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Reviving botany in the curriculum: the botanical journey of two Western Australian early childhood teachers

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Abstract

Environmental education across the early years has become increasingly important in Australia since the implementation of the Early Years Learning Framework and the Australian Curriculum. These documents promote a connection to nature for young children as well as environmental responsibility. In Western Australia, large areas of natural environments are bush spaces, accessible by young children, families and schools. There is no existing research investigating early childhood teacher's knowledge of plants in these bush spaces and the utilisation of these spaces in teaching botany as part of their teaching practice. The discussion in this article examines part of a larger year-long multi-site case study of the changes in the botanical understanding of two early childhood teachers of children aged 5–8 years, in Western Australian schools both before and after the Mosaic Approach, botanical practices and Indigenous knowledges were incorporated into their teaching practice. This article focuses on the changes of botanical literacies of the early childhood teachers specifically. The findings suggest that using inquiry-based and place-based methods and including First Nations Peoples' perspectives about plants whilst teaching in the bush can significantly increase the plant knowledge and understanding of teachers, as well their own scientific and botanical literacies.

Keywords: botanical literacies; inquiry-based learning; plant knowledge; botany; early childhood education; environmental education

Introduction

Plants surround us and are essential for life on this planet, yet plant knowledge is generally not a priority in most early childhood curricula around the world (Nyberg & Sanders, 2014; Swann & Pye, 2019). Research suggests that teachers generally do not have the basic plant knowledge required to educate children about the important role plants play in our everyday lives (Kaasinen, 2019; Robinson, Inger, & Gaston, 2016; Skarstein & Skarstein, 2020; Stagg & Donkin, 2013; Wandersee & Schussler, 1999). Plant knowledge and species recognition is considered by some as vital knowledge for children to establish an understanding of the world, and a positive attitude and desire to care for nature and our ecosystems (Kharod, 2017; Wandersee & Schussler, 1999). Suzuki and Hanington (2012) have warned that 'unless we are willing to encourage our children to reconnect with and appreciate the natural world, we can't expect them to help protect it and care for it' (p. 135).

The present study develops this idea of reconnection and suggests that plant knowledge is only one part of teaching about plants in an environmental education programme. We argue that plant knowledge and species recognition are components of botanical literacies but do not constitute sufficient botanical education. Following the idea of Suzuki and Hanington (2012) above, we argue

that botanical education should be developed to involve not just knowing about plants, but understanding and appreciating the interconnections between plants and humans within the world that have been understood by First Nations People for tens of thousands of years (Uno, 2009). This perspective aligns with the concept of scientific literacies in which children should not just have scientific knowledge, but also be able to use this knowledge to solve problems and make sense of the world (Organisation for Economic Co-operation and Development [OECD], 2017). In Australia, this concept of young children connecting to, and making sense of the world, is supported in the Early Years Learning Framework (EYLF) for teachers of children aged birth to 5 years in Learning Outcome 2: ‘Children are connected with and contribute to their world’ (Department of Education, Employment and Workplace Relations, [DEEWR], 2009, p. 32). This is continued in the Australian Curriculum for children aged 5–18 years under the Sustainability cross-curriculum priority which states as a key concept that there is an ‘interdependent and dynamic nature of systems that support all life on Earth and our collective wellbeing’ (Australian Curriculum and Reporting Authority [ACARA], 2019).

The present study was undertaken with two early childhood teachers and their classes: Carrie (pseudonym) with a pre-primary class of 17 5–6-year-old children and Anna (pseudonym) with a grade two class of 24 7–8-year-old children. In Western Australia, early childhood education (ECE) in school settings comprises pre-primary through to grade two. Both teachers were using play-based learning pedagogies in their early childhood classrooms before and during the research. This study was conducted over a full school year (minus eight weeks due to a Covid lockdown) and we investigated the botanical literacies and understandings of the teachers and the children in their classes. This article focuses on the teachers’ development of botanical literacies over the school year and is based on semistructured interviews with the teachers and the beginning and end of the research project. Despite the data for this article being based on these interviews, the methods used with the children throughout the year to develop their botanical literacies have also been discussed as this was inextricably linked to the development of the teacher’s botanical literacies.

Botanical literacies

Botanical literacies, we argue, are a subset of scientific literacy, which has been defined by the Programme for International Student Assessment (PISA) 2018 as requiring the three science-specific competencies of ‘Explaining phenomena scientifically, Evaluating and designing scientific inquiry, Interpreting data and evidence scientifically’ OECD (2019, p. 99).

On this understanding of scientific literacy, teaching botanical literacies is not just about knowing plant names, but involves deeper botanical understandings, inquiry skills, the acquisition of new knowledge, explaining botanical phenomena, solving problems, as well as supporting children to make responsible decisions about plants and nature. These scientific literacy competencies can be seen in relation to botanical literacies in the hierarchy of botanical literacy levels developed by Uno (2009) and refined by Beasley, Lee-Hammond, and Hesterman (2021). The hierarchy consists of four levels, namely Nominal, Functional, Structural, and Multidimensional, and assesses the knowledge, understanding and behaviours of individuals in relation to plants (Beasley et al., 2021). The Nominal level sees individuals being able to identify plants and name terms, but not being able to define or describe these terms or have any feelings of excitement on botanical topics (Beasley et al., 2021). This scales up to the highest level, Multidimensional, which sees individuals being capable of understanding the place of botany in the world, knowing plants are vital for life, explaining the interconnections between plants and life, formulating inquiries about plants and making ethical choices (Beasley et al., 2021).

Scientific literacy has been recognised as a vital element of education in preparation for the 21st century workforce (OECD, 2017). However, a study in the USA of 20 ECE classrooms found that teachers devoted only 4%–8% of their teaching time or an average of 2.3 minutes a day to science

experiences due to a lack of confidence in their knowledge and science abilities (Tu, 2006). We suspect this percentage would be even lower if research were to look specifically at the teaching time of botanical literacies.

The role of curriculum in improving children's botanical literacies

The Australian Curriculum lists three cross-curriculum priorities that are essential across all learning areas (Australian Curriculum and Reporting Authority [ACARA], 2019). Two of these priorities are related to improving students' botanical literacies.

The first is Sustainability, which has been developed around three key concepts (ACARA, 2019). The first key concept involves the interconnectedness and dynamic systems within nature that support all life on Earth, including the wellbeing of humans. The second key concept explores Earth's ecosystems and our diverse views and values that determine global and local actions for sustainability. The third key concept considers the thoughts and actions that are required to create a more sustainable future, seeking to promote more reflective thinking in young Australians and aiming to empower youth to take sustainable actions in the future (ACARA, 2019).

The second cross-curriculum priority that relates to this research is that of Aboriginal and Torres Strait Islander Histories and Cultures (ACARA, 2019). The Australian Curriculum recognises through this priority that Aboriginal and Torres Strait Islander Peoples have a special connection to the country by which they are spiritually and intellectually connected to the land, sea, sky and waterways which make up land and ecosystems (ACARA, 2019). Indigenous knowledges recognise and respects the interdependence of humans, plants and animals with the Earth (Johnston, 2020; Sammel & Whatman, 2018). Indigenous knowledges about local plants, animals, landforms, forests, waterways and seasons are treasured, valued and respected and teach care for all living things and their connections with each other (Hansen & Horsfall, 2016; Ritchie & Phillips, 2021). This cross-curriculum priority of Aboriginal and Torres Strait Islander Histories and Cultures has the potential to lead teachers to be informed by Indigenous botanical knowledges in relation to the land they with, in order to promote sustainable thinking in their students and develop a deeper respect for the country where they are located (Jackson-Barrett & Lee-Hammond, 2019). The research in this paper involved visits from a local Aboriginal plant expert to share his knowledge with two ECE teachers and their classes around Indigenous uses of the native plants in their school bush spaces. Previous research in colonised countries highlights that lived experiences within a particular place with Traditional Owners of that land can provide access to Indigenous world views, otherwise inaccessible to teachers and children (Rowan, 2017). Experiencing learning in one natural place over a long period of time enables learners to watch the subtle changes through the seasons and deeply connect with that space through a 'slow pedagogy' (Payne & Wattchow, 2008). This can support an understanding of First Nations perspectives about that place, including the interconnectedness of all things (Boyd, 2019; Suzuki et al., 2008).

Teachers and botanical knowledge

If adults are not interested in teaching about plants and their place in the environment, we argue that children will likely not develop botanical literacies or a deeper understanding of the ecological world. Several studies report the importance of the role of the adult in promoting sustainable and positive attitudes towards plants and nature (Barrable, 2019; Boyd, 2019; Chawla & Derr, 2012; Kaasinen, 2019). To be able to promote sustainable beliefs and attitudes towards plants, it is important that the teachers value plants and their place in the world (Merritt, Peterson, Evans, Marston, & Zuiker, 2021). It has been suggested that teachers have low levels of plant knowledge because it was not a part of their own schooling and they see it as irrelevant (Borsos, Borić, & Patocskai, 2021). There has been little research conducted on the plant knowledge of ECE teachers in Australia, let alone internationally. In the USA, a study by Cooper (2009) of 13 ECE teachers

found teachers could recognise 40% of plants in their school yard, and less than 20% of teachers could recognise poisonous flora within their school grounds. The teachers in the study also explained a lack of confidence in their teaching abilities around the topic of plants due to this lack of botanical knowledge from their own education (Cooper, 2009).

This lack of content knowledge reflects a suggested ‘pedagogical gap’ in which teachers know there is specific content to be taught about plants, but they don’t believe this content fits with the free play, child-led pedagogies of ‘nature play’ in ECE outdoor natural environments (Cutter-Mackenzie & Edwards, 2013). It is common for ECE teachers to hold the belief that ‘nature play’ is an energy outlet or for social and emotional development. Even when young children are learning through ‘nature play’, often this reflects anthropocentric practices, where the human, or in this case the child, is at the centre of the programme (Taylor & Pacini-Ketchabaw, 2015). This often entails using plants as a disposable resource for play or art, seeing nature as passive, with the goal being to *use* nature, not to learn *with* nature (Ross, 2020; Rowan, 2017). Following Kirksey and Helmreich’s (2010) model of multispecies, many researchers are attempting to avoid an anthropocentric perspective by moving away from a human-centred model towards a model that encompasses the entanglement of the relationships between children, teachers, flora and fauna as part of the natural world (Harwood, Barratt, & Collier, 2019; Pacini-Ketchabaw & Kummen, 2016; Taylor & Pacini-Ketchabaw, 2015). For environmental education to be successful and for ‘deep learning’ about nature and science to occur in ECE, a teaching strategy that includes intentional content teaching, exploration of nature, open-ended play and imaginary play has been suggested (Cutter-Mackenzie & Edwards, 2013; Fleeer, 2019). This highlights the importance of content knowledge about plants and the associated pedagogies for early childhood teachers. This paper explores the implementation of such a teaching strategy.

The current study

In this qualitative study, we investigate a year-long journey of two ECE teachers in Western Australia as they were supported to implement botany in their curriculum. This study was part of a larger PhD research project which looked at the botanical literacies of children and teachers in Western Australia developed through regular time in a bush space on the school grounds. The lead author conducted fortnightly visits for a year with two ECE classes and their teachers to bush spaces on the school grounds during the 2020 school year (February–December) and interviewed the teachers before and after the school year. The specific research questions addressed in this paper are:

- What are the botanical literacies of early childhood teachers in Western Australia?
- What are the impacts on teacher’s botanical literacies of implementing an inquiry-based, place-based learning model to teach botany in ECE?

Theoretical framing of the broader study

Based on practices from place-based education (Sobel, 2014) and inquiry-based learning methods (Murdoch, 2015), fortnightly visits by the researcher to each class were designed initially to elicit prior botanical knowledge of the children and teachers. Subsequently, visits were designed to support the children and teachers through the stages of inquiry (Murdoch, 2015) based on their questions related to the plants and trees in their unique bush spaces. Both teacher participants had an existing regular practice of taking their classes to the bush space. Previously, however, their bush space time focused on ‘nature play’ activities such as building dens and giving the children the opportunity to connect with nature. The focus was on social development and wellbeing, but was not planned to cover core curriculum subjects from the Australian Curriculum (ACARA, 2019).

During the research, the teachers and children were researching the plants in the bush space alongside the researcher. Initially, the children were invited to draw pictures of plants they knew, and in a group circle children discussed what they knew about plants. This included some plant names and the basic needs of plants such as water and sunlight. This knowledge was then taken deeper using techniques from the Mosaic Approach (Clark, 2017) such as map making of where plants were growing in the bush space, and child-led tours of the changes the children had noticed in the bush space since their previous visit. Unlike previous studies using the Mosaic Approach to find out what children know or think at one point in time (Beasley, 2015; Merewether & Fleet, 2014), this study drew on practices from the Mosaic Approach repeatedly to track changes in children's understandings as the seasons and the year progressed in the bush space.

Inquiry-based teaching methods assume that children will develop curiosity and learn about scientific processes if they attempt to find their own answers to scientific phenomena encountered in their environments. By asking questions, thinking of possible hypotheses, conducting investigations, drawing conclusions and taking action, the children as well as the teachers were able to scientifically study the plants unique to their school bush space (Fleer, 2019; Marida & Vassiliki, 2013; Murdoch, 2015).

During this latter phase of the project, traditional botanical practices were introduced to the classes including noticing, recording and drawing unfamiliar flowers and plants as they appeared, making identification cards for the plants in the spaces, using local plant identification books to identify the plants, as well as a visit from a local Aboriginal plant expert to provide information about Indigenous uses for the plants specific to that bush space. The year-long study provided opportunities for the teachers and children to observe the changes through the seasons, and this was a common topic of discussion and interest for both teachers.

Methodology

The approach taken in this research is qualitative, fitting within an interpretivist-participatory paradigm, where the understandings participants attribute to their experiences and environments are explored (Creswell, 2014). An analysis from an interpretive-participatory paradigm is concerned with the detailed examination of lived experiences and, in this case, how the teachers make sense of that experience (Willig & Stainton Rogers, 2017). Interest in the teacher's perspective of their learning and experience was important to the study and required an approach that reflected this human experience in a specific environment under specific conditions, that could not be replicated elsewhere.

Interpretivism has relativist ontological beliefs. Researching as a relativist means reality is developed through socially constructed means and there is no single shared reality (Ryan, 2018). For example, in this research, both teachers had their own perspective of, and experience with the plants in the space, which has been built on their prior knowledge and past experiences. The lead researcher's perspective as a participant in the research was also built on her own prior knowledge and past experiences. This demonstrates the proposition that there are multiple realities because of individuals' perspectives which are a reflection of each person's culture, norms, social situations and understandings (Krauss, 2005).

Epistemologically, the interpretive-participatory paradigm questions if and how something can be truly known and understood and follows the belief that data cannot be separated from context and is therefore constructed by the participants in the environment (Dean, 2018). In this research, the findings were co-created by the researcher, the teachers and the children over a year-long period where during each visit made to the bush spaces, the children and educators would revisit their questions, explore the plants in the bush space and make new discoveries which were recorded by the children, teachers and the participant-researcher.

The methodology of interpretivism involves reflexive practice which often entangles the researcher in the research environment alongside the participants (Denzin & Lincoln, 2018). This is the case for this study, where the lead researcher was immersed in the bush space visits and researching alongside the children and educators, guided by their questions and inquiry.

Study design

This multisite case study (Yin, 2018) of two early childhood teachers and their classes used a qualitative, multimodal design (Norris, 2019) including educator interviews at the beginning and end of the year as well as fortnightly researcher visits to the class, which were audio recorded and later transcribed. On completion of the year of visits and interviews, data were analysed. The part of the study discussed in this paper focuses on a comparison between the teacher interviews before and after the 2020 year-long study. The interview questions were developed solely for the purpose of this research and the teachers were not given the questions in advance.

Ethics

This study was approved by the human ethics board at Murdoch University (2019/170). Participation in the research was voluntary and both teachers gave their informed written consent. Written consent was also provided by the school principals and the parents of the children in the classes. The children involved gave written consent as well as ongoing verbal assent during each of the researcher's visits. The names and identities of the teachers, children and schools are protected through the use of pseudonyms.

Participants and site context

The two schools chosen are private schools within the Perth metropolitan area in Western Australia and were purposefully selected for the large bushland areas accessible within the school grounds. School A was adjacent to a large nature reserve and school B was close to a beach. Prior to this research, the two teachers, Carrie and Anna, took their classes to the bush spaces weekly, within the school grounds, and occasionally took their classes beyond the school grounds to the nature reserve or the beach.

The two teachers were both early childhood trained and both had over 10 years' experience in ECE, which in Western Australian schools caters from children aged from 5 to 8 years old. Both were what is termed Lead Teachers in their school, with a role of overseeing and mentoring other early childhood teachers. Carrie from school A had a class of 17 pre-primary students (5–6 years of age) while Anna from school B taught a class of 24 grade two students (7–8 years of age). Both classes were mixed gender.

Data collection

Interviews were conducted with the teachers on-site before the research began, to elicit prior knowledge, experience and understandings of plants. These were undertaken for an hour in the teacher's classroom before the beginning of the school year. During the fortnightly class visits, data were collected in line with the Mosaic Approach (Clark, 2017) including audio recordings of the lessons, children's and teacher's photographs and children's drawings and maps. This data recorded the gradual development of plant knowledge and botanical literacies of the teachers and children over time. A final interview after the last class visit was undertaken with the teachers to evaluate the process and document any changes in their botanical literacies and understandings. All interviews and visits were audio recorded and later transcribed.

Data analysis

Data analysis involved an initial familiarisation with the transcripts to identify themes and recurring concepts and implications of the teachers' comments. A constant comparative method (CCM) (Boeije, 2002; Glaser, Strauss, & Strutzel, 1968) was used to analyse the interview data at several levels. Using CCM enabled the development of themes that were grounded in the interview data, then further refined and conceptualised (Charmaz, 2017; Glaser et al., 1968). CCM involves the data within each single interview being coded, determining what was said and identifying themes related to the research questions. Following this, the initial interviews of each teacher are compared with each other allowing hypothesising about patterns and comparison of themes. To complete the full picture of the interviews, the final interviews were also coded individually and then compared with the teacher's initial interview, and then with the other teacher's final interview. The structure of the initial and final interviews was kept the same, using the same questions for ease of comparison and analysis. For example, the first question in both the beginning and final interviews was 'What do you know about plants?'. This intentionally broad question gave the lead researcher qualitative data for the comparison of each teacher's plant knowledge, both before and after the year-long research project. By comparing the data of the interviews individually, at each stage and overall, it was possible to code, delineate themes and categories and also connect them (Boeije, 2002; Charmaz, 2017).

Findings

The aim of this part of the study was to develop a comprehensive understanding of teachers' botanical literacies and plant knowledge for implementation of environmental education in a bush space on school grounds. The outcomes for both of the teachers included increased content knowledge and confidence in teaching about plants, an understanding of the impact of integrating the curriculum with the bush visits, changes in teaching practices and pedagogy when in the bush space, as well as an understanding that regular time in one space allows in-depth observation and awareness of the subtle changes through the seasons.

Case study one: Carrie

Carrie mentioned knowing mostly 'UK plants', having lived in England for a period of time, and named rosemary, lavender, hazelwood, daisies and roses and then explained that the only native plants she could name were kangaroo paw and gum trees. When initially recognising gaps in her botanical knowledge, Carrie said that she would like to know the groups of Australian native plants and also the 'plants that belong together' so that she could identify them on a bush walk with the children.

In the initial interviews, when explaining how she incorporated plants in her teaching, Carrie described using sticks and seed pods as a resource in the classroom for maths counters and free play instead of using plastic items. She also had a small vegetable garden bed that was planted with the children each year as a part of the healthy eating curriculum. Before the study began, Carrie described using the bush space for children's social-emotional development and confidence building as she explained that pre-primary children were initially afraid to venture into the bush and to play independently in the space and some of them had never been in this bush space before.

In the final interview, Carrie explained that, since participating in the study, she had seen a shift in her focus when taking the children to the bush space. She will follow the children's interests in the plants and document what they find with the children. She explained:

'It's interesting now that we've changed our focus, that the children have changed their focus as well. Some children still build cubbies and do what they like in the bush, but if they are engaged in those things and playing and they find something that is different or new, they

stop their game and then they come and find me. Then there's this whole investigation into what it is and why it's there. Let's log it, and draw it, and photograph it.'

Carrie also explained that the Indigenous Elder visit had made her more aware of the local Indigenous seasons and the related changes in the bush. As a result, the whole school has now embedded the Indigenous seasons into their curriculum, including placing signs at the front of the school with the names of the seasons and with drawings and photos of the local plants and animals that are active and visible in each season. Carrie plans to intentionally teach more about the Indigenous seasons and the native plants in her daily practice. She described plans to create a book with her class next year of dried and hand-drawn plants, created over the year, recording details of the native flowers as they occur throughout the year in relation to the Indigenous seasons. As a lead teacher, Carrie has also been mentoring other ECE teachers in the school on how to implement botanical practices in the bush space.

Case study two: Anna

Before the school year began, Anna expressed wanting to know more about specific plants needs so that she could better care for them in the garden at home. She recalled recognising the plant group of succulents and then daisies, lavender, and wheat (from growing up on a wheat farm). Anna explained that she used plants as a decoration in her classroom. This was visible in her classroom which contained around 20 potted plants including succulents by the windows and climbing plants across the rafters. Anna was already taking the children weekly to the bush space to learn about preserving nature but she had not taught the children about the plants in this space. Anna was initially concerned about the banksia in the bush space, thinking many of them were dead. After observing the banksias with the students over the year, she noticed small changes, new leaves and then flowers that she had not noticed before. After the study, when asked how she planned to include plants in her teaching, she described her intention to plant more native 'bush tucker' plants in the gardens around the school, as advised by the Indigenous plant expert who visited as a part of the study.

There was a moment during a research visit in spring, towards the end of the project, when Anna looked to the researcher and said 'Thank you for this'. The students in the class had noticed some very rare Dancing Spider Orchids growing in the bush space. They were all in awe of the flower, after discovering how rare they were in one of the local wildflower books provided as part of the study. The class became engaged in looking for the rare flowers during each visit, reminding each other to 'be careful of the orchids' and one student created a poster that was made at home and taken to every classroom in the school to educate the other students and teachers about the rare orchids in the bush space and to be careful not to step on them. Anna had explained in her initial interview that she wanted her students to really understand sustainability in terms of the bush space and care for it authentically. The discovery of the Dancing Spider Orchid in the bush space facilitated this understanding in an authentic and meaningful way.

Anna explained that because of the impact the research has had on the plant knowledge and awareness of herself and the grade two students, she planned to implement botanical practices in the curriculum from pre-primary next year and then continue this through the school's curriculum so that the children are more 'environmentally conscious'. As a lead educator in her school, Anna planned to share the teaching practices undertaken through the research with her fellow teachers to develop a whole school approach to botanical literacies that aligns with the Australian Curriculum.

Discussion

This discussion is organised according to the research questions that framed this study.

Research question 1: What are the botanical literacies of early childhood teachers in Western Australia?

Before the school visits began, the teachers were familiar with some common European garden plants but very few native Western Australian plants. Carrie had spent time living in England, so this was understandable. Anna, however, was from a Western Australian country town but had a deeper knowledge of European garden plants than of Australian natives. Both teachers said that they did not know much about plants but wanted to know more, particularly about native plants on the school grounds so that they could teach this to their students. Both teachers previously took their children to the bush space for ‘nature play’, but neither had ever used the plants in the bush as part of their teaching curriculum. This aligns with previous research highlighting that when early childhood teachers have low specific content knowledge, they lack confidence in teaching that area of study and avoid teaching it (Cooper, 2009; Gerde, Pierce, Lee, & Van Egeren, 2018). Increased content knowledge of teachers in ECE has been linked to improved outcomes for children (Hindsman & Wasik, 2012), so it is vital that teachers find ways to improve their content knowledge where they see gaps. This gap in content knowledge also extended to Indigenous Knowledges, including the names and uses of native plants. This knowledge is vital to embed First Nations perspectives in the curriculum as required by the Australian Curriculum (ACARA, 2019).

In the final interviews both teachers expressed that their knowledge of local native plants had grown, with Carrie explaining that she had ‘vastly improved plant knowledge’ and was ‘able to identify quite a lot of the local plants now’. Both said that they were now more aware of, and noticed the changes in, the plants in the bush spaces. Anna expressed that she was feeling more confident in teaching about the plants in their school space. The following narratives aim to provide insight into the year-long progression of each teacher’s botanical literacies.

Research question 2: What are the impacts on teacher’s botanical literacies of implementing an inquiry-based, place-based learning model to teach botany in ECE?

Impact 1: Increased content knowledge and increased confidence

For both teachers, the development of their own content knowledge through the course of the study increased their confidence in teaching botanical practices and plant knowledge with their class and their colleagues. At the end of the study, both teachers expressed the desire to share their knowledge, understanding and botanical practices with other early childhood teachers and have the strategies and practices used in all early childhood classrooms in their schools. The teachers were confident that they could guide other teachers through the process so that they too could improve their own and their children’s botanical knowledge. In environmental education, the teacher’s environmental knowledge was previously thought to be not as important as the teacher’s values when teaching environmental education (Elliott & Young, 2016). However, recent research has advised that there needs to be a pedagogical balance of knowledge, values and actions for environmental education to be successful (Elliott, Arlemalm-Hagser, & Davis, 2020). Both teachers initially articulated values around wanting to be in nature and knowing that nature is important for children’s wellbeing but did not have the content knowledge to fully support an active and engaging curriculum in the bush until their involvement in this study.

The Indigenous knowledges shared by the Elder during his visit positively impacted both teachers’ content knowledge. In the final interviews with both teachers, it was expressed that the teacher’s new insight into Indigenous uses of the plants in their space was what they valued the most from the research project. This knowledge provided new ways for the teachers to encourage children to interact with the plants, such as making string from reeds and using marri sap to treat eczema. These new interactions reflect an understanding of the inter-connection between humans and other living things, which is more aligned with Indigenous knowledge and enabled the

teachers to infuse First Nations Perspectives in authentic ways (Jackson-Barrett & Lee-Hammond, 2018; Johnston, 2020).

Impact 2: Integrating the curriculum in the bush

Throughout the research project it was the bush itself that inspired the inquiry and interest of the teachers and children. The trees and flowers changed and bloomed in their own time and the teachers and children observed the changes. This is vastly different from how plant biology is typically taught in early years classrooms, being mostly controlled by the educator for the purpose of teaching a concept in a short time frame (Campbell, Jobling, & Howitt, 2018). Vegetable gardens are often used as a means of teaching where food comes from and about the life cycle of the plant. An observation is that lessons of this kind present a view of plants as only being useful as a resource for human consumption and not having a reason to exist outside of human use (Ross, 2020; Taylor, 2017). Taylor (2017) asserts that nature-based lessons can risk portraying nature as utilitarian, its purpose being to serve humans. In our study, there were signs that the two teachers started with similar views. Carrie used plant parts such as nuts, sticks and leaves as indoor classroom resources and Anna used pot plants and succulents to improve the aesthetics of her classroom. Both teachers had only previously used vegetable gardens as a part of the curriculum to teach the life cycle and healthy eating. Plants were seen as a resource to be used by humans as required. These views evolved through the year with regular visits to the bush and resulted in a shift away from an anthropocentric framing of nature as a resource towards views of the local environment having intrinsic value and being connected to the children (Ross, 2020).

Both teachers' original plans for lessons in the bush space were about 'nature play', 'socialising' and 'building dens', where nature was passive and the goal was not interaction or learning *with* nature (Ross, 2020; Rowan, 2017). Being exposed to nature is not the same as knowing or having a relationship with nature. Both teachers' ideas around the role of nature in education changed from nature being a background for different kinds of play, or a teaching resource, to nature being the teacher and the instigator of learning. This finding supports previous research around place-based education by explaining that when teaching in nature, nature provides the context, and the curriculum stems from it (Lloyd, Truong, & Gray, 2018; MacQuarrie, Nugent, & Warden, 2015).

Impact 3: Changes to teaching practices and pedagogy in the bush space

During previous regular visits to the bush, both teachers engaged the children in free play or 'nature play' during their bush time. This is a common practice in many bush kindergartens and environmental education programmes which involves taking the children to an off-site bush or forest space. This practice has evolved from volumes of European research in the early 2000's addressing the benefits of nature play as increased physical fitness, increased social and imaginative play skills, improved concentration and increased language skills (Elliott & Chancellor, 2014; Knight, 2013).

With new opportunities to reflect on this practice, it has been established that play alone in a bush space is not enough to teach environmental education and develop sustainable attitudes and ideas in young children (Cutter-Mackenzie & Edwards, 2013; Elliott & Young, 2016). Early childhood teachers need to provoke dialogue and engage children in critical discussions about sustainability, the effects of colonisation and the local environment (Boyd, 2019; Hammond, Hesterman, & Knaus, 2015). Teachers should focus their scientific inquiries on the local biological species and follow these inquiries in an unhurried approach through the natural rhythm of the seasons (Boyd, 2019). In the present study, Carrie and Anna noticed a shift throughout the year in the children's play and learning behaviours in the bush space because of the change in focus from 'nature play' to a focus on botanical inquiry. The teachers changed their practice from supervising play to engaging the children in botanical and scientific questions. In the first bush visits of the study, the

researcher and teachers instigated the inquiry questions asking the children such things as ‘What can you see that has changed since last time we were here?’ and ‘What flowers did you notice today?’. The use of the Mosaic Approach, which involved the children touring, drawing, mapping and taking photos of the plants was fundamental in establishing this unhurried child-led inquiry. During the last visits of the study, the teachers stepped back from facilitating the lessons, because it was the children who were instigating the inquiry questions with each other and to the educator.

Impact 4: Time and a slow pedagogy of place

The natural cycle through the seasons takes time. Both teachers felt strongly at the end of the study that the regular visits to the space over the period of a year were vital to the children’s progression of understanding about the plants in the space. Anna explained in her final interview that the experience had demonstrated to her that science, particularly botany and biology, should not be taught for just one school term as a separate subject, but should be taught over a whole year as an ongoing process so that the children can watch and experience the changes and see the things they could not see before. In both bush spaces there were native orchids that only flower for one week a year during Djilba (the local early spring season). This was the first year that the teachers became aware of the flowers’ existence due to the regular visits and the curriculum focus on botany. Anna mentioned initially that she thought that some of the trees in the bush space were dead due their black and leafless appearance but watching over time she noticed small changes and then flowers, bringing her to understand that the trees were alive. The time spent in the unique places, combined with the botanical focus, promoted relationship building between the teachers, children and plants. A slow pedagogy of place (Payne & Wattchow, 2008) in this study shifted the teacher’s understanding of learning in the bush space from one of playing in nature to a pedagogy where teachers and children are active, aware, engaging in reciprocal relationships with the plants and are making meaning from their interactions. As the teacher’s and children’s knowledge grew over time and through the seasons, their botanical literacies, and therefore scientific literacy, developed further with each interaction.

Conclusion

Since the introduction of the EYLF (Department of Education Employment & Workplace Relations, 2009) and the Australian Curriculum (ACARA, 2019), which highlights sustainability and Aboriginal and Torres Strait Islander histories and cultures as cross-curriculum priorities, Australian early childhood teachers have been seeking ways to connect children to nature authentically and infuse sustainability and First Nations’ perspectives into the ECE curriculum. In Australia, inspired by the forest kindergartens of Europe, teachers have been searching for a teaching model to do this, but have found little instruction as to what this might look like apart from the idea of open-ended play in nature (Elliott & Young, 2016). This has left a pedagogical gap between teaching about nature and sustainability through environmental education and teaching within a play-based pedagogy (Cutter-Mackenzie & Edwards, 2013; Lloyd et al., 2018). This case study suggests that using inquiry-based and place-based methods infused with first-hand Indigenous knowledge to practice botany with young children in the bush can significantly increase the teachers’ plant knowledge and understanding as well as their botanical and scientific literacies. Inquiring alongside the children in the bush space for a whole year, allowed the teachers to take time to observe the changes in the nature through the seasons, notice things they had not noticed before and become curious. This study adds to research that has found that children need more than just play in natural environments to increase their knowledge and understanding of nature, and that content knowledge is required as well to achieve a deeper connection to, and understanding of, the natural world (Boyd, 2019; Elliott et al., 2020; Hughes, Elliott, Anderson, & Chancellor, 2021; Lloyd et al., 2018).

Previous research has also suggested that early childhood teachers hold little plant knowledge and have low confidence in teaching about plants (Skarstein & Skarstein, 2020). This study contributes to this research with a resolution that teachers who identified as having low plant knowledge can be brought to a place of feeling confident and knowledgeable enough in their botanical literacies to enable them to lead children in botanical inquiry, increase botanical literacies in their classroom and improve their own botanical knowledge at the same time.

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