Introduction

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Science in early childhood

For the second edition of this book, we wanted to create a text that would inform and guide students and practitioners of early childhood science, in both the pre-school and early years settings. Using current research, based on work done by the authors and reviews of the research literature, *Science in Early Childhood* provides information that is relevant and responsive to its intended audience. Each chapter helps to develop content knowledge of areas of science and instructs on how to guide children's learning in those areas. Many different approaches to science learning are taken, with an understanding that science is inter-related with most other curriculum areas and, in particular, with an understanding that young children tend to learn in an holistic way. There is a growing recognition of the importance of science explorations in children's lives as they try to make sense of the world around them. Cognitively, it is very important to have input into children's developing science understandings and to be able to guide their concept development. *Science in Early Childhood* is designed to complement Australia's Early Years Learning Framework (EYLF) and the Australian Curriculum: Science, with references in each chapter to the alignment of content with the philosophy and anticipated outcomes of the national guidelines. Internationally, the 'early years' comprise a period recognised as that time between birth and 8 years of age, and this book provides resources for practitioners working with this age range. In recognition of the general acceptance in the early years community of 'learning through play', this book highlights varied types of learning and learning environments:

naturalistic, informal and formal. Information in chapters is illustrated through the use of detailed case studies and practical examples that relate to both pre-school and the early years of schooling.

We have decided to split this second edition into four parts, based around the required elements of effective science teaching and learning. Our approach has been to label these sections based on questions that students and practitioners of early childhood science would ask. Thus, Part 1 is called 'What initial information should I know to teach science?' and includes information on policy documents and learning theories. Chapters 1–4 fall within this part. Part 2 is called 'How can I enhance children's learning of science?' It presents different approaches to science learning and looks at the importance of play as a pedagogy. This part covers Chapters 5–7. Part 3 is called 'How can I use the learning environment to enhance children's science understandings?' It covers learning environments, learning in informal contexts and environmental education. Chapters 8–10 lie within this part. Finally, Part 4 is called 'How do I plan and assess in science?' and covers the essentials of planning and assessment. It includes Chapters 11 and 12.

Chapter summaries

Chapter 1 starts with three short descriptions of 'typical' child-instigated exploration in science, highlighting the importance of early childhood education as a whole, and of developmental and cognitive psychology. This chapter describes children's wonder and curiosity about the world as it outlines what science looks like in the early years. As part of the definition of science, the chapter introduces conceptual, procedural and attitudinal science knowledge, and outlines important aspects of each for young children's learning of science. Chapter 2 provides the reader with an overview of Australia's first national curriculum framework for early childhood educators, the EYLF, which is set out in the document *Belonging, Being and Becoming: The Early Years Learning Framework* (DEEWR, 2009). The relevance of the EYLF in relation to teaching science in the early years is explained, concluding with the identification of science outcomes for children within the framework. The voices of early childhood educators and early childhood teacher educators are highlighted to illustrate how those working in the field are engaging with the framework.

Chapter 3 introduces the reader to the Australian Curriculum: Science, starting with a brief outline of the history of the Australian Curriculum. The three curriculum strands of Science Understanding, Science as Human Endeavour and Science Inquiry Skills are described, along with how these might be woven together to provide a framework for developing experiential, connected and sequential science learning experiences for children in the early years. The case studies in this chapter provide an insight into how the Australian Curriculum: Science can be implemented in the early years setting.

Chapter 4 discusses the many theories of learning that have an impact on how educators deal with young children. There are accepted theories about how

children (and, indeed, adults) learn science and the factors that affect learning in young children. This chapter describes those theories of children's development and the range of influences that can affect science learning. Case studies are used to illustrate various aspects of the influences on children's learning.

Chapter 5 links practice to theory with a discussion of the range of formal and informal teaching approaches used with young children to enhance their learning. It outlines the importance of such strategies as scaffolding and targeted explorations. Using illustrative case studies, attention is paid to process skills; guided discovery; interactive problem- and project-based learning; and intentional teaching. Whether through the processes of science, such as the development of observation, or through the skilful questioning of the educator, the approach used should enhance children's learning. The chapter includes a discussion about the importance of children's prior knowledge in terms of the teaching and learning of science.

Chapter 6 discusses the importance of play as a developmental tool, rather than just an informal aspect of childhood. Play is of great use in early childhood, and is of value to professionals. The chapter addresses theoretical aspects of play and how play supports child development. It discusses play in the pre-school and school curricula and the role of the professional in play pedagogies. Practical examples and case studies support the discussion in this chapter.

In Chapter 7, the discussion revolves around the pedagogical practices associated with teaching science in early childhood settings. Educators are being challenged as to why they should teach science, what to teach in the subject and how. Through the use of two case studies, this chapter explores pedagogical practices associated with the teaching and learning of science for young children using play as a medium, and relates the findings to the outcomes set out in the EYLF.

Chapter 8 focuses on the ways in which educators can use the indoor and outdoor learning environment to support science learning in play-based contexts. Space, layout and materials are discussed in relation to the inside learning environment, with the use of materials highlighted through the potential they offer to enhance the curriculum. The place of cooking, the science discovery table, and construction are emphasised. The unique characteristics offered by the outdoor learning environment are described. Examples of science opportunities available in the outdoor learning environment in relation to plants, animals, exploring materials and play equipment are presented.

Chapter 9 provides insight into the informal learning of science through home and community involvement. Sociocultural theory is used to examine some of the multiple and complex ways in which science skills and concepts are being developed within the everyday practices of families, and how families' 'funds of knowledge' provide a rich and meaningful basis for children's future learning in science.

Chapter 10 discusses a growing worldwide concern for the sustainability of our environment and ways in which young children can be provided with explorations of an environmental nature. Recent research on biophilia/biophobia and bush kinders is included. The chapter embraces the notion that young children can develop empathy for living things, knowledge of ecosystems and an understanding

of the inter-relationships between elements of their environment. Educators can enhance this learning through appropriate pedagogy and scaffolding practices.

Chapter 11 deals with the pragmatics of planning. While planning is covered in one of the final chapters in this book, it is fundamental to all science teaching and learning. This chapter discusses how effective planning ensures that students are engaged in appropriate science learning experiences that follow a logical and coherent sequence. Planning considers not only what to teach but how to teach. Thus, an educator's science content knowledge, science pedagogical knowledge, beliefs about science teaching and learning, and beliefs about young children's capability and competence in relation to learning science all play a part in effective science planning.

The final chapter of the book, Chapter 12, discusses how educators monitor, assess and document science learning. Early childhood educators use evidence to determine what children know and understand. Evidence may be based on how children explore and interact within their environment or on specific competency tests. Data relating to science is usually obtained through a process of observation, anecdotal note-taking, journal entries, checklists and folios of children's work. Consequently, this chapter outlines steps associated with the assessment of learning in science as outlined in the EYLF and in the Australian Curriculum: Science, with an indication of some associated strategies that are appropriate for each developmental level. The information in this chapter is similarly supported by reference to examples of authentic practice.

There are many people who have contributed directly or indirectly to this book. Professional discussions with practising educators, colleagues and students have provided ideas and inspirations in the writing of this book. Our thanks are extended to all reviewers for their insightful comments, and to those who contributed to revisions of the final chapters. Our photographs came from a range of sources, including family friends and a professional photographer. We thank these people for their trust in us and for the use of their treasured photographs.

We hope that you will find this second edition a useful addition to your science education library.

References

Department of Education, Employment and Workplace Relations (DEEWR). (2009). *Belonging, Being and Becoming: The Early Years Learning Framework for Australia*, Canberra: Commonwealth of Australia.

PART 1

What initial information should I know to teach science?

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CHAPTER 1

The place of science in the early years

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OBJECTIVES

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

- recognise the natural disposition young children have towards science
- describe the conceptual, procedural and attitudinal knowledge associated with science
- list a range of reasons why young children should engage with science
- describe young children's capacity for science at different ages.

Overview

'Where there is a child there is curiosity and where there is curiosity there is science' (Howitt & Blake, 2010, p. 3). Young children continually engage in science practices. But they do not call it science – they call it curiosity. This chapter describes children's wonder and curiosity towards the world as it outlines what science looks like in the early years. As part of the definition of science, the chapter introduces conceptual, procedural and attitudinal science knowledge, and outlines important aspects of each for young children's learning of science. The ability of science to engage and stimulate children makes it an ideal vehicle to assist in all aspects of child development.

What does science look like in the early years?

Fourteen-month-old Zara has her gumboots on. Holding Dad's hand tightly, she walks into the edge of the mud. Zara stands still and smiles, looking down at her feet as they slowly sink. She pulls her gumboots out of the mud, feeling the resistance. On dry land Zara stands still and looks down at her feet. She then walks back into the mud with another smile on her face.

Best friends Lily and Sam (both 3 years old) have noticed a caterpillar crawling along the branch of a bush. For 10 minutes they watch the caterpillar move, engaged in their own private conversation about what the caterpillar is doing, where it could be going, what it might eat and how it might stay dry in the rain.

Every morning 6-year-old Fatima plays with the magnets at the science learning centre. She explores the different sized and shaped magnets, watching how they 'attract' and 'repel' each other and a range of materials. When asked how she thought the magnets worked, Fatima confidently replied: 'They stick together because they have honey on the ends. I know this because honey is sticky.'

These three stories illustrate how young children are constantly exploring their world. They demonstrate a sense of wonder about all things around them and delight in the natural aspects of the world. This is demonstrated by Zara and her fascination with the feel (and possibly sounds) of the mud, and by the intensity of Lily and Sam's engagement while observing the caterpillar.

Photograph 1.1: Young children demonstrate a sense of wonder about all things around them, such as blowing seeds from a dandelion.

D'Arcangelo (2000) referred to the term 'scientist in a crib' to describe how young children constantly explore their world through play. She noted that if we look into a crib 'we find a little scientist peering back at us – a child who is desperately interested in making sense of the people, the objects, and the languages around him or her, a child doing mini-experiments to try to sort everything out' (pp. 8–9).

Children learn as they grow. Through curiosity, play, observation, trial, conversations and questioning children develop their own explanations and understandings of the world. This is often termed 'everyday science', referring to the way children interpret

their science experiences based on their everyday experiences. This is clearly illustrated by Fatima and her explanation of how magnets work.

Science learning can occur in planned situations or incidentally as children are involved or engaged in other activities. While the educator provides set activities for planned learning, incidental learning can occur in the home environment or early childhood centres as children undertake their normal play activities. Incidental science understandings can arise through observation of others or specific things (such as Zara exploring the mud and Lily and Sam watching the caterpillar), through problem-solving (working out how to balance on a tree stump) and through social interactions in which discussions with others may present new information. Incidental learning can also occur through the mistakes that children make when they adapt or accept an alternative way of doing or understanding something.

PRACTICAL TASK

OBSERVING A CHILD

Watch a child for an extended period of time to see how they are exploring their world.

- How do their actions reflect curiosity and wonder?
- How is their whole body engaged in their exploration?
- What do you think they are learning?

Have a conversation with the child afterwards. Do your observations match up with their experiences? If not, what does this tell you about learning to see the world from a child's perspective?

What is science?

The word 'science' comes from the Latin word *scientia*, meaning knowledge. However, science is much more than just a body of knowledge. Davis and Howe (2003) described science as consisting of conceptual knowledge (understanding of, and about, science), procedural knowledge (the skills and procedures associated with doing science) and attitudinal knowledge (attitudes and dispositions to enhance scientific thinking).

Early childhood practitioners require a basic understanding of key scientific concepts in order to support young children's learning. Young children also have a range of understandings of scientific concepts, developed as a consequence of their everyday interactions with the world. While their initial ideas may be far from the scientifically correct concepts, these ideas make perfect sense to them. This was illustrated by Fatima's explanation of how magnets work.

It can take 12 years, or more, of schooling to reach the correct scientific concept. In the early childhood years educators should distinguish between the 'right'

answer and the 'correct' answer (Harlen, 2001). A right answer allows children to answer based on their everyday experiences. While the right answer may be a long way from the scientifically correct truth, it is important to allow young children to make observations and gain confidence in their ability to describe what they think is happening and why it might be happening.

Young children's scientific understanding is also developed through the educator modelling effective scientific communication. Using appropriate scientific terminology acknowledges children as capable and competent learners, and helps them develop explanations and understandings of scientific concepts (Peterson & French, 2008). Brunton and Thornton (2010) noted that scientific language provides the tools young children require to describe natural phenomena, express their ideas and communicate their discoveries. Further, questioning to challenge ideas, encourage discussion or promote further exploration or investigation assists young children to develop scientific thinking and investigation.

Young children require many opportunities in a variety of contexts to practise the practical, intellectual, communication and social skills associated with doing science. These include:

- practical skills of observation, using all the senses, manual dexterity, fine motor control, hand–eye coordination and construction
- reasoning and thinking skills, such as questioning, speculating and inferring, problem-solving, noticing similarities and differences, and reflecting
- communication skills, including speaking, listening, discussing, representing, recording and reporting
- social skills of cooperation, negotiation, leadership, following instructions and behaving in a safe manner (Brunton & Thornton, 2010, p. 15).

Enthusiasm is contagious. Thus, early childhood educators should model and display positive attitudes towards science. Important scientific attitudes to develop in young children include curiosity, enthusiasm, motivation, cooperation, responsibility, originality, independence of thought and perseverance. They also include a respect for evidence, open-mindedness, critical reflection and an ability to accept the provisional nature of knowledge (Brunton & Thornton, 2010). It is important for young children to see that unusual observations can form the basis for further investigation and that if something does not work the first time then they should try again.

REFLECTION

- Within the Australian Curriculum, science is defined as 'a dynamic, collaborative and creative human endeavour arising from our desire to make sense of our world through exploring the unknown, investigating universal mysteries, making predictions and solving problems' (ACARA, 2014). AC What is your definition of science, and how does it compare to the above definition?