploration. - Teaches careful observation and respect for habitats and ecosystem. - Builds emotional resilience and curiosity.	- Check site for hazardous plants, fungi and litter before session. - Teach and remind children not to pick or eat plants. - Carry first aid kit and check for known allergies. - Practitioners to carry insect sting relief and prescribed EpiPens for children with known allergies. - Teach children gentle handling of bugs and mini beats. - Wash hands afterwards.	- Practitioner - Children	- Start and ongoing through the session	Medium
--	---	--	----------------------	---	---	--	---	---------------

		- Emotional upset			- Model safe lifting techniques, replace items gently. - Prepare children with calm explanations, allow space to opt out.			
--	--	---	--	--	---	--	--	--

Section 4: Evaluation of how adults support children's scientific and mathematical thinking outdoors

The outdoor environment offers a uniquely rich context for early years children to engage with mathematical and scientific concepts in ways that are embodied, exploratory and deeply connected to their lived experiences (Way *et al.*, 2023; Keith, 2017; Stronger Practice Hub, 2024). Within this space, the role of the adult is not peripheral but central; shifting fluidly between facilitator, co-learner and provocateur, those who deliberately provoke thinking and pose challenging questions to deepen children's engagement through intentional interactions. Their presence shapes both the quality and depth of learning.

Drawing on a range of theoretical perspectives, including Froebel's emphasis on nature and play (Froebel, 1887), Vygotsky's sociocultural theory and zone of proximal development (Vygotsky, 1978), Gibson's affordance theory (Gibson, 1979) and Nicholson's theory of loose parts (Nicholson, 1971), alongside recent research literature and policy frameworks such as the Curriculum for Wales 2022 (Welsh Government, 2022), this essay aims to critically evaluate how adults support and encourage children's mathematical and scientific learning outdoors.

When considering the adults' role in outdoor learning environments, it is evident that their role is heavily influenced by Froebel's and Vygotsky's theoretical perspectives. Froebel (1887) championed nature as a foundational context of early education, viewing the adult not as a distant overseer but as a "gardener of children" who nurtures curiosity through play and sensory engagement, rather than direct instruction. He believed that children should experience nature 'in all aspects - form, energy, substance, sound and colour' (Froebel quoted in Lilley, 1967), a view that is echoed by the Froebel Trust (2022), which emphasises that outdoor play helps aid children's understanding of interconnectedness, sustainability and environmental responsibility. Thus, giving children opportunities for meaningful learning that spans all areas of the curriculum (Tovey, 2020). When children are engaged with natural materials such as sorting leaves or observing and measuring shadows, they are not just playing; they are exploring mathematical patterns and scientific phenomena (Reynolds, 2018; Trina *et al.*, 2025).

Extending Froebel's ideas into embodied learning, Froebel's emphasis on hands-on, sensory-rich experiences supports embodied cognition, where the child's learning is anchored in movement, touch and real-world interactions and adults in this context are not merely passive observers but intentional co-participants, who shape the learning environment and respond to children's inquiries with purpose (Brown, 2025; Tovey, 2022). Recent research by Mackinder (2023) supports this view, highlighting how adults in Forest School settings co-construct learning experiences through sensory-rich, nature-based interactions. Her constructivist analysis shed light on adult behaviours and revealed that whether the adult scaffolds or co-participates, they significantly shape the depth and direction of children's outdoor learning.

However, while Froebel asks practitioners to observe and gently guide children's self-directed explorations, Vygotsky's sociocultural theory (1978) advocates for more direct involvement, believing that practitioners should join a child's play, ask probing questions and help guide the child to think more deeply. His concept of the Zone of Proximal Development (ZPD) positions the adult as the 'more knowledgeable other', who scaffolds the child, enabling them to move beyond their current abilities through intentional, collaborative dialogue and shared inquiry (Kurt, 2020). These adult roles closely align with the Curriculum for Wales (CfW) (2022), which emphasises the importance of developing ambitious, capable learners who can think critically and solve problems. Outdoor STEM experiences, when supported by intentional adult interaction, contribute directly to this vision. Supporting this policy-practice link, Kennedy and Tunncliffe (2022) argue that play-based STEM experiences in the early years are most effective when adults actively support inquiry through open-ended questioning and modelling. Their international review highlights the adults' role in bridging playful exploration with structured scientific thinking. In an outdoor context, this means that adults do not simply observe children's play but instead they actively participate, posing open-ended questions, encouraging prediction, and co-investigating phenomena such as shadows. For example, when a child has piled stones high, the adult might ask, "What would happen if you gently pushed the bottom stone?" Questions like this prompt the child to explore scientific concepts such as cause and effect.

Further reinforcing this approach, Hunter *et al.* (2020) note that adult engagement in outdoor classrooms is pivotal in balancing child-led exploration with structured

inquiry, particularly in STEM-rich environments. Similarly, when a child has built stones into a high tower, adults can introduce concepts of counting, balance and measuring. This is highlighted within the Early Years Foundation Stage guidance, which suggests the quality of adult interaction in the outdoors has a profound impact on children's learning, particularly within the STEM domains (Department for Education, 2023). It is these interactions between the child and adult that ensure the learning is not only supported but extended, as children are guided to make connections, assess ideas and reflect on outcomes within meaningful, embodied experiences (Howard *et al.* 2024; Dobrich, 2025). The adults, therefore, become a facilitator, bridging spontaneous exploration with structured cognitive development in ways that are both relational and intentional (Siraj, 2025a).

Building on Froebel's view as a nurturing co-participant and Vygotsky's emphasis on intentional scaffolding within the ZPD, contemporary theories such as Gibson's Affordance Theory (1979) and Nicholson's Loose Parts Theory (1971) offer further insight into how adults can support science and mathematics in outdoor environments. Gibson's ecological perspectives suggest that children perceive opportunities for action, or affordances, directly through interaction with their environment. Ramsden *et al.* (2025) found that natural features such as logs, slopes and water afford diverse types of play and inquiry, all dependent on the child's developmental readiness and intent. Importantly, these affordances become particularly powerful when adults recognise and extend them through subtle interventions, such as introducing measuring tools. As pointed out in Section two, this could be the child's own body or posing reflective questions such as "why do you think that happened?" a form of metacognitive talk that supports conceptual transfer (Howard *et al.*, 2024; Siraj, 2025b). Yet, despite growing recognition of the value of outdoor environments for early STEM learning, there is still a notable absence of validated assessment tools capable of capturing their pedagogical affordances and quality (Trina *et al.* 2025).

Nicholson's Loose Parts Theory complements this by highlighting the cognitive richness of open-ended materials. Clanfield (2025) and Creative STAR Learning (2024) emphasise that loose parts such as sticks, stones, shadows and recycled items enable children to manipulate variables, test hypotheses and construct meaning through self-directed exploration. In terms of STEM in the outdoor context,

these 'everyday' materials become tools for embodied cognition, where children can explore balance, volume, pattern and prediction through physical engagement. For instance, when a child pours water between containers, the adult may introduce vocabulary such as volume or capacity, linking directly to CfW progression steps and EYFS learning goals in mathematics and understanding the world. According to Trina *et al.* (2024), whose scoping review found that nature-based outdoor environments significantly enhance preschoolers' STEAM concept formation, particularly when adults play an active role in shaping the learning landscape.

Fanella *et al.* (2025) and Catro-Alonso *et al.* (2024) both support this, outlining that embodied cognition enhances instruction. Showing that learning is boosted when the brain, body and environment act together, particularly through manipulation of objects and the observation of the child's movements. The adult's role, therefore, is not fixed but fluid, oscillating between Froebelian observation and Vygotskian scaffolding. Hunter *et al.* (2020) observed that practitioners in outdoor classrooms shift between passive observation and active facilitation depending on the child's needs, highlighting the importance of adult responsiveness and intentionality in extending inquiry.

To further deepen this perspective, Thomas and Boulton (2022) and Louis (2018) argue that loose parts and affordances in the outdoor environments actively nurture schematic development, which underpins the early mathematical and scientific thinking. Their study found that children's self-directed engagement with natural materials, such as arranging stones in sequences or testing the stability of stick structures, revealed emergent schemas like trajectory, rotation, and transformation, all of which are foundational to STEM concepts. As a result, adults who understand these schemas can scaffold learning by offering provocations that align with children's current interests, such as introducing balance scales or posing "what if" questions to extend inquiry. Moreover, mapping these schemas to the curriculum, such as trajectory links to force and symmetry links to geometry, allows adults to scaffold learning with intentionality. Cankya *et al.* (2024) also highlight the importance of time, space and relationships in loose parts play, noting that adult sensitivity to these factors enhances children's capacity to experiment and reflect. Thus, the adults' support in outdoor STEM learning is not about directing outcomes

but about curating environments rich in affordances and materials and responding with intentionality to children's evolving investigations.

However, while the theoretical and pedagogical foundations for adults' roles in outdoor STEM learning are robust, there are several barriers and challenges exist that can hinder their effective implementation. Firstly, many educators report that rigid curriculum structures and assessment-driven priorities leave little time for outdoor, inquiry-based learning. For example, The OTTER Project (Rusitoru, 2023) conducted a cross-European analysis and found that in several European contexts, outdoor learning is perceived as a "waste of curricular time", especially when STEM outcomes are not explicitly mapped. This perception stems from a lack of alignment between national curriculum frameworks and outdoor pedagogies, resulting in outdoor STEM being undervalued or marginalised (Pitiortanpin *et al.*, 2025; Holmes *et al.*, 2021).

Secondly, Azevedo *et al.* (2025) argue that despite growing recognition of the benefits of outdoor learning, bureaucratic constraints and institutional inertia often prevent its integration into mainstream practice. Their study, published in the Journal of Adventure Education and Outdoor Learning, found that educators face significant challenges in securing time, resources and even administrative support for outdoor STEM activities, especially when these are not directly tied to measurable outcomes or standardised assessments. Furthermore, Correia *et al.* (2024) noted that even when teachers value outdoor STEM learning, institutional access to natural spaces often restricts their ability to implement it. Their study found that outdoor environments were underutilised, particularly in upper primary settings, due to curriculum pressures and accountability demands.

Thirdly, Leung (2023) highlights that many practitioners lack confidence and training in outdoor STEM facilitation. As a result, without a strong grounding in theories such as Gibson's affordances or Vygotsky's ZPD, educators may default to passive supervision rather than intentional scaffolding, thus limiting the depth of children's inquiry. This is compounded by limited opportunities for professional development in outdoor STEM, particularly in early years settings. This concern is reinforced by Nikolopoulou and Tsimperidis (2023) who noted that while teachers value STEM

learning, many feel underprepared to deliver it effectively in outdoor contexts due to gaps in pedagogical knowledge and institutional support.

These challenges become even more pronounced when supporting children with additional learning needs, English as an Additional Language (EAL) or sensory processing differences. Without targeted training and inclusive planning, outdoor STEM risks becoming inaccessible to those who benefit the most from embodied, sensory-rich learning. Kelly, Welan and Coulter (2025) argue that inclusive outdoor pedagogy requires not only practitioner awareness but also structural flexibility and policy clarity to ensure equitable access and meaningful participation for all children. In addition, Styliandidou *et al.* (2028) and Tunnicliffe and Kennedy (2022) both highlight that despite growing international recognition of outdoor STEM's developmental value, policy ambiguity and inconsistent curricular integration continue to marginalise inclusive practice. Consequently, without clear structural support, educators struggle to embed inquiry-rich and play-based STEM into everyday teaching, particularly for those children with additional needs or EAL.

In summary, within an outdoor environment, the adult's role is pivotal, not merely as a supervisor, but as a responsive co-participant who scaffolds inquiry, provokes thinking and extends further learning through intentional interactions. Grounded in Froebel's vision of nature and play, Vygotsky's sociocultural scaffolding, Gibson's affordance theory and Nicholsons' loose parts framework, this essay has shown that adult engagement in outdoor learning is both theoretically robust and essential. When enacted effectively, adults who recognise and respond to the affordances of natural materials and children's spontaneous inquiries transform outdoor play into powerful opportunities for conceptual development, thus bridging exploration with structured learning in ways that are relational and deeply meaningful.

Reference list

Azevedo, N.H., O'Neill, D., Kelly, R., McCormack, O., Järvinen-Taubert, J. and Valtonen, P. (2025) 'Redefining learning spaces: A pedagogical approach to sustainability education outside the classroom', *Journal of Adventure Education and Outdoor Learning*, 25(3), pp.210-228. Available at:

<https://doi.org/10.1080/14729679.2025.2542841> (Accessed: 20 September 2025).

Brown, E. (2025) *How to teach STEM outdoors. Learning through Landscapes*. Available at: <https://ltl.org.uk/news/stem-outdoors-how-to-teach/> (Accessed: 17 September 2025).

Cankaya, O., Leach, J. and Akdemir, K. (2024) 'The Journey of Loose Parts across Educational Landscapes and History: The Role of Materials, Relationships, Space, and Time in Children's Loose Parts Play', *American Journal of Play*, 16(2-3), pp.210-245. Available at: <https://www.museumofplay.org/app/uploads/2024/11/AJP-16-2-3-Article-3-Loose-Parts.pdf> (Accessed: 20 September 2025).

Castro-Alonso, J.C., Ayres, P., Zhang, S., de Koning, B.B. and Paas, F. (2024). 'Research Avenues Supporting Embodied Cognition in Learning and Instruction', *Educational Psychology Review*, 36(10). Available at: <https://link.springer.com/article/10.1007/s10648-024-09847-4> (Accessed: 17 September 2025).

Clanfield, J. (2025). *Loose Parts Play: A Quick Guide for Teachers. Teach Outdoors*. Available at: <https://www.teachoutdoors.co.uk/loose-parts-play-a-quick-guide-for-teachers/> (Accessed: 17 September 2025).

Correia, M., Ribeirinha, T., Beirante, D., Santos, R., Ramos, L., Simões Dias, I., Luís, H., Catela, D., Galinha, S., Arrais, A., Portelada, A., Pinto, P., Simões, V., Ferreira, R., Franco, S. and Martins, M.C. (2024) 'Outdoor STEAM education: Opportunities and challenges', *Education Sciences*, 14(7), Article 688. Available at: <https://www.mdpi.com/2227-7102/14/7/688> (Accessed: 22 September 2025).

Cox, A. (2025) Fire pit logs used for balancing, Personal Collection.

Cox, A. (2025) Woodland area, Personal collection.

Creative STAR Learning. (2024). *Simon Nicholson and The Theory of Loose Parts - 1 Million Thanks*. Available at: <https://creativestarlarning.co.uk/early-years-outdoors/simon-nicholson-and-the-theory-of-loose-parts-1-million-thanks/> (Accessed: 17 September 2025).

Department for Education (2023) *Statutory framework for the early years foundation stage: Setting the standards for learning, development and care for children from birth to five*. Available at: <https://www.gov.uk/government/publications/early-years-foundation-stage-framework--2> (Accessed: 17 September 2025).

Dobrich, E.O.R. (2025) 'An adult educator's reflection on designing and delivering an embodied learning community development programme and embodied teaching and learning methods', *Quality Education for All*, 2(2), pp. 75-92. Available at: <https://www.emerald.com/qea/article/2/2/75/1279059/An-adult-educator-s-reflection-on-designing-and> (Accessed: 17 September 2025).

Faella, P., Digennaro, S. and Iannaccone, A. (2025) 'Educational practices in motion: a scoping review of embodied learning approaches in school', *Frontiers in Education*, 10, Article 1568744. Available at: <https://www.frontiersin.org/journals/education/articles/10.3389/feduc.2025.1568744/pdf> (Accessed: 17 September 2025).

Froebel Trust (2022) *Children and Nature*. Available at: <https://www.froebel.org.uk/training-and-resources/children-and-nature> (Accessed: 17 September 2025).

Froebel, F. (1887) *The Education of Man*. Translated by Hailmann, W.N. New York: D. Appleton and Company. Available at: <https://www.loc.gov/item/06022553/> (Accessed: 16 September 2025).

Gibson, J.J. (1979) *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin.

Greyling, L. (n.d.) Dry Leaves, Sticks and Stones. Public Domain Pictures. Available at: <https://www.publicdomainpictures.net/en/view->

[image.php?image=316325&picture=dry-leaves-sticks-and-stones](#) (Accessed: 9 September 2025).

Greyling, L. (n.d.) Sequencing sticks and stones. Available at: <https://alittlelearningfortwo.blogspot.com/2012/07/sequencing-with-sticks-stones.html> (Accessed: 4 September 2025)

Holmes, K., Mackenzie, E., Berger, N. and Walker, M. (2021) 'Linking K-12 STEM pedagogy to local contexts: A scoping review of benefits and limitations', *Frontiers in Education*, 6, Article 693808. Available at: <https://doi.org/10.3389/feduc.2021.693808> (Accessed: 22 September 2025).

Howard, S.J., Lewis, K.L., Walter, E., Verenikina, I. and Kervin, L.K. (2024) 'Measuring the quality of adult–child interactions in the context of ECEC: a systematic review on the relationship with developmental and educational outcomes', *Educational Psychology Review*, 36, Article 6. Available at: <https://link.springer.com/article/10.1007/s10648-023-09832-3> (Accessed: 17 September 2025).

Hunter, J., Syversen, K.B., Graves, C. and Bodensteiner, A. (2020) 'Balancing outdoor learning and play: adult perspectives of teacher roles and practice in an outdoor classroom', *International Journal of Early Childhood Environmental Education*, 7(2), pp. 34-50. Available at: <https://files.eric.ed.gov/fulltext/EJ1254849.pdf> (Accessed: 17 September 2025).

Keith, L. (2017) *Developing Young Children's Mathematical Learning Outdoors: Linking Pedagogy and Practice*. London: Routledge.

Kelly, O., Whelan, J. and Coulter, M. (2025) 'A pedagogy of outdoor learning in the primary school – Insights from outdoor educators in Ireland', *Journal of Adventure Education and Outdoor Learning*. Available at: <https://www.tandfonline.com/doi/pdf/10.1080/14729679.2025.2477982> (Accessed: 22 September 2025).

Kennedy, T.J. and Tunnicliffe, S.D. (2022) 'Introduction: The role of play and STEM in the early years', in *Play and STEM Education in the Early Years: International Policies and Practices*, Cham: Springer, pp. 3-37. Available at:

https://link.springer.com/chapter/10.1007/978-3-030-99830-1_1 (Accessed: 17 September 2025).

Kurt, S. (2020) 'Vygotsky's Zone of Proximal Development and Scaffolding', *Educational Technology*. Available at: <https://educationaltechnology.net/vygotskys-zone-of-proximal-development-and-scaffolding/> (Accessed: 17 September 2025).

Leung, W.M.V. (2023) 'STEM education in early years: Challenges and opportunities in changing teachers' pedagogical strategies', *Education Sciences*, 13(5), Article 490. Available at: <https://www.mdpi.com/2227-7102/13/5/490> (Accessed: 22 September 2025).

Lilley, I. (1967) *Friedrich Froebel: A Selection from his Writings*. Cambridge: Cambridge University Press

Louis, S. (2018) *Understanding Schemas in Young Children: Again! Again!*. London: SAGE Publications.

Mackinder, M. (2023) 'A balancing act: a constructivist perspective of the adult's role in Forest School in England and Forest Kindergarten in Denmark', *Education 3-13*, 53(6), pp. 951-964. Available at: <https://www.tandfonline.com/doi/pdf/10.1080/03004279.2023.2250803> (Accessed: 17 September 2025).

Nicholson, S. (1971) 'How Not to Cheat Children: The Theory of Loose Parts', *Landscape Architecture*, 62(1), pp. 30–34.

Nikolopoulou, K. and Tsimperidis, I. (2023) 'STEM education in early primary years: Teachers' views and confidence', *Journal of Digital Educational Technology*, 3(1), Article ep2302. Available at: <https://www.jdet.net/download/stem-education-in-early-primary-years-teachers-views-and-confidence-12971.pdf> (Accessed: 22 September 2025).

Pitipornatapin, S., Butkatunyoo, O., Piyapimonsit, C., Thanarachataphoom, T., Chotitham, S. and Lalitpasan, U. (2025) 'Understanding teacher practices in outdoor STEM implementation: A pedagogical content knowledge perspective', *Research in Science Education*. Available at: <https://doi.org/10.1007/s11165-025-10272-y> (Accessed: 22 September 2025).

Ramsden, R., Pike, I., Thorne, S. and Brussoni, M. (2025). 'Children's outdoor play at early learning and child care centres: examining the impact of environmental play features on children's play behaviour', *medRxiv*. Available at:

<https://www.medrxiv.org/content/10.1101/2025.01.21.25320884v1.full.pdf> (Accessed: 17 September 2025).

Reynolds, O. (2018) 'A critical analysis of outdoor learning experiences and the impact on pupil development and conceptual understanding', *Student Teacher Perspectives Journal*, 5. Available at:

<https://ojs.cumbria.ac.uk/index.php/step/article/view/490/607> (Accessed: 17 September 2025).

Rusitoru, M. (2023) 'Barriers to Outdoor Education', *OTTER Project Blog*. Available at: <https://www.otter-project.eu/blog/post/16/barriers-to-outdoor-education> (Accessed: 22 September 2025).

Siraj, I. (2025) 'Intentional and relational pedagogy: The role of the adult in the classroom', *University of Oxford*. Available at: https://www.education.ox.ac.uk/wp-content/uploads/sites/3/2024/11/Int_Rel_Ped_2025_IramSiraj.pdf (Accessed: 17 September 2025).

Stronger Practice Hubs (2024) *Embracing Nature: Enhancing Early Years Mathematics through Outdoor Learning*. Available at:

<https://www.strongerpracticehubs.org.uk/hubs/ne/great-neysph/resources/embracing-nature-enhancing-ey-mathematics-through-outdoor> (Accessed: 17 September 2025).

Stylianidou, F., Glauert, E., Rossis, D., Compton, A., Cremin, T., Craft, A. and Havu-Nuutinen, S. (2018) 'Fostering inquiry and creativity in early years STEM education: Policy recommendations from the Creative Little Scientists Project', *European Journal of STEM Education*, 3(3), Article 15. Available at:

<https://files.eric.ed.gov/fulltext/EJ1190730.pdf> (Accessed: 22 September 2025).

Thomas, A. & Boulton, A. (2022) 'Schemas, loose parts and the outdoors-An affordance of possibilities', *International Education Studies Association Conference Proceedings*, pp.1-15. Available at:

<https://educationstudies.org.uk/abstract/schemas-loose-parts-and-the-outdoors-an-affordance-of-possibilities/> (Accessed: 20 September 2025).

Tovey, H. (2020) *Froebel's principles and practice today*. Froebel Trust. Available at: <https://www.froebel.org.uk/uploads/documents/FT-Froebels-principles-and-practice-today.pdf> (Accessed: 17 September 2025).

Tovey, H. (2020) *Outdoor play and exploration: a Froebelian approach*. Froebel Trust. Available at: <https://www.froebel.org.uk/uploads/documents/FT-Outdoor-Play-Pamphlet.pdf> (Accessed: 17 September 2025).

Trina, N.A., Monsur, M., Cosco, N., Shine, S., Loon, L. and Mastergeorge, A. (2025) 'Tools for assessing the STEAM learning affordances and quality of outdoor learning environments of childcare centers: A systematic review', *Early Childhood Education Journal*, 53. Available at: <https://link.springer.com/article/10.1007/s10643-025-01911-0> (Accessed: 17 September 2025).

Trina, N.A., Rahman, M.M. and Rahman, M.S. (2024) 'Nature-based outdoor environments and STEAM concept formation in early childhood: A scoping review', *Education Sciences*, 14(6), p.627. Available at: <https://www.mdpi.com/2227-7102/14/6/627> (Accessed: 22 September 2025).

Tunnicliffe, S.D. and Kennedy, T.J. (2022) *Play and STEM Education in the Early Years: International Policies and Practices*. Cham: Springer. Available at: <https://link.springer.com/book/10.1007/978-3-030-99830-1> (Accessed: 22 September 2025).

Vygotsky, L.S. (1978) *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.

Way, J., Cartwright, K. and Ginns, P. (2023) *A collective approach to embodied learning in early years mathematics (ELEMS Phase 1)*. Thirteenth Congress of the European Society for Research in Mathematics Education (CERME13), Budapest, Hungary. Available at: <https://hal.science/hal-04420789/document> (Accessed: 17 September 2025).

Welsh Government (2022) *Curriculum for Wales Framework*. Cardiff: Welsh Government. Available at: <https://www.daynurseries.co.uk/advice/curriculum-for-wales-early-years> (Accessed: 16 September 2025).

Welsh Government (2022) *Curriculum for Wales: Health and Well-being Area of Learning and Experience*. Available at: <https://hwb.gov.wales/curriculum-for-wales/health-and-well-being> (Accessed: 9 September 2025).

Welsh Government (2022a) *Curriculum for Wales: framework*. Available at: <https://www.gov.wales/curriculum-wales-framework> (Accessed: 9 September 2025).

Welsh Government (2022b) *Curriculum for Wales: Mathematics and Numeracy Area of Learning and Experience*. Available at: <https://hwb.gov.wales/curriculum-for-wales/mathematics-and-numeracy> (Accessed: 9 September 2025).

Welsh Government (2022c) *Curriculum for Wales: Mathematics and Numeracy – Principles of Progression*. Available at: <https://hwb.gov.wales/curriculum-for-wales/mathematics-and-numeracy/principles-of-progression> (Accessed: 9 September 2025).

Welsh Government (2022d) *Curriculum for Wales: Science and Technology Area of Learning and Experience*. Available at: <https://hwb.gov.wales/curriculum-for-wales/science-and-technology> (Accessed: 9 September 2025).

Welsh Government (2022e) *Curriculum for Wales: The Four Purposes*. Available at: <https://hwb.gov.wales/curriculum-for-wales/designing-your-curriculum/developing-a-vision-for-curriculum-design> (Accessed: 9 September 2025).

Welsh Government (2022f) *Curriculum for Wales: Health and Well-being Area of Learning and Experience*. Available at: <https://hwb.gov.wales/curriculum-for-wales/health-and-well-being> (Accessed: 9 September 2025).

Welsh Government (2022g) *Curriculum for Wales: Mathematics and Numeracy Area of Learning and Experience*. Available at: <https://hwb.gov.wales/curriculum-for-wales/mathematics-and-numeracy> (Accessed: 9 September 2025).

Welsh Government (2022h) *Curriculum for Wales: Mathematics and Numeracy Area of Learning and Experience*. Available at: <https://hwb.gov.wales/curriculum-for-wales/mathematics-and-numeracy> (Accessed: 9 September 2025).

Welsh Government (2022i) *Curriculum for Wales: Science and Technology Area of Learning and Experience*. Available at: <https://hwb.gov.wales/curriculum-for-wales/science-and-technology> (Accessed: 9 September 2025).

Welsh Government (2022k) *Curriculum for Wales: Developing a vision for curriculum design – The Four Purposes*. Available at: <https://hwb.gov.wales/curriculum-for-wales/designing-your-curriculum/developing-a-vision-for-curriculum-design> (Accessed: 9 September 2025).

Welsh Government (2022l) *Curriculum for Wales: Science and Technology Area of Learning and Experience*. Available at: <https://hwb.gov.wales/curriculum-for-wales/science-and-technology> (Accessed: 9 September 2025).

Welsh Government (2022m) *Curriculum for Wales: Designing your curriculum – Assessment and progression*. Available at: <https://hwb.gov.wales/curriculum-for-wales/designing-your-curriculum/assessment-and-progression> (Accessed: 9 September 2025).

Welsh Government (2022n) *Curriculum for Wales: Science and Technology – Designing your curriculum*. Available at: <https://hwb.gov.wales/curriculum-for-wales/science-and-technology/designing-your-curriculum> (Accessed: 9 September 2025).

Welsh Government (2022o) *Curriculum for Wales: Mathematics and Numeracy Area of Learning and Experience – Designing your curriculum*. Available at: <https://hwb.gov.wales/curriculum-for-wales/mathematics-and-numeracy/designing-your-curriculum> (Accessed: 9 September 2025).

Welsh Government (2022p) *Curriculum for Wales: Health and Well-being Area of Learning and Experience*. Available at: <https://hwb.gov.wales/curriculum-for-wales/health-and-well-being> (Accessed: 9 September 2025).