

Introduction

This book looks at the knowledge and processes of science in the context of supporting the learning and development of children from birth to five. It considers the value of nurturing and developing young children's curiosity about the world in which they live and the skills and knowledge which early years practitioners need in order to do this effectively.

Once children are helped to perceive themselves as authors and inventors, once they are helped to discover the pleasures of enquiry, their motivation and interest explode. (Malaguzzi, 1998: 67)

Why is science important?

Science encompasses both a body of knowledge which explain natural phenomena and the system for acquiring this knowledge through observation and experimentation. Science affects all our lives at every level. It governs the materials used to construct our homes, the processes by which electricity is generated, the way our food is grown and processed, the use we make of medicines and medical technology, and the technology we use for communication and transport. A degree of science literacy is essential for everyone to enable them to make informed decisions about the scientific advances and developments which affect us all.

Why is science important for young children?

Babies formulate theories, make and test predictions, seek explanations, do experiments and revise what they know in the light of new evidence. (Gopnick et al., 1999: 161)

From a very early age, babies have a strong exploratory urge, engaging with the world using all their senses. As they grow into toddlers they

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build on their early experiences and become intrigued by finding out what things can do and how things can be changed. All of this early experience leads to preschool children with the attitudes, dispositions and skills to explore and investigate independently. They draw on their growing body of knowledge to volunteer ideas, ask questions, pose challenges, solve problems and make discoveries, gradually building up their understanding of scientific concepts. They will take this experience with them into primary and secondary school to provide the firm foundations on which to build all their future scientific learning.

This is the 'ideal' scenario – one to which every young child is entitled. Nurturing a love of, and enthusiasm for, science will equip children as citizens of this increasingly technological society. Achieving this demands practitioners who are interested in, and enthusiastic about, science and who have the knowledge and skills to provide appropriate experiences for young children based on a firm understanding of how young children learn.

The approaches to young children's learning and development which underpin the philosophies of Steiner-Waldorf schools (Nicol, 2006), Montessori schools (Isaacs, 2006) and the early childhood centres of Reggio Emilia (Thornton and Brunton, 2005) are all based on the importance of children having first-hand experiences of the real world in order to build their knowledge and understanding. Exploring the natural world, handling tools and materials, observing closely, coming up with ideas and reviewing and revisiting these ideas to consolidate learning and build understanding are some of the key features of these different approaches.

When children are able to explore and investigate their immediate environment they develop the attitudes and skills which will make them lifelong learners. Building their understanding of themselves, of their influence on their surroundings and of the effects of their actions will help to shape their identity and sense of self. Experiencing the sense of wellbeing which comes with success and mastery will help them learn how to cope with the challenges of things not working out in quite the way they might have expected. Learning to see 'mistakes' not as failures, but rather as creative opportunities for developing a better understanding, is a valuable skill for life and well worth nurturing.

Starting from the child

In order to be relevant young children's scientific learning must happen within a context they can make sense of. Scientific exploration is best cultivated through experiences that build on children's current interests and preoccupations – the skill of the practitioner is to introduce

resources and ideas which will trigger these interests. Colleagues in Reggio Emilia use the wonderful term 'provocations' to describe the resources, experiences and ideas which they use to challenge children's thinking and stimulate long-term investigations and discoveries (Thornton and Brunton, 2005).

Although early years practitioners have become familiar with the notion of science in relation to experiences for preschool children they may be less confident with 'what science looks like' for babies and toddlers. This challenge is addressed in Chapters 3 to 13 of this book where direct connections are made between science skills, attitudes and processes and the behaviour and actions to look for when observing very young children exploring the world around them. The role of the key person is very important in this context. As the person who knows an individual child best she/he will have an in-depth understanding of that child's interests and preferred learning styles and will be best placed to observe and interpret the scientific learning opportunities which can arise.

Building on the interests of boys

There is much evidence to indicate the need to engage boys effectively in early learning (DCSE, 2007). Resources and equipment that encourage young children to put forward ideas, find out what things can do, solve problems and overcome challenges provide an ideal medium for engaging the interests of boys. The urge that many young boys have to try things out, take things apart and test out ideas can be productively channelled into interesting and exciting scientific exploration and discovery. Boys' interests in movement and playing outdoors can be harnessed into an exploration of materials, forces, the natural world, light, sound and the structure of the Earth. 'Superhero' play can become the medium for exploring how things work, air, water, friction, gravity, magnetism and light.

The only proviso about this approach is the need to be aware of the danger of reinforcing stereotypical images and giving the message that 'science is for boys' and is not the domain of equally curious and creative girls.

Involving parents

As with all aspects of early learning parents' involvement and interest of parents in their children's learning are of prime importance in achieving successful outcomes. Encouraging children to be curious about the world, to ask questions and to explore and investigate creates 'challenging

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children' who are unlikely to change their behaviour when they go home. It is essential that parents and family members understand the aims and objectives of the setting in encouraging children as strong, competent learners so that children do not become confused by mixed messages.

Sharing the enjoyment of exploration with family members through science-based family workshop sessions can often provide the ideal medium for engaging with parents to talk with them about how best to support their child's early learning (Brunton and Thornton, 2006).

The place of science within the UK's curriculum frameworks

All the early years curriculum frameworks in the UK promote the principle of starting from the child, listening to children's ideas and respecting their ideas and opinions. They advocate providing children with a rich range of first-hand experiences by which they can build their own competencies as active, independent learners.

England

In England the Early Years Foundation Stage (EYFS) Guidance (DfES, 2007) places science within the area of learning defined as 'Knowledge and Understanding of the World'. The requirement states that:

Children must be supported in developing the knowledge, skills and understanding that help them to make sense of the world. Their learning must be supported through offering opportunities for them to use a range of tools safely, to encounter creatures, people, plants and objects in their natural environments and in real-life situations, to undertake practical 'experiments' and to work with a range of materials.

Within 'Knowledge and Understanding of the World' the aspect most directly related to the knowledge base and processes of science is:

- Exploration and Investigation – how children investigate objects and materials and their properties, learn about change and patterns, similarities and differences, and question how and why things work.

However, three overarching commitments within the Learning and Development theme of the EYFS also have a significant bearing on the overall approach to promoting exploration and investigation to be adopted with young children. These are:

- Play and exploration: 'Children's play reflects their wide ranging and varied interests and preoccupations. In their play children learn at their highest level. Play with peers is important to children's development'.
- Active Learning: 'Children learn best through physical and mental challenges. Active learning involves other people, objects, ideas and events that involve children for sustained periods'.
- Creativity and critical thinking: 'When children have opportunities to play with ideas in different situations and with a variety of resources, they discover connections and come to new and better understandings and ways of doing things. Adult support in this process enhances their ability to think critically and ask questions'.

Northern Ireland

The Northern Ireland Curricular Guidance for Pre-School Education (CCEA, 1997) comprises seven areas of learning of which two are directly related to science, 'Early Experiences in Science and Technology' and 'Knowledge and Appreciation of the Environment'. The guidance is based on the principle that young children require:

Opportunities to investigate, satisfy their curiosity, explore the environment inside and outside, extend their sense of wonder, experience success and develop a positive attitude towards learning.

Children should be given opportunities to:

- observe and explore;
- use their senses to explore the environment;
- observe and respect living things;
- learn about themselves;
- talk about the weather and the seasons;
- take some responsibility for caring for their own environment. (CCEA, 1997)

The Foundation Stage Curriculum, which covers the first two years in primary school, emphasizes the need for children to have opportunities for exploration, investigation, problem solving and decision making and that children should have:

Rich and varied contexts for developing skills such as observing, investigating, organising, recording, interpreting and predicting. (CCEA, 2006)

Scotland

The new Curriculum for Excellence being developed in Scotland covers the age range 3–18, with children from age 3 to 7/8 years of age grouped

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together within the Early Level. The importance of active learning is one of the key principles which underpin this new curriculum.

Early years staff are committed to developing learning in natural and real contexts, familiar to children and appropriate to their interests and stages of development ... young children's learning is most effectively supported through interaction with adults and other children and through play and active exploration of their environment. Curriculum for Excellence promotes the need to view learning and teaching across curriculum subjects and areas as inter-connected and integrated. This is particularly important for young children, who will develop their understanding of, for example, science, language, communication, technology and mathematics from an everyday experience, such as water or sand play, supported by knowledgeable adults. (Learning and Teaching Scotland, 2009)

Within the Curriculum for Excellence the knowledge content of science at the Early Level is defined in a series of statements about what children will experience over the period from age 3 to age 7/8. These are set out under the following headings:

- Planet Earth: sustainability, biodiversity, climate and earth science, astronomy.
- Energy in the environment: energy in food, electricity
- Forces and motion.
- Life and cells: keeping my body healthy, using my senses.
- Communication: communication systems, sound.
- Materials: properties of materials. (Available at <http://www.ltscotland.org.uk/curriculumforexcellence/outcomes/science/levels.asp>)

Early learning and care for children under the age of 3 is governed by the principles of the birth to 3 framework:

Early learning involves opportunities to play, to interact, to explore, to create and to problem solve. It is supported by environments that are flexible and responsive which can adapt to children's immediate interests and needs. (Learning and Teaching Scotland, 2006)

Wales

The Foundation Phase Curriculum in Wales (DLEUS, 2008) covers the age range of 3 to 7 years. It is based on the principles that:

Children learn through first-hand experiential activities with the serious business of 'play' providing the vehicle. Through their play, children practise and consolidate their learning, play with ideas, experiment, take risks, solve problems, and make decisions individually, and in small and large groups. First-hand experiences allow children to develop an understanding of themselves and the world in which they live.

'Knowledge and Understanding of the World' is one of the seven areas of learning within the Foundation Phase. This places an emphasis on encouraging children's curiosity and includes developing their skills in:

- exploring and experimenting;
- thinking about questions and then asking them and listening to the answers;
- listening to others' ideas;
- what they want to find out and how to do it;
- thinking about what might happen if ...

The science knowledge base is grouped under four broad headings:

- Places and people.
- Time and people.
- Myself and other living things.
- Myself and non-living things.

Structure of the book

Science in the early years is divided into two parts. Part 1 (Chapters 1 and 2) reviews the skills, attributes, and dispositions which young children can acquire through scientific exploration and investigation and in creating 'science-rich' environments.

Chapter 1 covers the development of conceptual knowledge, attitudes and skills, the processes of science and the role of the adult in asking productive questions, co-constructing knowledge alongside children and observing and documenting their scientific learning. It also suggests a way of organizing and managing young children's exploration through the 'Spiral of Discovery'.

Chapter 2 examines the organization of space, equipment and resources, at how to capitalize on the wonderful potential of the outdoor environment and the importance of giving children opportunities to experience risk and challenge.

Part 2 (Chapters 3 to 13) then looks in more detail at the knowledge of scientific concepts which practitioners need in order to support young children's scientific learning and development. The information given has been here specially selected in relation to the contexts in which these concepts are likely to be experienced in an early years setting. Examples are then provided to show what these concepts look like when experienced by babies, toddlers and preschool children. The detailed structure of these chapters is set out in the introduction to Part 2.