

The importance of the outdoors in enhancing the learning of scientific and mathematical concepts.



This site in the image above is an outdoor environment attached to an early years setting for children between 3 and 4 years of age. There are 3 practitioners in the class and 23 children, with the maximum allowed ratio of 1 adult to a group of 8 Children. The activity of choice carried out in this environment to support the learning

of mathematical and scientific concepts was a sink or float experiment using authentic and natural loose parts. Children were encouraged to explore and collect their own natural loose parts, as real-life experiences enable children to take the lead in asking questions, identifying problems, making predictions, taking risks, recalling events and finding solutions.



The option of loose parts was used in this activity to demonstrate the hands-on, open-ended approach to playing and learning and support their holistic development. Natural materials that were found for this activity included shells, rocks, stones, sticks, leaves,

grass, flowers, conkers, and pine cones. Loose-part play is flexible and engaging for children of all ages and abilities, where adults can modify the complexity of science or mathematical experiments involving loose parts depending on their level of understanding. They are beneficial as they can motivate children's discovery of their interests and schemas and enhance their creative development through imagination. In this activity, a broad range of resources were gathered such as household items and natural items such as sticks, leaves, shells, stones, and tin foil to create boats. Curiosity and Exploration are the focus of enhancing science and mathematical development. The diverse range of loose parts allows children to seek answers to their questions through investigation, discovery, trial, and error. When presented with loose parts, they have a natural instinct to explore and compare properties and textures and determine the possibilities of transportation, creation, and manipulation to attain a deeper understanding of the materials by using their senses.



The reason that the sink or float experiment was selected to accompany the play of loose parts as it is a method that allows young Children to investigate the natural world, make scientific inquiries through observation of how objects behave differently in water through critical thinking and attention to detail and lays the foundation for a deeper understanding of the physical world. Children will begin to understand the concept of forces and how the buoyancy or density of an item is a determinant of whether it floats or sinks. This offers an engaging experience that motivates children to ask questions, hypothesize, predict, and draw their own evidence-based conclusions of why objects float or sink from what they observe, and make

connections with other materials that possess similar properties, for example, they may observe and conclude that metal objects sink and wooden materials float. This knowledge of classification and patterns is the beginning of understanding mathematical concepts. Under other circumstances, however, unexpected results may be encountered, for example, when an object they expected to float sinks or vice versa. This prompts a reevaluation of hypotheses. This further engages children's curiosity to investigate further to discover alternative answers.



An activity to expand their progression was offered, where floating devices could be created by using foil and working out how many loose parts it requires to sink the floatation device, learning further about buoyancy, density, and weight. Another concept of mathematical development is achieved through counting the same number of different loose parts into their floating creations exploring why one is sinking over the other and determining how the size

and weight of loose parts affect the way they behave in the water, whether they float or sink.



The benefits of activities like these in developing holistic skills are that these practical experiences challenge them to use simple mathematical vocabulary when exploring quantity, number, shape and pattern. They enhance problem-solving abilities, such as creating a structure that will float on the water, allowing children to apply these to practical challenges which is an essential skill to attain. This activity interconnects science and mathematical learning where children can describe their perspective of how the world operates around them and continue to make sense of it through repeating processes and using different loose parts to investigate.

Encouraging Children to ask questions, listen to adults and their peers on their observations, ideas, and predictions, along with offering group challenges to find loose parts in the natural world together promotes collaborative learning and communication skills. The Welsh Government's Curriculum for non-maintained nursery settings (2022) recommends a safe outdoor space like the one in the photograph provides an opportunity for children to begin to explore and express positive feelings and behaviours, take calculated risks through engagement to play which is joyful and challenging natural curiosity, which supports their emotional, physical and social well-being, resilience and self-esteem. Natural observations occur when practitioners engage in their play to determine their developmental understanding level.

The open dialogue between children, their peers, and adults during this activity can support children to discover how their actions have an impact on the world around them. This type of play has no one solitary goal for supporting development, it offers a cross-disciplinary approach to supporting children's creativity, language, physical, social, and emotional development as they are learning about the world.

Science and technology area of learning under the new curriculum from the Welsh government (2022) proposes that children's understanding of matter and the way it behaves defines our universe and shapes our lives and that forces and energy provide a foundation for understanding our universe. The aims and the progression steps of these are relevant to this activity as they correlate with the learning objectives, such as beginning to discover sequences in results, to be able to discuss their observations, make predictions, and explain why they predict an outcome. The structure of the floatation device requires the challenge of making decisions based

on previous knowledge learning of properties and what works well through trial and error and making improvements through engagement to play. Another progression goal is raising children's awareness of the reuse of natural materials and resources for play to protect the environment they live in.



The role of the adult in this activity is to play and engage alongside Children but not to interrupt their play. Some of the key factors that are involved in scientific enquiry include asking open-ended questions and metacognitive talk while playing. This is offered by adults to create an ongoing dialogue through an activity to produce thought and scaffold further learning.

"Oh look! This item sank, I didn't think that would happen, why do you think that happened?"

"I wonder which tree this pine cone came from".

"What if I place 5 rocks in my boat and 5 leaves in my friend's boat, which do you think will sink? Why?"

"I'm not sure what will happen if I place this item in."

"I was thinking that this rock is heavier than the shell."

"I am going to leave this leaf in the water for longer to see if it will sink."

"I am going to try and roll this pine cone and then roll the rock".

"I've just noticed that this shell has some really pretty patterns."

"I think I'll place a wooden curtain ring and a metal curtain ring and see what happens."

"I wonder what would happen if I place the bigger shell in, whether it will sink or float?"

"My friend thinks that the rock will sink. What do you think?"

"What do you think will happen?"

"How do you know that the helicopter seed floated?"

"Why do you think that the bigger/ conker sank?"

"Why do you think that some items sink, while others float?"

"How does the pine cone feel? How does the conker feel?"

"Do you remember when you were swimming? Did you float or sink? Why?"

Risk/Benefit Assessment.

Location / Activity:	Outdoor Play Area: Dechrau Disglair/Sink or float experiment using loose parts.	Date:	14/09/2023
Assessor:		Review date:	

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
The Outdoor space overall.	Secured with locked gates but has an open and spacious environment where children can receive the same opportunities as a forest school or exploring a public space but protects children from the dangers of unknown adults and getting lost. This requires lower adult-to-child ratios for children to explore, learn about the physical, and natural world, and play freely. Children develop confidence in what their bodies are capable of and refine their physical fitness and cognitive functioning through problem solving.	Uneven ground: Gravelled pathways and muddy grass could lead to slips, trips and falls and result in injuries such as cuts, bruises and sprains.	Children and adults.	Adults modeling how to walk across these areas carefully and continuing a dialogue in reminding children to be careful when walking across these areas will limit the amount of accidents. This will allow children to regulate and modify how they behave on and uneven ground and can develop confidence in these abilities as they familiarise themselves with walking on this ground often.	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
The Sheltered seating and play area.	Beneficial for imaginative play and creative play as it replicates a house in the outdoors. In this activity in question, it allowed children to regroup to listen to instructions from the adult and listening to their peers perspectives of the ideas and findings of loose parts in nature. This area is where language, communication and social development is nurtured. Additionally, it is a sheltered area that children can use in the event it begins to rain during their play.	The gravel from the pathway leading to the sheltered seating can be carried into the area, making the floor unpleasant to sit on to compare the loose parts. Sitting on the floor quickly could lead to injury.	Children and Adults.	Raise awareness to the children of this hazard, an activity prior to use the outdoor brushes to sweep the stones out which supports physical development and problem solving skills, placing a mat down to protect them from left over stones.	L
The Water Tray.	Physical development is refined in handling of water, exploring the schemas that interest them when handling water, of different materials and compare the properties of them through the sense of touch. Additionally, fine motor skills are supported through the manipulation of the tin foil to create the floating device to balance the loose parts. In terms of the tin foil floatation devices, how they decide to structure their floats and adjust them through trial and error is where true creativity and imagination is challenged. It is believed that water play can be extremely relaxing for children, and allows emotional regulation in themselves through sensory stimulation.	Risk of Drowning: In any form of large trays of water, there is a risk of submersion or drowning. Getting wet from the water can lead to later illness. Skin allergies or sensitivity to products in the water or in the environment.	Children.	The role of the adult is to supervise and monitor the water play area at all times. Children should be taught safe practice with water, to maintain an adequate distance from the water tray. First aid training is essential in practitioners to ensure an effective, immediate response in case of an emergency. Appropriate waterproof clothing is advisable also to wear over their clothes during waterplay, to avoid their clothes getting wet. Adults to be aware of these potential occurrences in children, anything in the environment that causes skin inflammation should be monitored and removed.	M
The exploration of loose-parts that are provided by adults.	Gives children an understanding of what loose parts entail, able to explore the properties of loose parts and understand the concepts of buoyancy and density of these parts before they are asked to gather their own during the independent, self directed play.	Choking Hazard – Children may place them in their mouths to explore their properties and choke.	Children.	Adults should closely supervise children in the handling of loose parts, model that the loose parts are to be explored using their hands and not their mouths. Age-appropriate items should be offered to young children. Asking open-ended questions prior to activity "why shouldn't we place items in our mouths?" to ensure children understand the danger and places the idea that this is a rule to follow at all times when engaging in loose parts play.	M

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The exploration of loose-parts: Independent, Self-directed play.	Creativity and imagination is developed through the self-directed play aspect, where they are encouraged to explore and collect loose parts of their own to investigate how they will behave in water. In terms of the tin foil floatation devices, how they decide to structure their floats and adjust them through trial and error is where true creativity and imagination is challenged. Cognitive development is supported through the opportunities offered for children to overcome their own challenges and find meaning to unexpected outcomes. They are linking newly learned words to the concepts they are learning, such as sink and float and will begin to explain why they predict that certain loose parts they find will sink or float.	Finding loose parts such as shells and stones may have broken or rough surfaces parts and may cut, sticks may cause splinters.	Children.	Adults to supervise from a distance, make a game through asking open-ended questions, what things look safe or unsafe to pick up. Use the activity as a teachable moment for children to respect the environment around them and to be observant of these objects and assessing whether they are safe enough to pick up.	L
Weather.	Being involved in nature in all forms of weather and during the seasons and provides children experiences to understand how the world operates, understanding the process of hot and cold temperatures, wet and dry, how wind blows leaves off of trees and other objects move as a result of wind, how ice is formed from water and how ice melts in heat.	Sun: Long exposure in hot weather can lead to sun stroke, heat exhaustion and sunburn. Rain: Long play in extreme rain can lead to illness such as a cold. Cold Weather: Long exposure in cold weather can lead to illness, such as hypothermia in extreme cases.	Children and Adults.	Sun: Children to be monitored to ensure safe protection from extreme weather conditions. Sun cream should be applied and children should be reminded to drink regularly. Rain: Children should be encouraged to wear waterproof clothing over their clothes and wellingtons, and the outdoor sheltered play area is available for children to play outside and will protect them from the rain. Cold weather: Warm layers and clothing such as hats, scarves, gloves and thick coats should be worn during these conditions, and play outside would be monitored and limited in extreme weather conditions.	L
Plants and weeds.	Explore properties of different plants, learning about life cycles of plants, and teaching children to respect living things within their environment.	Some nettle plants have thorns or thistles within the grassy area where children play and could cause minor skin grazes.	Children and Adults.	Adults teaching children to be aware of this hazard and any plants that could inflict more serious injury to be cut away and removed.	L

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Tuff Tray categorization area.	Scientific and mathematical reasoning is achieved through sorting loose parts in 2 groups on the tuff tray, one side with floating loose parts and the other with loose parts that sink. This allows children to observe, explore and compare loose parts freely to gain a true understanding of buoyancy and density and make cognitive connections.	The wooden frame the tuff tray sits on: The children could move and bump their head against the wooden brackets and the low roof could cause adults to bump their heads.	Children and Adults.	Adults to remind children to maintain a reasonably safe distance from the side brackets of the wooden frame, adults to be self-aware and observe from a safe distance to avoid these injuries.	L

The Role of the Practitioner and Why it is Important.

White (2011) believes that outdoor learning requires practitioners who have a positive attitude and appreciation for it and to reflect on what could they offer and provide in the environment to create rich experiences to facilitate mathematic and scientific learning and development and enhance awe and wonder. They believe that Children not only require the environment to learn but also role models who display a motivation to help Children succeed so that they adopt this attitude towards their curiosity and engagement to play and learn. Daly and Beloglovsky (2020) identify Children as natural explorers and scientists who require adults to offer experiences that foster the refinement of investigating hypotheses, finding reason for their findings, making adjustments to solve problems, and then repeating the process. Robertson (2014) states that effective practitioners who provide care for early years Children should value free play and playful learning in a safe, outdoor environment to develop creativity, which allows children to take control of their own learning and development and attain essential skills required for growth, such as empathy towards others. They can explore and understand natural processes and forces and be taught to respect the environment, plants, and wildlife. Waite (2018) and Bilton & Waters (2016) highlighted a challenge faced by practitioners not being able to provide the space and time for Children to receive outdoor play opportunities once they begin full-time education, due to busy schedules and requirements for rigid education in the classroom, which makes the early, meaningful experiences of natural learning in the outdoors more precious and significant. Bilton and Waters (2016) believe that practitioners who provide an abundance of outdoor play enhance pupils' joy in learning and it supports a cross-curricular approach, such as language, mathematics, science, physical, social, and emotional well-being. White (2019)

recommends outdoor exploration to appreciate living things, such as trees, plants, and wildlife. Practitioners can facilitate learning of these by creating bug hotels with the children, offering seeds and compost for planting flowers and vegetables to observe them grow like they are. Watering and caring for these living things teach them about empathy, that their actions make a difference, and enhances awe and wonder and natural curiosity about the world around them. Cremin et al (2014) suggest that scientific teaching in the early years should include creativity, play, exploration, motivation and affect, dialogue and collaboration, problem-solving, questioning and curiosity, reflection and reasoning, and teachers scaffolding learning when required.

How Outdoors Provision can Entail Cross-Curricular Benefits.

Williams (2022), Waters-Davies (2022) and Russell and Grigg (2016) advise that loose parts such as wooden planks, sticks, tires, sheets, and crates can be offered to Children to build dens or bridges which offers a cross-curricular approach to development. This entails physical challenges in assembling, cognitive functioning through trial and error and problem-solving, peer collaboration, and communication to assemble together. Scientific and Mathematical learning is achieved by comparing the properties of loose parts and determining whether a child will choose bigger or smaller loose parts to construct their design which is an example of creative learning opportunities. Robson and Rowe (2012) endorse activities like gardening and construction to challenge creative thinking through using their senses and observing their work. The Humanities area of learning, according to the Welsh Government's new curriculum (2022), covers the development of skills to understand concepts and articulate the past and present. This could be the understanding of "they were sticks on the floor, and now they are a den." Or "it was a seed and now it is a flower", realizing that what they do has cause and effect. The expressive arts area of learning supports creative development, the designing of dens, and rising to challenge to succeed. Activities like these allow the areas of learning to interlink and support children's holistic development. Curiosity and Belonging, which are the additional areas of learning in the curriculum for non-maintained nursery settings (2022), are supported through wondering, discovering, and exploring new ideas, such as the growth of flowers and finding answers to their questions about the properties of loose parts affect, promoting creativity and cognitive functioning and that they possess a strong belief that their actions are making a positive contribution to the world around them (Daly and Beloglovsky, 2020).

Observing and Assessing Mathematical and Scientific Learning.

According to Maynard (2014), when practitioners carry out observations of children in nature, there are noticeable changes in the regulation of behaviour and improvement of well-being and confidence in children, allowing the adult to gain more natural and accurate results. Observing Children and assessing the environment's affordance for learning is what allows the practitioners to extend the learning of individual children, based on a deeper understanding of a child's current abilities. Sargent's development of early science skills (2016) suggests that practitioners should keep recordings of children's approach to play by answering questions on their capabilities, such as the ability to explain properties of materials, textures, and living things in their environment, the ability to compare different materials, identify connections or patterns in results, the ability to use technology, such as cameras or ipads to capture images of what they have observed, whether they are confident in seeking answers to their questions, the ability to demonstrate that they can listen to instruction from adults, recalling experiences they have had and knowledge they have learned and sharing ideas for alternative adjustment to determine different outcomes. Sargent's Development of early maths skills (2016) recommend observations of children that answer questions to determine their individual level of mathematical understanding, such as the ability to explain why they are doing something, apply mathematical language to play, find solutions to solve problems in play when it arises, demonstrate their knowledge of number, counting and categorizing and mark making in mathematical form. This allows practitioners to assess the quality of the continuous provision that is available for children's development and how to enhance it to promote engagement and curiosity to learning (Curriculum for non-maintained nursery settings, 2022).

Sustained, Shared Thinking and Metacognitive talk.

Williams (2022) suggests the appreciation of children's ideas and discussion in the outdoors and providing space to explore and time for children to think about their answers and conclusions is what promotes effective sustained and shared thinking. Froebel, Vygotsky and Bruner have all made contributions to highlighting the importance of the outdoors and nature being exemplary in supporting children's learning and development. Froebel suggested that adults can use natural materials to provide sensory-rich experiences and allow children to engage in active exploration to stimulate creative and scientific play (Tovey, 2012). He advised that these experiences of facilitating independent play can allow the observing practitioner to create learning opportunities surrounding their interests (Conkbayir and Pascal, 2014) (Bradbury and Swailes, 2022). Vygotsky's Zone of Proximal Development emphasizes the significance of social interaction and observation in determining when a practitioner to offer guidance and encourage collaboration with their

peers and how this supports the further development of Children's mathematical and scientific understanding of concepts (Aubrey and Riley, 2022) (Conkbayir and Pascal, 2014). An aspect of his work, similar to Bruner, developed the concept of scaffolding learning in Children in the outdoors through asking open-ended questions, offering clues to solve problems, and guiding investigations in play. Bruner highlights the significance of narrative in supporting children's expression in recalling what they have learned and observed. This narrative or story-telling skill is what is known as metacognitive talk (Conkbayir and Pascal, 2014). Froebel, along with Vygotsky and Bruner explored how children should be encouraged to think about what they are seeing and playing with and the why's and how's of the environment which enhances awareness of thoughts and feelings and problem-solving capabilities (Conkbayir and Pascal, 2014) (Bradbury and Swailes, 2022) (Aubrey and Riley, 2022). Some of the challenges and critiques of these theories, however, is that practitioners may find this difficult to maintain a balance of allowing independent, self-directed play and scaffolding Children's learning. It is also argued by critics that some knowledge does need to be taught and not all learning can come from active engagement to play and social interactions. This suggests that practitioners need to maintain a balance of adult-led and child-initiated play to support Children's exploration and discovery (Aubrey and Riley, 2022) (Fisher, 2016). Williams (2022) suggests that a challenge for adults working in partnership with Children to support the learning of mathematical and scientific concepts in the outdoors is that many have experienced negative attitudes and feelings towards mathematics, science or the outdoors or are inexperienced, which can damage a child's interests to play, investigate and learn. The Welsh Government's Curriculum for non-maintained nursery settings (2022) has offered comprehensive guidance for practitioners to be able to understand the areas of learning, how to provide an environment and activities that are rich in learning opportunities, and how Children's learning can be enhanced by adults. Receiving training and the assessment of this guidance can help support practitioners to become more confident in the construction of a curriculum plan for their setting and to explore the activities and resources in the images to support children's numeracy and concept development. Ryder-Richardson (2013) discusses the "space to grow" project, which highlights the significance of utilising the curriculum to inspire practitioners to improve the standard of play and experiences, improve practice, and to develop higher confidence in being attuned to the outdoors and to design an effective environment to support mathematical and scientific development.

Creative Star Learning Ltd (2017) and King (2022) agree that the resources and equipment that practitioners offer within an outdoor environment context, the more opportunities there

are to observe children's learning through how they manipulate these materials, who they interact with when this play occurs and make sense of it. Nicholson (1971) explored deeper into the observation of children with loose parts. This compliments Gibson's affordance theory through the value of the natural environment and how natural materials can be reproduced for play opportunities and enhance engagement and play cues in Children to learn. (Lenarcic and Winter, 2013). Gibson also determined that the affordance of an outdoor environment is beneficial to the observer. (Dobromir G. Dotov¹, Lin Nie¹, and Matthieu M. de Wit, 2012). The affordance theory in practice suggests designing learning environments that offer these interactions and learning experiences. The placement of materials captures the attention of Children to explore and find solutions to problems and enquire about scientific properties. Nicholson's loose parts theory in practice demonstrates that the provision of natural materials allows Children to become deeply invested in play, investigation, and learning. It is in circumstances like these where opportunities arise for metacognitive talk and sustained, shared thinking between adults and Children, where ideas, observations, and recalling events are discussed.

In conclusion, outdoor environments offer an abundance of opportunities to facilitate curiosity, awe, and wonder and the learning of mathematical and scientific concepts through open-ended materials and hands-on experiences. Practitioners should implement these approaches to practice from authors and theorists to evaluate and enhance the environment and interactions with children through observation, assessment, sustained shared thinking, and metacognitive talk. While their approaches possess unique qualities, they all agree on the significance of enhancing engagement, narrative and reflective practice in the learning process.

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