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Objectives
At the end of this chapter, you will be able to:

- Recognise the areas of science that can be explored by young children in the inside and outside environments.
- Describe how language supports science learning.
- Recognise how educators can support young children’s explorations.
- Describe how digital technologies can be used to enhance and support young children’s explorations.
Overview
This chapter focuses on the ways in which educators promote science learning in play based contexts, in settings within and outside learning centres. Cases of interactions between children and educators are provided to highlight the ways in which language can enhance learning. These cases encompass the inside, natural and built environment and show how educators can use unplanned events to immediately scaffold learning as well as to inform their planning for teacher-led explorations to follow up on these occurrences.

Introduction
Regardless of how learning experiences are presented to children (unstructured, child-instigated, teacher-instigated) or are used in centres (free play, small group, whole group) it is imperative that materials are provided for children to explore (Lind, 2005). Harlan and Rivkin (2008) observed that making available exploration time for young children was important in ensuring that children had sufficient time to investigate and solve problems. This links directly with the EYLF, whereby one of the key components of Learning Outcome 4 is: ‘Children develop a range of skills and processes such as problem solving, enquiry, experimentation, hypothesising, researching and investigation’ (DEEWR, 2009, p. 34). Of increasing importance is the recognition of the role of language, talk and shared meaning-making through discussion in developing understanding while undertaking explorations.

Organising the inside environment
Taking a constructivist approach to learning, we believe that children construct their own understanding through their prior knowledge and the experiences we give them at pre-school. The arrangement of the learning environment is very important in providing maximal learning opportunities. Through the development of the physical learning environment, the teacher can encourage children to play in a range of mini environments, to investigate new things and to construct new ideas. Children are highly adaptable when it comes to using space creatively to test their own ideas – it just requires a teacher attuned to this to assist in the making of creative spaces and to supply materials and resources. Teaching needs to be responsive to what children are actually doing, so it is sometimes difficult to predict exactly what resources are needed and when they will be needed.

Considerations to be aware of in preparing to undertake activities inside include space, room layout, resources, flexibility and overlap, both in terms of space and learning ideas (Chaille & Britain, 2003). Many early childhood centres have a ‘discovery’ table set up, at which children are able to investigate natural materials that are not readily available in the pre-school outside environment. This discovery table
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is where teacher-instigated science investigations often begin. The material to be investigated might include shells or seed pods, or manufactured materials such as plastics, laminates, metals and timbers. We want children to be self-directed as much as possible, and free and easy access to activities and materials reduces their reliance upon adults. However, for teacher-directed activities, other materials and resources will become available as needed for the activity. Another consideration is that children can be over-stimulated if too much material and choice are available. This can lead to them 'flitting' between things and not spending enough time on any single activity to allow for development or consolidation of ideas. Using materials sensibly and rotating them through activities means that children will be stimulated anew as the different materials are made available.

However, there are some basic principles that should be followed so that children gain the optimal learning from the inside environment. Children should be able to move easily around the room. That is, space should be allowed between activities so that children do not have to negotiate convoluted pathways and narrow corners. This is obviously a safety issue as well. If we assume that children have the freedom to choose where they wish to play and what activity they will work on, then access to all activities and materials has to be easy and free-flowing.

In designing the room layout, consideration should be given to providing a range of activities. Apart from the discovery table, most pre-school centres have a quiet reading area, a writing/drawing area, a construction area, a painting area and an imaginative play area (including dress-ups). For special teacher-directed activities, a free space may be needed to accommodate a range of activities. Using low, movable dividers can create walled, inclusive spaces and provide the flexibility to move them at will, such as when a larger space is needed to accommodate more children or a larger activity.

Preparing activities

In preparing activities, the teacher is aware of children's physical, emotional, social and cognitive needs and how best to meet these needs through the activities, resources and interactions that are developed. Some children will prefer an occasional, one-on-one interaction with the teacher, while others will prefer to work alone or in small peer groups. Allowing for all these possibilities will enhance children's learning. When developing activities, the teacher needs to decide whether a whole-group discussion (tuning in) needs to occur or whether the activity can be left to children's 'discovery' with some teacher guidance or focusing. Either way, planning is crucial so that the teacher takes into account exactly the purpose of the activity and the needs of the children. In particular, activities need to be age-appropriate, open-ended and encouraging of some skill or knowledge development. Customised science learning experiences, based on children's demonstrated interests should:

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- promote independence in actions and thinking
- promote responsibility towards themselves, others and the objects they deal with
- promote autonomy and reduce the need for adult intervention
- encourage involved engagement and active participation
- promote enthusiasm and intrinsic motivation
- promote the development of conceptual understanding, problem-solving skills and creative thinking.

Using the inside environment

While the outside environment has a richness and diversity of possibilities for explorations of the natural world, the inside environment can provide alternatives and often can supplement the learning undertaken outside. For example, children who investigate the changing of plants and trees through the seasons may be able to undertake explorations of plant growth using a variation in growth conditions within the rooms of the early childhood centre – light, shade, dark, excess water, not enough water, hot, cold are some growth variations that can be achieved through indoor settings.

There are other aspects about the inside environment that facilitate learning. The actual physical spaces are much more adaptable to being changed, allowing children to use the space creatively and make use of materials found inside. The safe use of power (electricity) can provide resources to be investigated, whether it is a computer or some other tool. An example of this is in the area of cooking. In any cooking activity, children are engaged in a number of science skills and processes. The selection of ingredients encourages children to discuss the function of each ingredient and its purpose in the cooking. Measuring allows for children to develop hand–eye coordination as well as the ability to read marks as communicating significance, such as volume. When children follow a recipe, they are learning that a process can lead to an end point or conclusion. In mixing, children see physical change occurring through their own application. In using tools such as mixers, spatulas, lifters and spoons, children engage in exploration of forces, levers and measuring devices. The final stage, cooking, provides children with experiences of a chemical change to a substance – the original materials are no longer retrievable. Other cookery investigations that promote science understanding of basic chemistry (mixing, dissolving, evaporation, condensation, melting, solidification, thawing, freezing) include making jelly from gelatine and fruit/flavouring, making butter from cream, making ice-cream, mixing flavoured drinks and so on. The role of the early childhood educator is to ensure that the science is drawn out as part of the discussions and students’ questions.
The science discovery table is another way to provide children with materials not normally available to them. Children can investigate seeds, seed pods, leaves or bark as an extension of their outside explorations. They can use tools such as magnifying lenses, digital cameras, torches, magnets, wind-up toys and other moveable objects. The discovery table may provide objects that have a specific purpose, such as an egg slide, egg whisk, can-opener and other household implements. Construction items/kits, digital players (iPods etc.) can provide children with the opportunity to explore the reason for such instruments and how they work. The role of the early childhood educator is to encourage children to look closely at patterns, similarities, differences and change in any science exploration.

Using the outside environment
There is considerable variation in what comprises an outside environment in early childhood settings. This is in terms of both the natural environment and the built environment. The former can include a variety of vegetation and natural materials such as rocks, soil and mulch. The built environment includes items such as play equipment and structural elements of the centre such as taps, walls, paths and fences. The various components of this outside environment are discussed in terms of the opportunities that can be provided for learning.

Materials and their properties
Children's environments are comprised of a variety of natural and processed materials. These materials possess a range of properties that can influence the ways in which they can be used. Opportunities abound for children to use their senses to develop their understanding and appreciation of these properties and how they may be used in play.

Activity
Children use a digital camera to photograph a selection of different natural and processed materials in the playground. In doing so, they consider the range of colours, textures and origins of these materials. The educator models the associated vocabulary so that children can begin to describe their properties.

It is possible that children might classify the materials as follows, although children often have other important criteria to use as well:
- colour
- texture – rough, smooth, soft, hard
- processed or natural.

Additional activities with children include using the photographs to locate the materials in the playground.
In scaffolding children’s learning, use correct vocabulary and scientific language to describe the features of the materials. Ask children a range of open-ended questions that focus their attention on one or more of the characteristics of the material: Where do they come from? How are they processed? What are they made into?

As a follow-up activity, children might bring to the centre a selection of materials from home that they can manipulate in a variety of ways so that they can gain experiences in learning how properties influence use.

**Machines in the environment**

When we talk about machines in an early childhood environment, we are talking about simple machines such as levers, wedges, screws, inclined planes, pulleys, wheel and axle. Scientifically, simple machines make work easier for us by allowing us to push or pull over increased distances. If you think about children’s play areas, they are strewn with examples of these simple machines. A slide is an example of an inclined plane, a pair of scissors shows us how wedges work, while every time a child builds a ramp down which to run a car, she or he is demonstrating an awareness of an inclined plane as well as the mechanics of the wheel and axle. Most children have already discovered the effect of gravity, when they fall, slip down a slide or move on a swing. They know that if they let something go it falls to the ground. There are multiple opportunities for educators to raise awareness of these properties by asking further questions or scaffold children’s thinking through what is happening. When a child investigates what makes a toy move, she or he is looking at the system of mechanisms that create movement.

**The built environment**

The built environment provides children with opportunities to explore and develop science understandings as well as technological skills and understandings.

Other aspects of the child’s built environment can develop understanding of force as a ‘push’ or a ‘pull’. Forces can make things move or stop, or hold things up or squeeze things. When a child is pushed on a swing, she or he experiences the force of the push, then the force of resistance created by the air pushing back as the child moves through the air. A child can feel the pull of gravity as the swing ascends, then a sense of weightlessness at the top of the travel of the swing, before gravity affects the movement of the child back towards the earth.

The outside environment is a paradise for investigating a range of natural, non-living things. In particular, rocks are so common, yet so varied, that often young children are attracted to them because of their shape, colour or texture. When we consider rocks in children’s lives, we realise that children have many interactions with
Photograph 6.1: Even young children can benefit from experience with a range of simple machines and the effect of gravity. Using a slide also introduces children to other forces such as friction.

rocks and their constituent parts: the sandpit, talcum powder, toothpaste, aluminium foil, granite bench tops, bricks.

**Activity**

- Suggest some ways in which you could make use of the built environment in your setting (or a setting you have experienced).
- How might you develop science language related to the activities you have described in the built environment?

Science in the outside environment lends itself to integration with other conceptual areas such as mathematics. In the following case study on rocks, the children were classifying based on their own determinations. The classification activity could equally be considered a mathematics process as well as understanding the underlying science concept that rocks are all different shapes and sizes.

**CASE STUDY 6.1**

**Rocks**

*Science concept:* Rocks can be a single colour or contain many colours, and vary in size and texture.
There is an enormous variety of rocks and their constituent minerals present in Earth’s crust, but all rock varieties are classified as one of three basic types: igneous, sedimentary and metamorphic. These basic types of rock relate to the manner in which the rocks were formed.

**Prior knowledge (4/5-year-olds)**

**What can you tell us about rocks?**

Harrison – ‘They are heavy.’
Amie – ‘Heavy and big but some are small.’
Jordan – ‘They can be dug under ground.’
Hana – ‘They are dirty.’

**Activity – rock collection**

A child brings in a rock that he has found in the park, and all of the other children are very interested in the discussion that arises. The teacher suggests the children collect some rocks and bring them into class the following day for observations.

The children’s collections are varied with many different colours, sizes and textures. The children discuss their rocks, giving lots of details about similarities and differences; they draw their rocks and compare and contrast their findings.

**Determining the learning that children acquired**

**Open-ended question – What have you noticed is the same or different about these rocks?**

Hana – ‘Look, two the same colours.’
Jordan – ‘Those two [are] really smooth and soft.’
Amie – ‘Excuse me, they are both the same [pointing to two black-and-white speckled rocks].’
Harrison – ‘Look, they match.’

From their responses, the educator can determine that the children have an understanding that rocks vary in colour, texture and where they came from (where they were found).

**Modifications**

This topic could be extended by introducing other concepts such as:

- Some rocks are harder than others.
- Natural rocks are made in many different ways – children could also make their own rocks out of small rocks, mud and water.

**Acknowledgement**

This case study was provided by Mary Partridge, early childhood educator.
CASE STUDY 6.2

Research case study – Investigating the environmental scientific concepts in children’s play: How do children and teachers interpret play based learning?
(Edwards, Cutter-Mackenzie and Fleer study, presented at January 2008 Early Childhood Conference, Monash University, Australia.)

The researchers investigated:

• What the teachers believed the children were acquiring through play.
• What the children thought the teacher wanted them to learn and what they actually learned.

What the researchers found:

• When the children played with the materials – which could develop their everyday knowledge – teachers did not necessarily follow this up with modelling ways of solving the problem.
• A period of play with filtering materials (cotton wool, sand, pebbles) resulted in the children being more receptive to the teacher’s modelling. The children tended to develop a conscious understanding of the process and conceptual understandings.
• An assumption by the teachers that the materials alone would suggest ways to solve the problem set by the teacher (making dirty water clear).
• The children at the first of two sites in the small-scale study could not articulate the concepts they had been engaged in during the process. (Even though the teacher had some scientific views in mind.)

Reflection

What do these research findings suggest for an educator who is trying to develop children’s conceptual understandings?

If you consider how children manipulate the material in the outside environment to build cubby houses, you realise that they are investigating shapes, stability, forces, and often aesthetics.

Living things in the garden

These include plants and animals. Many pre-school centres have their own vegetable patches or construct vegetable gardens each year with the children so that they experience how living things grow and change over time. They can experience a life cycle first hand and are able to elaborate on the characteristics of living things and
some of the science concepts associated with living things. For example, 'living things respire.' Any harvesting of food can be used to involve children in cooking (physical and chemical changes), measuring quantities (mass and weight – mathematics, again) and broader opportunities for food technology. Children can learn which parts of the food we eat – stems (celery), leaves (lettuce), roots (carrots), fruits (eggplant). Science skills can be enhanced through close observation of, and participation in, the processes of the preparation and cooking of food.

**Small animals in the garden**

Children already know a lot about small animals that live in the garden. If asked they can tell you what is already there and where you most likely can find snails, worms, slaters and other small animals. Once new interest is demonstrated, you might ask the child what they already know about the small animal and if there is anything more they want to find out. As the educator, you may have to re-word the question so that it is within the abilities of the child to carry out the investigation. Working with the child, you would then construct a plan of action, a range of experiences that should lead the child to discover a solution to his or her own question.

**Using digital technology as a tool**

Nor can we ignore the fact that early childhood educators need to know how to make effective use of information and communication technologies (ICTs) in their classrooms, and need to be convinced that doing so will enhance the learning of their young students (Campbell & Scotellaro, 2009).

In this technological era, young children are often more comfortable with technology than the educators who are there to assist their learning. Ferguson (2005) commented that early childhood education, traditionally focusing on the development of interpersonal skills, has tended to ignore the use of technologies in young children’s learning. This has led to an inequitable situation, with some young children experiencing technologies in their home environment while others do not experience any technologies, even in their pre-school centre (Zevenbergen & Logan, 2008).

A number of relatively inexpensive digital technologies can enhance a child’s learning. Apart from computers, small digital microscopes can be linked to a computer to increase a small image to computer size. As an animal is crawling across a small container, children can view in detail how the animal moves, what food it might stop to eat and how the different parts of its body are interconnected. Close observation, one of the science skills, becomes so much easier for the child. The digital image can be frozen and saved onto the computer for the child to use or just to print. The image can be used to allow a child to reconstruct their understanding of the animal in other ways (drawing, painting or construction).
CASE STUDY 6.3

At one pre-school visited, the educator provided the children with a digital hand-held microscope so that children could see the small animals they had just collected from the outside garden. The children were given the option of drawing or using plasticine to record their animal.

Photograph 6.2: A plasticine spider made to record a spider seen in the garden

Looking at the plasticine spider, it is evident that the child knows quite a bit about spiders. She knows that spiders have eight legs. She knows that they have two body parts and that the abdomen is generally bigger than the cephalothorax. She knows that the legs are attached to only one part of the body, the abdomen. She knows that the spider has eyes and often feelers or palps. Eight significant facts about the spider and, yet, at first glance, we may dismiss this as a piece of art.

The importance of language in science explorations

In considering the conceptual development of science in young children, language is a crucial and integral component. Vygotsky’s view was that although initially language and thought developed independently in the young child, they eventually merged because of the social context in which children communicated with others (McInerney & McInerney, 1998). Early childhood practitioners promote language development while recognising that children learn in different ways. This can be
through the provision of enriched play experiences, which include visual, auditory, small and large group aspects.

In developing these play experiences, there are different ways that the teacher can guide further learning, such as enriching the experiences through language, providing additional resources that stimulate children's questions, being a co-investigator with the child (a feature of what is termed 'emergent curriculum' by Dockett and Fleer, 2002, p. 199) or asking effective questions that encourage further exploration (see Chapter 4). Modelling skills that young children can mimic may provide them with the opportunity to extend their own investigations.

There are three elements of literacy emerging in science experiences. These are: everyday literacies, the literacies of science and scientific literacy (Department of Education, Science and Technology, DEST, 2006). Any of these may be present at any time in a science investigation; however, with young children it is often everyday literacy that is most common. 'Everyday literacy' can be defined as the range of everyday common language practices that children use to describe the world around them. For example, children use the words 'I have lots of energy' in an everyday sense to mean that they are highly active, without fully understanding the scientific terminology of 'energy'. The 'literacies of science' include the specific words and representations common in science, models, drawings and role plays. For example, a child might draw a picture of what is happening with wind, demonstrating through the drawing his or her understandings. This representation is an aspect of a literacy of science. Finally, 'scientific literacy' refers to the knowledge of science content and processes and the ability to apply both in new situations. Goodrum, Hackling and Rennie (2001) cited in the introduction to Primary Connections units (DEST, 2006, p. v) included descriptions such as, 'the capacity for individuals to be interested in and understand the world around them ... be able to identify questions, investigate and draw evidence based conclusions, and make informed decisions about the environment and their own health and well-being.'

In terms of developing understanding in science and mathematics, it is crucial that the language-related areas of communication, connections and reasoning form a significant part of the child's early learning (Lind, 2005). Language is used to clarify ideas and also to include mathematics and science learning in everyday communications of discussion and listening. As children engage in play experiences, their language skills will become increasingly complex over time (Dockett & Fleer, 2002). A range of verbal scaffolding strategies aimed at effectively helping children to extend their knowledge, understanding and skills can be employed by educators (Dockett & Fleer, 2002). They include: direct guidance, explanation, cues and questions, demonstration and modelling, goal and problem identification, planning, keeping on track and evaluating actions.

Since young children are excellent at mimicking adults and adult language, it is extremely important that the early childhood practitioner uses correct terminology in
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science experiences, couching the new words in familiar contexts (everyday literacy) until the child gains an understanding of the meaning of the word and the underlying science concept (the literacy of science).

Conclusion
This chapter has dealt with the areas of science that can be explored by young children in the inside and outside environments and how educators can set up purposeful areas inside to facilitate exploration. The role of language in science developmental understanding was discussed with reference to becoming a scientifically literate person and how educators could promote accurate language from children’s ‘everyday literacy’. Examples of how educators can support children’s investigations using items from the built or natural environment were provided, and one such exploration was illustrated by the use of digital technology.

References


