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Introduction

Historically, science in early childhood has been supported by the theoretical approaches of Lev Vygotsky; the socio-culturalist and Jean Piaget; the constructivist (Fleer & Robbins, 2003). This research was framed within the context of these two perspectives, the new Australian National Quality Framework, which sets the National Quality Standard for early childhood development in Australia and the Department of Education and Early Childhood Development’s (DEECD) (2009), Victorian Early Years Learning and Development Framework (VEYLDF).

The VEYLDF advocates an integrated teaching and learning approach which balances child-initiated or directed play; teacher-initiated learning; and teacher-guided play and learning. It aims to advance the learning and development of children and has identified five learning and development outcomes. The focus of this research was the extent to which a teacher’s own pedagogical knowledge; their knowledge and understanding of science and scientific concepts; and the VEYLDF supported early childhood teachers in the development of science education in their curriculum.

The key questions explored were how the early childhood teachers:

- integrated science education in their curriculum
- planned for science
- capitalised on spontaneous teachable moments in science
- felt about their capacity to deliver science education
- used the VEYLDF to support science education in their settings?

Background

Early childhood education in Australia has experienced changes with the recent introduction of the National Quality Framework and curriculum frameworks, such as the VEYLDF. Siraj-Blatchford and Sylva (2004) found that the most effective kindergartens are those which have a balance of opportunities for teacher-directed learning and opportunities for learning through play, and it is this balance that underpins the integrated teaching and learning approach of the VEYLDF.

In the past, early childhood teachers have struggled to locate science education in their curriculum, displaying an overall apathy in relation to their own science knowledge (Fleer, 2001). In the early 1990s researchers established the key role played by early childhood teachers in developing children’s scientific thinking, and that a more integrated approach was needed (Fleer, 2001). There has been a shift in pedagogical approaches to science education and these include a discovery approach, a transmission approach and an integrated approach.

Discovery learning is a pedagogical approach applied to science education which, in early childhood settings, may include a science discovery space where children can explore a range of natural and man-made objects which can support the children’s curiosity and learning (Fleer, Jane & Hardy, 2007). Alternatively a transmission approach puts the teacher at the centre of the learning process with the outcomes focused on the acquisition of facts and knowledge (Fleer et al., 2007). An interactive approach is ‘designed to find out what children think and to encourage
them to ask questions” (Fleer, 2007, p. 21). These questions may arise from discussion or observations of children at play (Fleer et al., 2007). Whichever approach, or combination of approaches is taken, their subject knowledge and pedagogical knowledge are both important components.

An individual teacher’s understanding of how or why they teach, what they teach, and the way they teach is considered their Pedagogical Content Knowledge or PCK. PCK is the combination of knowledge and pedagogy (Shulman, 1987) or the transformation from teachers’ knowledge about a subject into learning opportunities for children (Kind, 2009). The ambiguous nature of PCK as a concept (Hedges & Cullen, 2005) can often lead to a large amount of teacher knowledge being naturally and implicitly applied to their practice (Kind, 2009), but when teachers become aware of their PCK, potential exists for quality improvement in their practices (Siraj-Blatchford, 2009).

Subject content knowledge was considered central to the development of a teacher’s PCK (Abell, 2008) and when subject content knowledge was combined with appropriate teaching strategies then meaningful learning occurred for children (Hedges & Cullen, 2005). While a teacher’s subject content knowledge supports their capacity to make knowledge accessible to young children (Garbett, 2003), their beliefs and values play a part in the development of their PCK (Shulman, 1987). A teacher who believes they have a subject content deficit has the potential to communicate this negativity to children (Harlan & Rivkin, 2008) and to use ineffective teaching practices (Fleer et al., 2007). This, in turn, can lead to children’s early development of negative views on science. However, since preservice teachers often had little more than Year 10 secondary science (Fleer et al., 2007), it is not surprising that pre-service teachers often find science difficult to teach, leading to a lack of confidence in integrating science into their curriculum (Yoon & Oncwari, 2006), and, therefore limiting science learning. Conversely if a teacher believed they had a sound content knowledge, they were more likely to employ an effective pedagogy in their curriculum (Watters, Diezmann, Grieshaber & Davis, 2001).

There is now a focus on a well-articulated and informed pedagogy that supports the development of knowledge and skills that children need for their future learning (Tayler, Ure, Brown, Deans & Cronin, 2009). However, little research is available about how early childhood teachers in Victoria made use of the VYLF in relation to their teaching and learning and how the framework supported early childhood teachers in Victorian kindergartens to develop science education in their curriculum.

Research methodology

A qualitative collective case study model (Punch, 2009) was chosen for this research project because the focus was on the particular issue of developing a deeper understanding of science education in early childhood. The intention was to view each case individually, and then engage in cross-case analysis, making comparisons and highlighting any cross-case similarities or distinctions (Yin, 1981).

Participants

Three early childhood teachers with the Bachelor of Early Childhood Education who were each working in Victorian kindergartens were recruited for this project. Inviting participants from similar settings was a deliberate attempt to gain a deeper understanding of what may constitute science in Victorian kindergartens specifically, as opposed to other early childhood learning environments. Participation in this project was purely voluntary and the three participants all had similar career trajectories. They had all completed their Diploma of Children’s Services, spent some time working in long day care before returning to study for their Bachelor of Early Childhood Education and are now working in Victorian kindergartens.

Research instruments and data collection

Two data collection tools were employed: semi-structured interviews and reflective journals. Data collection began with an initial interview to determine teaching practices of each of the participants, followed by keeping a reflective journal. This reflective journal gave each participant an opportunity to gain a deeper insight into their own knowledge and understanding of their practice. After one week the participants were interviewed again to capture any new insights. All the data collected was analysed individually and treated as a case within itself before any cross-case analysis was applied. All names used are pseudonyms to protect confidentiality.

Cross-case analysis

One clear commonality between the three teachers, Ellen, Louise and Therese, was that their science education experience in secondary school was both negative and unrewarding. Louise said that she ‘hated it, wasn’t very good at it and didn’t really like it’. Ellen similarly said that she ‘hated it, wasn’t smart, wasn’t interested’. While Therese revealed her memory of secondary school science was of ‘Bunsen Burners and not much else’.

The participants conveyed a sense that they were not smart enough for science and they seemed to lack confidence in their own understanding of science concepts. Therese explains that her understanding is ‘basic, I’m not confident of more advanced science concepts’ while Louise lacks the confidence to label science as science in her curriculum and Ellen believes that science is ‘high end’. Interestingly Louise says she would like to learn how ‘... to turn it into something they can understand ... you know ways to ensure that it is taught age appropriate’. 
She seeks not necessarily to improve her subject content knowledge but rather develop her understanding on how to convert her knowledge into appropriate learning opportunities for the children.

The teachers' prior experiences may have limited their awareness of opportunities for science learning in their curricula. This is consistent with Campbell and Jobling (2010) who found that a teacher who was confident in their own science understandings was more spontaneous, and prepared to encourage children to think more deeply in those teachable moments, than a teacher who was not as confident. It is therefore important that early childhood teachers not only have the appropriate science knowledge, but also the confidence to transform that knowledge into appropriate learning opportunities for the children, both planned and in those spontaneous teachable moments.

In all three cases the science curriculum was informed and guided by the interests of the children; responsive to children's questions, interests, prior knowledge and experiences; as well as observing children at play. However, teachers have some responsibility to introduce new and exciting concepts that pique the child's interest (Campbell & Jobling, 2012) as their limited life experiences prevent them from doing so themselves.

An example in the case studies of an observation leading to an exploration of a science concept being included in the curriculum, was an investigation of the magnetic properties of a variety of objects. The children were interested in 'seeing what it will stick to'. It is worth considering whether the teacher should have been looking for ways to transform this play-theme into further scientific learning, thus potentially extending their understanding of magnetic force. It could be argued that teacher knowledge, confidence and approach potentially impact on the children's development and extensions of scientific concepts.

All participants regarded discussion of science concepts as integral to their curriculum. These shared and sustained discussions are important to contemporary teaching and learning approaches in early childhood education (Siraj-Blatchford & Sylva, 2004) as they allow teachers to gauge and raise the level of understanding of the children, allowing them to clarify thoughts and ideas and provide an opportunity to introduce new scientific words. Therese said that when comfortable, she modeled correct scientific language to the children, for example when the children observed changes in the environment during Autumn she described photosynthesis. She noted in her initial interview that she had recently attended a professional development session which explored the use of the natural environment to investigate science, and that this had given her some ideas on how to use the environment to explore science concepts and the confidence to use correct scientific language.

**Teacher confidence**

All three teachers held negative perceptions of their science knowledge and their capacity to integrate science into their curriculum; however, in contrast to their beliefs there were examples of integration of science in their curricula, such as life cycles, seasons, chemical reactions, magnets, human body, plant growth, colour mixing, reflection and refraction of light and block construction. Even though there were these positive experiences of science exploration in their accounts of their kindergarten settings, the teachers still believed that they were not capable of taking the children's conceptual understanding to a more scientific level. Louise reported "but I still feel that I need to increase my knowledge to teach that basic stuff", while Ellen commented 'there is so much more potential, and we are not taught enough' and Therese observed 'I'd like to do more training in it ... I still get nervous about it [science]'. This lack of self-belief continues to perpetuate a lack of teacher confidence among all three participants and could be impacting on the sort of science they deliver in their curricula.

**Reflective practice**

As a research tool, the reflective journal afforded each of the teachers the opportunity to reflect on science in their curriculum. All three teachers reported improved confidence after reflecting on their practice. Reflective practice is indeed a powerful tool raising teachers' awareness of their implicit knowledge, of not only science content, but also pedagogical and curriculum knowledge (Holly, 1989). In this study, teachers reported that their reflections had given them greater confidence in their capacity to integrate science in their curriculum. Not only were they buoyed by the surprisingly high instances of science in their curriculum, but also from being able to identify their strengths and those areas which required further development. Therefore reflective practice, which is an essential component of the VEYLDF, was a contributing factor to the increase in teacher confidence.

Findings revealed a relationship between the manner with which teachers used the VEYLDF in their curriculum planning and the degree of science within the curriculum. Therese, for example commented that she 'finds it a good tool because I'm not confident in science' while Ellen asserts that she finds the VEYLDF 'not at all useful' and Louise thinks 'if I sat down and looked at it (VEYLDF) I probably would find more science'. The participants demonstrated varying degrees of engagement with, and understanding of, the VEYLDF. Where it had been used to support planning, observations and reflections, teachers were more clearly able to identify science in their curriculum. Therese for example uses the VEYLDF in her curriculum planning and states that 'my knowledge isn't extensive enough so I find the words I need [in the VEYLDF]... oh so they're hypothesising or problem solving
and investigating ... the words are written that I can't think of. Engagement with the VEYLDF has potential to support teachers in identifying children's current understandings and skills and assist teachers in extending these in their curriculum. However it is recognised that each individual early childhood teacher needs to be intrinsically motivated to engage more fully with the VEYLDF, and seek out further professional development to build on their confidence and knowledge if they seek to improve their own practice.

Summary

The teachers in this study expressed a lack of confidence in their capacity to deliver science in their curriculum. However, the case studies described a number of instances where the children engaged in science learning, exploration and discovery. There was some evidence of applying the principles of the VEYLDF in practice, though this was sometimes limited. The lack of subject content knowledge influenced the curricula across all the cases and potentially limited the scientific learning of the children in their settings. However, all the teachers demonstrated a capacity to create an atmosphere in their settings which was both accepting and supportive of the interests of the children, and a desire to enhance science education in their curriculum. It was also of interest that while the teachers were working within the context of the VEYLDF and the integrated teaching and learning approach, there seemed to be a more child-led and directed play approach to science. Louise viewed science as 'providing experiences where the children can explore themselves' and similarly the science in Ellen's curriculum was 'the children exploring how things work' while Therese was 'picking up on children's interests'. The data suggests that while the teachers were responsive to the children's interests they did not necessarily introduce science concepts themselves.

Familiarity with the VEYLDF may provide more support in science curriculum planning by developing teacher confidence to provoke children's interests in new science concepts. However, it is important to acknowledge the science that teachers are currently planning for and integrating into their curriculum. Teacher confidence played a significant role in the sort of science education that took place in the kindergarten settings and impacted directly on the teachers' capacity to integrate science. One teacher, who had attended professional development with a science theme, demonstrated a growing confidence and capacity in her ability. This indicated a relationship between knowledge and increased confidence in developing a more dynamic and engaging curriculum. This has implications for both pre-service and professional development training to present science in a way that develops teacher confidence by building their capacity to deliver science in their curriculum.

This study also showed a relationship between effective engagement with the VEYLDF and the development of a more effective science curriculum. The teachers were all at different stages of familiarity with, and understanding of, the VEYLDF, ranging from effective to limited, and this was reflected in their curriculum. It appeared the VEYLDF supported teachers with the development of their science curriculum when they were receptive to its content and applied it to their practice.

Conclusion

Further research could include investigating the effect of teachers' increased engagement with the VEYLDF in relation to science and how the children's understanding of scientific concepts is extended and enhanced, when science is planned within the context of the framework. Also, based on the negative secondary school science experiences of the teachers in this study, it would be interesting to understand how science education in our secondary schools can be of greater benefit to a wider range of students. Further research in these areas will continue to enhance our knowledge of science in early childhood and how practice can be continually improved and built upon.

This study suggests that early childhood teachers 'do not have to be expert science teachers' (Yoon & Onchwari, 2006, p. 422) in order to integrate science into their curriculum, but that they do need to be motivated to provide opportunities for exploration, problem solving, hypothesising, researching, experimenting and investigating in order to support children in their scientific discoveries.

References


