

Awe and Wonder – Science, Mathematics and the Outdoors

Part 1



Image: Stream and trees, Clyne Gardens (J MacDonald 2024)

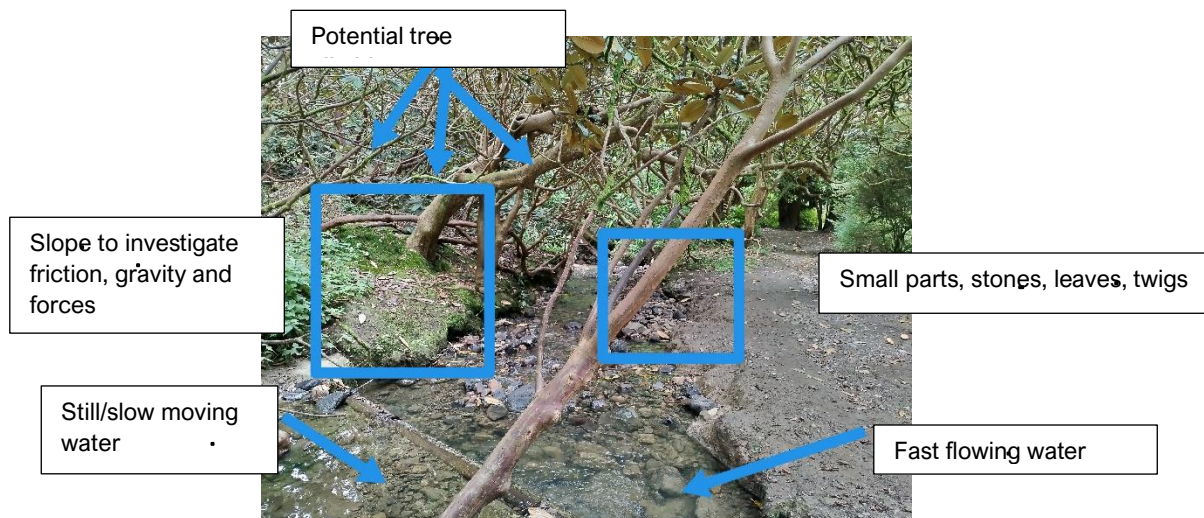
Part 2

The above image is of the proposed location for an excursion with Progression Step 1 pupils of the local primary school, with children's ages ranging from 3 to 5 years. Although the children fall into this progression step, learning potential will not be limited or restricted in line with the New Curriculum for Wales ethos (Welsh Government 2024). The children will be accompanied by staff ensuring the ratios for safety are met, with the initial input from these adults being ground rules and safety advice, for example areas that can be explored, trip hazards, water safety and making the children aware that members of the public may use the gardens so to be mindful of the dangers of wandering off or following anyone. The staff will provide baskets, to allow the children free reign to collect and gather items that interest them, fishing nets, to access parts of the stream, magnifying glasses, to encourage them to look closely and examine the things they find, and watering cans to collect water allowing the children to create their own streams and watch as the water searches for the fastest route back to the stream or creates pools and puddles. This excursion will be child-led with minimum input from the accompanying adults, allowing the children to explore and investigate. The

role of the adults in this situation is to enable the children to explore and discover concepts through play. As quoted by Bone (2021) Einstein famously said, "Play is the highest form of research", which shows his belief in the value of curiosity, creativity, and exploration. This emphasises that playful experimentation often leads to deeper insights and discoveries and shows that Einstein viewed play not just as a child's activity but as an essential part of intellectual and scientific inquiry. Allowing the children the opportunity to explore and play in this rich natural environment should continue this inquiry and follows the principle of Foundation Phase learning.

When introduced the new Curriculum for Wales (WG 2024) shared six what matters statements for the Science and Technology Area of Learning and Experience (AoLE). Further broken down at each progression step into specific descriptions of learning. These can overlap through the foundational learning of step one and two allowing for the educational growth of the children. The proposed natural environment will allow the development of a number of these mandatory statements. For the Maths and Numeracy AoLE there are four what matters statements again with descriptions of learning that offer guidance on progressing learners through each statement.

The location offers the opportunities to explore several concepts of science and mathematics while playing outdoors. There are life cycles of plants and bugs, forces and gravity, energy and friction, along with shape, number, patterns and sequencing to name a few. These concepts can be encouraged by metacognitive talk from the accompanying adults, as they share their thoughts and own ideas allowing the children to explore their own philosophies and interests. Metacognition is the starting block to evoke conversations that can impact and encourage the evolution of sensory experiences that build knowledge and effect the children's viewpoint of the world. Intelligent and relevant posing of question will be considerably beneficial in this situation.



The above image highlights a selection of areas that have the potential to spark the interest and excitement of the children as they play and explore the location. The accompanying adults may offer such questions as "I wonder if my leaves will float or sink?" "Will my twig stay still in the stream?" "Is it harder climbing up the tree or back down?" It is hoped these kinds of questions will encourage the children to think about their own ideas and questions and

experiment to find their own answers. When experiencing the outdoors, the enabling adults should be mindful of the holistic opportunity of the learning. The children are experiencing the environment with their whole bodies not just their brains so allowing them to splash in the water, dig through the mud, hold bugs and insects using all their senses will offer a rich cross-curricular learning experience, while stimulating the vestibular system. The vestibular system helps the body with balance, spatial awareness and co-ordination as the child grows, also interacting with other sensory systems like vision and proprioception to fine-tune balance and movement.

This area of the location in this image has a slight incline away from the stream which will allow for the investigation of forces, friction and gravity. Something as simple as walking up the slope away from the water offers the adult an opportunity to ask questions such as "I think it is harder walking up hill than down, what do you think?" opening the opportunity for dialogue about this and how we use energy returning the experience to science. Or "I wonder what would happen if we emptied the watering can here?" "Where will the water go?" these questions will give the children permission to empty the cans. It is anticipated that permission will promote experiments where the watering cans will be emptied further up the slope to observe the movement of the water as it travels to rejoin the stream. Allowing the excuse to further suggest and encourage more activities such as, "How could we change the directions of the water or even stop it?" Sanctioning the exploration with sticks, stones or other found resources to influence the direction of the flow. This will be in line with the first two descriptions of learning for both progression steps one and two within the first what matters statement for Science and Technology – being curious and searching for answers.



The organic resources available at this location offers the opportunity for the children to collect and gather stones, leaves, twigs, acorns, etc. This can lead to open-ended questions or metacognitive discussions from the accompanying adults along a scientific or mathematic route. As this will be a child led activity it will be important for the adult to wait to be invited into the child's play, although thinking out loud by the adult is encouraged. Ideas of patterns and counting could be explored with the parts collected in the children's baskets, investigating bigger/smaller than or heavier/lighter than, or considering what had been alive or not (leaves versus stone). As the ground is more level pattern or symmetry could be introduced with the items in their baskets or ordinal number. Question pondering who may have the most in their basket may introduce vocabular like "less than" or "more than" in relation to progression step one descriptions of learning for

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maths. Another advantage of the level ground could be here the potential for puddles and pools of water should be exploited, whether created naturally by the weather (potential for discussing weather here) or suggesting using the watering cans to create them. The adults can encourage experiments with jumping and splashing which will stimulate the vestibular system and digging which will provide proprioceptive feedback for the children's senses.



In the above image there is the opportunity to look at the different water. The area to the left is slightly deeper and contains slow moving water which will offer the opportunity of observing things floating or sinking. The adults can promote curiosity by wondering aloud such as, "Which stone will make the biggest splash?" or "Why is my stick not sinking?" while using the fishing nets to retrieve items again and trying for different outcomes.

The right side of the image highlights faster moving water which will introduce further scientific concepts and discussions with the movement of matter in line with the statement and description of learning for science. Depending on the time of year of the visit the state of the matter could be discussed introducing the children to solid and liquid water if the temperature is cold. Also discovering what substances travel faster on the water, "I wonder if the twig will be faster than the leaf?" will allow the children to conduct their own races which is playful and meaningful.

It is hoped the children will feel the awe and wonder of meaningful play in this environment and develop beneficial understanding of the world around them for these activities.

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Part 3

RISK BENEFIT ASSESSMENT

Location / Activity:	Clyne Gardens	Date:	16.9.2024
Assessor:	J. MacDonald	Review date:	16.12.2024

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
Exploring the stream and water	Learning about weight, sinking and floating. Being curious and seeking answers encourages exploration. Sharing ideas and reflecting on what happens. Sensory experience of feeling the water on their skin, hearing the babbling, trickling sounds.	Slipping on wet surface, resulting in cuts and sprains Falling into the water Getting clothes wet and being uncomfortable Drowning	Adults and children	Lessons about being safe near water before excursion. Ensure adult supervision at all times when children are near the water's edge. Remind children to only approach the water when an adult is with them. Waterproof clothing and wellington boots. Qualified first aider to accompany the children on the trip with an up to date first aid kit.	M
Walking on paths with exposed roots, stones and rocks	Learning how slopes and uneven paths affect balance and movement. Developing their proprioception and vestibular system. Experiencing the sensory feelings of uneven ground underfoot.	Trips or falls resulting in cuts and grazes or sprains or other injuries	Adults and children	Visit location before excursion to clear obvious hazards and check for sharp objects like glass. Explain to children the need to walk sensibly on uneven ground. Ensure appropriate shoes and clothing is worn.	L

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Exploring the outdoors in varied weather conditions	Children experience the rain on their skin, sun and heat and the shade and cool. Exposure to a range of vocabulary. Senses stimulated included hearing the wind rustling through trees or leaves on the ground. Becoming aware of self and personal risk.	In extreme weather the temperatures may be too hot or too cold – sun burn, heat stroke and hypothermia, icy conditions could increase risk of falling Strong wind may cause damage to trees and branches – head injuries, additional obstacles to traverse Getting clothes wet and being uncomfortable	Adults and children	Check with Met Office to ensure forecast is suitably safe – no strong winds or weather warnings Appropriate clothing to suit the conditions – sun hats and sun cream or waterproofs, hats and gloves	L
Collecting and gathering materials and resources like flowers, twigs, rocks or bugs and insects	Children can explore different areas, digging and examining closely. Opportunity to create patterns, explore number and counting. Children experience grouping, ordering items in sets or living and not living, or natural and man-made. Children will learn how to handle different shapes and sizes/weights of objects they collect.	Insects may bite or sting – need to consider allergies Objects may have sharp edges that cause cuts or be heavy resulting in pinches if dropped Branches may cause scratches or eye injury Awareness of plants that are poisonous or irritants Children may collect unsafe material such as rubbish	Adults and children	Discuss with children what is safe to pick up Remind the children nothing is to go near their mouth Regular hand washing (if available) or hand sanitiser Staff to take first aid, medications, antihistamine Reinforce where the children are allowed to go	L
Children exploring and experiencing the outdoor independently	Children get to explore and play in a new environment. Experience new situations and sensations	Children may wander off Trips and falls See also risks when collecting and gathering.	Adults and children	Ensure children are aware of the boundaries, discuss stranger danger Have previous lessons on safety and risk	L

	Communicate ideas and their observations. Learn to calculated risk. Develop fine and gross motor skills				
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Part 4

When it was introduced the Foundation Phase Framework for Children's Learning (Welsh Government, 2015) for 3–7-year-olds in Wales set a clear requirement that young children should spend a substantial portion of their early education outdoors, promoting hands-on learning and exploration in natural environments. Then with the introduction of the new Curriculum for Wales (WG, 2024) the Foundation Phase Framework was replaced, however the principles of the Foundation Phase, now referred to as Foundation Learning, continue to be upheld and are now integrated into a curriculum for children aged 3 to 16 years focusing on children’s progression and a more continuous learning journey. As discussed by Bilton and Waters (2016) since the late 1990s, there has been an increasing amount of international literature and research focusing on early years outdoor environments. This research particularly emphasises the practical aspects of outdoor work, advocating for staff to recognise its benefits and the educational value of utilising these spaces. In their research Bilton and Waters discovered schools in Wales were planning learning outcomes for literacy and numeracy in their outdoor provision from the outset of the Foundation Phase Framework in line with this international research, this also supports the Curriculum for Wales ethos and highlights the relevance of learning and experiencing educational concepts in outdoor environments.

In early childhood education, the role of the adults is crucial in creating high-affordance outdoor environments that support the development of all learning concepts, especially science and mathematics. Froebel, as discussed by Tovey (2015), was a pioneer of outdoor learning who believed that children should experience all aspects of nature, not just plants and animals. Froebel believed that children could learn everything in nature and that outdoor play was essential for physical, intellectual, and moral development. He invented the term "kindergarten" and developed a curriculum that focused on sensory experience in nature. Through real-life experiences, children gain an understanding of the interconnectedness of all living things. This awareness encourages them to contemplate larger issues outside their classroom learning related to the environment, sustainability, and climate change (Froebel Trust, no date).

When reflecting on children’s learning experiences it is important to consider the child development and education theorists who have massively influenced the way education is delivered today. Tucker (2014) shares Piaget’s constructivist theory which is a learning theory that states that learners actively construct their own knowledge through their experiences, rather than passively receiving information. Tucker proposes that Piaget (1958) not only influenced early years practitioners by encouraging the practice of allowing children to make their own choices, but promoted the idea that pre-number activities, such as matching and sorting, are essential before children can move on to counting and manipulating numbers. This reinforces the current Curriculum for Wales’ progression step theory

(WG 2024) which can also be linked with Maslow's Hierarchy of Needs (1987) where, for the child to be able to advance through the progression steps, not only their fundamental needs must be met but also their self-esteem and connections.

As suggested by Arlemalm-Hagser and Elliot (2021) adults play a vital role in engaging with children to support their outdoor play and learning. It is crucial for them to have a clear understanding of the affordances and provocations present in the outdoor play environment, as highlighted by Waters (2017) and, by this understanding, provide a holistic approach to the child's education. Essentially, children can participate in child-initiated and self-directed play whenever they are outdoors, whether in playgrounds, woods, or parks. These outdoor play environments provide children with opportunities to experience seasonality and all the of the natural world with the abundance of mathematical and scientific inquiry (Waller, 2007).

John Dewey, as highlighted by Aubrey and Riley (2022), was one of the first theorists to challenge traditional views on education. He believed that learning should be centred around practical life experiences and social interactions. For Dewey, the individual learner was at the core of the process, and he advocated for learning through active engagement, experimentation, and hands-on experiences, rather than passively receiving information. Adults are responsible for designing outdoor spaces that encourage exploration, inquiry, and hands-on learning as championed by Dewey. High-affordance environments have features and materials that naturally invite interaction and experimentation. The inclusion of natural resources, like stones and twigs, for sorting, counting and measuring promotes their mathematical thinking. While including a varied terrain allows the children to explore physical scientific concepts such as gravity, force and balance, and gardens encourage learning about life cycles, plants, and weather patterns, which relate to biology and environmental science as advocated for by Froebel (Tovey 2015). Ord and Leather (2011) argue that understanding Dewey's philosophy allows for the full potential of learning through outdoor education to be realised. By embracing Dewey's focus on experiential learning, the depth and meaning of outdoor learning experiences can be fully explored and maximised.

Adults have the responsibility to facilitate learning by encouraging children to explore and ask questions. Rather than giving direct instructions, they support curiosity, which is foundational in both science and math learning. This may be achieved through asking open-ended questions and practicing metacognitive thinking. The enabling adults can encourage predictions and hypotheses by guiding the children to think critically and make predictions, laying the groundwork for scientific inquiry. It is important to model curiosity and share the wonder by actively engaging with the children, showing enthusiasm for discovery and problem-solving. This aligns with Vygotsky (1978) who unlike Piaget, emphasised the importance of social interactions in fostering learning and development. His theory highlights that through social engagement with peers and adults, children can better understand their world and derive meaning from shared experiences, making social interaction a key component of cognitive growth. Tucker (2014) suggests that Vygotsky's concept of the "zones of proximal development" is supported through play, as it occurs in a meaningful and socially motivating context. Vygotsky's influence on mathematics education emphasises relating mathematical concepts to children's own experiences and encourages discussions about maths to deepen understanding. A role supported by the enabling adults of today's practitioners to ensure activities of each concept are not too easy for a

child as to quickly lead to boredom, or that they are not too challenging resulting in frustration and a lack of engagement. Finding the right level of difficulty is key to keeping children motivated and interested. Reggio Emilia schools also incorporate Vygotsky's ideas, emphasising open communication between children and their peers, children and adults, and teachers and parents. The Reggio Emilia Approach sees each child as inherently capable, creative, and intelligent. The teacher's role is to nurture these qualities and to appropriately challenge children, fostering their growth and development. This communication forms the foundation for collaborative learning, where relationships and dialogue are central to the educational process (Aubrey and Riley, 2022). However, critics contend that the emphasis on collaborative learning in the Reggio Emilia approach may not sufficiently accommodate the needs of children who prefer solitary play or have diverse learning styles. They argue that this focus might overlook the importance of individual learning experiences and the varying preferences among children (New, 2007).

The outdoor environments provide opportunities for hands-on learning that connects abstract science and math concepts to tangible experiences. By providing resources the adult facilitates learning, offering tools like rulers, magnifying glasses, and containers that encourage counting, measuring, sorting, and observation, while not directly influencing their activity unless invited by the child to do so. Allowing and encouraging physical activities like building with blocks or logs, rolling objects, or using pulleys introduce children to concepts like shapes, spatial awareness, weight, balance, and force. Providing resources follows the loose parts pedagogical approach, which encourages children to engage in their own learning using everyday objects. This concept was developed by architect Simon Nicholson, who highlighted the advantages of a loose parts environment for child development, emphasising creativity, exploration, and imaginative play (PACEY, 2019). By creating opportunities for mathematical thinking the adults can immerse maths into everyday activities, such as counting games, using language like less than and more than, measuring games and sorting.

Carr (2011) believes one of the key principles of early years pedagogy, as expressed in *Te Whāriki*, the New Zealand early childhood curriculum (Ministry of Education, 1996), is that "children learn through responsive and reciprocal relationships with people, places, and things." When learners take ownership of a conversation, they can connect their personal experiences to the discussion, facilitating deeper understanding and meaning. By sharing conversations and talking the enabling adults help children make connections between their outdoor discoveries and real-world applications. This helps solidify their understanding of concepts for example explaining how shadows change throughout the day connects to time, and building structures, such as bridges or shelters, introduces basic engineering principles.

Outdoor environments foster collaboration, where children work together to solve problems or share ideas. Adults guide this process by encouraging children to share their findings, compare results, and solve problems together, and modelling co-operative behaviour.

Adults provide the right level of support to extend children's thinking without taking control of their discoveries. They know when to step in to guide thinking and when to step back to allow independent exploration. This helps children make sense of their experiences and encourages deep learning, by following Blooms Taxonomy and promoting a mastery of learning through effective questioning to extend the learning, given sufficient time, appropriate pedagogy,

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and access to resources, all children can, in theory, achieve mastery of a subject. This approach emphasises the importance of support and learning opportunities (Bloom, 1956. Bloom, 1968. Aubrey and Riley, 2022).

Adults play an essential role in providing rich outdoor environments that invite interaction and experimentation, supporting the development of early science and math skills. Through thoughtful design, facilitation, and guidance, adults help children explore, question, and connect abstract concepts to real-world experiences.

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