

Awe and Wonder: Science and Mathematics in the Early Years



(Source: Children's House, Montessori School of Reston)

The image that I have chosen is taken of the sand area of a Montessori setting. I chose this image as the area looks inviting, exciting, and a fun place for children to explore and learn outdoors. Children enjoy and find relaxation in playing sand, just as they do with water.

Open-ended questions and tasks help children learn better than closed-ended ones, and sand is a naturally open-ended material. Sand is a suitable play resource regardless of a child's ability or cognitive level. Older children with more developed mental processes can utilise sand for exploration and creativity, while babies and toddlers can just sit in it and enjoy its texture and features.

Playing in sand has a variety of advantages which assists in covering various parts of the curriculum, including:

- Enhancing fine and gross motor skills.
- It offers opportunities for investigation and experimentation with various materials which can help them develop their problem-solving skills.
- It's a sensory, soothing, holistic experience.
- It enables space for inventive play and creativity as they play with various combinations of items.
- It encourages children to play outside and interact with one another. This interaction promotes communication skills which in turn can lead to a boost in self-esteem by achievements made with their friends.

Sand is a cheap resource and can be manipulated or used for experiments in many ways. Sand is dug out, sifted, built with, poured, enjoyed for the feel and scent, used in imaginary play, and its motion is explored. Children gain comfort in the idea that they can never make a mistake when playing with sand.

Sand has a multitude of characteristics that increase its open-endedness. Children can explore the texture and flexibility of dry sand by pouring it and sifting it through their fingers. Sand's physical properties vary significantly when water is added. Children can further explore and manipulate wet sand. Sand has little physical restrictions, which encourages children to experiment with it.

Sand play can provide a variety of weighing and measuring possibilities that enhance children's understanding of mathematics. It is essential that children's interactions with mathematics and numeracy is as captivating, stimulating, and accessible as possible, and that they are designed to foster the development of mathematical resilience.

Through play, young children are given the chance to problem solve, explore ideas, form connections, and collaborate with others, which supports in the early learning of numbers and numeracy. Children must have the opportunity to work freely and collaboratively in later years to build on the foundations established in the early years. (Welsh Government, 2020).

The area in the photograph can be used in numerous ways to enhance children's mathematical development, such as:

- Counting the amount of spoonful's, shovelfuls, or handfuls they need to fill a container.
- Arranging in size order and counting objects that have been retrieved from a sieve.
- Creating a handprint in the sand, then adding one more.
- Line up a row of full, half full, and empty containers.
- Using shapes to press into wet sand to create a pattern.
- Counting the total items and sorting after sieving out beads, stones, and large sequins.
- Dividing and sorting the digging tools from the container-filling tools in the sand.
- Tracing and drawing lines of different lengths in the sand with a stick.
- Watching how fast or slowly sand passes through a sieve.
- Adding to and removing from containers and using and encouraging size and weight vocabulary.

The activity planned for the children will involve weighing different amounts of sand, comparing the weight of dry and wet sand, and introducing loose parts by adding them into the sand and comparing their weights. These different materials will give the children even more opportunities for creative exploration. The learning outcomes for this activity are taken from the Welsh Government (2020) progression step 1.



(Source: The hidden treehouse)

Lesson Plan:

Subject: Mathematics	Class: Reception AL
Date: 20.09.23	Practitioner:
Learning outcome: 1. I can use direct comparisons with weight/mass, heavier/lighter. 2. I have explored forming a quantity in different ways, using combinations of objects or quantities.	
Resources: • Sand • Water • Small diggers • Cups • Buckets • Spades • Weighing scale Key Vocabulary: • Weigh • Heavy/heavier • Light/lighter • Fill • Full/empty • More/less/same • Weighing scale • Scale goes up/down • Dig • Scoop Key Questions: • Can you fill a cup/digger/bucket? • Is it heavy or light? • Which one is heavier/lighter? • What do you think will happen if I put more in/take some out? • Do you think the scale will go up/down?	
Introduction: 8 children, age 4 – 5 years old in the reception class are taken to the sand area with 2 practitioners. Approach the sand area - practitioners make the children aware of the uneven ground and small stumps around the sand. Demonstrate 'wibbling and wobbling' on the ground and tripping over the stumps. Ask the children how they might keep themselves safe from falling or tripping, and potentially hurting themselves, and demonstrate how they can overcome these. Before they enter the sand, practitioners ask the children if they can remember the golden rules and green choices for the sand area.	

The children eagerly put their hands up to remind each other that:
 'We don't throw sand as it might go in our eyes.
 Keep the sand in the ground/in a bucket.
 We don't put sand in our mouth or ears.
 We take turns and share the toys.
 Always stay near a teacher.
 Have kind hands with your friends.'
 The children are praised for remembering how to make green choices in the sand area and given a thumbs up.
 Allow the children to freely explore the sand without any input. After 10 minutes join in with the children (unless you have been invited in before this time) and tell them that you are going to weigh some sand in a cup to see if it is heavy or light. Ask the children if they can fill some items up and tell the practitioner if they think it is heavy or light.

Activity:

Demonstrate this and ask the children to fill a cup, bucket or digger with sand and see if they can lift it. Then get the children in to pairs to hold their friend's item as well as their own to see which one is heavier/lighter. Introduce a weighing scale – ask the children if they know what it is and if they know what it is used for? Ask the children what they think will happen if sand/parts are added. Let the children take turns in using the weighing scale. To keep the conversation going encourage sustained shared thinking with the children in their pairs or groups to chat about their predictions and findings, and the items/resources they are using.

To extend the activity introduce water to the sand. Ask the children if they can predict what will happen to the sand when the water is added. Demonstrate using wet and dry sand in cups/diggers/buckets/weighing scale to see which is heavier/lighter. At times use the scales purposefully wrong and state the wrong answers when weighing items - allow the children to correct the practitioner.

Extension:

Add loose parts to the sand area – pebbles, bark chippings, twigs, and shells. Again, chat to the children of the golden rules when playing with small parts and remind them to make good green choices. Encourage the children to use these parts to combine with the sand to weigh and compare.

Plenary:

At the end of the activity ask the children to tell their partner a new word they have learnt today during the activity. Ask them what they could do differently next time. Ask them what does the word weigh mean. Ask them which was heavier, for example the dry or wet sand.
 This will assess their understanding.

Risk Benefit Assessment

Location / Activity:	Reception Garden – sand area	Date:	20.09.23
Practitioner:	AL	Review date:	

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.

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
Uneven ground	Enhances balance, coordination, strength, and endurance. Development of the gross motor skills and core muscles. Fosters confidence in movement. Promotes problem solving.	Trips and falls. Cuts and grazes.	Everyone	Make the children aware of the uneven ground. Tell the children which area of the garden they are allowed to play in for this activity and that they must stay with the adult to ensure no children wander off. Adhere to correct ratios at all times. Practitioners to carry out site check before the area is used to ensure it is safe and remove any hazards or contaminants. Practitioners model how the children may trip and how they can overcome the uneven ground. Ensure suitable footwear is worn. First aid kit is kept nearby.	M
Sand	Sand play supports children in developing skills necessary for learning and life. Health and wellbeing from being in close contact. Fine and gross motor skills are enhanced when digging, lifting, pouring, gathering, and patting the sand. Child involvement in checking the area gives them a sense of ownership, responsibility, and raise awareness of hazards. Children learn independence and hygiene routines. Enhances social and emotional development. Builds on children's language and communication.	Sand in mouth, ears, and eyes. Dirty hands and clothes. Animal faeces.	Children	Golden rules will be explained to the children about appropriate behaviour with sand – they will be encouraged to make good green choices. Supervision and ratio's will be assessed and amended accordingly. Only commercially bought play sand will be used. The children will be involved in checking the area for contaminants by following the practitioners. Practitioners to remove contaminants. Sand will promptly be washed out of mouths or hands. The sand will be cleaned and changed regularly. Be aware of any allergic reactions and take medications with you if needed. Hand washing provisions after play.	L
Water	Adds an additional element to the activity, alters the state of the sand, and affects tipping and pouring. Covers science and maths, capacity, volume, and	Drowning. Consumption of contaminants. Stagnant water.	Children	Practitioners supervise closely, and only small amounts of water added from small containers such as cups and bowls. Golden rules will be explained to the children about appropriate behaviour with water – they will be encouraged to	L

	weight.			make good green choices. All cups and bowls are emptied at the end of the activity and cleaned.	
Weather Wet or dirty clothes and shoes	Environmental stimulation of the senses. Direct knowledge of weather patterns. Health benefits of fresh air include better concentration and learning readiness. There are several health benefits to going outside. Children learn responsibility for their belongings. Learning independence and skills to remove/change clothing and shoes and learn what is appropriate to wear for various weather scenarios.	Children get cold. Children get hot. Sun burn. Children get dirty.	Everyone	Parents are asked to provide appropriate clothing and footwear for the weather – wellies and coats/waterproofs/all in one/warm layers/sun cream/sun hats or cap/cool clothing. Assess the weather conditions on the day and consider any impact on the activity. Advise parents to apply sun cream.	L
Logs and tree stump	Building, creating, and constructing. Encourages problem solving.	Trips and falls. Cuts and grazes. Splinters. Splitting and cracking of wood.	Everyone	Practitioners model how the children may trip and advise how they can safely move around. Check logs are strong and durable. Remove any which may be hazardous. First aid kit is kept nearby.	M
Pebbles and natural loose parts	Enhancing fine and gross motor skills lifting, gathering, sorting, pouring. Enhances maths skills such as weight and pattern. Promotes imaginary play. Connects the children to nature. Promotes creativity.	Choking. Splinters, scrapes and scratches. Sharp edges. Pokes from sticks.	Children	Golden rules will be explained to the children about appropriate behaviour with small parts – they will be encouraged to make good green choices. Practitioners to model how to play appropriately with loose parts. Extra supervision is provided for children who are more likely to put things in their mouth. First aid kit is kept nearby.	L
Strong winds – falling trees/branches	Learning about the elements, nature, trees and how and what they need to grow.	Trips and falls. Branches falling.	Everyone	Think about the dangers of objects being blown around in windy conditions. Do not go outdoors if the wind is too strong. Assess the weather conditions on the day and consider any impact on the activity. Check area for fallen trees or branches. First aid kit is kept nearby.	L

The term 'outdoor learning' refers to intentionally inclusive, guided methods that primarily use outdoor activities and experiences to promote learning, improved wellbeing, and health, and understanding of the environment (Institute for outdoor learning, 2023). Because it provides uncommon chances for creativity, movement, noise, and risk-taking, the outdoors is the ideal setting for experiential learning. Weather, sounds, smells, and textures are just a few of the unique stimuli that can enrich and improve a child's learning environment that can be experienced outside (Welsh Government, 2009).

Two essential elements are needed for early learning environments to be successful:

- A true cognitive challenge.
- Significant child control over and choices in their educational experience (Brodie, 2018).

Children should have as much space as possible to roam and discover. When children have the freedom to move around an area, their independence and discovery are nurtured.

According to Oberle et al (2021) research studies carried out have identified a variety of individual and systemic barriers to outdoor learning in schools, including feeling ill-equipped and lacking confidence to teach outdoors, concern for classroom management and children's safety outdoors, lack of support, funding, and resources, being bound by conventional perspectives on teaching, and not having the time within the school day. Some settings may have a very basic outdoor area, such as a tarmac yard, however these can be enhanced affordably, or settings could consider utilising local natural areas near to the setting. There are several options for learning on Tarmac. It is the perfect surface for making artwork with chalk or water-based paints, educational activities, and various other activities. (Welsh Government, 2009). Settings could consider removing a section of the yard and letting it grow wild to introduce a more natural environment. To generate green space, they may also use pots and raised garden beds.

Equal importance is given to the indoor and outdoor environments. White (2008) cites several advantages of taking children outside, including the opportunity to breathe fresh air, the stimulation of the senses, and social connections. Just simply by going outside, children receive a holistic environment for learning. White (2008) 'there are six ingredients for a full menu of rich and satisfying outdoor provision for young children each offering a highly holistic learning experience'. These are:

1. Outdoors, natural materials
2. Spending time in the natural environment outside
3. Playing in water and sand
4. Physical activity and play
5. Creative and imaginative
6. Building and dens

The New Curriculum incorporates four main objectives created to support children in becoming:

- enthusiastic, capable pupils who welcome lifelong learning.
- independent and creative thinkers who are ready to engage completely in both life and work.
- ethical, informed citizens of Wales and all throughout the world.
- Individuals who are in good health and with self-confidence who are prepared to contribute positively to society (Welsh Government, 2020).

High-quality educational experiences outdoors can assist in accomplishing these goals. Good quality outdoor learning will promote the knowledge, skills, and attitudes necessary to achieve the objectives of the four main purposes. The curriculum should naturally integrate outdoor learning as a motivating component (Welsh council for outdoor learning, 2018). Malaguzzi believed that as well as the practitioner and the children, that the third teacher is the environment. Children can walk, observe, and explore both inside and outside, which enables them to communicate their ideas (Pound, 2020).

The new curriculum is being implemented in settings so that children can learn via play both inside and outside. Welsh Government (2016) guides practitioners to ensure that the learning environment supports each child's specific needs and encourages them to experiment and apply their knowledge in practical settings. Early childhood practitioners that appreciate the unique qualities of the outdoors understand that it offers a very different and complimentary setting for fostering children's wellbeing and promoting their learning (Ryder Richardson, 2014).

The New Curriculum for Wales (2021), which is significant, acknowledges the importance of outdoor learning. Taking learning outside offers numerous advantages for both the children and the practitioners. The Welsh Government highlights outdoor learning as a critical component of successful, learner-centred pedagogy, creating the potential for:

- significant levels of wellbeing, self-confidence, and involvement
- social, emotional, spiritual, and physical development
- genuine opportunities for children to foster and strengthen cross-curricular skills
- growth of imagination, creativity, and curiosity
- understanding of the environment, demonstrating an awareness of the effects they could have on the living world
- capacity to assess and experience risk, helping to develop resilience and confidence (Learning through landscapes, 2023).

By using outdoor equipment that are less accessible indoors, going outside can result in learning opportunities that are fun, messy, stimulating, and meaningful. Maths is a great subject to teach outside the classroom. Nature offers an incomparable canvas to engage and inspire children with its wide range of subject areas. There are many methods to use numeracy outside, from utilising leaves and pebbles for learning shapes to using natural resources to support equations (Learning through landscapes, 2023). Welsh Government (2022) states that to ensure that children acquire mathematical resilience (the capacity to view challenge as a positive part of learning), experiences related to mathematics and numeracy must be as engaging, exciting, and easily accessible for children. Building mathematical resiliency helps children become ambitious and capable learners. Children learn mathematics by experimenting and playing with concepts. Mathematical exercises

that would otherwise be difficult, unappealing, or beyond reach indoors are best planned in an outdoor setting. Children learn about number outside by interacting with each other, gathering natural objects, and playing games. They also explore size, shape, and space by building large structures and overcoming physical challenges. They also discover capacity by digging holes in sand and filling buckets with water (Sargent, no date).

Practitioners are the most crucial component of early childhood play, learning, and care because they are enabling adults. Having current knowledge and an accurate understanding of child development is essential to their job role (Welsh Government, 2023). To ensure that children engage in experiences that support their play, development, and learning, observations should be used to guide the possibilities that practitioners offer within their indoor and outdoor surroundings. The Curriculum for Wales (2021) emphasises that evaluation is crucial for fostering 'deep' learning. It needs to be utilised to decide what the children's next steps should be and whether they need to consolidate their knowledge or whether they need more guidance. Reggio Emilia practitioners are seen as more than just a partner in teaching curriculum. In addition to acting as a teacher, they take on a variety of other duties. Children are led by them as they travel the path of learning. They are the scribes who observe, note, and present classroom activities. To provide a welcoming, engaging, and local learning environment, they collaborate closely with peers and parents (Maara House, 2017).

It has been established that a practitioner's role in outdoor learning is that of a mediator or facilitator who enables learning with children by gaining knowledge alongside them. Working outside prompts practitioners to improve their approach to interacting with children (Lindfors et al, 2021).

Practitioners can support children's learning by creating their own zone of proximal development, as defined by Vygotsky in 1978, is the space between what a learner can do on their own and what they can achieve with guidance and encouragement from a knowledgeable partner or practitioner. Practitioners need to be aware of when to take a step back and observe, and when to join in and ask questions to take the children's learning further. This makes a significant contribution to the introduction of the concept of the practitioner's involvement in children's learning by stating that an adult may help a child communicate and learn within the parameters of what they now understand (McLeod, 2019).

Practitioners should construct learning experiences that support and challenge all children to develop in the direction of realising the four aims using observation and understanding of child development. The ability to self-reflect and self-regulate will improve as children accomplish developmental milestones, and they should become more confident across a larger range of competencies. They should learn additional skills, learn them in more detail, and be better equipped to use and apply what they have learned. As a result, they should start establishing solid links between the statements of what matters in the Areas (Welsh Government, 2023).

Sustained shared thinking can be used by practitioners which is a process in which two or more people work together intellectually to solve a challenge, make sense of an idea, assess a situation, and develop a narrative. The thought must involve both sides and must grow and expand (Siraj-Blatchford et al, 2002). This is an effective way of talking with children and to keep the conversation going by asking thoughtful, open-ended questions when it is appropriate. To foster sustained conversations, practitioners must first look at the mathematical tasks and challenges planned for the children. Do they prompt conversation and engagement? If not, how can they change this so that they open mathematical talks rather than shut them down by waiting for the right answers? and

secondly, by creating methods and questions that give them room to reflect, such as "Tell me more?" (Koshy et al, 2015). This will give practitioners opportunities to support and recognise children's understanding.

Children's curiosity, experimentation, and exploration in problem solving are facilitated when practitioners serve as mediators (Dowdell et al., 2011). However, due to the lack of understanding and desire, teachers do not always support outdoor learning and do not see its advantages from the perspective of a child's overall development. The suitability of natural areas, the usage of resources and tools, and safety concerns are all viewed as problems (Boileau and Dabaja, 2020).

It's important for young children's general development that they naturally seek out difficulties and take risks (Solly, 2015). According to Brodie (2018), a physical environment should be adjusted to the different stages of a child's growth while also taking health and safety considerations, such as trip and choking hazards, into account. Children can gain knowledge about their own safety and the other children from experiences they have outside. It gives children a lot of opportunities to be ambitious, test their own boundaries, and take risks while yet being safeguarded by practitioners and the environment they have created (Ryder Richardson, 2014). Practitioners support the children in these opportunities by involving them when carrying out the risk benefit assessment of the area and the activity they are taking part in, and discussing what the risks are and how they can overcome them. This is supported by Curriculum for Wales (2023), where it states that the environment should be adaptable and diverse, providing risk and challenge while encouraging children to grow in their capacity for resiliency, self-assurance, and independence.

Practitioners need to be prepared to break a task down into basic steps and explain why they have chosen to work in a particular method. Teaching children new skills involves knowledge of what those skills entail. Before letting the children try a new activity, practitioners must be clear about the safety guidelines (Welsh Government, 2009).

Understanding Piaget's work on schema led to research into children's schematic learning (Athey, 2007). Research is supported by Athey's description of schema, which was defined as 'patterns of behaviour and thinking in children that exist beneath the surface features of various contents, contexts, and specific experiences.' Children repeatedly line up their toys, turn the sand wheel, and fill containers with sand and water while they explore their surroundings. It can be concluded that a child's intrinsic play is focused on trajectories, rotation, or containing when they repeatedly do the same action in several circumstances; this behaviour is referred to as a schema (Athey, 2007). Schemas are combined into clusters by children, and as their play gets more complicated, it eventually has an impact on spoken language and abstract reasoning. Schemas were used in the sand area as the children repeatedly filled and emptied different containers and weighing scale and with support from the practitioners, developed their maths-based language.

Loose parts were added to extend the activity and the children's learning as according to Nicholson's (1971) theory of loose parts, he describes loose parts as open-ended, transportable variables which allow children to build, mix, and create new objects out of various materials, where practitioners can encourage problem solving. Nicholson states that for children to think about abstract ideas like weight in sand play, they require access to enabling environments with loose parts. Children also require space and opportunity to engage in this kind of experimental play repeatedly to promote their development (Play Scotland, no date). Froebel (cited by Tovey, no date) stated that

straightforward, open-ended materials enable children to express their thoughts, emotions, and experiences.

In summary, taking children outdoors is essential for their wellbeing, holistic learning, and education. It allows them to use their imaginations, and experience opportunities which they may not be able to have indoors and can explore the properties of nature. An outdoor sand area can be used to enhance children's maths skills and practitioners can support this. By adding toys, spades, cups, buckets, children can dig, fill, empty, and weigh sand in different forms, as well as added loose parts for extending the activity and taking their learning further. As stated by Malaguzzi, practitioners are key to children's learning. They use their knowledge and skills to provide an enabling environment to encourage children's curiosity, teach the children new skills, engage in meaningful conversation, observe, and assess them, and evaluate and plan for taking the next steps. Practitioners carry out risk assessments to ensure barriers and risks are identified and overcome to ensure the safety of the children and themselves.

By following the guidance and implementing the New Curriculum for Wales, settings and practitioners can provide a holistic approach to children's development across the curriculum.

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