Science in the early years: Evidence-based educator resources

Gayl O'Connor
Australian Council for Educational Research

https://doi.org/10.37517/978-1-74286-715-1-9

Gayl O'Connor is a Senior Research Fellow at the Australian Council for Educational Research where she works within the Assessment and Development Division. She has worked on national and international science assessments and curriculum projects and has special interests in supporting the development of inquiry skills, and in the application of digital learning tools for science assessment. Recently, she has contributed to PISA 2025 instrument development for the science domain and to the design of tasks for the innovative domain, Learning in the Digital World, in which students learn to use online tools and apply these to a challenge task. Gayl has conducted item writing and curriculum resource development training workshops for teachers in Australia, Indonesia and Malaysia. Gayl has a background in secondary science teaching, specialising in biology.

Abstract

The *Science in the early years* series was developed to assist preschool and Foundation to year 2 primary educators to incorporate the latest research in science learning into their programs and teaching practice. This paper focuses on the educator resources developed to support early years educators implement activities to assist children to develop science concepts and inquiry skills. The activities are underpinned by evidence-based research that revealed 4 themes in the early years' science literature.

Introduction

Science in the early years (Australian Council for Educational Research [ACER], 2020) is an online series of 4 research papers and 7 associated educator resources. This series provides preschool and early years primary school educators with insights drawn from current research in science learning and monitoring in the early years, and examples of how this research can be incorporated into their programs and teaching practice.

Four themes emerged from a literature review, with each theme providing the focus of a research paper. Educator resources were developed for the themes where it would be most useful in supporting practice based on the research evidence.

This paper describes the key research evidence that underpins the activities in the educator resources in the suite, and their design.

Themes

Paper 1 'Early years science and integration' focuses on the importance and value of science in the early years, how teaching science is supported by the Early Years Learning Framework (EYLF) and the Australian Curriculum Science: Foundation to Year 2 (AC Science F–2), and the value of integrating science in the early years into existing programs to foster science learning. The educator

resources support educators and children to recognise the elements of science in simple, everyday activities used in early years settings.

Paper 2 'Science inquiry skills' focuses on the importance and value of providing learning experiences that support the development of science inquiry skills (SIS) in the early years, as these are integral aspects of both the EYLF and the AC Science F–2. Incorporating science contexts and content in the early years within an inquiry-based approach is emphasised. The educator resources support children to conduct investigations into aspects of the world around them.

Paper 3 'Monitoring children's learning' focuses on the importance and value of monitoring young children's science learning. The educator resources use concept cartoons as monitoring tools, and checklists customised to the EYLF and the AC Science F–2 outcomes.

Paper 4 'Educator facilitation' focuses on the key role of educators in facilitating young children's science learning. It describes strategies found to be effective for facilitating science learning, and practices that support confidence-building for early years educators to incorporate science in their early years' programs. Educator resources were not needed to support this theme.

Educator resources

There are 4 main activities supported by concept cartoons and checklists. The 'Plant treasure hunt' and 'Floating and sinking' activities accompany Paper 1. The treasure hunt is an activity that encourages children to explore ideas about plants in an outdoor environment. They build on their understanding of what a plant is by drawing one, and then go outdoors on a 'treasure hunt' to find examples of plants. 'Floating and sinking' explores the scientific concepts behind floating and sinking. Children complete an activity in small groups to find out whether a range of objects float or sink.

'Exploring mixtures' and 'Light and shadows' accompany Paper 2. The 'Exploring mixtures' activity investigates the behaviour of 2 common household products (oil and water), with the emphasis on supporting children to develop their inquiry skills to describe what they observe when trying to mix these liquids. The activity 'Light and shadows' focuses on observing and explaining (for older children) how shadows form.

'Concept cartoons as monitoring tools' and 'Checklists for EYLF and for AC Science Foundation – Year 2' accompany Paper 3. There are 4 concept cartoons, each customised to one of the activities in the educator resources for Paper 1 and Paper 2. Each concept cartoon provides a monitoring tool for finding out how children's understandings about science concepts are developing. The cartoons provide a simple narrative in which 2 or more characters provide commentary or opinions about a phenomenon.

Checklists provide templates tailored to either the EYLF or AC Science F–2 learning outcomes. The checklists record evidence of children's science learning and monitor this over time. The checklists are customised for the educator resources 'Plant treasure hunt', 'Floating and sinking', 'Exploring mixtures' and 'Light and shadows', but can also be repurposed for educator-created resources.

Evidence base for development of activities

Plant treasure hunt

The Plant treasure hunt activity provides an opportunity for children to explore their immediate natural environment, linking science understanding back to the child's world in a relatable, everyday context. As children are keen and inquisitive learners, activities such as this encourage children to

explore their environment, and also nurture their sense of curiosity about their surroundings (Milford & Tippett, 2015). Supporting and developing natural curiosity is an essential trait for a scientist and for a successful science learner (Conezio & French, 2002; Gallenstein, 2005).

This activity allows children to learn about different examples of plants other than flowers or plants that are grown in a pot. The term 'plant' is used by children to refer most often to flowering plants (Tunnicliffe, 2001). Drawings are a valuable and non-threatening way to identify children's understanding and misconceptions, such as the meaning of a plant, but it is important to discuss the drawing with the child, as the drawing might have a different meaning to the child than to the educator (Chang, 2012).

Floating and sinking

This activity supports children to work together in small groups to test a range of objects and to share their observations. Children use their senses to observe what happens when they drop solid objects into a bucket of water. They sort the objects into two groups: the ones that sink to the bottom of the bucket and the ones that float.

The activity also assists children to become confident and involved learners, using persistence in finding those objects that float. When children are allowed to study the phenomenon of floating and sinking in a playful and creative manner, they develop a positive experience of the concept of density that can be built on later (Andersson & Gullberg, 2014).

Exploring mixtures

In this activity, children work in small groups, and are provided with guidance to predict what might happen when trying to mix two liquids. They use inquiry skills to observe what happens, check back to their prediction, and record what they have found out. Children can share what they did and what they observed with other groups of children. Communication is an important part of the scientific process (Conezio & French, 2002; Gallenstein, 2005) and young learners should practise these skills.

Light and shadows

In this activity, children work in small groups to create and explore the requirements for making shadows. Using toys that will block out the light and a torch, they use inquiry skills to make predictions about when a shadow will form, what shape it will have, and how large it will be. They then check their ideas by placing a torch and an object in different positions. Children record their observations and describe what they observed to others. Children can begin to explain behaviour, such as objects must be positioned to block light from a light source to create shadows (Delserieys et al., 2014).

Activity design

Educators play a key role in facilitating young children's science learning. Educators can guide young children so that their natural curiosity is also the beginning of the development of their science inquiry skills (Worth, 2010). The need for an educator to support and scaffold activities is important. For example, it was found that providing materials alone for children to play with independently in the context of mixtures, did not result in the formation of scientific concepts (Fleer, 2009). Science concepts and the development of inquiry skills are interconnected so that by situating science learning within inquiry investigations that are supported by educators (as illustrated by the 4 activities described), overall science understanding is developed (Lind, 1998). Opportunities for young learners to use their senses to demonstrate they are capable of making relevant and creative observations should be provided (Johnston, 2009).

Early years educators do not need to be a 'fount of all knowledge' about science, but instead they can be facilitators who help children make connections and develop their understandings. Educators and children can 'find out together' if necessary (Tu, 2006).

To assist educators to facilitate the 4 activities, the resources are designed using a consistent structure. Each activity includes an activity description, links (mapping) to the EYLF and AC Science F–2 outcomes, and explanations about the concepts to support educators unfamiliar with them. For example, in 'Exploring mixtures', the reason oil floats on water is provided, the action of an emulsifier is described, and 3 types of mixtures are outlined: solutions, suspensions and colloids.

Each scaffolded activity has 4 sections:

- What to provide? (a list of materials required)
- What to do? (step-by-step scaffolding including responses to look for)
- What to record? (suggestions for noting the key ideas and understandings demonstrated by the children
- What comes next? (suggestions for extending the activity to provide further learning opportunities).

The learning intentions of the activity and suggested success criteria are also provided to assist in monitoring children's learning.

The *Science in the early years* series is available for free download from the ACER research repository. Feedback from educators implementing the resources is welcome, and can be emailed to gayl.oconnor@acer.org

References

Andersson, K., & Gullberg, A. (2014). What is science in preschool and what do teachers have to know to empower children? *Cultural Studies of Science Education*, *9*(2), 275–296. https://link.springer.com/ article/10.1007/s11422-012-9439-6

Chang, N. (2012). What are the roles that children's drawings play in inquiry of science concepts? *Early Child Development and Care*, *182*(5), 621–637.

Conezio K., & French, L. (2002). Science in the preschool classroom: Capitalizing on children's fascination with the everyday world to foster language and literacy development. *Young Children*, *57*(5), 12–18.

Delserieys, A., Jégou, C., & Givry, D. (2014). Preschool children's understanding of a precursor model of shadow formation. In C. P. Constantinou, N. Papadouris, & A. Hadjigeorgiou (Eds.), *E-book proceedings of the ESERA 2013 conference: Science education research for evidence-based teaching and coherence in learning* (pp. 5–13). European Science Education Research Association.

Fleer, M. (2009). Supporting scientific conceptual consciousness or learning in 'a roundabout way' in play-based contexts. *International Journal of Science Education*, *31*(8), 1069–1089.

Gallenstein, N. L. (2005). Engaging young children in science and mathematics. *Journal of Elementary Science Education*, *17*(2), 27–41. http://search. https://www.jstor.org/stable/43156150

Johnston, J. (2009). Observation as an important enquiry skill. *Primary Science*, *106*, 15–17.

Lind, K. (1998). *Science in early childhood: Developing and acquiring fundamental concepts and skills* [Paper presentation]. Forum on Early Childhood Science, Mathematics, and Technology Education, Washington DC, United States.

Milford, T., & Tippett, C. (2015). The design and validation of an early childhood STEM classroom observational protocol. *International Research in Early Childhood Education*, *6*(1), 24–37.

O'Connor, G. & Rosicka, C. (2020). *Science in the early years. Paper 2: Science inquiry skills*. Australian Council for Educational Research. https://research.acer.edu.au/early_childhood_misc/16

O'Connor, G. & Rosicka, C. (2020). *Science in the early years. Paper 4: Educator facilitation*. Australian Council for Educational Research. https://research.acer.edu.au/early_childhood_misc/18

Rosicka, C., & O'Connor, G. (2020). *Science in the early years. Paper 1: Early years science and integration.* Australian Council for Educational Research. https://research.acer.edu.au/early_childhood_misc/15

Rosicka, C., & O'Connor, G. (2020). *Science in the early years. Paper 3: Monitoring children's learning.* Australian Council for Educational Research. https://research.acer.edu.au/early_childhood_misc/17

Tu, T. (2006). Preschool science environment: What is available in a preschool classroom? *Early Childhood Education Journal*, *33*(4), 245–251.

Tunnicliffe, S.D. (2001) Talking about plants - comments of primary school groups looking at plant exhibits in a botanical garden. *Journal of Biological Education*, *36*(1), 27–34. https://doi.org/10.1080/00219266.2001.9655792

Worth, K. (2010). *Science in early childhood classrooms: Content and process*. SEED Papers. https://ecrp.illinois.edu/beyond/seed/worth.html