Introduction

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Science in early childhood

As we present the third edition of this book, we are aware that science education in early childhood has moved significantly since the first edition. While retaining the essential elements of science learning and teaching that inform and guide students and educators of pre-school and early years settings, we wanted to include some new thoughts and material into this current edition – Science, Technology, Engineering and Mathematics (STEM), inclusive strategies, Indigenous approaches, outdoor learning, intentional teaching and professional learning as reflective practice. Research in early childhood science is developing internationally as well as in Australia and we have drawn on work done by the authors and reviews of the broader research literature, such that *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 that area. 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 through play, in a 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 important for educators 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 in this age range. In recognition of the general acceptance in the early years' community of 'learning through play', *Science in Early Childhood* 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 school.

The third edition maintains its four parts, constructed 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:

Part 1 'What initial information should I know to teach science?' includes information on policy documents and learning theories. Chapters 1–4 fall within this part.

Part 2 'How can I enhance children's learning of science?' presents different approaches to science learning and the importance of play as a pedagogy. This part covers Chapters 5–9.

Part 3 'How can I use the learning environment to enhance children's science understandings?' covers learning environments, learning in informal contexts, and outside learning environments. Chapters 10–12 are within this part.

Part 4 'How do I plan and assess in science?' covers essentials of planning, intentional teaching and assessment and reflective practice. It includes Chapters 13–16.

Chapter summaries

Chapter 1 starts with a short case study 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 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. 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 could be woven together to provide a framework for developing experiential, connected and sequential science learning experiences for children in the early years. The seven general capabilities and three cross-curriculum priorities are

presented, along with examples that relate to science in the early years. Case studies provide an insight into how the Australian Curriculum: Science can be implemented.

Chapter 4 discusses the many theories of learning that have an impact on how educators work 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 on the importance of children's prior knowledge in terms of the teaching and learning of science.

Chapter 6 focuses on inclusive teaching principles and practices in relation to science teaching and learning. It describes Indigenous learning in science, in particular the *8 Aboriginal Ways of Learning*. The chapter outlines the relationship between Indigenous learning and inclusive teaching practises. It indicates ways in which educators can be more inclusive, particularly in early childhood.

Chapter 7 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 curriculum and the role of the professional educator in play pedagogies. Practical examples and case studies support the discussion in this chapter.

Chapter 8 explores how young children's science identity can be enhanced when thoughtful pedagogy is provided by the educator. The first part of this chapter presents the definitions of science identity and pedagogy, followed by an exploration of the relationship between educator beliefs and what they teach. The second half of the chapter presents two case studies to illustrate pedagogical practices associated with the learning and teaching of science with young children, using play as a medium, in order to enhance their science identity.

Chapter 9 focuses on STEM education in early childhood. It describes what STEM looks like in early childhood settings and identifies ways in which STEM elements can be incorporated into children's learning. The chapter describes how STEM-related play can enhance young children's appreciation of the world and provides a range of examples that have potential for STEM learning.

Chapter 10 discusses the indoor learning environment and the ways in which educators can use this 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. Examples of science opportunities available in the built learning environment are included, along with a brief discussion on the value of digital technologies.

Chapter 11 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 12 discusses a growing interest in the value of children learning in the outside environment. It provides examples of the benefits of outdoor learning, using case studies of bush kinders and their affordances for science learning. Environmental learning is highlighted indicating how young children can be provided with explorations of an environmental nature. 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.

Chapter 13 deals with the pragmatics of planning. Planning 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.

Chapter 14 highlights the role of an intentional, purposeful educator. It provides ideas and examples of how an intentional educator can plan for and teach children with regard for their individual and collective learning experiences. The chapter highlights the important place of verbal scaffolding and lesson planning. The components of a lesson plan are described and illustrated.

Chapter 15 presents information on 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.

The final chapter in this book, Chapter 16, refers to an important aspect of any professional educator's role – that of ongoing professional learning. This chapter discusses reflective practice as a means of ensuring that educators review and monitor their own practice and how this practice affects children's learning outcomes. Tools such as reflective journals and professional portfolios are discussed. The theoretical aspects of educators' pedagogical content knowledge, content knowledge and pedagogical knowledge are presented.

There are many people who have contributed directly or indirectly to *Science in Early Childhood*. Professional discussions with practising educators, colleagues and students have provided ideas and inspirations in the writing of this book. All new chapters have been blind peer reviewed by two academics, while the other revised chapters have been academically reviewed. Our thanks are extended to all reviewers for their insightful comments, as we recognise the value these add to the strength of the book. 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.

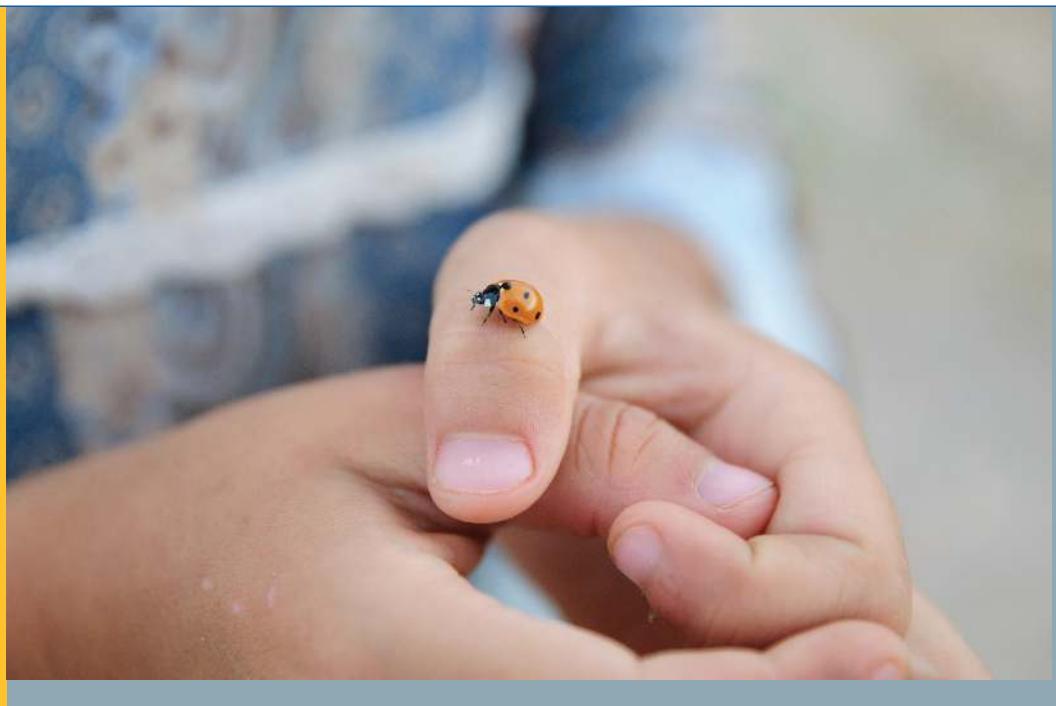
We hope that you will find this third edition a useful addition to your science education library.

Reference

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?



The place of science in the early years

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'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.

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
- describe the relationship between science and creativity
- list a range of reasons why young children should engage with science
- describe young children's capacity for science at different ages.

What does science look like in the early years?

FIGURE 1.1 Young children demonstrate a sense of wonder about all things around them – such as blowing seeds from a dandelion

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.

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).

Curiosity – children's wondering, observing, exploring, questioning and discovering as they try to make sense of the world.

Everyday science – refers to the way children interpret their science experiences based on their everyday experiences.

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