

Awe and Wonder of Science, Mathematics and the Outdoors



(Source: Smeaton, S. 2017).

“Children are like ‘little scientists’”

(Piaget, 1936)

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Photograph of Outdoor area



Introduction

Feature 1 - Garden stream of water, running into pond with waterfall.

One feature of the setting that can be explored is the water stream that runs from the source and flows downwards towards the pond creating a waterfall at the end where the water meets the pond. There are many learning opportunities with this feature that supports mathematical concepts within children's learning such as, the declined plane (slope) of the stream that offers numerous considerations for children to investigate in terms of forces and weight. These investigations can be developed using natural and artificial resources within the stream, and depending on the size and weight of the resources used there will have different outcomes. Larger and heavier resources may be used to create barriers that change the flow of the water, in likeness by using lighter resources the outcome will be different. Things such as leaves or petals from flowers are more likely to run with the water downstream and fall into the pond.

The stream and pond also support living things and life cycle as the natural plants grow around them. This can be an introduction to the science of photosynthesis and how plants need sunlight and water to grow. Children have the opportunity to explore living creatures that inhabit these areas of the outdoors.

Forces/slopes/weight; *what makes the water flow and move? Which direction is it moving in? how and why is it moving in that direction? Is there a way that we can change the natural direction of the flow? what happens to the water if there is something placed in the stream? What has been created between the water from the stream and the water in the pond? Waterfall - what noise does it make (kinetic energy)?*

Life cycles; *What living things live in ponds? (Frogs, insects, fish, flies) Why do they live there? (Frogs lay their eggs because tadpoles live underwater until they become into frogs/fish live underwater etc.) What do they eat? Are there other living things that may eat them? (Life cycles, ideas of birds such as herrings) Apart from the creatures, are there any other living things that live in ponds? (Pond plants and flowers - water lily pads)*

Feature 2 - Trees

The trees seen in the picture can support scientific and mathematical concepts around weight. Naturally the trees have leaves and branches and, in the picture, you can see two different types of trees, one apple tree and a plumb tree. Everything found on the trees are made of distinctive shapes and sizes, for example the branches are long and thin, the stumps are large and thick with bark on them and they all hold different variables for different uses. The focus on the idea of weight supports the scientific concept of gravity. The children can consider what keeps the tree standing upright when gravity pulls the dead fruit down once it is too heavy for the tree branches to hold. The reason for this is the roots of the tree that grow downwards and out to keep the tree stable and balanced, this is called the 'capillary action'. Additionally, these ideas can be developed by adding resources and loose parts. They can explore how leaves and fruits fall from the branches to the ground and what noise they make when they hit the ground, this supports the scientific concept of Kinetic energy, it also ties in mathematical concepts of weight, sizes and shapes. The heavier the resource the greater the kinetic energy, meaning the faster the force of the fall which results in a louder sound when it lands on the ground, children can investigate how these changes when the resource is lighter or smaller and where it lands on the ground.

Forces/slopes/weight; *how do the trees stand upright? (Capillary action). What force makes the leaves and fruits fall onto the ground? What happens when different things fall onto the ground? Do they all make the same sound when they hit the ground? (Kinetic energy). What happens to it when it lands on the ground? (splat or roll away) Are the trees climbable for children?*

Life cycles; *How do trees grow from plantation to fully grown? How long does that take? Why do we have trees, what is their purpose? (Produce oxygen that we breath in) What are the different types of fruit trees? What living things live in trees? (Insects, birds) Why do they live there?*

Feature 3 - Swing

The swing can be seen in the image tucked into the tree that it is attached to, but it can be used to support specific focus on mathematical and scientific concepts, this introduces forces. This feature can be explored by the children with the consideration of when they swing, and the force that pushes them forwards being momentum, and the force acting to pull them back is gravity. Children's investigations may find that the more momentum giving into the first initial push of the swing, the higher the swing may reach and in addition the faster the swing will go. This can be developed by increasing the height in which the child begins the swing, also considering the child has someone pushing them while swinging what happens? (The swing goes higher). The swing also supports the physical development of children by allowing them to explore balance and strength. Furthermore, the children can add resources to investigate change in their play. For example, if they were to stand on something higher up such as a box before the start of the swing, such as a box or a large stone that can be found in the area, would that change the speed or height of the swing? Also, the children can use nearby loose parts such as sticks and stones and place them onto the seat of the swing, by then releasing the swing children investigate what materials can balance on the seat and what resources they fall off. With the help of discussion through the practitioner, children can explore why these outcomes happen and what can they do to change the outcome.

Forces/slopes/weight; *if they sit or stand, does this change the swing? (Faster or slower) what happens if they were to jump onto the seat as appose to already being seated? What happens when the swing is pushed with no one sat on it? What does that feel like - lighter or heavier? If loose parts and natural resources and placed onto the seat of the swing before it is pushed, what happens to them? Do they stay on or do they fall off? Following on from this, if the resources fall do they land flat on the floor and stay still, or do they roll?* This takes mathematical concepts of shapes and sizes into considerations for the children's investigations.

RISK BENEFIT ASSESSMENT

Location / Activity:	Garden Environment	Date:	30 th November 2021
Assessor:	Rachel Maguire	Review date:	April 15 th , 2022

The boxes in the table below will expand as you type into them; pre-entered text is simply for illustration. You should delete irrelevant items and replace with text relevant to your circumstances.

Your overall risk rating – Low, medium or high – is based on your judgement about whether the BENEFITS of the activity or opportunity outweigh the RISKS.

ACTIVITY	How will young people BENEFIT from this activity?	Possible hazards	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk RATING: L/M/H
Walking on uneven ground	Supporting children's awareness of their own bodies and sense of balance. Children's understanding of slopes and gradients on different surfaces which can support scientific concepts of forces and energy.	Accidents such as trips or falls that cause injury.	Children and adults	Discuss with the children the different surfaces that they will be walking on, and share a strategy with how they may have to walk differently to support their sense of balance. Ensure children are wearing appropriate clothing.	L
Children playing with water	Children learning about the 'texture' of water, supporting scientific concept of viscosity and mathematics by exploring how things move through water depending on size and shapes. Life cycles learning opportunities, considering living things inside and around the pond.	Children slip due to the water spills on the grassy areas. Possibility of children falling into the pond.	Children	Appropriate practitioners to children ratios implemented, and supervision standards will be discussed with practitioners and children. Ensure children are wearing appropriate footwear.	M
Exploration of trees, flowers	Children gain an understanding around living things and scientific concepts of the different stages of flower and tree development (photosynthesis). The metamorphosis of living animals that inhabit the trees/flowers, e.g butterflies.	Fruit from the trees could fall onto children. Stings or scrapes from the tree barks and flower stems. Allergic reactions to specific flowers.	Children	Show children different types of flowers and trees in the surrounding areas, and touch them gently to feel and describe the different textures. Gain information of allergies of all children.	L

ACTIVITY	How will young people BENEFIT from this activity?	Possible hazards	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk RATING: L/M/H
Collecting materials	Physical development of the gross motor skills, learning eye-hand coordination. Understanding of mathematical concepts such as weight, size and textures of materials will affect how they hold them. Enhance creative development - children's discussions and considerations of their findings.	Animal faeces or urine. Insects on materials that could sting or bite children (wasps' nests). Toxic poisons on hidden flowers, causing illness or allergic reaction.	Children	Fauna and flora knowledge, and reconnaissance of the area to find possible fatal hazards before activity. First aider to be present in the area. Discuss with children aims and demonstrate good practice of the activity, make a statement to put nothing in their mouth, and show practitioners findings, supported by practitioners nearby to observe children.	H
Outdoors in different weather conditions	Promotes problem-solving and cognitive development through invaluable experiences. Encourages responsibility and independence when dressing for different weathers. Health benefits such as exposure to fresh air and vitamin D, reducing the risk or spread of infection in open spaces. Creates understanding of how living things and garden environments need for different weathers to grow supporting scientific concepts like photosynthesis. Rain/cloudy days provide opportunity to learn concepts around condensation.	Children skin could be burned from the sun. Children could become overwhelmed from the heat if not hydrated. Wet weather can cause muddy grounds, possibility of slip hazards.	Children	Practitioners to check weather reports day before activity takes place and ensure suitable recommendations are provided in letters to the parents for children to be prepared appropriately (e.g. sunscreen, water bottles, suitable footwear such as wellington boots). Practitioners to apply sunscreen to children before sun exposure.	H
Exploring independently in environment	Promotes independence and responsibility of own practice and learning which enhances development in a holistic manner. Children learn predominately through sensory and physical experiences which supports opportunities for cognitive development. Allows children to explore materials, concepts and ideas at their own pace. Boosts confidence which enhances social and creative development.	Safety concerns are more likely to happen when young children explore independently.	Children	Formative discussion takes place prior to activity between children and practitioner. Ensure each group of children has designated practitioner that keeps children under observation during activity. Reconnaissance of area signed off.	L

Role of the adult

The holistic development of children and their skills is the centre of the statutory curriculum framework from Welsh Government (2015). The idea of promoting an equality of opportunity for children with play at the heart of it. The new curriculum for Gov.Wales (2021) encourages practitioners to develop a more interconnected approach to learning that brings the six leading cross disciplinary areas together to provide a holistic experience where science, mathematics, expressive arts, humanities, language and communication, wellbeing, health and physical development are inseparable (Gov. Wales, 2021). With this in mind, there is a great emphasises on the safe outdoors environments as a resource to promote children's discovery and natural curiosity of learning through first-hand experimental activities for children with the provision of risk taking, problem solving and decision making.

Tovey (no date) asserts the significance of the outdoors and the Froebelian approach towards children's learning. Implying the outdoors as a place where children can grow and learn at their own pace through first-hand explorations and experiences. Frobel describes children as active, curious and creative learners (Tovey, no date). Similar to Piagé's theory that suggests children are 'little scientists' (1956 cited in Evans, 2018) claiming that there are endless natural opportunities for explorations and experimentations of play in the outdoors constructing knowledge from the world around them in relation to scientific and mathematical concepts. The work of Watts (2021) illuminates Frobel's ecological view of the natural world and how there is a sense of wonder and mystery for children during their investigating and discovering.

Similarly, Steiner's perspective on learning, discussed in the work of Foundation Years (no date) supports the notion that mathematical concepts are integrated into everyday activities and spontaneous play in settings. For example, children can collect natural resources such as sticks, pinecones and leaves and arrange them into different grouped categories such as counting how many they have which can support numeracy concepts. They can also be ordered by size and weight, considering how the resources are affected

by scientific concepts such as gravity. Additionally, children can use senses to feel different patterns, textures and properties of the materials and gain understanding of material properties and how they are used for different things (Foundation Years, no date). Suggesting this approach is an introduction of mathematics but in a natural context in the real world.

Gov. Wales (2021) sets the expectation for learning and how it derives from the practitioners providing stimulating play environments for children, in order for the children to research experimentations and make scientific and mathematical discoveries within open-ended play opportunities. The work of Tucker (2014) considers the importance of the learning environment and how it will encourage the independent learner as a young mathematician in a playful context. Additionally, Tucker explores in what way children's ideas can be developed by adding a range of natural resources to enhance their play, this is said to encourage children to formulate links between mathematical and experiences (Maguire, 2021).

Similarly, Sprouts (2019) states 'the environment is regarded as the third teacher'. The work of Reggio Emilia model of education led by Loris Malaguzzi which has a focus on a child's learning through real-life experiences as appose to fixed curriculum. The Reggio Emilia approach supports the idea children learn best through collaboration of exciting environments and natural self-led play, thus allowing children's natural embodiment of working explorers (Sprouts, 2019). Play offers a deep sense of learning for children as it is during 'play' where children gain an increase sense of independence and confidence, promoting a positive attitude towards their learning (Tucker, 2014). Albert Einstein once said "Play is the highest form of research".

While there is an understanding across the Foundation Phase framework (Welsh Government, 2015) of the importance of the teacher stepping aside and allowing children to explore independently and how this can promote the children's development of creativity. Moreover, the work of Gibson 1979 asserts the idea that children's learning is enhanced when they are permitted space and extended periods of time to explore and

revisit unfinished, experimental projects in order to extend their learning during their journey of discovery (Gibson 1979, cited in Zamani and Moore, no date). However, the Donaldson report (2015) highlights the significance of sustained shared thinking between practitioners and children during and that there is scope for children to develop the competence to collaborate with peers and influence their learning in a holistic manner. Froebel's work cited in Tovey (no date) emphasises that when adults interact to children's hypothesis and respond in ways that are in tune with their interests can lead to rich and meaningful conversations.

Furthermore, Better Kid Care (no date) indicates Froebel's work presents opportunities for children through a range of open-ended resources, claiming that children can explore them in multiple ways. For example, anyone can represent aspects of mathematical or scientific conceptual understanding. Equivalently, Nicholson has a similar approach in regarding loose parts as 'variables'. Nicholson considered loose materials and shapes as formative connections that empower creativity in an environment (Better Kid Care, no date). Nicholson's work describes loose parts such as ropes, planks of wood, plant pots and containers to be considered as resources that can enhance scientific and mathematical concepts such as weight, length, volume, gravity and friction, through play (Nicholson 1972, cited in Gull *et al*, 2019).

The new curriculum for Wales (2022) has a focus on these ideas of a child's learning and development in a holistic manner, and supports practitioners in allowing for more open-ended curiosity-based discoveries in regards to children's ways of learning, regarding scientific and mathematical concepts. However, despite these opportunities granted within the new curriculum there are barriers that stand in the way. The work of Tinney *et al* (2020) outlines professional extensive training available, that is intended to support learners, and how there is an allowance of exploration of everyday activities that may occur during children's play, with the main purpose and objective as to encourage through experimentation and discussion with the children, specifically in the area of science for young children. Furthermore, Goddard (2019) discusses that despite these opportunities there are time restrictions as time is limited for practitioners due to deadlines and targets

having to be met and that not all practitioners have a good understanding of the value of open-ended play and adults lack confidence to see this learning as 'real' learning due to own experiences and frameworks. Goddard (2019) asserts that early year's teachers can feel pressure from senior leadership although creative play hinges primarily on the adult role, and the importance of the practitioner giving them scaffolding around social interaction issues.

Gov. Wales (2021) supports child-led practice with considerations and understanding of child's interests in order to plan future learning experiences in order to build the child's development of resilience, independence and confidence by encourage them to take risks. In relation to mathematical and scientific concepts, children need practical experiences that support them to use scientific and mathematical vocabulary when exploring quantity, numeracy, shape and pattern. Moreover, the Donaldson report (2015) recognises that there is absence of clear understanding of an acceptable curriculum and led to unacceptable inconsistency of modern educational theories on children's learning. It is said that the national curriculum sought to expose national aims across Wales in order to secure efficiency in resource development which includes teacher training: presenting valuable aims that will be considered during assessment arrangements (Gov Wales, 2015).

According to Mclachlan et al (2010) the work of Vygotsky (1987) is an importance part for framing approaches to teaching of mathematics and science in the context of the environment for children. The role of the teacher plays a significant part in identifying mathematical concepts of everyday activities and practices, and that teacher having conversations with children, such as sustained shared thinking, supports better learning outcomes for children. Mclachen et al (2010) work also indicates Vygotsky's theory that everyday activities lay the foundations for learning scientific concepts successfully. Similarly, Gov. Wales (2021) claims that children who are able to engage and connect with the natural world can begin to practically explore the concept of sustainability. The statements from the national literacy and numeracy framework provide a clear understanding for practitioners to consider that children are able to make connections

with basic mathematical concepts that are transferrable during play and classroom activities in a variety of ways (Welsh Government, 2021).

The focus does not lie on the imposing curriculum targets, rather it is about building on child's interests and extending children's learning in valuable ways (Tovey, no date). Research asserts there needs to be a change in the system for early years practitioners and children when considering mathematical and scientific concepts. Research tells us that barriers that impose on children learning stem from lack of training and confidence within our practitioner's practice. Furthermore, the new curriculum from Welsh Government (2022) recognises these flaws within the system and have a more child-led and open-ended play-based view on children's learning for children in the early years, in respect of the Froebelian approach to learning and the outdoor environments being considered at a 'third teacher' for children (Sprouts, 2019).

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