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ORIGINAL PAPER

Dipping your toes in the water: early childhood science learning at a beach kindergarten

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Abstract

The forest school approach to learning has gathered momentum in the UK and parts of Europe for well over 50 years. In other contexts such as Canada, China, New Zealand and Australia, nature-based early childhood education and care (ECEC) settings, influenced by European forest school approaches, are in a growth phase. While research attention is often given to 'green spaces' such as nature reserves, parklands and forests, less consideration has been given to the 'blue spaces'. Blue spaces incorporate beaches and coastal environments and can be rich contexts for early childhood science education. One example of a nature-based approach to ECEC is the Australian 'bush kinder'. Bush kinders are growing in number and educators have been observed to include sessions at beach environments as part of year-long bush kinder programmes. Beach kinders often involve four- to five-year-old preschool children and provide experiences to learn from and about the natural world through play in the water, on the sand and amongst coastal woodlands. This paper highlights the importance of educators in fostering science teaching and learning in the context of beach kinders. Through analysing early years science education research, guiding curriculum frameworks and early childhood learning, the importance of providing children with beach kinder opportunities to enhance understandings of early childhood science education is discussed. Drawing on vignettes from ethnographic data, gained through researcher participant observation, the benefits of educators scaffolding children's of physical, chemical and biological science experiences present in coastal environments is considered in this paper.

Keywords Science knowledge · Outdoor education · Nature-based learning · Beach kinder · Blue spaces · Early childhood · Inquiry-based teaching

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Introduction

In recent years, studies have confirmed the considerable benefits to children's self-confidence levels and academic attainment through the experiences afforded by spending time in nature (Barrable & Barrable, 2022; Kuo et al., 2019). One of the most significant benefits children gain from interacting with natural settings is a developing sense of appreciation and care for the environment (Dowdell et al., 2011; Harvey et al., 2020). Over recent decades, there has been growth in numbers of nature-based early childhood education and care (ECEC) settings such as nature or forest kindergartens. How these settings have proliferated has, at times, been determined by local conditions, leading to different interpretations of nature-based ECEC programs around the world (Knight, 2016). The nature kindergarten approach to ECEC has been taken up in growing numbers in Australia in a wide range of situations including but not limited to parklands, nature reserves, paddocks, and creeks (Speldewinde et al., 2024). In many cases, this has translated into nature or bush kindergartens (known as 'bush kinder'), an Australian approach to nature-based ECEC informed by their European and UK counterparts. In addition, there are also a growing number of beach kinders (Boyd & Hirst, 2018).

Overwhelmingly, nature-based ECEC research has been in the context of what Barrable and Barrable (2022) call 'green spaces', that is 'parks, forests and gardens'. Yet, there is a growing appreciation amongst educators and researchers of the benefits for children's nature-based education at beach and coastal environments. These 'blue spaces' (Vitale et al., 2022) provide children with wide open spaces to learn through play. To date, there has been limited empirical research considering the educative merits of blue spaces (Barrable & Barrable, 2022) (a term used interchangeably throughout this paper with beaches and coastal environments). Ocean literacy gained through time spent in blue spaces, embedded in an early years' context as a beach kinder, can contribute to children's understanding of sustainable development (Boyd & Hirst, 2018). Coastal settings provide educators with new, exciting dynamics to learning. Educators can draw on beach environments to build children's understandings of water, weather, climate, food and food supplies that are provided and regulated by the sea (Boyd & Hirst, 2018). From the perspective of ECEC STEM learning, blue spaces provide children opportunities to write in the sand, engineer sandcastles, categorise shells and rocks for sorting, and to enjoy water play whilst observing tidal changes (Speldewinde, 2022a, b). The list of possibilities to interact with what only nature provides for learning is long, and the play achievable is only limited to the child's imagination (Dowdell et al., 2011) and what educators deem to be safe. Amongst the extensive children's learning that can occur at a blue space, there are myriad prospects for science teaching to be included as part of a beach kinder session.

This research adopted an ethnographic approach (Madden, 2017). Fieldwork observations and the interactions that occur between researcher, children and educators, written as vignettes, are analysed here to illustrate how blue spaces facilitate science knowledge learning. Understanding the affordances (the significant properties which allow learning) for science learning apparent within coastal and beach settings, as well as the impact of educators within the setting,

informs the discussions here. This paper is novel as it contributes to the scholarship of both ECEC science teaching and learning and provides examples of how blue spaces provide educators with opportunities to support young children's science knowledge learning, that is the physical, chemical and biological sciences apparent in blue spaces. It draws on examples of educator interactions and how educators involve themselves in children's inquiry-based learning (Howitt et al., 2011) at the beach. This paper is an important contribution to the field of nature-based education as these blue spaces are often given limited consideration and are occasionally included as an aside to broader discussions of outdoor spaces for nature-based ECEC. The paper responds to the research question, how can educators use blue spaces to encourage children's early childhood science knowledge development?

Nature-based early childhood education and care

For some time, educators have known the benefits of taking preschool children into nature (Knight, 2016). For over 50 years, ECEC places of learning such as nature kindergartens have grown in numbers across the world, often influenced by Scandinavian, Nordic and UK forest kindergarten ECEC approaches (Elliott & Chancellor, 2014). Nordic countries, for example, have a long tradition of nature kindergartens and view nature as a space suitable to be used as a pedagogical playground (Grindheim, 2021). Outdoor play in Nordic nature environments forms a valued part of daily life and pedagogical practice for most ECEC settings (Sandseter & Lysklett, 2018; Sorensen, 2021). There is a strong emphasis on children's right to play in nature and the necessity of giving children the opportunity for free play and self-initiated exploration is strongly emphasised in Nordic ECEC curricula (Grindheim, 2021; Sandseter & Lysklett, 2018).

In Australia, there has been considerable growth in nature-based ECEC services which have titles including nature playgroups, nature kindergartens and bush kinders. These services have been observed to support educators to deepen children's understandings of, and relationships with, the environment. The views of families and the wider community towards natural places for learning through play and children's risk management have been shown to be positive (Elliott & Chancellor, 2014; Hamilton & Hile, 2023) and can lead to educators adopting a pedagogical approach that enhances risky play in in nature (Speldewinde, 2024; Vander Donk, 2023; Zeni, 2023). The nature-based ECEC at sites such as bush kinders, a name frequently applied to services for four- to five-year-old Australian preschool children, offer a point of difference from traditional kindergarten settings. They are not occasional excursions to outdoor locations such as farms or zoos, rather sessions are regular and consistent elements of ECEC programs. Often occurring in Australian urban, peri-urban and regional settings, nature-based programs have been documented in settings such as open paddocks (fields) and wooded parklands (at times referred to as 'the bush' in Australia), along with public reserves and beaches (Cumming & Nash, 2015).

Providing freer movement than a regular kindergarten, often with weekly classes incorporating up to twenty-five children and three to four educators, learning occurs through play in wide-open natural spaces. The children experience seasonal changes and interact with different plants and animals that inhabit the nature setting, generally for three to five hours weekly, all-year round, and in almost all types of weather (Speldewinde, 2022a, b). Despite their growing popularity, programs such as bush kinders remain dynamic and locally contextualised due to the limited formal education and professional learning available to prepare the educators who work in them. There remains only limited agreed sets of bush kinder curricula practices in Australian states and these are often determined by local government or other regulatory bodies (Campbell & Speldewinde, 2020).

Australian bush and beach kinders are in a growth phase. Having their origins in the early 2010s, nature-based ECEC programs were one response to a policy directive of the Australian government whereby four-year-old children were mandated to be provided access to 15 h of quality preschool per week (Elliott & Chancellor, 2014). The creation of an Australian Early Years Learning Framework (EYLF), a curriculum document designed to ensure quality ECEC for all children, also played an important role leading to the uptake of programs such as bush kinders (Christiansen et al., 2018). The EYLF highlights the importance of fostering engaging outdoor experiences for young children. When revised in 2022, embedded within the EYLF was a call to educators to draw upon 'physical learning environments' as they foster 'a positive impact on children's learning' (AGDE, 2022, p. 14). The EYLF also highlights that through natural environments, a platform is provided for 'ongoing environmental education' (AGDE, 20222, p. 16). Similarly, the EYLF states that 'outdoor spaces invite open-ended play and interactions, physically active play and games, spontaneity, risk-taking, exploration, discovery and connection with nature' (AGDE, 2022, p. 22).

Educators in nature-based settings often apply a pedagogical approach that focusses upon children's discoveries in nature (Speldewinde et al., 2023). These approaches can range from teacher-led, teacher-guided and child discovery-led (Speldewinde et al., 2023). The accessibility of nature provides a place for play through which children can reconnect with nature in urban settings (Kaplan et al., 1989). Often 'self-directed, imaginative, challenging, self-directed and meaningful' (Hesterman & Hunter, 2021, p. 138), play in nature can build science understandings and apply what children learn in nature to other contexts such as kitchen gardens, indoor classroom science activities and around the home (Howitt & Campbell, 2021). Nature pedagogy or nature-based learning compliments science learning (Speldewinde, 2022a, b) as it leads to ways of observing the 'natural methods and practice of working with nature (and how they) that sit within a set of values' (Warden, 2015, p. 35). As a place for science learning, bush kinders generally provide an abundance of living animals and plants and non-living materials for educators to practice their preferred pedagogical approach to science teaching in nature. To adhere to nature pedagogy, children's nature play does not incorporate artificial and synthetic implements that are often found in regular kindergarten situations (Speldewinde et al., 2023). Toys, balls and games are not taken to the setting, so children are reliant only on what is

available in nature for play. An array of science teaching opportunities become apparent when taking young children into nature that provides exposure to the real world, particularly when all that is available for play is what nature provides (Campbell & Speldewinde, 2020). Commencing when children observe and explore nature, a child's discoveries, experimentation, predicting and sharing of learning outcomes have a place to reflect on how children learn science through their nature-based science education experience.

Science in early childhood education

Science, for the purposes of this paper, is considered as the knowledge or a system of knowledge covering the operation of general laws especially as obtained and tested through scientific method (Merriam Webster online dictionary, 2020). The method and the knowledge of science are equally important to taking a 'systematic approach in which hypotheses are tested through observation and experimentation' (Turner & Williams, 2020, p. 3). The definition of science in ECEC is reliant upon curriculum documents such as the EYLF (AGDE, 2022) and what is commonly termed play-based learning (Speldewinde et al., 2023). An interpretation of science in the EYLF is, where children become independent observers of everyday objects, materials and living things (AGDE, 2022). Science in ECEC includes two key areas. Science knowledge, that involves physical, chemical and biological science (Paige, 2021), and science skills that include observing, classifying, comparing, predicting and recording (Guarrella et al., 2022). Science knowledge, the focus of this paper, is readily apparent in nature-based ECEC settings providing opportunities to apply science skills while young children experience and learn about the natural world. It is acknowledged that exposing young children to science learning experiences is essential for scientific knowledge and inquiry skill development (Eshach & Fried, 2005).

This paper focusses upon science knowledge that children can develop in blue spaces. In one curriculum framework, the Victorian F-10 Curriculum, Science Understanding is divided into categories that include: biological sciences, that focusses on 'understanding living things'; chemical sciences that emphasises 'the composition and behaviour of substances' and; physical sciences that are 'concerned with understanding the nature of forces and motion, and matter and energy' (VCAA, 2023). These three categories support building science knowledge that occurs when children explore the natural world and contemplate what is occurring in the environment around them. These explorations often have been found to provide young children with considerable enjoyment (Campbell & Howitt, 2021).

Participating in play has been observed as important in early childhood as it can provide a link to children's science learning (Hesterman & Hunter, 2021). Often, children's fascination and discoveries instigate their play in nature which in turn leads to learning of science (García-González & Schenetti, 2022). Curiosity about living and non-living things coupled with growing comprehension of cause-and-effect can lead to young children can notice patterns and similarities in

the world around them (Campbell & Howitt, 2021, p. 15). Often, to support science teaching and learning, educators apply an inquiry-based learning approach in the early years (Campbell & Howitt, 2021). Inquiry-based science learning furthers young children's scientific thinking, allowing them to respond to science questions and 'to act like scientists' (Howitt, 2021, p. 93). The process of scientific inquiry supports the development of problem solving, questioning and exploration, often through play in nature when children (Hesterman & Hunter, 2021).

Returning to earlier consideration of the EYLF, science education curriculum in the context of Australian ECEC is influenced by this Framework (AGDE, 2022). Yet, early iterations of the EYLF (DEEWR, 2009) failed to include science as a discipline. This oversight has been remedied to a point fashion in the EYLF's second version through limited mention of providing science learning experiences for children (AGDE, 2022). Where this has become problematic as discussed by Guarrella and colleagues (2022), is that due to the lack of acknowledgment of science teaching and learning in the EYLF, educators are reliant on their own knowledge, with little guidance when arranging for the inclusion of science education in ECEC. Where the EYLF (AGDE, 2022) can be helpful is through the implementation of a child-centred learning approach as the EYLF leads educators to 'draw on a rich repertoire of pedagogical practices to inform curriculum for children's learning, development and wellbeing' (p. 20). This child-centred approach can be attained through principles that incorporate holistic, interconnected and integrated approaches to children's wellbeing and learning; creating environments for learning that combine physical, temporal, intellectual, social and emotional elements; being culturally responsive and attentive; responsiveness to children's strengths and capabilities; planning and implementing intentional play-based learning; delivering experiences with continuity and enabling effective transitions and; embedding practices of assessment to achieve intended learning outcomes that includes observation, documentation, analysis, planning, implementing and critical reflection.

Beaches and coastal environments as place of learning

Blue spaces are often incorporated into discussions of green spaces, and evidence exists of the benefits of utilising blue spaces for school aged children, yet there is limited consideration of how these places can be utilised in ECEC (Barrable & Barrable, 2022). Learning at the beach has been found beneficial in developing respectful relationships between learners and nature. A sense of safety and comfort in nature is created which empowers learners to learn about safeguarding the natural world (Omidvar et al., 2019). Consistent visits through a year to a blue space provides the significant benefit for children's learning as it builds comprehension of how the place is everchanging which provides challenges for children to overcome (Hives & Scheffel, 2019; Mackintosh, 2017). Through a range of physical and social development opportunities, blue spaces open to the

natural elements of wind and tide, have been observed to assist educators in the provision of formal and informal learning (Mackintosh, 2017).

Blue spaces provide a backdrop for science learning. Physical science knowledge becomes apparent in these contexts such the sensory experiences of light, sound and waves (Vitale et al., 2022). Children who spend time in blue spaces can encounter the uneven ground of rocky and sandy terrain creating the challenge of how best to manoeuvre while drawing on problem-solving skills, creativity, imagination, and teamwork. Confidence and resilience far beyond what can take place in the indoor classroom can also be developed (Barrable & Barrable, 2022; Evans, 2021). Blue spaces 'provide a contextualised place for contesting and challenging critical issues centred on the child's locality' and have been found to be valuable in applying 'the natural environment of the coastline to demonstrate the biodiversity of the planet' (Boyd & Hirst, 2018, p. 877). With abundant water, a beach setting becomes an effective site for biological science knowledge and sustainable development within ECEC as children interact with living plants and animals. Boyd and Hirst (2018, p. 889) also note that ocean literacy programs have value 'as a useful pedagogic tool to build coherent and conceptually sound scientific learning experiences for young children'. Blue spaces can act as a place of intervention for children with behavioural, mental, emotional and/or social issues (Mackintosh, 2017). Evidence exists of children's greater language learning and memory imprinting of place, improved classroom learning, and educators becoming 'more adventurous in their planning' in beach settings (Mackintosh, 2017, p. 85). These benefits experienced by primary school level educators have been observed to be applied to the teaching of the disciplines that comprise literacy, social and emotional learning, and all components of STEM (Barrable & Barrable, 2022).

Theoretical framework

This study's theoretical framing draws upon Piaget's (1950) developmental theory and his belief that children are 'little scientists' who actively learn about the world around them through interactions and observations. Assuming that all children develop sequentially but at different rates, Piaget's focus on development and learning theorises that individuals form understandings from experiences and can then link more and more experiences together to form mental representations and operations. According to Piaget, children from two to seven years can complete 'one-step logic problems, develop language, continue to be egocentric, and complete operations' (Blake & Pope 2008, p. 59). Piaget's work informs this study as it supports the notion that hands-on experiences in the natural world help children to develop scientific understandings of the world surrounding them.

In addition to Piaget's work informing deliberations of how children learn, understanding inquiry-based approaches in nature-based learning was influential to the thinking here. Howitt and colleagues (2011, p. 46) see inquiry-based learning occurring when 'the student tr(ies) to make sense of the phenomena under study.' The stages of an inquiry-based approach include (sequentially) children

questioning and predicting events; planning and conducting investigations; sorting and analysing information; comparing with predictions and; sharing their findings (Howitt et al., 2011). Additionally, Eick (2012), demonstrates that inquiry-based approaches form a theoretical framework lending itself to teaching and learning science.

Children's development of processes such as questioning and observing which lead to investigations of the world around them, form part of an inquiry-based approach to science. Wondering, exploring and being curious about the natural world is often captured in 'explorations of the learning that ensue' in nature (Eick, 2012, p. 791) and can engage families t**o** foster a love of outdoor exploration in young children (Hamilton & Hile, 2023). Fostering of children's love of nature can often be achieved through educators taking an inquiry-based teaching approach and this is particularly so in the context of a nature-based setting where the educators participate in the children's learning through play (Speldewinde et al., 2023). Lee and Bailie's (2019, 157) conclusion that young children's science learning in nature that includes teacher-led inquiry-based activities 'allow(s) children to form explanations based on evidence' is important in this context. The activities that nature-based play-oriented learning affords, provides educators with a range of opportunities to build 'little scientists' knowledge. Through considering inquiry-based approaches to teaching in outdoor spaces such as beach kinders, educators can be challenged to foster children's play and learning with only what nature provides and for children to deepen their understandings of the world around them. Applying an inquiry-based learning approach in beach kinder, where the children take a lead role in determining what was being taught, led to considering beach kinders and approaches to science as a context requiring further exploration due to a gap in the past empirical research.

Methodology

Ethnography

Reporting on findings from a longitudinal project that commenced in 2015 titled 'Bush kinders: Locating the Science', this paper applies ethnographic data collected in 2023. At its outset, the research project sought to understand how science teaching and learning occurs in nature-based ECEC contexts (bush kinders) (Campbell & Speldewinde, 2020). In 2023, the intent of the research fieldwork was to observe how educators teach STEM both as individual domains and in an integrated manner. The study's ethnographic design (Delamont, 2016; Madden, 2017) sought to capture the stories of people's sociality, culture and behaviours (Madden, 2017). Presenting oneself at a research site with a set focus leads to issues in an ethnographic study as often, the researcher conducting ethnography needs to expect the unexpected (Speldewinde, 2021). In this study, topics including science concepts and skills, gender, educator pedagogy, and children's STEM identity have been discovered. Fieldwork in 2015, 2017, 2020 and 2023 then resultant data interpretation also led to the theorising of a model for integrated

STEM teaching and learning (Speldewinde, 2022a, b) and, consideration of the connections between risky play and science (Speldewinde, 2024). The study initially focussed on bush kinder settings in parklands and paddocks, but it became apparent that the educators were also using beach spaces as places of teaching and learning.

Ethnography's value as a methodological approach in education is that it fosters researcher immersion in social-cultural classroom contexts. Ethnography facilitates deep, lengthy interactions with educators and children over extended periods (Last, 2019). Trust building and deep understandings of the events taking place allow for relationships to grow between researcher and participants (Delamont, 2016). Several educators in this research had been teaching in bush kinders for almost a decade and had participated in the study across the years, supporting me in allowing entry into their bush kinder sessions. The close interactions I have had over the duration of this research were evidenced by the warm response received when enquiring about returning in 2023. Yet prior to 2023 I had only participated in sessions that were taking place in 'green spaces'.

The ethnographer needs to be adaptable to the situations they encounter (Madden, 2017). At times, alternating between being an observer, then at other times a participant in the events occurring in the blue spaces around me, proved beneficial to considerations of the play-based science teaching and learning at the beach kinder. Ethnographic observations of the educators informed my awareness that a child-led, discovery-based pedagogy, where the children led their learning (Speldewinde et al., 2023), was being adopted at the beach kinder. However, the consistently changing nature of the beach kinder sites, oftentimes required adaptable approaches to the facilitation of teaching and learning. Occasionally for example, the learning was educator-led (Speldewinde et al., 2021) and included intentional teaching (Speldewinde et al., 2024). Ethnography therefore becomes beneficial as it leads to researcher participation in the daily events occurring around them (Madden, 2017). The researcher can be drawn into the educator's teaching, the children's play or they can switch guises to become an observer who is distant from or close to the children's activity (Speldewinde, 2022a). Participant observation can even lead to the researcher participating in teaching. Both the children's and educator's science knowledge growth over time that are captured by the beach kinder researcher through ethnography can clarify the researcher's contextual understanding (Last, 2019) of the events transpiring around them.

Participants

Over the duration of the fieldwork conducted between 2015 and 2023, six bush kinder groups participated in the study. The groups participating in this study were selected due to their proximity to the researcher's university and each bush kinder educator's willingness to participate in this research. When the study commenced in 2015, there were only a small number of bush kinders in operation in Australia limiting the choice of research field-sites. Added to this, not all bush kinders incorporate sessions at the beach. Beach kinder programs are generally

determined by their location and proximity to the coast. Of the six bush kinder groups who have participated in this study, three use beach and coastal settings in their program and for one school term per year. The beach programs observed did not have a specific focus and the educators did not prepare activities for the children. The children would arrive at the site then immediately commence play for the duration of the session, only stopping to eat or visit a toilet. Educators applied an emergent curriculum (Speldewinde et al., 2024), teaching at point of need as children discover through their play on the sand or rocks or in the water.

A bush kinder groups involved had three or four educators and between 15 and 25 children. The beach kinder sessions occurred for between three and five hours each week. The children would meet at a designated drop-off place near the beach to begin their five-hour, weekly beach kinder session then, once gathered, would walk along the sand to find a place to play. Where the group would stop was often determined by the tide and the general weather conditions. In addition to the long tract of sandy beach, the environment had a long rocky outcrop and shelf which at low tide, would become exposed creating a network of rock pools for the children to explore.

In total, 10 educators and approximately 75 children were observed at beach kinder for four weeks of the program. University ethics and regulatory bodies' approval was gained for the study (Deakin University: HAE-24-033; Department of Education: 2023_004730) and procedures put in place following Human Research Ethics protocols. Participation in the research was voluntary and signed consents by the kindergarten organisation, its educators and its parents were obtained using the University's formats. Children were introduced to the researchers and given the option of excluding themselves from any observation, discussion, or videoing. All names of individuals and places used in this paper are pseudonyms.

Data collection

To comprehend how blue spaces compliment science teaching and learning, data was generated by drawing upon what Madden (2017, p. 25) describes as a 'toolkit' of research methods. Journal notes were taken in the field and reflexive note taking completed upon returning from the beach in data logs. These data logs formed documentary evidence of what was witnessed during time spent as a participant observer (Madden, 2017). Additionally, images captured, such as those used in this paper, and the quotes applied here, are drawn from informal conversations with and between myself, children and educators. These images and conversations were captured on iPads and handheld voice recorders. All photographs used here were taken in 2023 during twelve beach kinder visitations.

At times, during the research, data was collected by the researcher maintaining a distance from the children, watching what was transpiring across the beach kinder setting. On other occasions, despite attempts to remain distant and observe, I was beckoned to see what was happening creating a mix of participation and observation. At other times, the children and the educators would simply include me as an active part of the learning that was occurring, leading to active

participation (Speldewinde, 2022a, b), wanting me to climb rocks, help digging in the sand or hold shells. I would ask the educators questions such as 'What do you see here (indicating a child's action)? What science knowledge is being demonstrated? What else do you know about this child's previous science understandings? What is influencing the child's application of science in this situation?' The science development in children over time, illuminated my contextual understanding of the events occurring around me in real time.

Data analysis

A thematic analysis approach (Braun & Clarke, 2006) has been applied to the data using physical, chemical and biological science themes to categorise what became evident in the vignettes. The vignettes provide examples of how inquiry-based learning can lead to educators deepening children's understandings of the science in nature. The three vignettes were selected from many dozens of rich examples to support the narrative of this paper as they are representative of the science learning activities that would consistently occur at beach kinder. They were chosen as they individually represent physical, chemical and biological science learning in action, and they support the demonstration of the educators' experiences of the teaching and learning that can develop through an inquiry-based approach within a beach kinder.

Findings

Over the duration of the time spent conducting this research at the beach kinders, it became apparent that children were developing their science knowledge using an inquiry-based approach to their learning. The educators played a critical role in supporting children to build upon their understandings of science evident at beach kinders, highlighting important elements of the science in nature. Often, educators were presented with opportunities to support children's learning of biological, chemical and physical science simultaneously. Divided into three categories, science knowledge constitutes biological sciences that focusses on 'understanding living things'; the chemical science that is seeks to comprehend 'the composition and behaviour of substances' and physical sciences that are 'concerned with understanding the nature of forces and motion, and matter and energy' (VCAA, 2023). To understand these phenomena in more depth, three vignettes are provided. The vignettes are all taken from one beach kinder at Whitesands, to provide continuity in the accounts of what was occurring at this place.

Biological science: seaweed poppers floating downstream

When considering the array of living things apparent within a blue space, educators have myriad opportunities to teach children biological science. The EYLF (AGDE, 2022, p. 13) considers that 'place-based sciences foster community con-

nections in ways that build on local (children, families, communities and educators) funds of knowledge (experiences and understandings), assist in building thriving learners and communities'. By developing understandings of the plant and animal life that abounds in the oceans, in rockpools and amongst sand dunes, educators can have discussions with children about what inhabits a blue space. The first vignette is an example that emphasises biological science whilst elements of physical science were also occurring. Here, the educator Steph, spends time talking to Clara a 'little scientist', about what she is observing and experiencing as small pieces of seaweed are dropped into a moving stream of water.

> Watching on as Clara and her educator Steph were kneeling on the rock shelf, I could see they were investigating small, globular pieces of seaweed that had been exposed due to the low tide. Commonly found along the beach the children would often place this seaweed in their hand and, when squeezed, it would pop. At a distance away from where they were positioned, the waves were crashing onto the rock shelf. The water from the waves would make its way through rock pools and gently over the rock shelf to where Clara and Steph were kneeling. A small amount of water was flowing, cascading over a ledge and pooling adjacent to where Clara and Steph were. Resembling a small waterfall, Clara had found a small seaweed plant and rather than pop the small balls she determined to use them as boats to go over the waterfall. One at a time she released them into the stream of water and watched them float over into the pool below. Steph asked Clara what was happening. 'Was the seaweed floating and what was happening to the seaweed? Where was it going? Why was the water moving so fast?' Steph had Clara feel the seaweed and asked her 'how does the seaweed feel?', trying to elicit discussion about the texture and 'tell me what colours you can see?' encouraging as discussion of the colour of the seaweed. Clara, who experienced a learning disability and was limited with her speech, was able to use the words 'float' and 'go' and 'lumps' and 'brown' to describe her experience of the seaweed floating downstream. Clara smiled at Steph as she placed more pieces of the seaweed into the stream and watched them float away.

Water provides many opportunities to experience science. The tidal movement as well as the salty sea water led to a discussion about the properties within the water and what happens with the shifting tide. Trudi, the educator, spent time talking to the boys which led to considerations of chemical science combined with physical science.

Chemical science: dipping your toes in the water

Chemical science can often not be as readily apparent for young children in a blue space. Through adopting an inquiry-based approach to the children's learning, Trudi's discussions with two boys involved considering how the composition of water can change. While the transition of water from liquid to gas in the blue space may be difficult for young children to visualise, the residual salt in seawater provides for an interesting experiment which educators could conduct. The example provided support the premise that children, prior to entering primary school, should according to the Victorian Science Curriculum (VCAA, 2023), be able to identify an object's properties and that objects can be mixed and changed.

> Sam and Charlie had removed their footwear as they intended to enter the water. While the children were allowed to enter the water, the beach kinder rules in place were that they could only go so up to a certain point. Alongside educator Trudi, I watched as she spoke to the boys, confirming that they could not go any deeper than their knees. Trudi talked to the boys about what was happening, asking 'why was the water rushing over the rock they were stand-

ing on?' Sam replied that it is the 'waves but they don't do it every time' and Charlie said the tide was 'making the water go up and down'. At one point, a slightly larger wave came creating a splash, spraying the boys' faces with the seawater. A conversation then ensued regarding the waves and the tides. I asked Trudi if she ever thought of the chemistry associated with this and she immediately asked, 'how does the water taste boys?' Both boys simultaneously replied, 'salty'. Trudi asked, 'why do you think there is salt in the water?' Both boys were unable to answer this question and left the rock to play elsewhere. Half an hour or so later, again, alongside Trudi, we were talking about why the boys couldn't respond to her question, so we approached the boys who were now building a sandcastle. Trudi noticed Charlie swiping his face and putting this hand in his mouth. She asked 'how does that taste? He replied 'salty'. Trudi asked the boys 'why do think it is tastes salty?' and 'have you heard the word evaporation before?' Sam replied yes, who stated that 'it is because the water has dried out and left some salt'.

The continual movement of water and sand at a beach can provide children with possibilities to understand the natural environment. The beach kinder setting attended by Whitesands Bush Kinder's children included rocky areas with layers that one boy described as looking like a 'stack of pancakes.'

Physical science: a stack of pancakes

When, as Backshall (2016) found, two thirds of young children's science play is focussed on the physical world, there is little wonder that much of the children's science learning in a blue space relates to the physical sciences. The geology apparent in this blue space and its associated biological, physical and chemical science provided me, in the guise of an educator, with an opportunity to talk to three boys about what they had observed in the rock formation. Using an inquiry-based approach, the vignette below emphasises my attention to the physical science while capturing biology and chemistry evident.

> The coastal environment included some rocky areas approximately, three to four meters in height. The children were not permitted to climb these rocks as they were unstable, yet they were a place of intrigue for some boys, Sam, Charlie and Max, who were playing near the small cliff. On this occasion, I was on my own watching and listening to their conversation. At one point, one of the boys said, 'look at the stack of pancakes there in the rocks.' The three boys then spoke of what may have caused this with one boy talking of volcanoes and tsunamis. I called out to the boys 'what else could have caused this?' and they looked at me quizzically. Joining in their play, we talked about how the layers could be formed. At one point, Max asked me 'do the waves could have had anything to do with the layers.' I replied that 'the wave motion may have helped to create this'. We also spoke about the science associated with the layers of sand starting to be soft then becoming hard, so hard they would allow the next layer to go on top. Sam found a small piece of shell embedded into the rock shelf and he asked me 'Chris, could have happened a long time ago when the sand was soft so it got stuck in the sand?' Replying yes it was a possibility, Charlie, who quite was adventurous, deduced that it may not be safe to climb as it was unstable because of how the layers were made of sand. I asked the boys, 'what do you know about forces and how they could help form the layers of pancakes? Again, we continued our discussion eventually, Max stating, 'so it is gravity pressing down that formed the layers'. Sam asked me, so that is how the animals like carbs and shellfish could get trapped, they would just get stuck?' We continued to search among the rock shelf for shells and talked about how the composition of the sand had changed over time to become hardened to create the stack of pancakes.

Discussion

This research seeks to identify how educators draw upon inquiry-based approaches to embed science learning children's learning in blue spaces. It comes at an important juncture in ECEC teaching and learning when considering the lack of acknowledgment of science teaching and learning in the EYLF (AGDE, 2022). Educators need support so that they are not solely reliant on their own knowledge when including science education in their programs. The many opportunities to learn through play, in addition to those described here, created opportunities for children to build their understandings in relation to physical, chemical and biological science knowledge that include plants, small animals, water and forces available in coastal environments. As importantly, while the children played, the educators would consistently seize upon opportunities to talk to the children about what they were experiencing, turning play into teaching events. Natural settings like beach kinders provide children with features unlike those in a conventional kindergarten giving educators and children space to move around and be creative (Campbell & Speldewinde, 2020). The importance of the educator role to implement science curriculum in beach kinders suggest that through educators eliciting discussions and adopting an inquiry-based approach to teaching, children are encouraged to articulate their science ideas. The natural phenomenon occurring in a blue space act as a catalyst for children's play (Berrington, 2012; Davis & Waite, 2005).

In the vignettes, adopting an inquiry-based approach facilitated opportunities for the educator to deepen their understanding of the child(ren)'s interpretation of the science in the world around them. The educator through an inquiry-based approach, by allowing play to occur aided in the children 'mak(ing) sense of the phenomena under study' (Howitt et al., 2011, p. 46). The educator presence and their movement into the children's play ensured that the 'explorations of the learning that ensue(d)' in nature (Eick, 2012, p. 791) built upon the children's curiosity about the natural world. Then the educator becoming involved in the play and learning was an important element of the inquiry-based approach to the science learning taking place. Educator participation ensured the children had the time to experience on their own then discuss their experience. For example, in Vignette 1, Steph's discussion facilitated an opportunity for Clara to build her comprehension of the biology of plant life in the marine environment. Trudi's attention to Sam and Charlie's investigation of the salty taste explained in Vignette 2, supports Lee and Bailie's (2019) point that teacher-led inquiry-based activities 'allow(s) children to form explanations based on evidence' that important in this context. Trudi's attention to the simple act of a child expressing the taste of the salt, provided a rich teaching opportunity facilitated by asking a question such as 'how does that taste?' My own interaction as educator in Vignette 3, when the boys were considering the rock formation, allowed me to engage with the children and ask, 'what else could have caused this?' The questioning and predicting events allow me to apply the inquiry-based approach and have the children think deeply about what they were experiencing as the conversation ensued.

The thematic analysis (Braun & Clarke, 2006) conducted here allowed for categorisation of the children's play-based learning and educator's responses in the vignettes into physical, chemical and biological science (Table 1). Table 1 demonstrates how the educators were able to respond to what they were observing. The beach kinder setting described in this paper is a vital asset to educators to foster children's science learning. Educators challenge children to explore, to investigate materials and draw their own conclusions about what is occurring in their world. What becomes apparent here is that educators require simple science understandings to facilitate conversations such as those provided here. It also confirms the merits of an inquiry-based approach to teaching that allows children to experience the world around them and the merits of blue spaces for science learning.

Conclusion

The examples of science knowledge learning in the context of blue spaces described here demonstrates young children are only limited in their discoveries by the tide, weather and the safety boundaries educators establish. Beach kinders are rich environments that exhibit numerous biological, chemical and physical science characteristics. This paper set out to develop an understanding of the intersections between science and the blue spaces of beach and coastal environments from the perspective of Australian ECEC. Children's enjoyment of their natural surroundings, the sand, the water, and the rockpools supports educators to facilitate inquiry-based science learning. The data analysis of the three vignettes, examples chosen from many avail-

Table 1 Analysis of educator beach kinder actions

	Science knowledge	Educator's teaching opportunity	Children's inquiry-based learning involvement
Vignette One	Biological	Steph asks Clara 'how does the seaweed feel?' and 'tell me what colours you can see?'	Clara plays with the seaweed. She uses er senses to understand the colour and texture of the plant.
	Physical	Steph talks to Clara about the water flow and how the plant floats.	Clara drops the seaweed into the flowing water and observes it as it floats away.
Vignette Two	Chemical	Trudi discusses with the boys about the salt in the seawater. She also supports a discussion about evaporation and the salt residue on the boys' skin.	Sam and Charlie taste the water when it splashes the faces. Later, once the water has dried, they deduce that some water had evaporated leading to the salty residue.
	Physical	Trudi facilitates a conversation about the tides and the force of water.	Sam and Charlie balance on the small rock ledge. They feel the water as it flows past their legs and sense the water moving higher and lower as each wave passes by.
Vignette Three	Biological	Chris asks the boys why there are shells embedded in the rocks	Sam deduced that the shell embedded in the rock wall had been there a long time.
	Chemical	Chris talks about the way the sand moves and how the layering may have occurred as wet sand and rocks dry out.	Sam also deduced that the compacted sand had changed composition over time.
	Physical	Chris uses the chance to talk about the compacting of the sand to make the layers visible in the rock wall.	Max believes that gravity played a part in forcing the layers of sand to be compacted.

able, highlights the important role that educators play and that providing teaching and learning experiences are an important component of a beach kinder session. For children to develop a sense of agency in their science learning, they need to feel that their voice is heard and viewpoint valued. The vignettes demonstrate that children's learning is activated by educator engagement, a necessary component of the educator's teaching practice in a beach kinder.

The small number of field sites are a limitation in this research. Additionally, this paper applies data in a cross-sectional manner, drawing on specific incidents at a point in time. However, these limitations are mitigated through the longitudinal aspect of the study and the ability to return to the beach kinder sessions multiple times. Regular visits supported the development of a robust understanding of what occurs in and during beach kinder sessions. Despite the small number of sites that participated in this research being a restricting factor, the daily environmental changes provided a wide-ranging experience. Rather than it being a static place for learning and teaching, these changes led to children's differing interests being piqued, so a diverse range and volume of data for analysis was generated.

What I came to realise whilst conducting this research was that my attention was drawn by experienced educators to their own interaction with the beach kinder being as much a learning experience for themselves as the children. Further interrogation of the voluminous data captured during the (enjoyable) hours spent at the beach has the potential to uncover other learning areas including literacy, numeracy and children's social and emotional development through time spent in blue spaces. If, as Fleer

(2010, p. 565) states that 'the main purpose of science curriculum in early childhood education is to give young children a new perspective of/on their surroundings' and we provide educators with rich examples of how children can learn in a blue space, we will continue to support children's capacity to grow their science understandings. The eventuality of educators allowing children to be active learners in blue spaces and beach kinder sessions will arm children with the knowledge of how science plays an important role in nature. For educators, this paper highlights the value of allowing for effective science teaching and learning to occur in nature-based settings.

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