Science in the early years

PAPER 4

Educator facilitation

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Introduction

This fourth paper in the *Science in the early years* series concludes the review of current research into science learning and monitoring in the early years. The aim of this series is to provide early years educators with an insight into current research; highlight how research findings relate to children's science learning; look at the current understandings about early years science; and provide examples of how early years educators can incorporate this research into their practices.

This series defines 'early years' as the two years prior to school and the first three years of primary school, which in Australia generally includes children aged three to eight years.

Children in the early years may attend early childhood centres, kindergartens or primary schools. Educational expectations for children of this age range are covered by the Early Years Learning Framework (EYLF) for preschool children and the Foundation to Year 2 Australian Curriculum (AC) for school students.

The *Science in the early years* series reviews Australian and international research to highlight aspects of the learning and monitoring of science in the early years that are significant to Australian children and their educators.

This paper focuses on the key role of educators in facilitating young children's science learning.

The critical role of educators as facilitators of science learning

Early years educators play a crucial role in supporting young children across a wide range of outcomes: social, emotional, and cognitive, including literacy and numeracy.

Key aspects that impact positively on delivering early education for young children include:

- using age-appropriate intentional teaching strategies
- extending children's thinking through scaffolding (guiding, modelling and questioning) to stimulate learning
- letting children's natural curiosity act as a driver of learning (Fox & Geddes, 2016).

Fostering curiosity can lead to play-based integrated learning of basic science concepts and the development of inquiry skills, as explored in Paper 1 and Paper 2 of this series. Conceptual understandings and inquiry skills are interconnected: by situating science learning within inquiry investigations, young children's science understanding, with the support of educators, is developed (Lind, 1998).

Early years educators can foster positive attitudes and dispositions that encourage children to think scientifically and can acknowledge that these are important when children demonstrate scientific thinking (Wilson, 2007). Educators can highlight to children that science is not only used by stereotypical scientists, wearing white coats and working in a lab, but that a range of occupations use science, including electricians, horticulturists, architects and mechanics (Worth, 2010). By directing children to the wide application of science, they can help young children see science in the world, making it more accessible and relatable.

Educators can guide young children so that their natural curiosity about the world around them is also the beginning of the development of their science inquiry skills (Worth, 2010).

When determining content for children in the early years to explore, the science should be accessible and drawn from the world around them, and be focused on significant scientific concepts. Educators can make time for science, ensuring that it is developmentally appropriate and interesting, and can allow children time to explore and develop their understanding, especially for inquiry-based science (Lind, 1998; Worth, 2010).

Strategies for facilitating science learning

Young children may like to discover and explore through play; however, it is important that children are supported and encouraged by educators, with children's own curiosity and observations informing the direction their learning will take (Nayfeld, Brenneman & Gelman, 2011). There is also a key role for the early years educator in scaffolding interactions the children have as they use provided materials. The role of the educator as mediator (guide or facilitator) is a common thread in the literature. Having a science corner or science table in the classroom can stimulate conversations between children and educators, but this alone is not always sufficient to lead to deeper thinking (Nayfeld et al., 2011). Educators can plan formal 'sciencing' activities in which young children are active participants in learning science (Nayfeld et al., 2011). Such activities can be as simple as cooking and sorting, which provide children with opportunities to develop skills including 'observing, comparing, organising and classifying' (Nayfeld et al., 2011, p. 251).

The degree of scaffolding provided by an educator can vary between science-related activities. Facilitation may include scaffolding the use of scientific equipment (Nayfeld et al., 2011) so that when areas of the room are set aside for explorative play, the educator can increase children's interaction by indicating the purpose of the science tools. For example, the proper use of a balance scale might not be obvious to young children. Once they are shown how it works there is a greater chance that children will develop a related inquiry skill (observing, describing, comparing, questioning, predicting). A six-month study by Gallegos-Cázares, Flores-Camacho, and Calderón (2009) looked at the context of colour, shadows and light through an educator-led approach, and introduced resources (e.g. artefacts, devices, measuring instruments) in a scaffolded manner using a sequence of activities. Children were able to handle different materials linked to exploring the same concepts. Video recordings of the children were made as they interacted with the materials, and focused on identifying the children's evolving ideas. It was found that the children's explanations of concepts were more extensive and explicit when discussing the targeted concepts after the intervention. Experimental activities that are based on familiar contexts (e.g. apples floating on water) can be used in a highly scaffolded, educator-led formal approach (Martins & Veiga, 2001) with educators asking questions as the students design, hypothesise and perform experiments.

Active, hands-on learning opportunities allow children to have personal experiences as they develop science concepts (Lind, 1998; Cremin, Glauert, Craft & Compton, 2015), as well as support their interest in future science learning (Lind, 1998). Science should be very tactile in the early years, and provide opportunities for young learners to use all of their senses and show that they are capable of making very relevant and creative observations as a result (Johnston, 2009). Cremin et al. (2015) identified some common features of teaching both science and creativity:

- play and exploration
- motivation and affect
- dialogue and collaboration
- problem-solving and agency (generating and testing their own ideas stemming from their interests)
- questioning and curiosity
- reflection and feedback
- teacher scaffolding and involvement.

The role of the educator in moving children's thinking about everyday concepts to more formal concepts is recognised as well as the critical role of 'playful interaction' (Cremin et al., 2015, p. 409).

Young learners have the capacity to develop inquiry, creativity and critical thinking skills (Siry, 2013; Andersson & Gullberg, 2014). For example, for children to work out 'cause and effect' through

inquiry, they need to be provided with contexts that enable relationships to be observed, such as what happens when they sink a model boat. There are roles for educators to provide multiple opportunities for the children to repeat their actions when interacting with such materials. Educators can ask questions of the children during play-based experiences, to highlight and formalise some of the trends the children observe.

Educators can model and support children's use of language and thinking processes associated with scientific inquiry. For example, in a study describing children exploring colour mixing (Peterson & French, 2008), teachers used the colour terms (e.g. 'it's green'), colour categories (e.g. 'it's primary'), verbs related to mixing ('when we mix these together we get orange'), and causal terms ('because', 'so'). In another study, when 5-year-olds worked with experimental variables, the term 'variable' was explicitly introduced to the children and examples were given (van der Graaf, Segers, & Verhoeven, 2015). The children worked with a hands-on task using ramps and changed variables (weight of the ball, steepness of slope, place of the starting gate, surface texture of the slope). The children were given the challenge of designing experiments using two ramps and the four variables, and were provided with feedback after each experiment. Identifying the controlled variable becomes more difficult as more variables were used but using the hands-on assessment task supported the development of an understanding of the importance of controlling all variables other than the one being studied. Explicit instruction about the need to control one variable at a time was found to be more effective than allowing the children to design these experiments themselves (van der Graaf et al., 2015). Children of kindergarten age, can, however, be empowered when they retain control of experiments themselves where educators provide 'mindful guidance' within open-ended experiments (Siry, 2013, p.2427).

Children's attention spans will determine the nature of the science learning activities, given that one of the critical differences between 3- and 4-year-old children is the shorter attention span of 3-year-olds (Fox & Geddes, 2016). With the educator in the role of supportive faciliator, instead of children moving from one activity to another, young children can persist and stay on task to solve problems using rich materials such as large blocks, sand, water, dress-ups, clay and construction sets.

Misconceptions about science concepts are common among early years children, especially on topics such as shadow formation, dissolving and floating (Carey, 2000; Tu, 2006). The Resources that accompany Papers 1 and 2 cover these and show how misconceptions can be addressed and challenged directly with teacher support. It is important that scientific content 'be within the realm of possibility of comprehension, matching science content and cognitive capacity' of young learners (Lind, 1998, p. 14), and this is essential to learning science, developing positive attitudes toward science and in retaining an interest in science.

Building confidence in facilitating science learning

In an early years environment, the educator's science knowledge can guide children by asking questions to help them notice and reflect on key aspects of their explorations (Worth, 2010). Educators do not have to be a 'fount of all knowledge', rather they can be a facilitator who helps students make connections and develop their understandings. It is acceptable for educators to say 'I don't know, why don't we find out together' (Tu, 2006, p. 251). Educators and children working together to explore scientific phenomena can help children develop positive feelings towards science that reinforce self-confidence for both educators and children (Andersson & Gullberg, 2014). Early years' educators may commonly lack confidence to teach science if they are not supported by a science background (Worth, 2010). They may also worry that they will not be able to retain control of the learning process (Cremin et al., 2015), or feel that they are unable to engage children in meaningful science activities and discussions (Nayfeld et al., 2011). Educators may also be challenged in implementing open-ended science activities (Cremin et al., 2015).

Supporting early years educators with pre-service and in-service professional development is critical (Nayfeld et al., 2011, p. 985) for their confidence in their ability to teach science, which can directly influence children's development and desire to learn. Educators need to have an understanding of children's existing science knowledge and the required curriculum, including science inquiry skills and content knowledge, but these are not always areas that are covered well in pre-service or in-service teacher training (Brenneman, 2011).

Educators may also feel pressured to prioritise language and literacy activities above those with a science focus (Henrichs & Leseman, 2014). Science activities can lose focus on science concepts and inquiry skills when they are viewed as 'vehicles' for the development of vocabulary and skills such as fine motor coordination, counting, and color and shape recognition (Worth, 2010). Therefore it is important to ensure that the science is drawn out and explicitly taught during these activities.

In the context of integrated STEM (science, technology, engineering and mathematics) in primary schools, teacher professional development has been shown to have a positive impact on student skills and knowledge. Ongoing support is effective in allowing teachers to reflect on their teaching practice (Rosicka, 2016). In addition to this, other strategies (Rosicka, 2016) relevant to supporting early years educators' capacity to facilitate the teaching of science include: employing specialists and coaches, mentoring by science professionals, and implementing school-based professional learning communities.

Summary

Early years educators play a critical role in fostering positive attitudes and dispositions in young children towards science. Play is crucial in allowing children to 'experience and make sense of their world, to challenge themselves, practise skills and manage their emotions, interact with others or enjoy time alone' (Scottish Government, 2013, p. 17). Children's natural curiosity supports the development of science concepts and inquiry skills when they can see the connections of science to their everyday world. Early years educators can facilitate science learning, and scaffold instructional activities that have a hands- on approach using familiar materials. Although scaffolding is important, children should still have the opportunity to develop their own science investigations, as these can lead to a feeling of empowerment.

Educators are not expected to know everything about science – its conceptual understandings and inquiry processes – but rather be open to working together with children to help them make connections and develop their understandings, with the aim of finding out the answers to questions children might raise collaboratively. It is imporant, however, that educators have an understanding of children's existing science knowledge and the common misconceptions children might hold. Educators should know where children's learning needs to be directed to move from making observations, to explaining scientific phenomena, but their expectations should be matched to the cognitive abilities and attention span of young learners.

Educators need to be supported by pre-service and in-service professional development programs, to increase levels of confidence in teaching science. Given the crucial role early years educators have in fostering lifelong interest and positive attitudes towards science, supporting each other through establishing centre-based or school-based learning communities across the early years is also a strategy for educators to consider.

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