Teaching science in Australian bush kindergartens: Understanding what teachers need

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Abstract

Across 2015-2017, we conducted research at four Australian bush kindergartens to understand the teachers' science pedagogy and practice. The initial results were presented back to the participants at a teachers' professional development day. Forest kindergarten research exists, but is limited in the Australian context and little consideration of teacher professional development directly associated with bush kindergartens exists. As we live in a society that constantly changes, teacher professional development or professional learning is essential for ensuring that teachers in all sectors of education continue to address their students' learning needs. Our study involved the theoretical framework of 'capacity-building', where improvement in teachers' knowledge, skills and dispositions is critical to improving children's science understandings. The intention of capacity building is to generate change in current practice. This research used a mixed methods approach over two stages. Initially, observations of six early childhood (EC) teachers' science strategies and practices were recorded and discussed with the teachers. Then, a pre-intervention survey of bush kindergarten teachers was delivered, aimed at understanding teacher science knowledge and development needs within the context of the provision of science professional learning. This research reports on the initial observations of EC teachers' practice and strategies in science in bush kindergartens, and their articulation of their needs through the survey.

Keywords: Early childhood, bush kindergarten, science professional learning

Introduction

Professional development, or professional learning, is essential to ensure that teachers in all sectors of education continue to address their students' learning needs in a society where change is continuous. Effective professional learning is both complex and difficult. A 'skills and knowledge' approach has been shown to be quite ineffective in supporting more fundamental aspects of teaching practice (Pickering, Daly & Pachler, 2005). Campbell and Chittleborough (2014) highlight the need for professional learning to connect with learning priorities or the direct needs and concerns of participants, and to be planned around a long-term and systematic approach. Professional development sensitive to the needs of teachers and their contexts is necessary to support teacher development.
In particular, early childhood (EC) teacher professional learning needs to be a reflective process, whereby EC teachers have the ability to reflect critically on their beliefs, understandings and practices (Nolan & Mekonnen, 2017). However, the science professional learning needs of EC teachers arise from emerging challenges in their professional practices. Darling-Hammond, Hyler and Gardner (2017) indicate that teachers use their experiences as resources for new learning; however, science experiences tend to be limited in teachers' backgrounds (Campbell & Jobling, 2010).

This research used the theoretical framework of 'capacity-building'. Capacity building refers to the development of a teacher's capability to make changes to his/her practice and includes changes to *'dispositions, skills, knowledge, motivation and resources'* (Fullan, 2005). These changes to teachers' practice underpin the improvement of children's science understandings.

Science in EC settings

There is a large body of evidence suggesting that science is not often 'taught' in Early Childhood (EC) settings; however, this is not to indicate that science experiences do not occur – particularly through play (Campbell & Jobling, 2010). As far back as 2005, researchers were starting to think about the reasons for introducing science to very young children. Eshach and Fried (2005, p.319) articulated that there were at least six reasons that science education should become part of an early childhood setting:

- Children naturally enjoy observing and thinking about nature;
- Exposing children to science develops positive attitudes towards science;
- Early exposure to scientific phenomena leads to better understanding of the scientific concepts studied later in a formal way;
- The use of scientifically-informed language at an early age influences the eventual development of scientific concepts;
- Children can understand scientific concepts and reason scientifically; and
- Science is an efficient means for developing scientific thinking.

Their research described the circumstances in which these reasons hold true in early childhood settings. However, an additional reason that arose through discussions with teachers is that, with science all around us, in so many ways, young children's learning is impoverished if they are not engaged in learning science (Campbell & Jobling, 2010). Saçkes, Trundle, Bell and O'Connell (2011, p.217) further write that *'experiential science education in early childhood is of great importance to many aspects of child development, and researchers suggest that science education should begin during the early years of preschool'*. They determined that not only did young children's basic understanding of science and fundamental processing skills develop in early childhood, but that these skills and knowledge remained with children through later education (Saçkes *et al,* 2011).

Much of the science learning in kindergartens develops from children's play situations in which children are involved in explorations and creative activities (Davies, 2011). Science learning builds on children's own questions and wonder about the world around them. These early play experiences in science help to develop positive attitudes to science. Thulin and Pramling (2009) have found that children want to know more about their world and are comfortable with new language, new worlds and new concepts. Research by Duschl, Schweingruber & Shouse (2007, p.2) indicates that young children already have *'substantial knowledge of the natural world'* and that their thinking is quite sophisticated. They suggest that children can use a wide range of reasoning processes, which underpin scientific thinking.

However, there is little research into science learning in bush kindergartens, although international studies have provided some background understanding in more general terms. For example, research (Borradaile, 2006; Elliot, 2013) indicates that there are multiple benefits associated with taking children to these natural settings. Children have autonomy over their choice of activity, freely exploring the settings and accepting challenging situations that cannot be duplicated in a normal kindergarten setting. The most significant benefit in terms of science learning is that participation helps children to appreciate and care for their natural environment. Honig (2017) identified a number of learning dimensions, particularly with young children, which exist in natural environments – learning new concepts (mathematics, science, language, environment) was mentioned.

In Australia, the 'forest kindergarten' movement has translated into 'bush kindergartens'. Whilst some research in Australia around the benefits of a bush kindergarten approach has occurred (Elliot, 2013), it has tended to focus on the positive aspects in terms of children's biophilia and risk-taking behaviour.

A compounding issue for science education in EC settings and specifically bush kindergartens is that EC teachers have indicated a lack of confidence in their own science understanding and in teaching science (Torquati, Cutler, Gilkerson & Sarver, 2013; Edwards & Loveridge, 2011). With teachers' subject matter knowledge a predictor of student engagement in science learning (Saçkes, 2014), it is critical that support is provided to teachers to improve their science pedagogical content

knowledge (Appleton, 2006). A study by Saçkes (2014, p.181) provides evidence that *'limited content knowledge and low efficacy for teaching affects teachers' decisions about what content to teach and how frequently to teach science concepts'.*

Many EC teachers undertook their training when the idea of 'teaching' very young children was not considered the responsibility of EC centres, and therefore would have received little training in science other than 'nature study' or 'integrated studies'. Current EC Bachelor degrees offered by universities now include science education in some form, sometimes standalone, or linked to another area of learning. Previous research (Campbell & Jobling, 2010) indicates that many EC teachers lack qualifications that deal specifically with science and that they would like more science-orientated professional learning. Research by Saçkes *et al* (2011) highlighted that the limited time and limited nature of instruction provided to early cognitive experiences (in science) related to reduced achievement (in science).

Children try to make sense of their world through their own play explorations; however, they are limited in how far their discovery can aid understanding. For this reason, it is crucial that EC teachers have a basic understanding of the underpinning science. The research sought to understand EC teachers' professional learning needs in the belief that teachers who are attuned may recognise the science in spontaneous events and can make use of these to develop children's deeper understandings.

Our research questions are:

- How is science teaching and learning being enacted in and across the bush kindergartens?
- What professional learning issues arise in discussion with EC teachers about science education?

The research project – methods

The research involved the development of a case study for each of four different bush kindergarten settings. Our data gathering involved two distinct data collection points. Firstly, between 2015 and 2017, we visited and observed the teachers and children on 3-5 separate occasions at each site.

Data were gathered for an hour for each visit. The site visits allowed us to gather data that supported our understanding of the overall programmes, the science experiences of the children in the bush settings and to illuminate science learning through play. Since this represented an interpretive study of a system that was 'bounded' in both time and space, case study was identified as the most appropriate methodology. The research used a qualitative, interpretive approach and data were collected through:

Field visits – interviews with teachers

Formal interviews were undertaken with six teachers prior to the first researcher observations. These interviews were conducted to understand their philosophy when running the bush kindergarten. The questions included:

- How is science learning and teaching being enacted in a bush kindergarten?
- What is available in the play environment that provides opportunities for exploration related to science?
- How do educators scaffold children's science play in the physical environment?

Informal interviews occurred as children undertook activities that researchers were observing and recording. EC teachers were asked to comment on what they observed as science in children's play. Questions included:

- Can you tell me what is happening here?
- What are the children doing here?
- What is the purpose of your involvement here?

The informal interviews were recorded as part of the video-recording of children's activities.

Field visits – researcher observations

Over the 3-5 sessions, researchers observed and recorded children's science play and explorations for an hour at a time. These recordings were initially described in narrative style, such as *'four children climbing trees'* or *'two girls making potions'*. They were then categorised according to the guide on the next page.

Due to the extent of children's science play, the observations in each session tended to exceed the

Observation Guide			
Session/date	**Observation tag**	**Context – children at play**	**Time during session in which the observation took place**
Session One	Observation One	Physical sciences – e.g. balancing	
	Observation Two	Chemical sciences – e.g. mixing mud pies	
	Observation Three	Biological sciences – e.g. plant or animal engagement	
	Observation Four	Something unusual	

table parameters. That is, there were more than four observations of science play in any single hour. Children were not interviewed/questioned or any aspect of children's involvement recorded.

Pre-intervention survey

Our second data collection point occurred preceding a series of six professional development sessions that we provided for the teachers between 2016 and 2017. Prior to the first of the six sessions, we asked the teachers to complete a paper-based survey (pre-intervention survey), which allowed us to understand their development needs in science teaching. Using a range of Likert-style and short-answer questions, we were able to develop our own understanding of this group of teachers' needs and how we could best support these teachers in identifying opportunities upon which to act. Examples of these questions included:

- How do you incorporate science into your programme?
- Indicate your level of knowledge in science topics, including *Electricity, Forces, Matter (Chemistry), Energy, Plants, Animals.*
- Indicate your level of enjoyment in teaching science topics.
- When planning a science topic, indicate your level of use of the following resources, such as: *Science continuum P-10 resources, Internet, Centre-based resources, other resources.*

Then, at the completion of the six professional development sessions and using the same survey question and, again, in paper-based form, we surveyed the teachers to allow us to understand if any change had occurred in their understanding of science-based concepts. There were deficiencies in this process in that we had a significant disparity in the number of individuals who completed the first survey (28), in comparison to the second survey (9), due to attrition in those who attended all six sessions. As a consequence, we were unable to use aggregated data for the second data collection point (post-interventions survey).

Results

Field visits – interviews with teachers

Formal interviews were undertaken with six teachers and four other educators (non-qualified) prior to the first researcher observations. All were enthusiastic about the opportunity for children's involvement through a bush setting.

The initial discussions revealed a slight variation in the demographics of the kindergarten communities, but that seemed to have little effect on the teacher expectations of the children and their learning. Teachers anticipated that the learning would encompass a strong element of science, especially biological science.

Interviewee 1 – '*I believe that what we're doing here is a partnership with the sciences, they go hand in hand. A lot of the things I originally assumed this might mean have taken a totally different path.*'

Interviewee 2 – *'So there's insects, bugs, I know there's a new word for that now – Little live creatures. Plants, environment, weather.'*

Informal interviews – These interviews occurred as children undertook activities that researchers were observing and recording. EC teachers were commenting on what they observed as science in children's play, but were also asking for additional information from the researchers and questioning whether they had provided enough or the right information to children. The informal interviews were recorded as part of the video-recording of children's activities.

Teacher 1 stated: *'I know the science, but don't know quite how to put it into words for the kids…'.*

Teacher 2 commented: *'I am not sure how to integrate my understanding of science into play activities for children… do I do enough… it concerns me.'*

Teacher 3 stated: *'I don't' really know much science, other than biology… I'm not sure what to do sometimes.'*

Researcher: *'I can see lots of science in what they're [the children] doing and, as an educator, I'm tempted to go in and talk to them but I noticed most of the staff stepped out of things like this. Did you want to make a comment on this?'*

Teacher 4: *'I suppose initially, because it is a new environment, we're letting the children explore it and finding out things for themselves. Unless it is specifically or extremely dangerous… we will step in at this point … we understand the children's abilities at this stage but it's just seeing them extend it and extend it on their own. Then, looking at that from a learning point of view, then we would probably extend into more specifics with the children, like whether it's a group discussion for them to approach different concepts, whether it be gravity and support and that type of thing, or whether it's imaginative-based, whether there's a certain routine patterns that they do and repeat their physical skills.'*

A teacher, Jasmine (pseudonym), who indicated that she followed a Reggio Emilia approach, tended to stand back from involvement and stated: '…*We are truly guided by the children. You really almost couldn't make a plan for out here. It is truly led by the children's interests. The only thing I think I could do better is the writing up of the stories each week' (Jasmine, teacher interview, August 2015).* Another teacher commented on Jasmine's practice:

'Jasmine gives the children a lot more freedom, she allows them to self-discipline themselves. The other group are more defined… They don't do as much exploration, they've got more solid boundaries, a more cautious teacher… Jasmine has a lot more freedom, she always has had that in her classrooms.'

During informal discussions, all educators/teachers expressed a desire to know more science.

Field Visits – researcher observations

During our field visits, we observed science experiences and explorations as undertaken by children (see Table 1). These occurred many times across the multiple visits and at different sites.

Overall, we observed that the scaffolding of children's science experiences varied from one educator to the next. Scaffolding in bush kindergartens took on the roles of interaction and communication and depended on an educator's personal philosophy. Some teachers 'stood back' with a strong belief in allowing the children to discover things for themselves. Interaction took place when the children called on the educator for assistance. However, other educators would step in to introduce new science language or ideas as they saw a need. At one bush kindergarten site, the teacher was quite proactive in that she would frequently engage in science exploration herself and call on children to join her. At other times, she moved from group to group, asking questions, focusing discussion and engaging others in the activity. In some cases, she supplemented the environment with additional resources (e.g. magnifying lenses, containers for collection).

Occasionally, some teachers took the bush kindergarten experiences into normal kindergarten sessions, to reinforce the learning, but this was reported to occur infrequently.

Pre-intervention survey

Following our observations, we conducted a pre-intervention survey with 26 teachers, to more specifically hone in on their science learning needs, following an initial professional learning session.

Table 1: Researcher observations of children's science experiences.

	Children's observed activity	Science concept or skill involvement
1	Classifying	Science skill
2	3D building with rocks	Technology skill
3	Balancing	Forces/gravity/friction
4	Climbing	Forces/gravity/friction
5	Testing branch strength	Forces/gravity/friction
6	Jumping	Forces/gravity
7	Small animal observation	Science skill – observation
8	Small animal ethical behaviour	Science skill – safe handling
9	Mixing mud	Chemistry - mixtures
10	Digging	Forces
11	Planting	Growth characteristics and requirements
12	Nature walks	Ecosystems - knowledge
13	Rock pooling	Ecosystems - knowledge
14	Language development	Science skill - communication

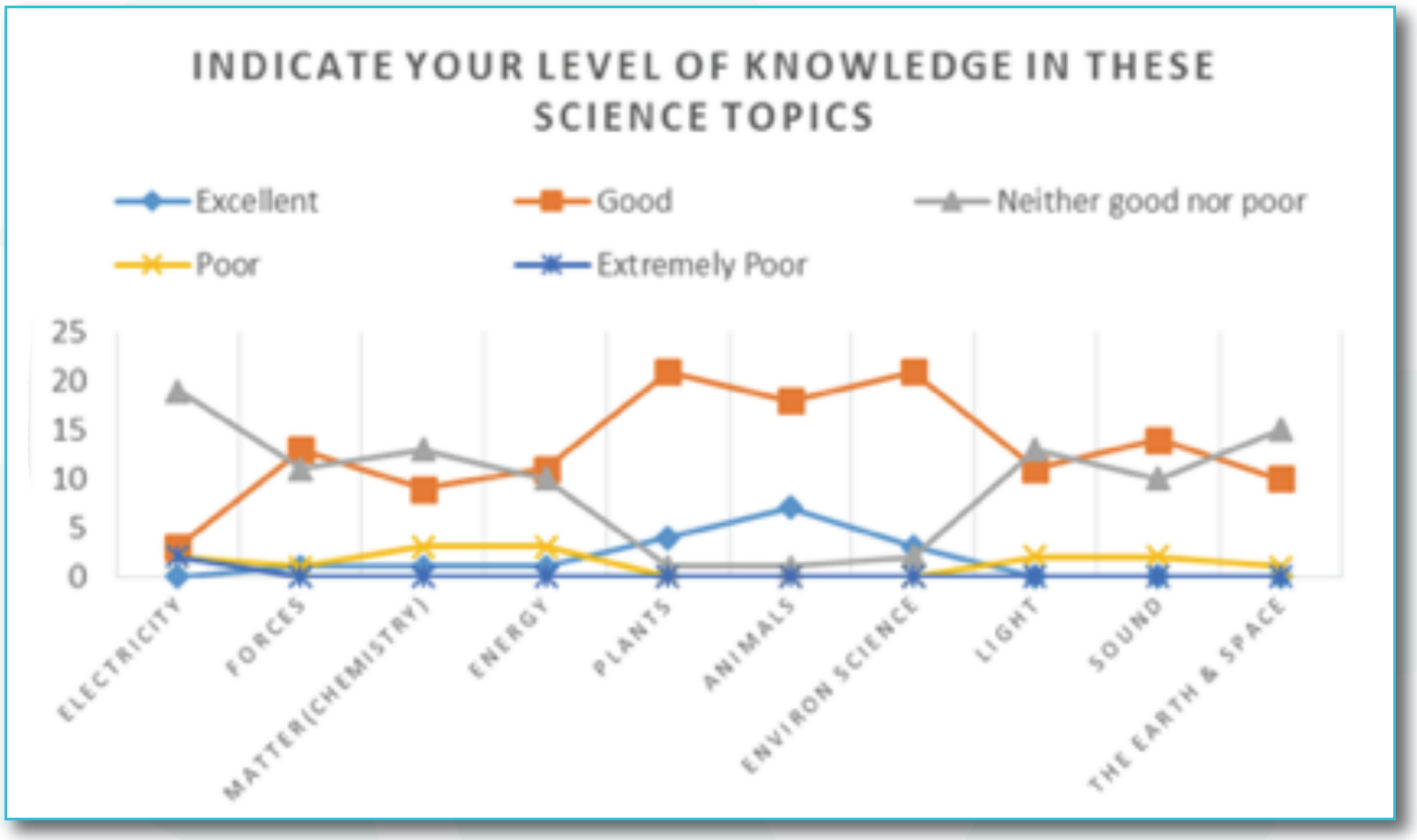
The survey data, some of which is captured in Table 2 and Figure 1, revealed some interesting insights into teachers' perceived strengths and weaknesses in their science knowledge:

- > 20/26 teachers felt comfortable with their knowledge of plants, animals and environmental science – a few teachers felt that they had excellent knowledge;

	Excellent	Good	Neither good nor poor	Poor	Extremely poor	No response
Electricity	0	3	19	2	2	0
Forces	1	13	11	1	0	0
Matter (Chemistry)	1	9	13	3	0	0
Energy	1	11	10	3	0	1
Plants	4	21	1	0	0	0
Animals	7	18	1	0	0	0
Environmental Science	3	21	2	0	0	0
Light	0	11	13	2	0	0
Sound	0	14	10	2	0	0
The Earth & Space	0	10	15	1	0	0

Table 2: Teachers' perceived level of knowledge in a range of science topics.

Figure 1: Teacher responses to the request 'Indicate your level of knowledge in each of these science topics.'



- half the teachers indicated that they didn't feel comfortable with forces, chemistry, energy, light, sound, Earth and space, and some indicated that their knowledge was poor;
- Two teachers indicated that their knowledge of electricity was extremely poor; and
- Teachers indicated that they had some knowledge of all science areas.

As indicated previously, the post-intervention surveys were not statistically viable to use as data; however, the general response of the 9 surveys was positive – that teachers/educators felt more confident in their science knowledge and practice after the science professional development sessions.

Discussion

Bringing together these two very different methods of data collection allowed us to develop an understanding of the teachers' interpretation of their own development needs. It also allowed us to incorporate both the survey feedback and our earlier participant observation during the fieldwork, to create a varied evidence base through which we could support the development of the teachers.

Results from the data collected before any observational visits indicated that teachers were aware that science would be part of the bush kindergarten experience. They expected that it would form a large component of children's explorations. The subsequent observations at each site confirmed that this was indeed the case – a large number of children's play activities were comprised of science explorations or experiences.

These observations highlighted the richness of the different bush kindergarten environments for providing multiple types of science experience.

However, the data from the observations of teacher involvement appear to be a little contradictory, with some teachers choosing not to engage in the science activities with the children, even though all of them had previously recognised how much of the children's explorations involved science. For these teachers, was it that their philosophy dictated their lack of intervention? Was it that they didn't recognise the science, or was it that they didn't know how to scaffold appropriately? For example, the teacher Jasmine indicated that part of it was her teaching philosophy, grounded in a Reggio Emilia approach.

Others indicated that they held back until they felt that children had enough time to fully explore the environments themselves. Some teachers were more active in their scaffolding, with one engaging strongly in science. However, some of the in-field informal interviews presented a picture of teachers and educators who were not certain of how and when to scaffold science explorations. As expressed by all teachers, they felt that more understanding of science was necessary.

The pre-intervention survey results clearly highlighted what some research was stating – that teachers lacked both the confidence in and knowledge of science to actively contribute to children's science learning (Torquati *et al,* 2013). While some areas of science biological or ecological knowledge were strong, other areas were perceived to be weak or not as strong (Saçkes, 2014). With teachers indicating such lack of confidence in their understanding in some science areas, they would probably lack the confidence to interact in children's science learning in those particular areas. This was confirmed to some extent by the informal interviews with some teachers/educators, but also through other research results (Saçkes, 2014).

Conclusion

The current study was limited in some respects. Teachers' and educators' understanding of science content was in the form of self-reports or based on their personal perceptions. Additionally, the study focused on the type of science content and did not consider aspects such as skills, or the quality of interactions and science play activities. However, there are strengths in the study, stemming from the rich descriptive data arising from the observations and the opportunity to speak with teachers and educators 'in the moment'.

In conclusion, we return to the initial research questions:

- How is science teaching and learning being enacted in and across the bush kindergartens?
- What professional learning issues arise in discussion with EC teachers about science education?

We found that science teaching and learning across the four bush kindergarten settings varied considerably and tended to be determined by the teachers' science understanding, but was also based on a broader philosophy of pedagogy and intervention. In considering what professional learning issues arise, the following teacher needs were identified through interview: they needed to be able to integrate science into bush kindergarten teaching scenarios, and to be able to translate knowledge into the appropriate level explanation.

The surveys indicated that teachers perceived that they needed to have deeper understanding of science content. This building of teachers' capacity relies on changing their dispositions, skills, knowledge, motivation and resources. With greater understanding of science concepts comes the ability to 'see' more science in a vast range of children's experiences and this may provide teachers with strategies to promote science understanding in children's play. Being more familiar with science enables an EC teacher to integrate science more successfully into bush kindergarten exploration and to develop children's understanding. The findings of this small-scale study demonstrate that more targeted professional learning, supporting the contexts of bush kindergartens, is needed.

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