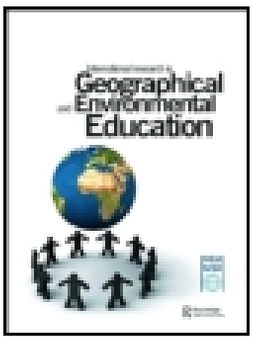

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Transdisciplinary learning in a kitchen garden: connecting to nature and constructing a path to ecoliteracy?

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ABSTRACT

This article reports on a qualitative investigation of Australian, grade 4 primary (elementary) school children's reflections on their learning in a year-long kitchen garden program. Focus group interviews, journal collection, and observations were conducted with three cohorts of students (age 9–11 years) to give insight into whether kitchen garden programs can assist with connecting children to nature and developing ecoliteracy. Findings suggested that frequent visits by the children to the garden assisted with building familiarity and ownership of the garden. This intimacy with the garden created the basis for perceptive observations on changes to the plants and animals in the garden, increased empathy with living creatures, and built interest in the natural environment. Some children also discovered complex interconnections and noted their actions could affect the health of the environment. Facilitated, reflective discussion enabled the primary aged students to explicate their increased engagement with and concern for nature. It is contended that, over time, immersion in transdisciplinary kitchen garden learning experiences can develop students' *ecoliteracy*.

KEYWORDS

Ecoliteracy; connection to nature; kitchen garden; environmental education; transdisciplinary; garden-based learning

Introduction

Providing opportunities for garden-based learning has been promoted as one way of connecting children to nature (Bell & Dyment, 2008; Capra, 2001; Green, 2007; Martin, 2006; Moore, 1995; Thorp, 2005). Capra (2001) explained,

> Learning in the school garden is learning in the real world at its very best. It is beneficial for the development of the individual student and the school community, and it is one of the best ways for children to become ecologically literate and thus able to contribute to building a sustainable future (p. 22).

Increased contact with the natural environment is linked with improved physical, social, mental, and spiritual health (Bell & Dyment, 2008; Canaris, 1995; Dyment & Reid, 2005; White, 2004). Connection to nature has become particularly pertinent in the western world as an important body of research has found today's modern

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lifestyle leaves children with less opportunity to engage with nature (Kellert, 2002; Kuo, 2003; Malone & Tranter, 2003; Pyle, 2002; Rivkin, 1990). Kellert (2002) warned our society has become "so estranged from its natural origins, it has failed to recognize our species' basic dependence on *nature* as a condition of growth and development" (p. 118). Building connections to nature during childhood is important. Monroe (2003) found people that chose a career in environmental fields, nominated education at school and the opportunity to experience and develop an affinity to natural environments as being significant factors influencing their choice of career. Chawla (2006) also found educating about nature and providing opportunities to connect with nature as children, shaped adults' "environmental attitudes and actions" (p. 360). As many children grow up in urban environments, often without gardens or easily accessed outdoor environments (Bucklin-Sporer & Pringle, 2010; Louv, 2008), building connection to nature within school programs has become an imperative for both the health of the environment and our health as individuals.

Connectedness to nature has been linked to increased concern and empathy for nature and fostering ecological behavior. "[A]n individual's affective, experiential connection to nature" (Mayer & Frantz, 2004, p. 504) has been used to predict pro-environmental ethics and actions in later life (Chawla, 2006; Cheng & Monroe, 2012; Wells & Lekies, 2006). Skelly and Zajicek (1998) found a positive correlation between the number of outdoor activities children experienced and their caring attitude toward the environment, although significantly they found gardening alone was not enough to influence attitudes. Other international research found an influential role model such as a family member or a teacher helped promote environmental empathy (Chawla & Flanders Cushing, 2007; Tugurian & Carrier, 2017). In their Florida-based study, Cheng and Monroe (2012) identified four main dimensions in children's connections to nature; "enjoyment of nature, empathy for its creatures, sense of oneness, and sense of responsibility" (p. 46). Cheng and Monroe reasoned ecoliteracy is demonstrated when students show understanding that they are part of nature and inextricably interdependent on the natural systems and cycles of nature.

Ecoliteracy is a term coined by David Orr (2004) and Fritjof Capra (2007) and is central to a new educational paradigm that uses the principles of ecology to promote sustainable human communities. Ecoliteracy is the understanding of the interconnectedness of all life and an appreciation of our role in it (Capra, 2007; Orr, 2004). Capra (1999, para 2–3) supports the holistic approach to knowledge creation when he defines ecoliteracy as "the understanding of the principles of organization that ecosystems have developed to sustain the web of life" and gives the example of "one species' waste being another species food". He further explains that ecological literacy requires people to see the world in terms of "relationships, connectedness, and context" or, what he calls, "systems thinking" (2007, p. 12). Integrated curricula, where things are explained in terms of their context and connections within the broader environment, is essential for developing ecoliteracy and, in turn, sustainable communities (Capra, 2007).

In a classroom, a system thinking approach might manifest in more collaborative forms of teaching and learning. Collaborative group work, can be used to extend an individual's knowledge by positive interdependence resulting in improved

performance by the entire group (Brame & Biel, 2015). By constructively building on each other's understandings, the group can achieve more than the individual (Brame & Biel, 2015; Wells, 1999). Wells found that in "tackling a difficult task as a group, although no member has expertise beyond his or her peers, the group as a whole, by working at the problem together, is able to construct a solution that none could have achieved alone" (p. 324). Such an approach supports systems thinking and the understanding that, in ecosystems, living things interact and relationships between individual elements are often more important than the single elements. When reflective discourse is informed by a common context, it can play a key role in assisting the tacit understandings of the individual to become explicit group knowledge (Nonaka & Toyama, 2003). Constructivist epistemology overarches Nonaka's (1991) Socialization, Externalization, Combination, Internalization (SECI) knowledge creation model to explain and enable the utilization of the embedded knowledge. In the SECI process, the shared context and experiences forms a base from which to accumulate tacit knowledge, to contextualize experiences, and develop empathy. This provides the groundwork for the sharing, creation, and utilization of knowledge (Nonaka, 1991; Nonaka & Toyama, 2003).

With the rise in popularity of kitchen garden programs in schools in Australia (Cutter-Mackenzie, 2009; Gibbs et al., 2013), it is timely to evaluate the efficacy of kitchen garden projects in connecting children to nature. There has been a call from a myriad of researchers for children's voices to be heard, to shed light on what they think, particularly in regard to nature and the environment (Adams & Savahl, 2017; Cutter-Mackenzie, 2014; Louv, 2008; Orr, 2004; Payne, 1998). Adams and Savahl (2017, p. 291), for example, stated that "an urgent need exists for studies with children to begin to explore their [the children's] subjective understandings, perceptions, and discursive constructions of natural spaces … ". Cheng and Monroe (2012) called for explorations into how children develop a connection to nature. This study aimed to add to this body of research by using the children's discourse about their learning in the garden to explore whether kitchen garden programs have a role in increasing connectivity to nature and development of ecoliteracy. While the garden in this study was a domesticated environment rather than untamed wilderness (Kahn & Hasbach, 2013), the objective was to explore children's developing attitudes to the *nature* that they were immersed in.

Context of the study

This qualitative study was part of a broader study on learning in a kitchen garden aiming to analyze the children's perceptions of their own learning, through their reflections on participation in the kitchen garden program. For the purpose of this article, only the components related to developing environmental connection and/or understanding have been drawn on. The researcher, although on leave at the time of the focus groups, was a previous teacher of one of the student cohorts (Focus group C).

Students from three grade four classes, from a regional school (enrollment of 400 students) in Victoria participated in a weekly timetabled three-hour kitchen garden

session. They rotated between gardening, cooking, and science/nature inquiries connected to the kitchen garden. These sessions were supervised by the classroom teachers. Parent volunteers assisted with the cooking and gardening sessions. The time spent in garden maintenance, such as watering during the hot summer months was rostered between the three classes. Access to the garden during recess and lunchtimes created additional opportunities for the children to connect to the garden.

Methodology

This study drew on narrative research methodology and used an interpretive approach to explore students' reflections on their learning in the kitchen garden. Narrative research "seeks to understand and represent experiences through the stories individual(s) live and tell" (Creswell, 2013). An interpretive approach provided the opportunity to explore the subjective meanings and experiences constructed in the social reality of one school. The construction of knowledge while gardening or preparing food is subjective and personal; but it is also transactional. This is relevant to the focus group interview where the interviewer and student participants both affect what is said or explained, and the interpretation and meaning given to the narrative (Polkinghorne, 2004; Riessman, 2008).

Focus group interviews were utilized as the main form of data collection. These focus group interviews provided an opportunity to both gain an appreciation of the common group experience and the meaning the individual participants gave to the experience. The focus groups were held toward the end of the yearlong kitchen garden program. Seven children from each of the three, grade four classes made up the focus groups and one interview of 40–45 min was conducted for each of the classes. Open-ended questions and photos from the kitchen garden sessions were used to stimulate discussion. Examples of questions included; "How would you describe the kitchen garden project to someone from a different school? What would you tell them about what you have learnt? Do you think gardening helps the environment?" The interviews were audio-recorded, transcribed verbatim, and then analyzed thematically. Other data sources included children's garden journals and the researcher's journal, which recorded observations of students in the garden and notes from conversations with teachers.

Children's writing from their garden journals (part of their normal school work) was photocopied after all assessment had taken place. Data from interviews, children's journals and the researcher journal were analyzed using interpretative analysis of narrative (Polkinghorne, 2004) to develop thematic categories and meaning codes. Interpretive analysis of narrative was selected as the most appropriate analytical method to allow the key themes and subthemes to emerge from the narrative data. Each sentence was analyzed for the key idea. These were then linked together in themes. Analysis of the Grade 4 focus group interviews resulted in the development of four reoccurring key themes across the three focus groups. The theme of nature, environment and ecoliteracy is explored in this article. The coding was then double checked by the children's teachers to ensure agreement of codes. The children's comments in the focus group interviews and written reflections were then differentiated

Table 1. Blooms taxonomy framework.

Level of thinking	Indicated by
Remembering— recognising, recalling	Comments about learning or developing knowledge
Understanding— comparing, classifying, inferring,	Comments about explaining, constructing meaning, or reflecting on curiosity and wondering
Applying— implementing,	Comments indicating applying knowledge in practice
Analysing—differentiating, attributing	Explaining cause and effect, comments about connectedness or relationships
Evaluating—making judgements, critiquing	Comments about responsibility, or predictions with supporting reasons
Creating— formulating	Comments that indicate synthesis, bringing different elements together—Ecoliteracy

Adapted from Blooms revise Taxonomy (Anderson & Krathwohl, 2001).

according to the type of thinking exhibited using Bloom's Taxonomy (Anderson & Krathwohl, 2001) to assist with evaluating differences in cognitive thinking (Table 1).

Ethical approval was granted for the research from the relevant Education Department and Human Research Ethics Committee. Participation was voluntary. Informed consent was gained from the Assistant Principal, classroom teachers, the students and their parent/guardian. Data were deidentified and fictitious names used for students and teachers. As the interviews were held during school hours, a pragmatic approach was taken in that each classroom teacher nominated students available at the time of the focus group interviews.

Discussion and findings

When Bloom's taxonomy was used as an overlay to categorize the types of cognition shown through the children's reflections on the kitchen garden program, it became apparent the level of connection students demonstrated toward the environment could be differentiated (Table 2). In the first row of Table 2, Bloom's first two levels, Remembering and Understanding are aligned with *Building knowledge and understanding of the environment*. Applying and analyzing align with *Building connection and empathy with living things* and evaluating and creating relate to *Developing deeper understanding (or ecoliteracy)*. The examples of the children's statements show how the sharing of reflections facilitated through focus group interviews built common understandings of their experiences in the garden. The children built on each other's ideas rather than nominating purely personal anecdotes. Classifying the interview data according to the level of thinking and associated level of connection informed the model for Developing Ecoliteracy (Figure 1). This will be further elaborated below.

Building knowledge and understanding

As children became more familiar with the garden, observations, and wonderings about the plants and creatures living in the garden habitat increased. For example, a teacher noted the students' wonderment and understanding when they observed the developing immature pea pod emerging from the flower and realized the connection between the fertilized flower and the food we eat (Researcher journal). The

Table 2. Nature, environment, and ecoliteracy.

Meaning codes & blooms taxonomy	Theme: Nature, environment and ecoliteracy Examples of quotes that illustrate the theme and codes (Focus group interviews with 3 cohorts grade 4 students)
Developing knowledge (Remembering—Recognising, recalling)	I liked gardening and working outside and learning about plants … what they like and how they grow (Jim, Focus group C). My favourite jobs in the garden were watering and planting things. I learnt about seed growth and what a plant needs (Joe, Kitchen garden journal group A). Plants need to have water, mulch and fertilizers and lots of sunlight (Rosie, Kitchen garden journal Group C). Well I sort of found out how like … a seed grows and all that and what they need and all that … and why worms are good for the garden and why you need to keep weeding because they will just steal all the water (Simon, Focus group C). … before I didn't really garden a lot but now that I know the different plants and stuff, now I garden a lot (Jane, Focus group B). We used to have science about kitchen garden and plants you learnt a lot and when we were doing our beans you learnt what was in the bean and then we planted them and they grew (Ellie, Focus group A).
Curiosity/ wondering Fascination (Understanding—constructing meaning, comparing, classifying, inferring, explaining)	… and the mint. It smelled really strong when you picked it … the herbs grew really well (Mandy, Focus group C). There is one thing that stands out to me which is the animals and bugs that you find in the garden. My particular favourite are the spiders (Mandy, Focus group C). I remember them wondering why some of the plants grew such big leaves and why there were no flowers and also the wonderings about what if we did this to the plant or it didn't get watered … or what would happen if the soil weren't any good? (Research journal, teacher conversation).
Connectedness and being part of the web of life or recognising benefit for the environment (Applying and Analysing—implementing, differentiating, attributing)	Worms help with the garden so you put all the bad plants from the garden into the worm farm and then all the castings go back into the garden so it is like recycling (Lily, Focus group B). When you work in the garden you have to know what is what. You don't want to pull the wrong plant out [that you thought was a weed] and then you have to replant the plant. You also want to have the correct life in your garden; you never want snails, flies or mosquitoes. You want spiders or lizards that eat the insects (Jane, Kitchen garden journal Group B, 2009). I'm glad there is rain otherwise crops and stuff would be dead … and think any other planet … there's no rain! (Joe, Focus group A). You plant a seed, water it and look after it, then pick it then eat it. I felt happy because I was helping life (Mary, Kitchen garden journal group A).
Responsibility (Evaluating— Making judgements, critiquing)	… it's better for the environment when we all garden (Mandy, Focus group C). I think actually it does help the environment … with animals like frogs and because it makes the environment more green and fresh (Ellie, Focus group A).

(*continued*)

Table 2. Continued.

Meaning codes & blooms taxonomy	Theme: Nature, environment and ecoliteracy Examples of quotes that illustrate the theme and codes (Focus group interviews with 3 cohorts grade 4 students)
	I look after my garden at least once a week now. Cos last time, I had a garden, outside my window; I didn't water it or weed it or anything. Eventually it just died. So now I try and get out there as often as I can … (Liz, Focus group B).
Interconnecting relationships Ecoliteracy (Creating—making a coherent whole, formulating)	Yeah! It (the kitchen garden) is helping our generation of people learn more about keeping the earth alive … and keeping us fit with gardening and growing things (Liz, Focus group B). … and it's encouraging people to do more and instead of using energy by cars and stuff it encourages you to go walking more because you are fitter (Alex, Focus group B continues on from Liz) You put all the weeds from the garden into the worm farm (Kim, Focus group B). … then all the castings go back into the garden to be recycled (Liz, Focus group B). Vegetable plants are [like] trees and trees help the environment because they make more oxygen … so it is helping us in two ways because vegetables are also very healthy so, keeping us healthy and also making sure that we have plenty of oxygen (Leesa, Focus group C). Well … it is good for the environment because normally when you want to get some fresh vegetables a lot of people would drive down to the supermarket … pick it up … put it in a plastic bag which is bad for the environment … drive home again which is bad for the environment as well … whereas if you have a garden out the back you can just walk out the back door and pick something and walk back inside again. You know that it is fresh and not overdue (Simon, Focus group C).

children noticed when something was different in the garden which in turn generated discussion and new learning.

The nature of work and play in the garden was experiential and also had rich sensory components. The Assistant Principal commented on how he observed a group of boys gathered around the kitchen garden. As he went closer to investigate, he sniffed the air. "I can smell that from here. What is it?" "Mint, Sir, isn't it strong!" was the enthusiastic reply. He commented how he was surprised at their curiosity and enthusiasm (Researcher journal). The strong odor surprised and delighted the students prompting them to show other children how crushing the leaves released the oils.

Children must find the knowledge useful to incorporate it into their *lifeworld*. This was seen in their plant knowledge—teachers noted that the children could name and describe the uses of the plants they planted, tended and used for cooking (Researcher journal). This is an example of authentic learning. For these children, these plants had become resources; they were useful, and they were remembered because they were relevant to the child. Using Bloom's Taxonomy, the knowledge and understanding demonstrated when children recalled the names of plants would be classified as lower order thinking (Anderson & Krathwohl, 2001). All the children in the focus groups exhibited this type of understanding and knowledge; however, the nurturing

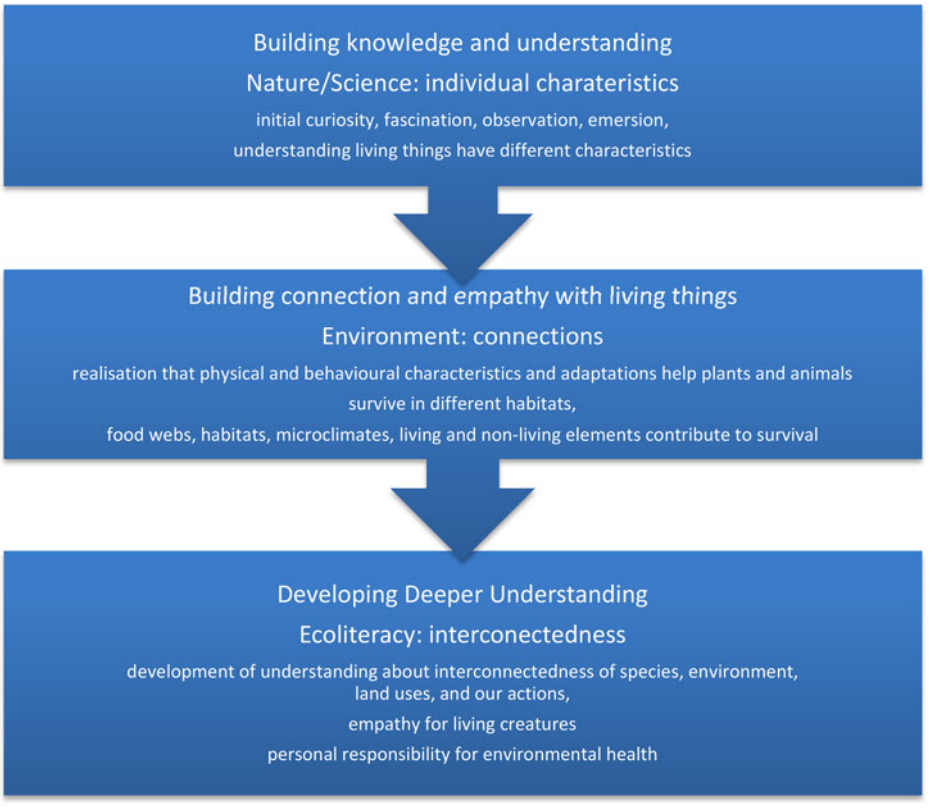

Figure 1. Developing ecoliteracy.

of the plants and cooking with the herbs and vegetables built up layers of experience and formed the basis for the next level, the applying and analyzing, and assisted *Building connection and empathy with living things.*

Building connection and empathy with living things

Some children were particularly drawn to the garden and actively sought it out as a quiet place to talk or reflect during recess demonstrating a "positive affinity with nature" (Chawla, 1998). Two girls were observed quietly sitting beside a vegetable bed. When asked what they were doing they explained that it was nice and quiet and they could look after their bean seedlings (Researcher journal). Other children, like Mandy, sought greater interaction with their surrounds and were often drawn to the bugs and spiders found in the garden (Focus group interview C) and would observe them, completely fascinated for long periods of time. Children cared about the plants and animals as they became more familiar with them. This building of understanding, and empathy with the creatures in the garden, was evidenced when the children were observed carefully rescuing worms instead of chopping them in half [as they were prone to in the early garden sessions] (Researcher journal observation). It was also evidenced when the snails that had been carefully collected from the plants became actors in imaginative games. The snails had been given names and were fed. They obviously had to be "rehoused" rather than

destroyed. All the children in the three focus group interviews demonstrated that they had built connections to the garden's plants and animals, and had begun to develop understandings about the relationships between plants, animals and the environment. As Lily explained, "[you put] bad plants from the garden into the worm farm and then all the castings go back into the garden so it is like recycling" (Focus group B).

Developing deeper understanding

The environment emerged as a separate theme in all of the focus group interviews; however, two focus groups emphasized the "interconnectedness" of the environment and sustainability. This demonstrated the emergent understanding of the complex links between the actions of individuals, and the sustainability and health of the environment reflective of a deeper understanding. In the children's reflections, there was evidence of the formation of abstract concepts and generalizations, as some children linked the creation of the kitchen garden with the dual outcomes of providing healthy food and helping the environment. This is illustrated in the following excerpt from a focus group interview:

> **Ian:** … even vegetable plants are trees and trees help the environment because they make more oxygen … so it is helping us in two ways because vegetables are also very healthy so … keeping us healthy and also making sure that we have plenty of oxygen.
>
> **Simon:** Well … it is good for the environment because normally when you want to get some fresh vegetables a lot of people would drive down to the supermarket … pick it up … put it in a plastic bag which is bad for the environment … drive home again which is bad for the environment as well … whereas if you have a garden out the back you can just walk out the back door and pick something and walk back inside again. You know that it is fresh and not overdue (sic).
>
> **Mandy:** Yes … and it's better for the environment when we all garden.
>
> (Focus group interview C)

The conversation above illustrates how each child built on the discussion and provided examples of how it was personally relevant. Simon's narrative demonstrates a capacity to synthesize information and create a holistic explanation of how having a garden assists the environment. Having broken the information into parts to explore understandings and relationships, Simon then explains the interconnectedness and the *web of* all our actions, our health and the environment. He goes on to create a contemporary understanding about how our actions affect the environment. Simon's insight demonstrates Bloom's higher-order thinking (Anderson & Krathwohl, 2001) and shows an emergent ecoliteracy (Capra, 1999; Orr, 2004).

Providing time to play, observe, and relate to nature may have assisted in developing this connection to all living things. Learning through play, a widely accepted pedagogy in the early years of schooling (Murdoch & Wilson, 2008; Saracho, 2012; Stegelin, 2005; White & Sharp, 2007), appeared to be a significant factor in establishing empathy. The children's transformed attitude around the safety of the worms and

snails were examples of changes in children's relationships with nature and their affinity with and understanding of the garden ecosystem.

Several of the children demonstrated understanding of the link between the way they live, their actions and the health of the environment. Ian (see above) explained how growing food plants connect two different areas: healthy eating and the production of oxygen, resulting in a healthier environment. The comment by Liz, " … the kitchen garden is helping our generation learn more about keeping the earth alive" (Focus group B, see Table 1), indicated a reflection on our role and place in nature's web—and perhaps the beginning of her own "custodian" attitude toward nature (Rule & Zhbanova, 2014; Strang, 2009). The familiarity and knowledge built through the kitchen garden assisted the children to extrapolate their understandings to the complex interrelationships of ecosystems. They developed understanding of the interconnectedness of animals and plants in the ecosystem and how they work together to sustain life. These are realizations identified by both Orr and Capra as being essential for the development of ecoliteracy (Capra, 2007; Orr, 2004).

Developing ecoliteracy

Ecoliteracy is more complex than a mere *liking* of nature. It involves higher order thinking where children establish cause and effect and link the processes they observe in more sophisticated ways and see the environment as a complex network of systems. Comments about nature and the environment were prompted by the question "do you think gardening is good for the environment?" This promoted discussion in all the focus groups; however, evidence of ecoliteracy came predominantly from two of the three focus group interviews. The reason for this difference is not clear. However, it is possible that the children in two of the classes had developed a stronger environmental ethic and deeper appreciation of nature due to the discussions that arose in these classes. It may have been stimulated by the environmental ethic of one or two specific children, by the group of children, or their teachers.

The excerpts from the focus group interviews illustrated how the children actively engaged with each other's thoughts, ideas, and environmental concerns; gradually moving toward ecoliteracy. The children searched for ideas from their own experiences to add to the discussion and the construction of the group understanding. This underscored the social nature of learning (Cozolino, 2012; Lave & Wenger, 1991); the children were willing to share their ideas indicating that the conditions for providing a safe learning environment had been met (Cozolino, 2012; Smyth, 2017).

The learning demonstrated by the children ranged from the most basic remembering or recall of factual knowledge; for example, being able to name different plants, to increasingly sophisticated higher order thinking skills (Anderson & Krathwohl, 2001), where they built up an understanding of how gardening could contribute to living a more sustainable lifestyle. The children personalized the knowledge and created more and more complex connections. They understood their actions were important and affected their own health as well as the health of the environment. Some of the children took this further, linking themselves and their actions to

survival and the interconnectedness of their health, environmental health and species diversity, into a developing understanding or *ecoliteracy*.

Analyzing the children's reflective comments and organizing them into the Blooms taxonomy framework drew attention to the pathway the children took toward ecoliteracy. This is illustrated below as three main stages (Figure 1) and can be used to inform teaching to promote connection to nature and the development of ecoliteracy.

Implications for teaching

1. Immersion in a real garden

The experiential learning activities, the acts of growing, tending, harvesting, and preparing healthy, nutritious foods appears to have been transformative for this group of children and helped them connect to nature. The context of the garden was real and helped the children make sense of and offer plausible explanations for their observations. Learning tasks and activities situated in the garden built up familiarity with the garden and generated ownership. Empathy for the creatures through observation and incorporation into play, built over multiple visits to the ever-changing garden, assisting the development of a different way of knowing. Multiple immersive activities in the garden are required to build the essential connections needed to promote the evolution into ecoliterate, environmentally aware citizens.

2. Collaborative, social nature of learning

The very nature of the garden promoted social and emotional learning. Planting, maintaining, and harvesting produce in the garden provides multiple opportunities for children to build up social skills while working alongside their classmates. The nature of the tasks promoted social engagement, whether it was to draw attention to some fascinating observation, negotiate a solution, or work toward a common goal.

To progress student learning, it is important to provide time for group reflections. Social negotiation of meaning in the garden resulted deeper understandings about living ecosystems. The opportunity to talk about and reflect on their experiences in the focus group interviews generated perceptive statements of personal learning. The collaborative nature of knowledge building and discourse is illustrated when the children discussed the interdependence of everything in nature, linking cause and effect. The children's reflective discourse assisted the group to make connections between their personal learning experiences and the understandings of the group. Each child contributed to the group's understanding, building up connections to the point where children articulated understandings about the interrelationships of the environment and their lives, and progressed toward *ecoliteracy* (Capra, 2007; Orr, 2004). The synergistic action of experiential learning in a common context, followed by written reflections in garden journals, and the verbal reflections and dialectic process of meaning making in the focus group interviews, assisted with the metamorphosis from tacit knowledge (Polanyi, 1967) to explicit vocalized "new knowledge" (Nonaka & Toyama, 2003) as children reflected on their learning (Nonaka & Toyama, 2003; Smith, 2001).

3. Transdisciplinary nature of learning

The garden provided the context for the teacher's curriculum agenda, incorporating the knowledge across the academic disciplines in a transdisciplinary way. Separate disciplines become artificial in the garden; the context, the seasons and needs of the kitchen garden are paramount and dictate the knowledge and skills relevant to a particular task. When designing a kitchen garden, one may need to measure up the space, check the orientation, analyze the soil, decide on the plants that are suitable for the climate, record ideas, draft a birds-eye view plan, budget, discuss and come to a consensus with fellow collaborators and then put the plan into action. It does not make sense to segment the activities into mathematics, geography, botany, economics, literacy, and art. Work in the garden was integrated; the garden context both dictated the content and assisted children to make sense of the new knowledge. It is more than Lauritzen and Jaegers' (1997, p. 41) drawing together of disciplines through context, "linking different disciplines in meaningful and authentic ways." The context provides the link to the child's *lifeworld* and the motive or reason for knowing. When starting from the point of the garden as the context for learning, the interconnected knowledge that is needed to make sense of the whole means the learning is essentially transdisciplinary.

4. Connectedness to nature-3 main stages

The children progressed from initial interest in and fascination with individual plants and creatures, to a more intricate and complex understanding of the interdependence of all species and the environment. Elements of Cheng and Monroe's connection to nature index, i.e. enjoyment of nature, empathy for its creatures, sense of oneness, and sense of responsibility, were reflected in the children's comments (Cheng & Monroe, 2012). Some of these children took this further and constructed a more complex view of the world, going beyond simple cause and effect, or even responsibility, toward ecoliteracy.

It is unclear whether the opportunity to discuss the environment in the focus group interview assisted the children to make understandings already held explicit; or whether the discussion extended their understandings or prompted new connections. The question of whether the environmental values and expanded understandings were spontaneously developed through the experience, supported by the agency of the teacher, established at home, and/or due to other influences, is worthy of further study. What is clear was the value of collaborative, reflective discourse in developing ecoliteracy and care for the environment. Progression in understanding is a complex matter that requires both depth of study and "opportunities for constructive thinking." Teachers should carefully consider "the ideas, experiences and cognitive activities which could contribute to the development of the students' understanding" (Bennetts, 2005, p.130). Through shared experiences built up in the garden, the children articulated their personal stories and contributed to the creation of a common understanding in the focus group interviews.

Conclusion

In today's modern, screen-dependent lifestyle, there is a concern that we have swung too far toward technology. There has been recognition of the need to get some

balance, to reconnect children to the natural world. The success of kitchen garden programs in primary schools is part of this desire to rebalance. The work in the garden was transdisciplinary with the garden providing the context and reason for learning. The children's language of ownership in discourse about the environment indicated a sense of themselves as active participants in their world (Preston, 2015).

This research responded to the demand to hear the children's voices (Adams & Savahl, 2017; Cutter-Mackenzie, 2014; Louv, 2008; Orr, 2004; Payne, 1998) and through their conversations offer insight into how the children constructively built shared understandings (Bennetts, 2005; Brame & Biel, 2015). It explored how these children viewed their connection to nature (Cheng & Monroe, 2012; Šorytė & Pakalniškienė 2019) and shed light on their path to ecoliteracy. Although the kitchen garden in this study was in a primary school in Victoria, Australia, the findings may have implications for other nations where teachers are seeking strategies to more effectively strengthen connections with the natural world. The garden provided the context for engaging, interactive, and transdisciplinary environmental educational programs; the *space* to promote knowledge, collaboration, and shared understandings. The use of school gardens as learning spaces in primary schools can provide a conduit for reconnecting children to nature, offering hope for more ecoliterate citizens and a sustainable future.

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