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**Module: Awe and wonder science, mathematics, and the outdoors
(ECEY5005)**

AI Cover Sheet

I acknowledge my use of Grammarly to help with grammar and spelling.

I acknowledge my use of Co-pilot to check for repetition and rephrase work to help bring the word count down.

I confirm that I have copies of my drafts, notes, and other resources I used before and after using AI tools, which I may be asked to provide as evidence.

Part 1: The environment

(Morris-Evans, 2025)

Part 2 Learning journal

Date: 6th September 2025

Group: 4 children aged 3-4, and 1 Adult

Setting: Woodland learning area

Introduction

During outdoor session we took the children to a forest area with fallen leaves, mud and a gentle stream which invited exploration. The children were drawn to the mud and water, an ideal setting for play.

They began with joyful sensory activities: stomping in mud, watching it squish, and jumping in puddles. But as play evolved, a learning opportunity emerged. Their curiosity led to experimenting with materials, observing changes, and asking questions.

Resources added to support and enhance learning:

*Small measuring cups and jugs

*Buckets

*Old paintbrushes, sticks

*Plastic pots, scoops, and trays

*Saucepans, mixing spoons, and spatulas

Observation

One child took a small bucket, filled it with water from the stream, and poured it onto a patch of dry soil. Using a stick, she stirred carefully, then exclaimed, "It's going darker! Now it's squishy!" When asked what caused the change, she replied, "The water made it change!" Later, after adding more water, she giggled, "Now it's soup! It's too much!" When prompted to reflect, she noted, "It stopped being like mud, it's runny like soup." She then predicted, "If I add more soil, it will go thick again. Like porridge!"

This exchange captured the essence of scientific thinking, predicting, observing, and reasoning and highlighted the early development of metacognitive awareness. The child not only recognised the change but explained why it happened and anticipated what might happen next.

As more children joined, they created their own mud mixtures using jugs, cups, and sticks. They compared consistencies and shared ideas. "We need more dirt; this is

like soup,” said one. Another replied, “Mine’s too thick, it’s like cake,” patting her mud to demonstrate. When asked how she knew, she responded, “Because it was drippy before, and now it’s not moving much.” We encouraged her to reflect on whether she noticed this by how the mud looked, felt, or moved.

To deepen their thinking, we asked open-ended questions like, “Why does water make mud thinner?” and “What would you do differently next time to make it just right?” These prompts encouraged children to plan, monitor, and evaluate their actions, core components of metacognitive development. Other children soon joined the investigation, experimenting with different ratios and textures, and creating their own mud recipes.

Throughout the session, I modelled reflective language to support deeper thinking:

“I wonder what would happen if I added more water?”

“What could I do differently next time?”

“Why do you think your mud feels different from your friend’s?”

“Are you trying to make thick mud or thin paint?”

“What steps will you take to get there?”

These questions helped children articulate their intentions and reflect on their processes, fostering independent learning and self-regulation.

Children naturally engaged in mathematical thinking. They counted scoops aloud and compared mixtures:

“I used two scoops of soil and one cup of water.”

“Mine has half a cup, and it’s still runny!”

Vocabulary such as thick, thin, half, more, and less emerged. They explored ratios, measurement, and estimation, adjusting proportions and describing changes. One child added half a cup of water, while another tried one scoop of soil with two scoops of water, noting, “Three scoops! It’s getting softer!”

We asked questions to extend their reasoning:

“Why did that mixture work better than the last one?”

“How did you know when to stop adding water?”

“Can you explain your method to a friend?”

“Did anyone try a different way? What happened?”

Later, we introduced natural materials like leaves, sticks, and scrap cardboard, inviting the children to paint with their mud mixtures. They noticed how consistency affected their results. “Mine is brown and lumpy!” said one child, inspecting her brush

marks. Another observed, “Mine is falling off the paper!” because her mud was runnier. Children experimented with application methods, splatting, stroking gently, or dragging sticks through the mud, they described their mixtures using rich sensory language: “sticky,” “squishy,” “sloppy,” and “lumpy.”

We encouraged further reflection:

“Did your paint do what you wanted?”

“What would you change next time?”

“How does your mud paint compare to your friend’s?”

“Which mud worked best for painting and why?”

“What did you do differently that made it work better?”

These prompts supported critical thinking about both outcomes and processes, helping children articulate their goals and decisions.

Throughout the exploration, children demonstrated cause-and-effect thinking by predicting results, adjusting proportions, and responding to the changing properties of the mud. They used early mathematical concepts such as measurement, volume, estimation, and comparison, using everyday tools like scoops, cups, and spoons to investigate quantity and proportion. Their language reflected this learning, with terms like “more,” “less,” “too much,” “half,” “thick,” and “thin” emerging naturally in their discussions.

Importantly, this experience fostered early metacognitive skills. Children began to plan, monitor, adjust, and explain their thinking. Through thoughtful questioning, modelling, and rich play-based interaction, they learned to reflect not only on outcomes but on their learning process itself.

The children remained highly engaged throughout collaborating, problem-solving, making predictions, testing ideas, and evaluating choices. This hands-on, sensory play in a natural, open environment exemplified child-led inquiry in action.

This experience strongly aligns with the Curriculum for Wales and Non-Maintained Settings, particularly in:

Science and Technology: exploring how materials combine and change

Mathematics and Numeracy: measuring, estimating, comparing

Language, Literacy and Communication: using expressive and reflective language

Health and Wellbeing: engaging senses, building confidence, and working collaboratively

Children investigated the world through their senses, developed early numeracy, and practised reflective thinking in a meaningful, real-world context. The integration of scientific inquiry, mathematical reasoning, and metacognitive reflection within a playful, outdoor setting highlights the power of experiential learning and the role of adults in scaffolding rich, child-led exploration.

Scientific Concept Explored

- *Properties of materials, classification, observation: What is mud?
 - *Material change, cause and effect, mixing reactions: How do soil and water combine?
 - *Measurement, volume, ratio, cause and effect: What happens when you change the amounts?
 - *Sensory exploration and observation: What does it feel like? Looks like? Smell like?
 - *Function of materials, and practical use of material properties: Can we paint with it?
- Children investigated how adding water to dry soil transforms it, how it changes from dust to a paste to goo. They observed how materials change, and how the quantity of each ingredient (water/soil) affects the outcome. Children took sticks to see if it could be used to paint with.

Mathematical Concepts Explored

- *Volume: Full/empty, half-full, more/less
 - *Measurement: Using cups/spoons to measure soil and water
 - *Comparisons: Thick vs. thin, wet vs. dry, heavy vs. light
 - *Estimation and counting: "How many scoops do you need?"
- Children counted as they added scoops of soil and cups of water, they added more water to see if it would make the mud runnier and more soil to see if it would be thicker.

Links to the curriculum.

Welsh Government (2020b) Science and Technology

- * I can explore how materials change when they are mixed.
- * I can observe and describe the effects of mixing materials.
- * I can explore how things work and why things happen.

Welsh Government (2020a) Mathematics and Numeracy

- * I can use non-standard units to measure.
- * I can compare quantities using language like more, less, full, and empty.
- * I can explore and describe the properties of objects and materials.

Welsh Government (n.d.) Curriculum for Non-Maintained Settings (3–4 years)

- * Understanding how natural materials behave when combined.
- * Exploring through sensory play and creative use of the outdoors.
- * Using number language and measurement in real contexts.

Reflection

What stood out was the depth of scientific observation happening through play. The children were not simply making a mess, they were experimenting with materials and learning about properties, transformation, and quantity through joyful, direct experience. This experience reinforced how powerful child-led exploration can be when paired with thoughtful adult support. By tuning in to the children's interests and extending their thinking through reflective dialogue, we nurtured not only their curiosity but also their capacity for self-directed learning.

Next Steps

- *Continue to model reflective language and questioning in sensory and investigative play.
- *Offer more opportunities for children to mix, test, and create using natural materials.
- *Introduce tools for simple documentation (e.g., drawing, mark-making, or photo sequences) to support reflection and recall.
- *Explore how we might incorporate children's reflections into learning stories or group discussions.

Part 3: Risk-benefit assessment

Activity	Hazard (Potentially dangerous item or situation)	Risk (Incident / accident that MAY happen)	Likelihood × Severity	Benefit	Action to Remove or Reduce Risk	Who?	When?	Risk Level (when actions observed)
Woodland exploration	Uneven ground/tree roots	Trips and falls	$5 \times 3 = 15$	Develops balance and spatial awareness. Children learn to manage risk.	Pre-visit site check for trip hazards. Children are encouraged to walk carefully. First aid kit on hand.	Teacher	Before and during the session	Medium
Mud play & puddles	Wet/slippery surfaces	Slips and falls	$4 \times 3 = 12$	Sensory exploration and gross motor skill development	Appropriate footwear. Make children aware of slippery areas.	Teacher	Before and during the session	Medium

					First aid kit on hand.			
Log/stump climbing	Unstable logs	Falls, bumps, or splinters	$3 \times 3 = 9$	Builds strength and coordination. Confidence through managed risk.	Check log stability beforehand. Supervise climbing. Teach safe techniques. First aid kit on hand.	Teacher	During session	Medium
Natural materials (e.g., sticks, leaves)	Sharp edges or contact with the face or other children Children could throw and hit someone	Scratches, eye injury, bumps	$3 \times 2 = 6$	Sensory and imaginative play. Using natural objects for other purposes	Model safe stick use. Use sticks below shoulder height. Remind children to be aware of others.	Teacher	Before and during session	Medium

					First aid kit on hand.			
Low-hanging branches	Low-level branches, children or staff could walk into them	Bumped heads or eye injuries	$2 \times 2 = 4$	Encourages spatial awareness	Highlight branches to avoid. Trim if necessary. Supervise and guide children's movement. First aid kit on hand.	Teacher	Before and during the session	Low
Insects or stinging plants	Allergic reaction, stings, bites	Mild allergic response or discomfort	$2 \times 3 = 6$	Nature awareness and biodiversity learning	Pre-check for nettles or nests. Discuss safe plant interaction. First aid kit on hand.	Teacher	Before and during the session	Medium

Boundaries path/building	Children wandering off	Separation from the group	$2 \times 4 = 8$	Develops boundary awareness and independence	Set clear boundaries. Use visual markers. Conduct regular headcounts.	Teacher	Before during and at the end the session	Medium
Use of tools (e.g. spoons, scoops)	Throwing, misuse	Minor injuries	$2 \times 2 = 4$	Encourages fine motor skills and problem-solving	Model tool use. Encourage sharing and safe handling.	Teacher	During session	Low
Stream (small muddy channel)	Slips, falls getting stuck	Slips, trips, wet feet	$4 \times 3 = 12$	Children learn to manage risk. Enhances understanding of natural elements like water flow, soil, and	Appropriate footwear Adult supervision. Children are encouraged to walk carefully.	Teacher	During session	Medium

				weather impact.				

Part 4: Academic piece

Outdoor Environments as Foundations for Mathematical and Scientific Thinking.

Outdoor environments are increasingly recognised as powerful grounds for nurturing mathematical and scientific thinking. These spaces, when intentionally designed and facilitated, become dynamic learning landscapes where curiosity thrives, and foundational concepts take root. Adults play a pivotal role in this process, not merely as supervisors but as co-explorers and architects of enabling environments that invite inquiry, experimentation, and discovery. Through thoughtfully arranged spaces, purposeful interactions, and sensitive facilitation, outdoor environments can provide children with the freedom to explore while ensuring their learning is scaffolded in meaningful, developmentally appropriate ways.

Research by Trina *et al.* (2025) supports this perspective by highlighting that purposefully designed outdoor environments offer rich affordances for early Science, Technology, Engineering, Arts, and Mathematics (STEAM) learning. When educators thoughtfully set up outdoor spaces using natural materials such as sand, water, and plants, they create environments that support children's learning in science, problem-solving, and critical thinking. Pentagon Play (2025) further emphasises the role of adult scaffolding in transforming outdoor play into structured STEAM learning opportunities, suggesting that educator-led questioning and modelling are key to deepening children's engagement. Similarly, Trina *et al.* (2025) demonstrate that nature-based outdoor learning environments have a significant influence on early years STEAM concept formation, particularly when design features are aligned with developmental needs. These findings underscore the importance of both environmental design and adult interaction in cultivating rich, inquiry-driven STEAM experiences in early childhood settings.

The effectiveness of outdoor mathematical and scientific learning hinges not only on the environment itself but also on the quality of adult engagement within it.

Evaluating adult support requires attention to how educators recognise and respond to mathematical moments in play, and whether they extend children's thinking through open-ended questioning, modelling of mathematical language, and encouragement of sustained shared thinking (Campbell *et al.* 2018)

Adults who are attuned to children's explorations can transform spontaneous encounters with quantity, pattern, and spatial reasoning into rich learning experiences that foster deeper cognitive development.

Fleer's concept of "conceptual play" highlights the significance of adult-guided interactions in everyday contexts, where meaning is co-constructed through shared imaginative engagement (Monash University, n.d.). This approach positions adults as active facilitators who scaffold children's understanding by embedding learning within playful, narrative-rich experiences. Kiviranta, Salminen and Pihlaja (2024) suggest that practitioners support children's outdoor mathematical learning by encouraging different ways of seeing, touching, and doing. They argue that ongoing professional development is crucial for equipping practitioners with the skills to design and guide meaningful mathematical experiences outdoors.

Building on this, Meylani (2024) underscores the importance of culturally responsive facilitation, noting that adults who are attuned to children's backgrounds and interests can foster deeper mathematical thinking through play-based and environmental exploration. This approach not only supports cognitive development but also promotes inclusivity and engagement. Together, these studies point to the need for intentional adult scaffolding, where educators blend pedagogical knowledge with cultural sensitivity to create rich, inquiry-driven mathematical encounters in natural settings.

Alongside adult scaffolding and conceptual play, metacognition has emerged as a vital component in early childhood education, particularly in fostering children's independence and reflective thinking. Metacognitive skills—such as planning, monitoring, and evaluating one's own learning—enable children to become more self-aware and strategic learners. Eberhart, Ingendahl and Bryce (2024) found that metacognitive interventions significantly enhance young children's self-regulated learning and academic achievement, with long-term benefits for self-efficacy and executive functioning. These findings align with Ozturk's (2024) emphasis on embedding metacognitive interactions within familiar, meaningful tasks and social contexts, where children are encouraged to think about their thinking through shared regulation and reflective dialogue. Moreover, Jacobson (2024) highlights that metacognitive thinking helps children manage frustration, build resilience, and shift

from “I can’t” to “How can I?”, especially when facing challenges in learning or social situations. When integrated with Fler’s conceptual play framework, metacognitive strategies can deepen children’s engagement by prompting them to reflect on their imaginative choices and problem-solving processes. Thus, metacognition not only complements adult facilitation but also reinforces the importance of creating emotionally safe, cognitively rich environments where children can explore, reflect, and grow.

At the same time, research cautions that excessive scaffolding may unintentionally suppress children’s independence and creativity, limiting their choices and imagination and resulting in low-depth learning with little independence. Mulholland (2025) argues that while scaffolding is essential for supporting learners, it must be gradually withdrawn to promote autonomy, warning that over-scaffolding can lead to dependency and hinder deeper engagement. Effective facilitation demands pedagogical sensitivity, the ability to balance adult support with children’s autonomy. Papadopoulou and Vincent (2025) emphasise that such sensitivity is crucial in outdoor settings, where educators must reflect on their role and intentionally step back to allow children’s agency to flourish. Their findings demonstrate that when adults scaffold learning responsively rather than prescriptively, children engage more deeply with mathematical ideas through exploration, problem-solving, and place-based inquiry.

Experiential Learning Theory (Kolb, 1984) provides a valuable framework for understanding how children construct knowledge through direct interaction. In outdoor contexts, this theory comes alive as children manipulate objects, test ideas, and refine their understanding through trial and error. Sutton (2025) expands upon Kolb’s model by highlighting the importance of sensory and emotional engagement in the learning process, suggesting that a holistic approach enhances cognitive development. Recent studies in early childhood education further show that such hands-on, nature-based experiences deepen learning by engaging children in meaningful, real-world contexts (European Proceedings, 2023). Adults who embrace this approach foster deeper learning by asking open-ended questions, encouraging predictions, and validating children’s theories—even when imperfect.

Curiosity is central to scientific and mathematical thinking. It is not an innate trait that develops in isolation but must be intentionally nurtured. Jirout (2020) highlights that adults who model wonder, engage in joint exploration, and provide diverse materials create environments where children feel safe to ask questions and take intellectual risks. Everyday moments such as observing insects, collecting leaves, or experimenting with water often spark curiosity, forming the foundation of scientific reasoning and early mathematical understanding. When adults encourage inquiry and guide reflection, they transform spontaneous play into meaningful learning experiences that support long-term cognitive growth.

The Reggio Emilia philosophy positions the environment as the “third teacher,” highlighting the importance of spatial design and adult intentionality. Bartolini (2021) illustrates how Reggio-inspired outdoor STEM environments can spark inquiry and reasoning through provocations such as pattern-making with natural materials or exploring symmetry in leaf structures.

Froebel’s educational philosophy similarly offers a compelling framework for outdoor learning in mathematics and science. Central to his vision was the kindergarten as a “garden for children,” where nature itself becomes a dynamic learning environment (Tovey, 2023). Froebel emphasised self-activity, hands-on exploration, and guided play—principles closely aligned with contemporary approaches to outdoor STEAM education. Recent practitioner research extends these ideas, showing how Froebelian principles can spark interest in outdoor numeracy among children who may otherwise disengage (McInnes & Wright, 2023).

The Woodland Trust’s Outdoor Learning Resource Pack (2020) offers a valuable framework for understanding how adults can scaffold early mathematical and scientific thinking in outdoor environments. Drawing on Maslow’s Hierarchy of Needs, the resource emphasizes that outdoor learning supports children’s cognitive development by meeting their physiological and emotional needs. Adults act as facilitators, guiding embodied activities such as estimating tree height through visual trigonometry or calculating age via trunk girth. Scientific inquiry is supported through biodiversity mapping, tree identification, and thermal experiments, with adult mediation essential for provoking questions and guiding safe exploration.

These practices reflect guided play principles outlined by Skene *et al.* (2022), and align with statutory guidance such as the EYFS Framework (Department for Education, 2025a, 2025b) and Development Matters (2023). Collectively, they demonstrate how national policy supports the integration of mathematics and science into everyday outdoor experiences, underscoring the significance of adult facilitation in linking play with learning outcomes.

Loose Parts Theory, originally proposed by Nicholson (1971, cited in Play Scotland, 2016) emphasises the value of open-ended materials that children can manipulate, combine, and repurpose. Such materials—sticks, stones, shells, fabrics—stimulate creativity, exploration, and problem-solving. Oskar’s Wooden Ark (2022) and Wehrell-Grabowski (2018) demonstrate how loose parts play can promote STEAM content, encouraging design thinking, experimentation, and collaboration.

Gibson’s theory of affordances enriches this understanding by showing how children perceive and act upon the possibilities offered by their environment. Affordances are relational rather than static, emerging through the interaction between child and environment (Davis, 2014). As children engage with natural materials outdoors, they discover new affordances shaped by their motor development, intentions, and cultural context. Adults who sensitively support this process scaffold experiences that integrate scientific and mathematical reasoning into imaginative play (Creative STAR Learning, 2024).

Vygotsky’s sociocultural theory remains central to understanding outdoor learning, particularly through concepts of scaffolding and the Zone of Proximal Development (ZPD). Recent studies confirm that teacher mediation strongly influences children’s ability to engage in scientific practices, aligning with Vygotsky’s view of co-constructed knowledge (Hsin, Wu & Chen, 2024). Wibowo, Wangid and Firdaus (2025) further show how ZPD underpins differentiated learning approaches that meet diverse needs, while Rigopouli (2025) extends these principles to creativity and technology-enhanced learning. However, Carranza-Pinedo, de Bruin and Verheij (2025) caution that misaligned scaffolding can constrain autonomy, reiterating the importance of facilitation that is responsive rather than prescriptive.

Piaget's theory of cognitive development also provides insight into how children learn outdoors. In the sensorimotor stage, infants learn through sensory exploration and motor interactions, while preschoolers in the preoperational stage engage in imaginative and symbolic play. Recent studies confirm these claims: Craig *et al.* (2024) found that nature-based play environments for children under three enhance sensory, motor, and perceptual development, while Cakan and Acer (2024) observed that outdoor play in natural settings promotes symbolic play aligned with Piaget's preoperational stage. Dewey's philosophy of "learning by doing" complements this, arguing that education emerges through active engagement with real environments (Sulistiawati, 2024).

Piaget and Bruner together provide complementary lenses. Piaget emphasises biological maturation and discovery, while Bruner highlights scaffolding, cultural tools, and symbolic representation. Bruner's concept of the spiral curriculum and his socially responsive framework align particularly well with trauma-informed and inquiry-based pedagogies, offering flexible ways to scaffold learning in outdoor, STEAM-rich contexts (Aubrey & Riley, 2021).

Carbon (2013) observes how nature-based play naturally fosters sensory engagement, inquiry, and creativity, integrating multiple domains of STEAM. Activities such as comparing the weight of rocks and leaves or observing the hues of the sky combine scientific reasoning, mathematical thinking, artistic exploration, and emergent engineering. Stronger Practice Hubs (2024) reinforce this view, arguing that natural materials, loose parts, and thoughtfully arranged spaces offer powerful affordances for inquiry. Ultimately, the true value lies in the quality of adult engagement—educators who recognise "teachable moments," model curiosity, and balance scaffolding with children's autonomy transform play into deep, inquiry-driven learning.

When framed by theories from Kolb, Froebel, Vygotsky, and Piaget, enriched by approaches such as Reggio Emilia and Loose Parts Theory, and supported by frameworks such as EYFS, outdoor environments emerge as uniquely capable spaces for fostering curiosity, creativity, and foundational STEAM concepts.

Outdoor environments hold immense potential for nurturing early mathematical and scientific thinking, particularly when purposefully designed and paired with sensitive adult facilitation. Research demonstrates that natural spaces enriched with loose parts and open-ended materials foster inquiry, problem-solving, and creativity.

Theoretical foundations from Kolb's experiential learning to Vygotsky's sociocultural theory provide insight into how children learn through exploration, collaboration, and scaffolding. Practical frameworks, such as the Woodland Trust's resource pack and EYFS guidance, further highlight the importance of aligning pedagogy with policy.

Ultimately, outdoor learning thrives when educators balance structure with freedom, scaffolding with sensitivity, and curiosity with guidance. In these environments, children not only develop foundational mathematical and scientific concepts but also build resilience, creativity, and a sense of connection to the world around them.

Nature becomes the classroom, play becomes the pedagogy, and curiosity becomes the driver of lifelong learning.

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