Awe and Wonder – Science, Mathematics and the Outdoors

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AI Statement

I have not used AI in the completion of this assignment.

Part 1 - Photograph

Figure 1: Woodland Area (personal collection, 2025)

Part 2 – Narrative Observation and Learning Analysis

Introduction:

Narrative observation for Child A, detailing a trip taken to a local wooded area as part of a group of eight mixed-gender four-year-olds. The children were accompanied by three staff members, operating on a one-to-four ratio with a supernumerary to facilitate safer, deeper learning. Further to this, each child was given an 'explorer's pack'– a waterproof backpack containing a magnifying glass, a small clipboard with attached pencil and paper, a pair of plastic tweezers, a child-sized hand trowel and a clear, plastic container.

Learning Experience #1:

When the group arrived at the wooded area, Child A was immediately drawn to the abundant natural loose parts on the ground and quickly set about gathering an assortment of leaves, pebbles, pinecones, and twigs.

A staff member observed as she used her tweezers to place one of the leaves on her clip board and her magnifying glass to look closely at it.

Child A: "Miss! Come look! The leaf has little lines all over it, just like my hands!"

The staff member walked over and knelt beside her, looking intently at the leaf as well.

Staff member: "So it does! I wonder what those little lines do?"

Child A, after thinking for a moment: "I think the tree uses them like straws, so it can catch all the rain as it falls down."

Staff member: "Why would the tree want to catch the rain? Is it trying to have a shower?"

Child A, laughing and shaking her head: "No! It needs to drink it because it doesn't have a tap to fill its water bottle."

Staff member: “That makes sense, why do you think some of the leaves are different sizes then?”

Child A: “Because the trees are different sizes, so they need different size straws.”

The staff member then picked up a smaller leaf from the ground beside them and held it up against the one on the clipboard.

Staff member: “So, do you think the tree that this leaf comes from is bigger or smaller than the tree your leaf is from?”

Child A took the leaf and examined it closely, moving her head back and forth between the leaf on the clipboard and the one in her hand.

Child A: “Smaller because it’s smaller than my leaf. See.”

She pressed the leaf on top of the one on the clipboard and pointed to the overhang.

Child A: “My leaf has lots of space left.”

Staff member: “It does! I wonder how many little leaves it would take to fill up your whole leaf?”

Child A looked around them carefully, selecting more of the small leaves, comparing them to the original to make sure that they were the ‘right ones.’

Child A: “It takes three! My leaf is three little leaves big!”

Analysis of Learning:

In this interaction, Child A demonstrated clear early scientific enquiry by forming a hypothesis that trees drink through their leaves and linking that to her understanding of her own hydration needs. This is direct evidence of Curriculum for Wales Science and Technology Progression Step 1: ‘I can show curiosity and question how things work’ and ‘I can recognise that plants and animals are living things which grow’ (Welsh Government, 2020a).

Furthermore, by choosing to overlay the smaller leaves to measure the larger one, Child A demonstrated her ability to compare the relative size of objects and was able to accurately use cardinal numbers to convey the quantity of smaller leaves required

to cover the surface area of the larger leaf. This links to Mathematics and Numeracy Progression Step 1: ‘I can make estimates and comparisons with measures, such as ‘shorter than’, ‘heavier than’’ and ‘I can count objects that I can touch and ones I cannot’ (Welsh Government, 2020b).

Learning Experience #2:

Bored of comparing leaves, Child A pulled her trowel from her pack and began scraping away at the earth by their feet before standing up.

Child A: “This is bad for digging, we need to find somewhere more squishy to dig.”

The staff member nodded and allowed Child A to lead her towards the trees where the ground was softer.

Child A stamped her feet a couple times before nodding happily.

Child A: “This is good for digging, it’s all squishy. Look.”

She held up her boot, showing the staff member the mud that was now stuck to it.

Staff Member: “It is, it’s stuck to your shoes now. I wonder why it stuck over here but not when we were looking at the leaves?”

Child A looked back and forth between where they stood and where they’d been sat.

Child A: “Maybe the sun took all the water from there. Mummy says that the sun takes all the water from our clothes.”

She dropped down into the mud and began digging in the soft earth.

Seeing that Child A was happily engaged in this activity and no longer interested in conversation, the staff member walked over to another child and began conversing with them.

A short while later, Child A ran over to the staff member and began pulling her towards the spot she’d been digging.

Child A: “Miss! I found a wiggly worm!”

She crouched down and pointed at a small wriggling worm, on top of the pile of dirt she’d amassed.

Child A: “See! It’s a wiggly worm!”

The staff member crouched beside her and watched the worm as well.

“It is a wiggly worm, where do you think it’s going?”

Child A watched as it began to burrow its head into the earth.

Child A: “I think it’s digging too. It moved the mud, just like me.”

Staff Member: “I think you’re probably right. It’s making a little hole, just like the one you dug. Does it have a trowel like you?”

Child A pulled out her magnifying glass and stared intently at the worm.

Child A: “No! It’s just wiggling the dirt around.”

Staff Member: “That’s interesting. I wonder why it’s not using a trowel?”

Child A returned to her examination and watched the worm work its way deeper into the pile of earth.

Child A: “I think it’s going to its house now. I can’t see it anymore.”

Learning Analysis:

Here, Child A demonstrates an understanding of the changeable nature of different materials by moving to an area of softer ground where digging is more achievable, linking to Science and Technology Progression Step 1: ‘I can explore the environment, make observations and communicate my ideas’ and ‘I can explore the properties of different materials for a particular use’ (Welsh Government, 2020a). Furthermore, Child A’s observations of the worm indicate emergent causal thinking–drawing parallels between her own digging and the worm’s movements. This links to Science and Technology Progression Step 1: ‘I can identify, follow, and begin to create sequences and patterns in everyday activities’ (Welsh Government, 2020a), in addition to Mathematics and Numeracy Progression Step 1: ‘I am beginning to recognise, copy, extend, and generalise patterns and sequences around me’ (Welsh Government, 2020b).

Encouraging Further Learning:

Child A has demonstrated a clear enthusiasm for exploring her environment and understanding the differences between organisms. To encourage this interest and extend Child A's learning, plans have been made for the children to undertake several return trips throughout the year. It is hoped that this will allow Child A first-hand experience of the shifting nature of natural areas and deepen her understanding of the lifecycles within that environment.

These trips will also allow staff to extend upon Child A's mathematical and numerical learning by introducing measuring apparatus such as rulers, weighing scales and volumetric containers. These resources are intended to facilitate further exploration into the relative properties of materials and to introduce the concept of units of measurement, in preparation for later learning.

Part 3 – Risk-Benefit Assessment

Location:	Local Woodland	**Date:**	20 September 2026
Assessor:	Maddison Slade	**Review date:**	20 March 2027

Experience exploring outdoor space in photograph	**How will young people BENEFIT from this activity?**	**Hazards and associated risks**	**Who is at risk?**	**PRECAUTIONS in place to reduce the risk of injury**	**Overall risk after precautions RATING: L/M/H**
Walking on uneven ground	Walking on uneven ground benefits children's physical development in several key ways, such as; improving their vestibular sense, allowing them to balance more easily; strengthening their joints, making them less prone to injury; encouraging body awareness, leading to better control of their gross motor movements. Walking on uneven ground also helps to develop children's situational awareness as they must pay more attention to their surroundings to ensure that they are placing their feet correctly, particularly in unfamiliar areas. This can also aid children in developing the ability to more accurately assess risks for themselves,	One hazard associated with walking over uneven ground is the possibility of tripping or falling. This carries a risk of injury such as bruises, cuts, scrapes, or sprains. There is a secondary risk of infection due to the potential contamination of outdoor surfaces.	Children and Adults	The staff will discuss safe practices for walking over more challenging surfaces such as walking slowly until comfortable and confident, what signs to look for to suggest a path maybe safer or more challenging, and what to do if they fall while on the trip. Further to this, games sessions will be held at the setting to encourage the children to develop these skills in a controlled environment. Everybody attending any of these trips will be required to dress appropriately for the environment, including long trousers and long sleeved t-shirts, to help provide protection in the event of a fall. Sensible footwear is required at all times.	L

Experience exploring outdoor space in photograph	How will young people BENEFIT from this activity?	Hazards and associated risks	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk after precautions RATING: L/M/H
	enabling them to take steps to protect themselves.			A first aid kit must be carried at all times while off premises, to allow for prompt treatment of any injury.	
Exploring natural areas	Exploring natural areas allows children to develop their spatial reasoning skills by estimating whether they will fit into different areas and improves their problem solving by requiring them to independently consider which movements may be required to do so. Time spent in natural areas also fosters interest in and develops understanding of the non-human life that makes up the majority of our ecosystem, such as plants, animals, and mini-beasts. This is linked to improved environmental awareness in later life while also providing immediately usable knowledge. Exploring natural areas helps to foster children's feelings of	There are several hazards related to exploring natural areas, such as low branches, which may cause eye injury; raised roots, which can cause trips and falls; contact with poisonous, irritant or otherwise harmful plants, animals or mini-beasts, potentially leading to an allergic reaction.	Children and Adults.	In addition to the steps outlined above, children will be educated regarding safety rules for outdoor exploration such as nothing in the mouth, wash hands when finished, stay where the adults can see you, and always keep your high-visibility vest on. Games sessions will also be held to embed these lessons prior to undertaking trips off premises. Furthermore, children will be equipped with whistles to enable them to be found quicker if they should wander out of sight and become lost or hurt. Children and staff will be educated on common plants and creatures, allowing them to identify and avoid harmful plants. Instruction will also be given to avoid interaction with anything that cannot confidently be identified.	L

Experience exploring outdoor space in photograph	How will young people BENEFIT from this activity?	Hazards and associated risks	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk after precautions RATING: L/M/H
	independence and self-determination, allowing them to feel a greater sense of ownership over their learning. This has been shown to help foster a lifelong love of learning.	In unsecured areas, children run the risk of becoming lost, interacting with strangers, or being approached by an off-lead dog.		Children will be instructed not to approach anyone not involved with the trip and staff will be trained on the proper protocol and procedure for interactions with off-lead dogs and members of the public. Medications for any known allergies or sensitivities must be carried by staff members at all times and a mobile phone must be available to contact emergency services, if necessary.	
Collecting natural resources	Collecting natural resources allows children to develop their fine motor skills by learning to grasp and grip objects of different sizes, textures, and fragility. This, in turn, allows children to begin learning how to examine the properties of a material and to begin forming theories about how they might be used. The variety inherent in natural resources lends itself to grouping, counting and sorting activities. These activities are foundational to developing children's	Children may collect things hazardous to their health. For example, sharp stones may cause cuts, while collect twigs can cause splinters. Increasing littering and fouling issues may lead children to collect	Children and Adults	The area will be checked and cleared of all litter and faecal matter by staff members equipped with gloves and any other required PPE prior to the children's arrival. The setting will utilise flashcards and other play-based teaching methods to help the children learn to identify things which are safe to collect and examine and those which would be unsafe or unwise to collect. Adults will maintain strict supervision of the children at all times, allowing them to identify hazardous material	L

Experience exploring outdoor space in photograph	How will young people BENEFIT from this activity?	Hazards and associated risks	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk after precautions RATING: L/M/H
	understanding of broader mathematical and numerical concepts. Collecting activities also allow for conversations between children and staff regarding safe collecting and ensuring that we don't harm the environment with our actions.	contaminated matter, leading to an increased risk of illness.		and remove it from the children's play space. This will also support the children learning to identify and avoid these items independently by showing concrete examples of items from their flashcards.	
Digging and playing with soil	Digging and playing with soil is a multi-sensory experience which allows children to experiment with transforming the state of a material by breaking hard earth, compacting loose earth, and mixing it with water. By disturbing the earth, children are also afforded the opportunity to discover the hidden wildlife beneath the forest floor such as worms, beetles, and other such creatures.	Children could ingest or absorb harmful chemicals if the soil is contaminated. Slipping with a tool could cause injury, if sufficiently sharp or forceful.	Children and Adults	Children will be remined not to put anything in their mouths, to wash their hands after playing in the soil, and to inform an adult if they notice any reaction to anything they touch. Staff will monitor for any sign of reaction and will disallow this activity if there is any reason to suspect it would be unsafe such as nearby pesticide use or evidence of heavy animal activity. Tools will be checked for sharp edges and safe use will be modelled at all times.	L

Part 4 – Academic Writing Piece

This essay intends to explore the role of early years practitioners in supporting early mathematical and scientific learning for children under seven years of age. Through discussion of longstanding theory, recent research, and current Welsh frameworks, it will examine the dynamic interplay between resources, environment, and pedagogy which influences the current approach to early Science, Technology, Engineering, and Mathematics [STEM] education in Wales. Consideration will also be given to a selection of limiting factors faced by early years practitioners operating in today's climate.

In their scoping review, Trina *et al.* (2024, p. 15) described natural, outdoor environments as 'living schools'– high affordance environments which encourage scientific enquiry. Conceptualised by James Gibson in 1979 (Gibson, 2014, p. 1), affordance theory refers to the understanding that all environments can encourage learning if the individual is primed to perceive the opportunity (Campbell and Speldewinde, 2020, p. 2). Within this theory, it is further understood that environments which allow for direct interaction offer more possibilities for learning and thus a higher affordance (Trina *et al.,* 2024, p. 15). Moreover, Experiential Learning Theory highlights the interaction between children in early childhood and their environment as a key element of their ability to construct a holistic understanding of the world (Wiedel-Lubinski, 2019, p. 179).

The diverse features of a natural landscape encourage children to engage in hands-on exploration of scientific concepts (Trina *et al.,* 2025, p. 55). Soft earth is likely to encourage children to dig, thereby introducing the scientific concepts of force and the mathematical concept of depth (Bucher and Hernández, 2016, para. 7). Meanwhile, a child's urge to collect small objects, such as pebbles and twigs, lends itself to grouping, counting, and identifying activities (National Education Nature Park, n.d). The Curriculum for Wales highlights the foundational nature of these skills, listing them among the Descriptions of Learning in Progression Step 1 of both the Science and Technology and Mathematics and Numeracy Areas of Learning and Experience [AoLEs] (Welsh Government, 2020a; 2020b).

However, while it is a statutory requirement for all nurseries operating in Wales to make suitable provisions for regular outdoor play (Welsh Government, 2026), this provision is often limited to unstructured play sessions in rubberised playgrounds (Maynard, Waters and Clement, 2013, pp. 282-299). While the move towards these standardised playground structures has developed from a desire to prevent harm to children, the standardisation of children's play areas removes much of the affordance provided by more natural outdoor environments (Play Wales, 2021; Craig *et al.*, 2024, p. 2).

When the variability of natural features is stripped away, replaced by safety flooring, equally spaced monkey-bars and prescriptive usage guidance, a child's innate curiosity is inadvertently stunted (University of Sheffield, n.d). Natural features serve as spark points, encouraging children to observe, question and investigate the non-human world (Speldewinde and Campbell, 2022, pp. 775-792). Research analysis conducted by Summers, Vivian and Summers (2019, pp. 142-150) found that children who regularly spent time in nature showed more interest in natural phenomena and a better understanding of the interconnection of the lifecycles in the ecosystem. Furthermore, Rosa, Profice and Collado (2018, pp. 7-8) noted that exposure to natural environments in early childhood was positively associated with environmental awareness into adulthood.

Therefore, early years practitioners can support mathematical and scientific learning in early childhood by facilitating access to thoughtfully selected, diverse outdoor environments. However, a natural environment alone is not sufficient to educate children on scientific or mathematical concepts. The Reggio Emilia approach advises that equal thought must be given to the preparation of the area, noting that the correct resources can exponentially extend a child's learning (Yufiarti *et al.,* 2022, p. 300).

The theory of loose parts, originally published by Nicholson (1971, pp. 30-34), highlights the role of open-ended materials in encouraging children to engage in engineering behaviours. In his introductory paper, Nicholson (1971, p. 31) observed that when children are provided with these manipulable, open-ended materials, they engage in problem-solving processes akin to those employed by adult engineers– hypothesising, testing ideas, evaluating failures and refining their approach until they

achieved their desired goal. Furthermore, recent research conducted by Cankaya *et al.* (2025, p. 5) found that the children showed significantly more engagement with STEM concepts when provided with loose parts, compared to a control group supplied with musical resources.

The term loose parts, defined by Gull *et al.* (2019, p. 48) as 'open-ended, interactive, natural and manufactured materials', encompasses a wide range of resources that facilitate multi-faceted learning. For example, when provided with sticks and string, children might explore structural engineering by constructing a den – testing concepts of balance, gravity, and material properties (Donnelly, Speldewinde and Bridle, 2025, pp. 2185-2209). Equally, children may choose to use those same materials as non-standard units of measurement, comparing lengths of sticks or using the string to quantify the perimeter of objects (Rosmayanti, Rahmat and Syarifudin, 2026, pp. 232-233). When provided with guttering alongside natural loose parts, like water, pebbles and sand, children can explore concepts of fluid dynamics, gravity, and friction (Dinwiddie, 2005). Furthermore, children can experiment with cause and effect by adjusting the angle of the guttering and use the results to construct a deeper scientific understanding of physical forces (Cankaya *et al.,* 2023, p. 3).

However, practitioners play a crucial role in the efficacy this provision, carefully curating the selection of loose parts to extend learning while avoiding cognitive overload or resource clutter (Foster, 2025, pp. 17-22). Effective support of early mathematical and scientific enquiry requires practitioners to actively observe the children at play and use this information to dynamically adapt the outdoor environment to scaffold the children's emerging interests (Estyn, 2024).

In his Zone of Proximal Development [ZPD] theory, Vygotsky highlighted the role of social learning in child development, arguing that the 'more knowledgeable other' serves a vital role in supporting children's development (Abtahi, 2017, pp. 35-36). Building on Vygotskian theory, Wood, Bruner and Ross (1976, pp. 89-99) conceptualised this role as similar to scaffolding, encouraging practitioners to provide tailored support which is gradually withdrawn as the child's independent competence grows. However, for this approach to be successful and to avoid causing unproductive frustration, practitioners must be attuned to the child's current

competency, meeting them where they are and building upon it incrementally (Smit *et al.*, 2017, pp. 124-127).

Therefore, practitioners must be actively engaged in the children's learning so that they can develop a clear understanding of the child's individual aptitudes and identify areas where they may require additional support (Louis, 2022). This approach aligns with the pedagogical guidance found in the Curriculum for Wales (Welsh Government, 2023), which emphasises the importance of child-led education and a child-centred approach to observation.

Moreover, practitioners can use these observations to scaffold the children's learning through Sustained Shared Thinking [SST]. Originally conceptualized by Siraj-Blatchford *et al.* (2002), SST occurs when two or more individuals work together to evaluate a problem and move towards a solution. In the context of early childhood education, this helps to elevate unstructured play and discovery into a rich learning opportunity (Siraj-Blatchford, 2009, pp. 77-81). However, it is crucial that the practitioner does not overpower the child's voice but instead uses open-ended questions to encourage the child to develop their ability to formulate hypotheses, communicate ideas and evaluate cause and effect (Brodie, n.d). These instances of SST also provide a valuable opportunity for practitioners to introduce precise mathematical and scientific vocabulary in directly applicable, physical contexts (Simoncini and Anyos, 2025, p. 171).

However, in practice, practitioners often report lacking the time to dedicate to tailoring the learning environment for each individual child. For instance, research by Purdon (2014, pp. 269-276) and Kiviranta *et al.* (2023, p. 278) highlights that while practitioners recognise the value of pedagogical interactions as described above, competing daily responsibilities limit their capacity to facilitate individualised, high-quality interactions with all children in their care. This suggests a profound disconnect between theoretical foundations, policy frameworks, and real-world practice, leading to suboptimal learning conditions for the children.

Furthermore, a scoping literature review conducted by Gray *et al.* (2025, pp. 1-3) indicates that early years practitioners frequently perceive natural outdoor settings as high-risk environments, driven primarily by fears of physical harm and negative parental reactions. This is indicative of the wider societal shift towards risk aversion

in early childhood and beyond, noted by Jerebine *et al.* (2024, pp. 1-9). While the instinct to protect children is natural and foundational to high-quality childcare provision (Social Care Wales, 2018), a culture of risk elimination inadvertently limits the ability of early years practitioners to support the full breadth of scientific exploration afforded by time spent outdoors (Hanrahan, 2023, pp. 208-219).

Therefore, it is essential that early years practitioners are trained to assess both the risks and the benefits of a given location or activity (Gray *et al.*, 2025, pp. 42-43). This aligns with the Forest School approach which highlights the importance of allowing children to experience controlled risks to prepare them for later life and encourage independent risk assessment (Forest School Education, 2019). Furthermore, efforts must be made to educate parents on the developmental necessity and cognitive benefits of risky play (Manners, 2019). This would enable practitioners to encourage the child's scientific exploration without fear of reprisal or rebuke, helping to align practice with governmental guidance issued by such departments as the Health and Safety Executive (n.d).

In conclusion, while both the environment and its preparation play key roles in supporting early STEM acquisition, the most influential way in which early years practitioners foster mathematical and scientific enquiry is their pedagogy. However, it cannot be denied that there are significant, external limitations to a practitioner's ability to provide effective outdoor pedagogy in the current educational climate.

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