

ECEY5005/C – Awe and wonder – Science, mathematics and the outdoors.

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AI statement – I acknowledge the use of ChatGPT on 3rd September 2026 for research and source credibility.

I used the prompt(s):

1. Find recent academic research on outdoor learning in early childhood, particularly loose parts, affordances, science and mathematics.

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 in evidence.

AI statement – I acknowledge the use of ChatGPT on 16th September 2026 to check sources.

I used the prompt(s):

1. Can you check whether I have used enough recent sources alongside seminal theory?

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 in evidence.

AI statement – I acknowledge the use of ChatGPT on 2nd October 2026 for proofreading.

I used the prompt(s):

1. Proofread this checking for grammar, clarity and structure. Do not change anything just highlight what needs changing & I will change it myself.

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 in evidence.

Part 1 - Outdoor Woodland Play Environment



Figure 1: Outdoor woodland play environment photographed during a university study visit to Finland (Meredith, 2026).

Part 2 - Using the Outdoor Environment to Develop Mathematical and Scientific Concepts.



Figure 2: Outdoor woodland play environment photographed during a university study visit to Finland (Meredith, 2026).

The outdoor environment I have chosen was photographed during a university study visit to Finland. I was particularly interested in this space because, although some manufactured play equipment is present, it is integrated within a wider natural landscape. Mature trees, uneven and sloping ground, exposed roots, rocks, soil, pine needles and naturally occurring loose materials provide opportunities for children to move, investigate and experiment. The scale of the trees and changing levels can create a sense of awe and wonder, encouraging children to look closely and ask questions. White (2020) recognises the value of outdoor environments that allow young children to engage physically with natural spaces and materials, while Keith (2018) identifies outdoor environments as valuable contexts for mathematical thinking. I would use this environment mainly to explore forces and movement, particularly gravity and friction, alongside comparison, distance and measurement.

I would plan the experience for eight children aged four to five years, supported by two practitioners. This working ratio of one adult to four children would allow close supervision while still giving children freedom to explore independently.

Although I have previously visited the site, I would carry out another pre-visit because conditions can change. I would check boundaries, entrances and exits, visibility, fallen branches, exposed roots, loose rocks, wet or unstable ground, toilets,

shelter and emergency access. Weather conditions would also be checked, and children would need suitable clothing and footwear.

Before the visit, I would review individual medical, mobility, communication and additional learning needs. Adaptations would depend on individual need. For example, a child who found unfamiliar environments difficult could view photographs beforehand and use a simple visual sequence, while a child requiring communication support could use visual symbols for words such as up, down, fast and slow. If mobility was restricted, an accessible slope or movable ramp could allow the same concepts to be explored.

On arrival, I would explain the boundaries and allow the children time to explore before introducing resources to see where their interest takes them. White (2020) highlights the importance of allowing children to interact with outdoor environments in ways that are meaningful to them.

Child A walks up a slope before turning and running back down.

“Look! I’m fast!”

Child B follows but stops halfway.

“This is hard.”

I ask, “What’s hard?”

“Going up.”

“What about going down?”

“That’s easy!”

Child A adds, “You go fast down.”

“Why do you think you go faster?”

“Because it goes down.”

Rather than immediately explaining gravity, I would allow the children to experience the difference between moving uphill and downhill through their own bodies.

Tunnicliffe (2015) supports inquiry-based early science through looking, talking,



Figure 3: Children participating in an outdoor nature walk activity (The Learning Tree Private Pre School Nursery & Out of School Club, 2025).

thinking and doing. Curriculum for Wales also encourages young children to explore their environment, make observations and communicate ideas within Science and Technology (Welsh Government, 2022b).

I would then place a small basket containing balls of different sizes, wooden discs and toy vehicles near the slope, with pinecones also available. I would not explain what the resources were for, which would allow me to observe how the children used them.

Child A releases a ball down the slope.

“It went far!”

Child C tries a pinecone, which moves slightly before stopping.

“Mine stopped.”

“Why did it stop?”

“It got stuck.”

Child A says, “My ball is better.”

“How can we find out?”

“Do them again!”

The children place the ball and pinecone together and release them at the same time. The ball travels further.

Child C watches the ball continue down the slope.

“It’s still going!”

Child C picks up the pinecone.

“It’s bumpy.”

She touches the ball.

“This one’s smooth.”



Figure 4: Children exploring movement with a ball on uneven woodland ground (Efeuhof, no date).

The children are beginning to consider how properties such as shape and surface affect movement through observation and comparison. Johnson and Watts (2019) emphasise how outdoor environments can support curiosity and allow children's observations to influence further investigation.

The children then test the same ball or vehicle over compact soil, pine needles, grass and rougher ground.

Child B rolls a vehicle over a rough area.

"It stopped again!"

"What's the ground like?"

"Bumpy."

We move to a smoother area and try again.

"It went faster!"

I then introduce the scientific vocabulary by saying, "The rough ground makes it harder to move. We call that friction."

Child B points back.

"The bumpy bit stops it."

"Yes, it slows it down."

Introducing the word after the child has experienced its effect connects scientific vocabulary to something meaningful.

Mathematical learning develops through the same investigation. Robertson (2017) demonstrates how outdoor experiences can support mathematical thinking through real materials, while Keith (2018) emphasises comparison and measurement within outdoor play.

Child A rolls his ball again.

"Mine went really far!"

Child C points towards hers.



Figure 5: *Forest Ground Render Day 02* (Armellini, 2023).

“Mine went more.”

“Which went furthest?”

“That one.”

“How could we check?”

“Count it.”

“What could we count?”

“My steps.”

Child A walks from the starting point, counting to seven.

“Seven!”

Child C then measures her ball.

“Mine is ten!”

“Which one went further?”

“Mine!”

The number has a purpose because it helps the children answer a question arising from their play.

I then extend this by measuring the same distance using adult steps.

“Mine was only five steps.”

Child A says, “Your steps are big!”

“Why did I get five and you got ten?”

“Because you’re bigger.”

I then introduce a tape measure, explaining that this tape stays the same whoever uses it. This develops an early understanding of standard measurement while remaining linked to the children’s investigation. However, I **use** my professional judgement when deciding when to introduce the tape measure, as I **do not** want to interrupt the children’s play or cause the experience to end unnaturally. Curriculum for Wales Mathematics and Numeracy supports number, comparison and

measurement through meaningful experiences in indoor and outdoor environments (Welsh Government, 2022a).

As the investigation continues, children also begin to recognise the importance of starting objects from the same place.

Child B moves higher up the slope.

“Mine went the furthest!”

Child A says, “You went up there!”

I ask, “Did you start in the same place?”

“No.”

“What could we do?”

Child A places a stick across the ground.

“Start here.”

The children position their vehicles behind the stick and release them together. Without using formal terminology, they are beginning to recognise that keeping the starting position the same makes the comparison fairer.



Figure 6:
Outdoor
learning with
kids:
measuring
stuff (Reid,
2023).

The environment also encourages mathematical language such as higher, lower, up, down, near, far, steep, flat, fast, slow, heavy and light because children can physically experience these differences.

The experience remains flexible enough to follow children’s interests. Child C notices that a pinecone repeatedly moves sideways.

“Why does it go that way?”

“What do you think?”

“It’s a funny shape.”

“Shall we try another one?”

“Yes!”

The children begin comparing different pinecones, creating another investigation from their own observation. This allows curiosity to shape the direction of learning rather than expecting every child to follow an identical activity.

I make resources available for the children to record their discoveries by placing sticks where objects stopped, taking photographs, drawing what happened or sorting objects into groups such as “went far” and “stopped”. Learning also extends beyond science and mathematics through balancing, moving across uneven surfaces, explaining ideas, listening to others and developing confidence and decision-making.

Towards the end, I briefly revisit the learning.

“What happened to the things we rolled down the hill?”

“They went fast.”

Child B adds, “Not on the bumpy bit.”

“What happened there?”

“They stopped.”

“What did we call it when the rough ground slowed things down?”

“Friction! When we go back maybe we can find a book to find out how friction works?”

I then ask, “What would you like to try next time?”

“A bigger ball!”

Child C holds up her pinecone.

“I want to do these again.”

Their responses can inform the next experience and allow the investigation to continue.

Through this experience, children would encounter gravity, friction, distance and measurement through movement and exploration rather than as isolated concepts. The slopes, different surfaces and natural materials within the Finnish woodland provide genuine problems for children to investigate. Practitioners can extend this learning through observation, questions, appropriate scientific and mathematical

vocabulary and carefully chosen resources, while still allowing children's curiosity to shape where the learning goes.



Figure 7: Nature loose parts mandalas (places_spaces_wonder_delight, 2023).

PART 3: RISK-BENEFIT ASSESSMENT**Area/activity being assessed**

Walking to and exploring a fenced woodland play area open to the public

Age of children / group size

4-5 years / 8 children and 2 practitioners

Assessor

Jenna Meredith

Date of assessment

25/09/2026

Risk rating key: 1 = Very low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very high.

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
Walking from the setting to the woodland area	A child could become separated from the group or move towards the road. A child could step into the road or be struck by a vehicle when crossing, resulting in serious or potentially life-	Children and practitioners	Walking supports physical activity, stamina, independence and awareness of the local environment. It can also support early road-safety awareness	4	Practitioners would walk the route beforehand and choose the safest route using pavements and controlled crossings where possible. One adult would position themselves towards the front and one towards the rear. Children would walk in agreed pairs. Head counts would take place before leaving, after	2

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
	changing injury. Trips and falls could also occur on the journey.		and positional language such as near, far, left and right.		crossings and on arrival. High-visibility clothing would be used for the journey where appropriate.	
Fenced boundary with public entrances and gates	Although fenced, the area is not a secure early years site because members of the public can enter and leave. A child could leave through an open gate, follow another family or move beyond the agreed area.	Children	The fencing provides a visible boundary and allows children a larger area in which to develop independence, confidence and child-led exploration.	4	All entrances and exits would be identified during the pre-visit. Children would be shown the boundary on arrival. Adults would position themselves so that gates and less visible areas remain supervised. Regular head counts would take place.	2
Members of the public using the area	A child could approach an unfamiliar adult, become confused about who they are with or	Children	Using a shared community space can support children's awareness of other	3	Practitioners would remain aware of who enters and leaves the space. Children would know which adults are responsible for them and would remain	2

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
	follow another person towards an exit. Busy public use could also reduce adult visibility of the group.		people and appropriate behaviour in public environments.		within the agreed boundary. Activities would be moved or paused if an area became unusually busy.	
Dogs within the public area	An unfamiliar dog may be off lead. A child could be knocked over, scratched or bitten. Some children may be frightened of dogs or have allergies.	Children	Observing animals can encourage curiosity about living things and provide opportunities to discuss responsible behaviour around animals.	3	Allergies and significant fears would be checked beforehand. Children would be taught not to approach or touch unfamiliar dogs. If an uncontrolled dog entered the immediate activity area, practitioners would bring the children together and move away until it had passed.	2
Insects, ticks, wasps and	A child or practitioner could be bitten or stung, causing pain, swelling or	Children and practitioners	Observing insects can support curiosity about living things, habitats	3	Known allergies would be checked before the visit and any required medication carried. Children would be	2

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
other bites or stings	an allergic reaction. Ticks may attach to skin and can occasionally transmit infection if not noticed and removed appropriately.		and seasonal change. Woodland exploration also allows children to develop confidence and awareness of how to behave safely around wildlife.		encouraged not to disturb nests or handle unfamiliar insects. Suitable clothing and footwear would be worn where appropriate. Practitioners would remain alert for nests or unusually high insect activity, provide first aid for bites or stings and follow emergency procedures if a serious allergic reaction occurred. Parents/carers would be advised to check exposed skin for ticks after the visit where relevant.	
Uneven ground, exposed roots, stones and holes	Children could trip or lose balance, resulting in grazes, cuts, sprains, fractures or head injury. Roots and holes may be	Children and practitioners	Uneven terrain develops balance, coordination, spatial awareness, strength and confidence. It also	3	Practitioners would inspect the intended area before use. Significant hazards would be identified, but ordinary uneven terrain would not automatically be removed or avoided because this is part	2

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
	harder to see where leaves or natural materials cover the ground.		allows children to experience different levels and surfaces rather than only flat manufactured ground.		of the benefit. Children would wear suitable footwear and initially move more slowly while becoming familiar with the area.	
Steep or sloping ground	A child running downhill could gain speed, lose control and fall or collide with another child, tree or object. This could result in fractures or head injury.	Children	Slopes provide direct experiences of gravity, speed, balance and movement. They also allow children to develop physical confidence and begin judging manageable risks for themselves.	4	The slope would be inspected for gradient, surface and what lies at the bottom. Slopes ending near hard obstacles, public paths, roads or significant drops would not be used. Adults would position themselves strategically and children would explore the slope by walking before faster movement developed.	3
Rolling balls, wooden	Objects could strike another child or member	Children, practitioners	Supports investigation of gravity, friction,	3	A clear investigation area would be selected away from main paths and	2

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
discs, pinecones and vehicles down slopes	of the public. Children may impulsively run after an object and fall. An object could roll outside the agreed area.	and members of the public	speed, distance, shape and surface. Children can predict, compare and test their ideas.		gates. Children would release objects only when the area below was clear and would stand to the side rather than directly in the path. Adults would model safe retrieval rather than children immediately chasing objects down the slope.	
Sticks and branches	Children may wave, throw, poke or run while carrying sticks, potentially causing eye injuries, cuts, grazes or more serious injury. Splintered wood may cause splinters, and contaminated sticks	Children and practitioners	Sticks are open-ended natural materials that can support measuring, comparing length and thickness, construction, imaginative play, problem-solving, creativity and physical	3	Sharp or badly splintered sticks would be removed. Children would be shown how to carry sticks safely at their side and would not run while carrying them. Adequate space would be maintained, and practitioners would intervene where sticks were deliberately swung, thrown or used towards another person's body.	2

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
	could carry dirt or animal waste.		development. They also allow children to learn how to manage risk rather than simply avoiding it.			
Stones and other heavy natural materials	A stone could be dropped onto fingers or feet or deliberately thrown, causing bruising, cuts or head injury. A child could attempt to lift something beyond their capability.	Children and practitioners	Stones support comparison of size, weight, shape and texture and can be used for sorting, counting and scientific investigation. Moving them also develops strength and coordination.	3	Practitioners would remove stones that were clearly too heavy or sharp for the intended activity. Children would be supported to judge whether they could lift an object safely and reminded that stones are not to be thrown towards people.	2

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
Low branches, trees and falling branches	Children could walk into a low branch causing scratches or eye injury. Dead or damaged branches may fall, especially during or after strong winds, causing serious head or bodily injury.	Children and practitioners	Trees contribute to awe and wonder and provide opportunities to investigate height, size, texture, seasonal change and living things.	4	The weather forecast and wind warnings would be checked. The site would be inspected for visibly damaged trees or hanging branches. Children would not use areas beneath visibly unstable branches. The visit would be cancelled or relocated during strong winds where falling branches became a significant concern.	2
Climbing natural features or fixed equipment	A child could slip or fall from height, causing bruises, fractures or head injury. Wet surfaces may become slippery, and	Children	Climbing develops balance, strength, coordination, confidence, spatial awareness and judgement of personal capability. It can also	4	Equipment and climbing areas would be visually checked before use. Wet, damaged or unstable equipment would not be used. Adults would consider the individual child's ability and the possible consequence of a fall rather than automatically preventing climbing.	3

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
	overcrowding may increase collision risk.		support mathematical concepts such as higher, lower and distance.		Numbers using a particular feature would be managed if overcrowding increased risk.	
Finger trapping, entrapment or clothing becoming caught on fixed play equipment	Fingers could become trapped in gaps, joints or moving parts. Loose clothing, cords or accessories could catch on equipment, causing pain, cuts, bruising or, in a more serious case, restricting movement or causing a fall.	Children	Using fixed equipment develops coordination, strength, spatial awareness, problem-solving and confidence. Learning to use equipment safely also supports children to judge their own capabilities and manage everyday risks.	3	Fixed equipment would be visually checked before use for damaged parts, unsafe gaps, exposed fixings or other obvious trapping points. Children would be supervised according to the level of challenge. Loose scarves, drawstrings or items likely to catch would be secured or removed where appropriate. Children would be encouraged to use equipment as intended and practitioners would intervene if overcrowding or unsafe use increased the likelihood of entrapment.	2

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
Plants, fungi, berries and unknown natural materials	Children could touch an irritant plant or eat a toxic berry, fungus or plant material, potentially causing skin irritation, allergic reaction or poisoning.	Children	Close observation of plants and fungi can support curiosity, classification, sensory exploration and understanding of living things and seasonal change.	4	Practitioners would inspect the immediate area and discuss with children that unknown plants, berries and fungi can be looked at but should not be eaten. Children would be encouraged to ask an adult before handling unfamiliar materials. Handwashing would take place afterwards.	2
Animal faeces, litter, broken glass or discarded harmful objects	Contact with animal waste could lead to infection. Broken glass could cause deep cuts. A discarded sharp object could cause puncture injuries.	Children and practitioners	There is little developmental benefit in direct contact with these hazards, although encountering them can help children learn that not	5	Practitioners would complete an environmental check before children entered the activity area. Serious contamination, broken glass or dangerous discarded objects would make that section immediately out of bounds until safely cleared. Children	2

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
			everything found outdoors is safe to handle.		would be taught to tell an adult if they saw something they were unsure about rather than picking it up.	
Wet, cold, hot or windy weather	Rain can make slopes, roots and equipment slippery. Children may become cold in wet conditions. Hot weather can cause dehydration, overheating or sunburn. Strong winds increase the possibility of falling branches.	Children and practitioners	Experiencing weather provides sensory experiences and opportunities to notice how the environment changes. Rain can change friction, movement and the appearance of natural materials.	4	Weather forecasts and warnings would be checked before leaving and monitored during the visit. Children would wear suitable clothing and footwear. Water, sun protection or spare clothing would be available as appropriate. The visit would be shortened, moved or cancelled if conditions changed enough to make the risk unacceptable.	2
Child becomes separated	A child may move out of adult sight behind trees, become distressed,	Children	Giving children some space away from constant direct adult	4	Clear physical boundaries would be established. Two practitioners would position themselves to maximise	2

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
from the group	leave through a gate or be unable to find the group.		control supports independence, confidence, agency and decision-making.		visibility rather than remaining together. Regular head counts would take place. Children would know where adults were based and what to do if they could not immediately see the group.	
Medical emergency, allergy or injury away from the setting	A child could experience an allergic reaction, asthma attack, seizure or significant injury. If practitioners could not contact help quickly, the consequences could become more serious.	Children and practitioners	Accessing the woodland provides experiences that cannot be fully recreated inside the setting and supports physical, scientific and mathematical learning.	4	Children's medical information would be reviewed beforehand. Required medication, first-aid equipment, emergency contacts and a charged mobile phone would be carried. At least one appropriate first aider would be present. The pre-visit would identify the exact location, emergency access point and whether mobile signal was reliable.	2

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
Toileting and access to toilet facilities	A child may need the toilet urgently, have an accident or become distressed if facilities are not nearby or immediately accessible. A child leaving the activity area for the toilet could also affect supervision of the remaining group.	Children and practitioners	Planning for toileting allows children to participate in longer outdoor experiences comfortably and with dignity. It also supports independence and self-care while reducing unnecessary interruption to exploration and learning.	2	Toilet facilities and the route to them would be identified during the pre-visit. Children would be encouraged to use the toilet before leaving the setting and reminded to tell an adult when they needed to go. Practitioners would plan how one adult could support a child with toileting without leaving the remaining group inadequately supervised. Spare clothing and hygiene materials would be available where appropriate, and individual toileting or intimate-care plans would be followed.	1
Children with ALN, sensory,	A child may become overwhelmed by an unfamiliar or busy public	Individual children and	Inclusion allows children with different needs to access the	4	Individual plans would be reviewed before the visit. Photographs, visual sequences or communication aids could	2

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measures	Control measures	Risk rating after control measures
communication or mobility needs	space, may not understand boundaries or may find uneven terrain inaccessible. Individual children may require closer supervision than the general group ratio provides.	supporting practitioners	same opportunities for curiosity, investigation, physical development and mathematical/scientific learning.		be used. Accessible routes or alternative slopes could be selected. If a child needed dedicated one-to-one support, staffing would be adjusted rather than assuming that the standard 1:4 working ratio remained sufficient.	
Children collecting or damaging too many natural materials	Plants or habitats could be damaged and insects or other wildlife could be disturbed.	Natural environment	Collecting small amounts of natural material supports classification, counting, comparison and sensory exploration and can	2	Children would be encouraged to collect fallen materials rather than pulling living plants apart unnecessarily. Adults would model respect for living things and discuss leaving enough materials and habitats undisturbed for wildlife.	1

Hazard / activity	Risk: what could happen?	Who is at risk?	Benefits	Risk rating before control measur es	Control measures	Risk rating after control measur es
			encourage connection with nature.			

Part 4 - The Role of Adults in Supporting Mathematical and Scientific Learning Outdoors.

An outdoor setting offers unique opportunities for practical learning in mathematics and science (White, 2020; Tunncliffe, 2015; Keith, 2018). The outdoors is dynamic rather than static, as factors such as weather, surfaces, light, natural resources and landscape create experiences that can be difficult to replicate indoors (Johnson and Watts, 2019; White, 2020). Children can explore weight by picking up stones, experience speed and gravity when moving down slopes, gain knowledge about balance while walking on uneven ground, and study friction when moving from rough to smooth surfaces (Keith, 2018; Tunncliffe, 2015). These authors similarly emphasise the value of first-hand experience in supporting curiosity and exploration.

Moreover, Curriculum for Wales considers outdoor learning, observation, play, and authentic, purposeful learning to be key elements in early education, and emphasises that effective environments must encourage awe, wonder, curiosity, and problem solving (Welsh Government, 2023). However, just being outside does not guarantee targeted learning as the quality of the environment and the interactions within it influence what children are able to gain from the experience (White, 2020; Kiviranta *et al.*, 2024; Smedsrud *et al.*, 2024). Therefore, the role of the adult is to create an enabling environment, recognise learning as it emerges and decide when interaction will extend rather than interrupt children's thinking (Tunncliffe, 2015; Zeng and Ng, 2025; Welsh Government, 2023).

Gibson's (2015) theory of affordances provides a useful way of understanding this relationship between the child and the environment. Affordances concern the possibilities for action that an individual perceives within their surroundings. Therefore, the same feature may have different meanings for different children. A slope may afford running for one child, cautious balancing for another and rolling objects for a child interested in movement. Likewise, a stick may be carried, measured, balanced, built with or transformed symbolically during imaginative play. This suggests that adults should avoid determining one fixed use for an outdoor resource. Instead, they can observe what children perceive and how they interact with the environment before deciding how learning might be extended. Smedsrud *et al.* (2024), in their systematic review of teacher support in nature-based outdoor

spaces, similarly identified the importance of facilitating children's free play while also using communication and collaboration to support learning. Consequently, the practitioner is not passive, but neither do they need to control the direction of every experience.

Nicholson's (1971) theory of loose parts complements Gibson because it emphasises environments containing materials that can be moved, combined, redesigned and used in numerous ways, an approach that continues to inform contemporary understandings of play and early childhood practice (King, 2022). This is particularly relevant within a nature-based environment where stones, pinecones, leaves, sticks, soil and other materials are already available. One resource may have many potential uses depending on the child. Mathematical concepts such as quantity, pattern, size, length, weight and classification can emerge alongside scientific ideas concerning movement, balance, force, materials and cause and effect. Nicholson's theory therefore supports creativity and freedom through open-ended use of materials. Similarly, White (2020) and Johnson and Watts (2019) emphasise open-ended outdoor environments where children have space, time and materials with which to explore their own interests. Together, these theories suggest that the value of the outdoor environment lies not simply in the materials available, but in how children perceive and use them and how sensitively adults respond to those possibilities.

More recent research strengthens this argument but also introduces an important limitation. Cankaya *et al.* (2025) compared children's play with loose parts to play involving toys that offered more limited affordances. The children demonstrated significantly more spontaneous STEM behaviours when using loose parts, including construction, mathematical exploration and explaining how things worked. However, this study involved 60 children engaged in solitary indoor play, and children's individual characteristics and home experiences also influenced engagement. It would therefore be inappropriate to conclude that providing loose parts outdoors will automatically produce mathematical or scientific learning for every child. Instead, the findings support the potential of open-ended materials while also demonstrating why adults need to consider the child, context and quality of provision. Therefore, loose parts should be viewed as a potentially valuable pedagogical resource rather than as an intervention that guarantees STEM learning.

Repeated use of materials can also help practitioners notice children's schemas (Boulton and Thomas, 2022). For example, repeated rolling or throwing may indicate an interest in trajectory. Rather than disrupting this behaviour, the practitioner might offer objects of different dimensions, allowing the child to explore speed, distance, gravity and friction. However, schemas should be interpreted cautiously, as adult interpretation should not replace the child's own intentions.

The outdoors also allows children to experience mathematical and scientific concepts through whole-body movement (White, 2020; Keith, 2018). Running down a slope allows children to experience speed and gravity physically, while climbing, balancing, pushing, pulling and carrying involve weight, body position and spatial relationships (Keith, 2018; Tunnicliffe, 2015). Curriculum for Wales similarly recognises physical development, balance, coordination and movement as interconnected with exploration and learning (Welsh Government, 2023). Therefore, mathematical and scientific understanding may initially be expressed through children's movement and actions before they possess the language to explain what is happening (White, 2020; Tunnicliffe, 2015).

Piaget's constructivist theory is applicable because it positions children as active contributors in constructing knowledge through interaction with their environment (Cade, Wardle and Otter, 2022). Children aged four to five are generally associated with Piaget's preoperational stage, which extends approximately from two to seven years and is associated with developing symbolic thought (Cade, Wardle and Otter, 2022). From this perspective, repeatedly rolling, lifting, dropping, comparing or building allows children to test their own ideas rather than simply being told facts. However, using developmental stages too rigidly can underestimate what children may achieve with social support. Vygotsky's zone of proximal development places greater emphasis on what can become possible through interaction with a more knowledgeable other (Xi and Lantolf, 2021), while Monteiro, Jiménez-Aleixandre and Siry (2022) describe scaffolding as temporary support that can be adjusted as children's competence develops, an approach that continues to underpin contemporary research into adult support for learning (Gaffney and Rodgers, 2018). This suggests that direct experience alone may not be sufficient for all children, as carefully timed adult interaction can help transform experience into more explicit mathematical and scientific understanding.

When considered together rather than separately, these perspectives are particularly useful. A child may independently discover that a toy vehicle travels further across one surface than another. A practitioner could immediately explain friction, but doing so may end the child's investigation. Alternatively, the adult could ask, "What is different about the ground here?" or "What could we try next?" before introducing words such as rough, smooth, faster, slower and eventually friction. In this way, direct experience remains child-led, but adult interaction can support the child to notice relationships and develop more precise language. Tunnicliffe (2015) similarly emphasises looking, talking, thinking and doing within early science.

The timing of adult intervention is therefore as important as the interaction itself. Zeng and Ng (2025) found that five-year-old children demonstrated stronger science process skills and more complex exploration when periods of uninterrupted loose-parts play were followed by open-ended questioning. Children also independently explored scientific concepts linked to changes in movement and materials. This suggests that effective practitioners need to read children's verbal and non-verbal cues and recognise when intervention may extend learning and when it may interrupt sustained play. Pyle and Danniels (2017) similarly describe play-based learning as a continuum rather than a choice between complete adult direction and complete adult withdrawal. Their research identified practitioners' concerns about adults taking over children's play when educational objectives begin to dominate the child's purpose. Therefore, the quality and timing of intervention appear more significant than the amount of adult involvement, because effective interaction should extend children's thinking without replacing their enquiry.

Sustained shared thinking can provide a useful model for this adult role. Siraj-Blatchford *et al.* (2002) describe sustained shared thinking as situations in which an adult and child work intellectually together to solve a problem, clarify an idea or extend understanding. Rather than asking a succession of questions to check whether the child knows a predetermined answer, the practitioner joins the thinking process. For example, if a child notices that a pinecone continually moves sideways while a ball travels straight down a slope, the adult might respond, "I wonder why that happened?" followed by, "What could we try to find out?" This can encourage metacognitive talk because the child begins to consider not only what happened but how they investigated it. Questions such as "What did you try last time?" and "How

could we check?” can support planning, prediction and reflection (Chen and McDunn, 2022).

This approach connects strongly with Curriculum for Wales. Children are encouraged to develop curiosity about how things work, explore their environment, make observations and communicate their ideas through science, while mathematics similarly values first-hand experience, problem-solving and mathematically rich environments (Welsh Government, 2022a; Welsh Government, 2022b; Welsh Government, 2023). Furthermore, the Enabling Learning guidance emphasises the interconnection between enabling adults, engaging experiences and effective environments. Welsh Government (2023) states that adults should be attuned to children’s interests and provide time and opportunities for children to explore, rehearse skills and test emerging theories. This demonstrates that the adult role involves more than simply providing resources. Practitioners need to observe, listen, model language, introduce materials where appropriate and protect sufficient time for investigations to develop. However, policy expectations depend on practitioners having sufficient confidence, subject knowledge and time to recognise learning as it occurs, meaning that the principles of Curriculum for Wales may be more difficult to realise consistently in practice.

Children also need time to repeat and revisit investigations. Nicholson’s (1971) emphasis on loose parts supports opportunities for experimentation, while Zeng and Ng’s (2025) findings on uninterrupted play highlight the importance of allowing investigations to develop over time. However, this responsive form of practice depends on adult confidence and subject knowledge. Practitioners need sufficient understanding of mathematics and science to recognise concepts within play. Without this knowledge, a practitioner might observe children repeatedly rolling objects without recognising opportunities to develop ideas about force, friction, speed, distance or fair comparison. Similarly, mathematical learning can be overlooked if mathematics is understood mainly as written numbers rather than including pattern, measure, spatial relationships, classification and comparison. Kiviranta *et al.* (2024), in their review of international research on outdoor learning in early childhood education, identified teacher knowledge alongside organisation, safety, resources and other practical factors as important influences on outdoor provision. This demonstrates that a rich physical environment alone is insufficient if

adults do not recognise or feel confident in extending the learning that occurs within it.

There are also practical tensions between children's freedom and adult responsibility. Nature-based outdoor learning benefits from choice, time, access, challenge and opportunities for independent movement, yet adults retain responsibility for safety and inclusion. Therefore, the adult role is partly one of professional decision-making, maintaining worthwhile challenge while controlling hazards children cannot reasonably be expected to manage independently. Curriculum for Wales supports this balance by stating that effective environments should offer flexibility, risk and challenge while supporting resilience, confidence and independence (Welsh Government, 2023).

The assumption that every child will enjoy outdoor learning should also be considered, as children's responses to outdoor environments can differ according to previous experience, sensory preferences, confidence and individual need (White, 2020; Kiviranta *et al.*, 2024). While some children may have mobility, communication or additional learning needs that limit their access to certain possibilities, others might find the sensory demands of an open public setting challenging (Smedsrud *et al.*, 2024; Welsh Government, 2023). Based on Gibson's (2015) understanding of affordance, not every child has the same possibilities in the same setting. To maintain the concept under investigation, practitioners may need to modify communication, resources, routes, time, or levels of support (Welsh Government, 2023; Smedsrud *et al.*, 2024). This challenges the assumption that equal provision necessarily creates equal opportunities to learn.

Outdoor exploration can also contribute to children's broader wellbeing. Thoilliez (2011, cited in Young, 2026) distinguishes between hedonic wellbeing, linked to enjoyment, and eudaemonic wellbeing, associated with growth and flourishing. Outdoor experiences may support both through enjoyment, challenge, persistence and growing confidence, reflecting the holistic principles of Curriculum for Wales (Welsh Government, 2023).

In conclusion, practitioners have a balancing role in supporting mathematical and scientific exploration outdoors. Concepts such as loose parts, affordance, active learning and scaffolding support the development of enabling environments,

responsive interaction and children's autonomy. Research suggests that open-ended resources and well-timed intervention can help extend STEM learning, although effective practice requires adults to know when to support and when to pull back (Cankaya *et al.*, 2025; Zeng and Ng, 2025). This balance also reflects the holistic principles of Curriculum for Wales, where learning, wellbeing and development are closely connected (Thoilliez, 2011, cited in Young, 2026; Welsh Government, 2023). Children's curiosity should therefore remain central, with adults creating environments that enable meaningful mathematical and scientific thinking.

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