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Learning science locally: Community gardens and our future

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The wholistic nature of gardening is an approach to learning that provides opportunities to place science education in a context that also values other ways of knowing and draws on the cognitive, the affective and the spiritual—knowing, feeling, connecting. This paper offers a case study of teaching gardening to primary students at The Old School Community Garden (TOSCG), in the Adelaide Hills, South Australia. As experienced science educators, we find that engaging young people in gardening provides them with the opportunity to see the world as a whole, learn science concepts while also addressing local issues such as organic food production. Our focus in this project is the use of the garden as a learning place for Year 1 students (aged 6–7) working with Year 4 students (aged 9–10). We also argue that nature teaching is part of the answer to liveable futures in this time of climate change, pandemics, and the possible crossing of other Earth boundaries. These challenges require educators to focus on futures thinking and transdisciplinary approaches in order to develop the dispositions needed to live in the present with a well-formed idea of where we want to go. Learning the science of gardening is clearly a central aspect—soil science, biological science, ecosystem management and a sustainable food supply.

KEYWORDS

science education, futures thinking, community gardens, transdisciplinary, eco justice

Introduction

The value of community parks and gardens throughout history, and particularly in present and future times, has been well documented (Roseland, 2012; Murphy, 2014; Lloyd, 2015). They can be sites of cultural and social activity as well as places of practical small-scale food production which contribute to the sustainability, resilience, and flourishing of communities (Franklin et al., 2011; Gaylie, 2011; Payne, 2015). The development of the Old School Community Garden (OSCG) is taking place at a time of globalization, where our planet is reaching social, environmental, and economic limits. This is a situation which we may not be able to solve in an ideal way, but which we may survive. Eckersley (2012) encouragingly suggests that “there is still plenty to dream of, and to strive for” (p. 22).

To achieve a sustainable society in harmony with Earth's ecosystems, educators and educational policymakers will have to rethink the curriculum and adopt a different approach to teaching and learning (Bentley, 2010; Barker and McConnell Franklin, 2017). We need to develop curriculum and pedagogy that integrates humans more fully with the rest of nature and that develops a disposition for living in the present while planning for sustainable futures. As Berry (1999) argues, "We are not here to control. We are here to become integral with the larger Earth community" (p. 48). It is important for science education, and for transdisciplinary learning more broadly, to promote educative experiences where students contemplate the beliefs, interests, and feelings of others impacted by environmental socio-scientific issues. "Learners can form an intrinsic connection with nature, in the sense that nature should be afforded similar intrinsic value and justice, that is extended to people" (Herman et al., 2018, p. 2). Given the opportunity, students will see themselves as part of their nature world—likely more affectively and spiritually, than cognitively. Such an approach to science and environmental education is often hard to achieve, moving past, while drawing upon, the knowledge work of the disciplines that have more traditionally comprised science education. Participating in community gardening offers a significant opportunity for developing and illustrating the complexity of a futures-oriented science education.

The Old School Community Garden (TOSCG) is a public garden developed on the former site of the Stirling East School, in the Adelaide Hills (Mt Lofty Ranges), South Australia. This paper is built around the experiences and learning of young students who have been visiting the garden as part of their schooling in order to grow vegetables and plant indigenous trees and shrubs, with the primary aim of preparing them to care for and restore Earth's degraded and exploited ecosystems.

We start by drawing on our own experiences as educators, gardeners, and parents. Together, we bring over 100 years of experience in environmental science education. Our own stories describe what impacted on us in our early years, and what experiences have contributed to our passion for an eco-active curriculum. Clandinin and Connelly (2000) argue that "life is filled with narrative fragments, enacted on storied moments of time and space, and reflected upon and understood in terms of narrative unities and discontinues" p. 17. It is for this reason we have woven our early life and education stories through this paper. As "elders," our intention is to reflect on our evolving understanding and journey, and to leave a legacy for those picking up the baton for the future. We work from the ethical position that our generation should leave a world worth passing on to our grandchildren and theirs.

The authors are two "retired" academics from the University of South Australia with environmental science and futures studies backgrounds. We have taught pedagogical courses for science and mathematics, including environmental science and integral studies. We have worked particularly with

pre-service teachers aiming for careers in primary and junior secondary education.

David Lloyd

I was born in Ormskirk, a market town in Lancashire, England, during the Second World War—a time when community gardens (allotments) became a necessity. After the war, my family immigrated to South Australia, where I attended schools in the metropolitan area. A teaching scholarship enabled me to complete Education and Science degrees which led to a career teaching secondary school general science and chemistry. After further study (MSc and PhD), I spent fifteen years lecturing at the University of South Australia. Throughout my schooling, I developed a love for the natural world through adventures in Adelaide's Mt Lofty Ranges. Later in life I enjoyed caravanning and camping with my family and friends and, of course, vegetable gardening for my family at home. I became an enthusiastic member of TOSCG and have worked with local primary school teachers who visit the garden with their classes. My academic work, and my understanding of the importance of living as part of nature through my connection with it, motivated me to explore many aspects of our environment and I became concerned with the way it is being used and (mis) managed. My grandchildren have a lot of work to do to repair natural ecosystems and to hopefully live in a vibrant, sustainable, and nature-filled world.

Kathryn Paige

I was born and raised in Berri, a rural agricultural town along the River Murray, South Australia. This river system is a major source of domestic and environmental water and, while the rhetoric was that there was sufficient for everyone, I remember brown water baths and being constantly mindful of the preciousness of water and the precariousness of the river flow. As a well-educated white woman of privilege, I am conscious that my "lot" have used more than our share of Earth's resources. The 70s were the times of Vietnam war, hippies and living simply. At Teachers College, our ecology lecturer inspired us to participate in frog counts (as a measure of healthy water systems) and to march down the main street of Adelaide chanting "ban the can" in a campaign that resulted in a deposit scheme for soft drink cans which remains to this day. Through my 17 years teaching in primary classrooms and 25 years educating future primary/middle teachers, I always strived to "walk the talk," reducing my carbon footprint through recycling, replacing single use items with reusables, cycling rather than driving wherever possible, planting trees, and gardening (later guerrilla gardening).

It is these educational and life experiences we bring to this community garden project. Using the community garden

as a case study, we explore sustainable and transdisciplinary educational practice with two classes of school students who regularly engage with gardening. As experienced science educators, we find that engaging young people in gardening provides them with the opportunity to see the world as a whole, learning science concepts while also addressing local issues such as organic food production. Our focus in this project is the use of the garden as a learning place for Year 1 students (aged 6–7) and Year 4 students (aged 9–10) as they learn to live locally and make wider community connections. Data from primary students and teachers involved in learning in the community garden provide insights into their experiences. It orients also to a set of eco-justice principles which are then used to inform a curriculum structure for liveable futures and for teacher educators to develop.

Science education for environmental and futures learning

Children's understanding of science is acquired from early interaction with the world. Through play and their everyday experiences children are developing the own ideas about how the world works (Howitt, 2022). Building on children's natural curiosity in nature and embracing sustainability and futures thinking is an approach to science education many teachers are adopting. Sustainability is not just another issue to be added to an overcrowded curriculum but a gateway to a different view of pedagogy, of organizational change, of policy and particularly of ethos (Sterling, 2001; Gilbert, 2016).

In the Australian Curriculum, Science is one of eight learning areas. It has three strands, Science understanding, Science Inquiry Skills, and Science as Human Endeavor. It is intended that these three strands are interwoven together and science in the community garden is the perfect vehicle. It is the Science as Human Endeavor Strand that highlights the importance of science in contemporary decision-making and problem-solving, as well as cultural, ethical and social implications to be taken into account (Australian Curriculum Assessment and Reporting Authority [ACARA], 2022). In addition to the learning areas Australian Curriculum has two other components, General Capabilities and Cross Curriculum Priorities which includes sustainability. Pedagogies which advocate for educating for sustainability include envisioning a better future, systemic thinking, critical thinking and participation in decision making (Australian Research Institute for Environment and Sustainability [ARIES], 2005; Skamp and Preston, 2021). This approach aims to shift the study of "science" beyond a eighteenth century and twentieth century view of progress, and technical know-how, and of narrow versions of objectivity and links well with the pedagogy modeled in the community garden (Brennan and Widdop Quinton, 2020).

A necessary process in conceiving a community garden is that how we understand and "value" the future will determine how we proceed in the present. Our global and local economies are destroying Earth's natural support systems, putting us on a path of decline and collapse. Current literature on sustainable futures identifies the challenges for a safe and liveable environment. These challenges include climate change, ocean acidification, chemical pollution, nitrogen and phosphorus loading, freshwater withdrawals, land conversion, biodiversity loss, air pollution and ozone layer depletion (Flannery, 2015; Jickling et al., 2018; Figueres and Rivett-Carnac, 2020). Earth is heading for an uncertain future with the likelihood of dramatic changes—a good reason to be concerned (Norberg-Hodge, 2020). If Earth is to remain liveable, we need a futures vision that can turn things around. Futures thinking is about exploring possible futures that are evidence based and investigating how trends will affect us and our community, promoting decisions on what action needs to be taken to either fulfill the future scenario or work to prevent negative aspects.

At the personal level our minds have the faculties of memory and prevision (de Jouvenel, 1967; Cornish, 1977) and we have no choice but to have images of possible futures. They are a central aspect of our worldview (Kelly, 1963; de Jouvenel, 1967; Damasio, 1994; Loye, 1998; Eckersley, 2002; Bowers, 2017). Images of possible futures are mental tools that deal with possible future states and are composed of a mixture of concepts, beliefs and desires that affect our choices and guide decision making and actions. They are flexible, changeable, and personal in nature and are mental constructions dealing with possible future states (Ziegler, 1991; Rubin and Linturi, 2001). Images of possible futures are important and life forming, and prediction is both intuitive and learned, and can be improved when acknowledged and attended to Loye (1998). Hicks (1996), says that "One of the main concerns of environmental education is the need to create a more ecologically sustainable future," and that images "of possible futures seem to be important at both the personal and community levels" (see also Hicks, 1994, 1996; Hicks and Holden, 1995; Slaughter, 2012; Kopnina et al., 2018). Schools as community groups need practical ways to express and build their hope and agency for the future.

The following extract is from a positive future story using a guided fantasy to get participants thinking about the world in 20 years, in this example, an adult:

I spend my day working in my small garden and glasshouse with my vegetables and fruit. I enjoy the society of the main street, the library. I take interest in the public orchard I helped plant 10 years ago. The freeway is quieter, there are two train tracks where roads were; people now find the new train to the city more convenient. There is much more local cultural life, films, music, and local sociability (Lloyd, 2013).

The choice of preferred futures identifies what the author would like their Earth to be like. Many would like to see a future based on greater environmental awareness and personal

and community action for sustainable futures as argued by Slaughter (1991, 1995, 1998) and many other authors (e.g., Boulding, 1996; Gidley, 2016). There is ample evidence in these articles that having positive expectations for the future, emerging from active engagement in the present, has a positive effect on our world view and wellbeing. We believe that what student images of possible futures reveal about their interests and concerns provides a primary justification for a more explicit futures perspective in education (Lloyd, 2005; Paige and Lloyd, 2016; Paige et al., 2018b). They constitute prior knowledge that can influence motivation, conceptual development, and what is valued as knowledge.

Climate change, brought about by human behavior, is currently the Earth's primary challenge. Climate change is exacerbated by deforestation, a major cause of biodiversity loss and carbon dioxide removal (Rockström et al., 2018). A further significant challenge is the destruction of our natural environment—the homes of so many native plants, animals and insects. In Australia, overfishing and illegal fishing, introduction of exotic species, pollution, and infrastructure development add up to degradation of the natural environment (Australian Government Department of Agriculture, Water and the Environment, 2022). Environmental degradation is evident at even well-managed sites. At TOSCG rabbits—an introduced pest—want our fruit and vegetables, leaving nothing for humans!

Toulmin (1990, p. 2) explains that “futures scenario are available futures, not just those that we can passively forecast, but those that we can actively create.” This position enhances considerably the need for community parks and gardens that can provide spaces for the non-human residents (plants and animals) and the growing of organic food for humans (Kolbert, 2006; Lindenmayer, 2007; Spratt and Sutton, 2008; Lloyd, 2015; Raskin, 2016).

Community gardening for connections and wellbeing

The use of parks and gardens to improve health is known as *social and therapeutic horticulture* (Goleman, 1996; Armstrong, 2000; Arvay, 2018). As well as promoting physical and mental health benefits, social and therapeutic horticulture has also been shown to help improve people's communication and thinking skills. The University of Hull's Center for Systems Studies is researching ways community gardening can boost wellbeing for people, societies and the wider world (Metcalf et al., 2021). They have, since 1998, been maintaining trees, shrubs and wildlife areas, growing vegetables and salad crops, and holding crafting activities. Similarly, TOSCG runs workshops on how to mulch, build wicking beds, as well as plant propagation. We must not forget social events such as barbecues and picnics—often occurring after a hard day of digging, weeding, and planting. Spending time in the outdoors, taking time out of the everyday

to surround yourself with greenery and bird life we have found to be one of life's great joys.

Norbert-Hodge sees a need to “work to renew ecological, social and spiritual wellbeing by promoting a systemic shift away from economic globalization toward localization” (Local Futures—Building economies that restore community and nature). Community gardens are an expression of localization that respects nature, justice, and real democracy, rebuilding local economies and communities, and restoring cultural and biological diversity.

When it comes to food, the value of local production is paramount:

The logic of local food production is unassailable: locally grown food is fresher, and therefore tastier and more nutritious, than food transported over long distances. It is also likely to contain fewer preservatives and other artificial chemicals, because when the producer knows the consumer personally and not only as a faceless target market, he or she is less likely to take risks and liberties with the consumer's health (Norberg-Hodge, 2020, p. xxiv).

Gardening can directly improve our wellbeing and encourage us to adopt healthier behaviors through physical activity, collaborating with friends, relaxing, or meditating in a quiet and beautiful place, coming to a better understanding of plant growth, soil properties and the ecology of gardens (Payne and Wattchow, 2009; Nettle, 2010). Growing food, for own use and for local distribution or sale, is often the motivating purpose of community gardening. For example, surplus food from TOSCG goes to people in need and is distributed by The Hut Community Center, operated by local government. Unlike growing food in private gardens, community gardening requires an element of cooperation and collective planning. Working together toward shared goals can create a real sense of community. And in a garden, a feeling of connection may develop, not just with other people, but with the living world. For example, Australian magpies are often our companions at the garden, particularly if turning over soil—they find food for lunch or tea for themselves and their children.

Community gardens connect people to nature and help towns and cities to move toward local, healthy, less expensive food with a reduced carbon footprint (Costanza et al., 2013). Learning about our environment and how to live sustainably within it is critical for a liveable future for all species including humans, so understanding, valuing, behaving, and taking action to care for our natural environment—for ourselves and for future generations—is our greatest challenge for sustainability (Walker, 2019).

Individual wellbeing and societal wellbeing are inextricably linked. Community gardens support this connection in part by placing people in nature. They can demonstrate that it is possible to make spaces inclusive and accessible. Wicking beds and paved pathways, for example, can improve access for wheelchair users.

Community gardens such as TOSCG highlight the importance of nature places and the many benefits they can bring for people, society and the other-than-humans.

Community gardens can also play a significant role in conserving biodiversity through developing wildlife pockets and corridors across towns and cities. Gardens can also help to mitigate climate change: their vegetation captures carbon dioxide and improves air quality, provided there is enough of them to use the carbon dioxide we generate for them. Tree and shrub roots absorb water and help stop flooding and erosion but also reduce evaporation, a very important local consideration in South Australia's hot, dry summers.

Community gardens: A context for sustainable educational practices

The Old School Community Garden was once a primary school, hence the name. Located in the township of Stirling, approximately 15 km from the Adelaide city center, the land is government-controlled and is managed by the district council. In 2013, the council leased the site to a group of local people who wanted to develop a community garden (Lloyd, 2015). The garden is two hectares in size and has a flat area suitable for growing vegetables, and an undulating area ideal for growing indigenous flora. Koalas are starting to find their homes in the trees and native birds of many species are at home in the garden.

The original OSCG community team, all interested in gardening and/or growing food, also saw the site as a community meeting space, for both health and economic reasons and, in particular, the local production of food which was seen as becoming an increasingly higher priority for communities. During early consultations, with the community, the managing committee established six objectives for the garden (Lloyd, 2015):

1. A Meeting Place
2. A Growing Place
3. A Learning Place
4. A Healthy Place
5. A Sustainable Place
6. A Beautiful Place

Environmentalists such as Edward O. Wilson support these objectives, as seen in his “biophilia hypothesis” (Wilson Edward, 1984). Wilson spoke about the “human urge to affiliate with other forms of life,” in other words, about our connection with nature. It is a connection that has evolved over millions of years. Human beings come from nature. We have been formed by our interaction with nature. We should therefore be considered a part of nature, just like all other life forms (Arvay, 2018, p. 3).

In this paper, the educational value of TOSCG (Objective 3) is our primary concern. We focus here on the use of the garden as a learning place for Year 1 students (aged 6–7) and Year 4 students (aged 9–10). As Gaylie (2011) and Lloyd (2013) note, many schools already have their own food gardens as strategies for developing sound nutritional practices and cooking skills, encouraging outdoor physical activity, and preparing students for living locally food-wise. It is hoped that this generation of young people, with the opportunity to learn how to grow food, will be better prepared for a likely challenging future (Cattaneo et al., 2012; Ehrlich and Ehrlich, 2012; Stevenson et al., 2013).

The explicit objective 4 of making TOSCG “A Healthy Place” objective has four main aspects—cultural inclusion, ecosystem health, and personal mental and physical wellbeing. Student visits to the garden promote social interactions, physical exercise, and ecological knowledge. This is a complex space for diverse kinds of learning, socializing and being with the environment. Text book biology, physics, chemistry, and geology take on real meaning when applied to an understanding of the needs of plants and animals and of the needs of the humans who manage the garden.

It is important to recognize that the cognitive, scientific and conceptual work, has to take account of the emotional dimensions of relating to the rest of the world, other humans and to oneself, not customarily a feature of science education. Awareness of local and global issues is not generally the result of the school curriculum but rather emerges from television and other forms of mass media (Hutchinson, 1996; Oscarsson, 1996). Many young people intuit the dangers of our time and are “deeply cynical, alienated, pessimistic, disillusioned, and disengaged” as well as “uncertain of what the future holds” (Eckersley, 1997, p. 244). Eckersley (1995) argues that the lack of confidence that youth have in futures may be due to cultural failures, loss of key values, and the rapid pace of change. Goodall and Abrams (2021) in their “Book of Hope” highlight “ego-grief”:

I read a report by the American Psychological Association found that “the climate crisis can cause people to experience a whole range of feelings including helplessness, depression, fear, fatalism, resignation, and what they are now calling eco-grief or eco-anxiety” (p. 73).

Because people's relationships with the living world affects their behaviors toward it, taking part in community gardening can also help people, old and young, be environmentally conscious, and responsible (Sobel, 2017). The mature gum trees and those we are planting at TOSCG provide food and shelter for koalas. The creek that runs through the garden provides a home for animal species such as frogs, lizards and Australian wood ducks (see Figure 1).

There are so many positives gained through community gardens that their popularity is likely to rise as we learn how to live more locally. There are challenges such as suitable sites in towns and cities, but as one of us discovered in their narrative,



FIGURE 1
A shared space for humans and wildlife.

in times of need such as the Second World War, suitable places for community gardens can be found. We suggest that they are necessary for sustainable and flourishing communities. The many benefits of community gardens include:

- Workshops that ensure our continuous learning for sustainable futures, for example building wicking beds to reduce water use; native bee workshop (Lloyd and Deans, 2017; Paige et al., 2020).
- Supporting inner wellbeing
- Connecting to community and its culture
- Living a life in harmony with the natural world
- Developing knowledge about indigenous plants that support local species¹

These garden experiences fit well with objectives 5 (A sustainable place) and 6 (A beautiful Place). This is reflected in the pleasure that community including children take in being in the garden working toward a sustainable place appreciating the beauty of native plants and animals species.

The study

We report on the year when two classes and their teachers were involved in the community garden. A Year 4 class of 20 students and their buddy class of Year 1s visited the garden over the growing period for vegetables. They walked to the

community garden from school and back, taking about 15 min each way. This provided opportunity for talking, building friendships, and noticing what was happening around them. For example, seeing koalas in the trees. They visited TOSCG once a week for a 3-h morning or afternoon session. But many also visited in their own time, often with their parents.

An in-depth, purposeful case study (Merriam, 1998; Stake, 1998; Yin, 2016) was undertaken using a participatory methodology, alongside the teachers and students around sharing the gardening experience. Both researchers had current working with children checks. Data collected over an extended period of time included observations and notes from conversations with students and teachers, student writing, illustrations, and future thinking, reports by the teachers and photographs of learning experiences. With young children especially, and the complex learning experiences offered through the gardening, we needed a range of qualitative methods to capture aspects of their multiple ways of knowing and being in the garden. We include two photographs of the community garden illustrating vegetable plots, wicking beds (Figure 2) and shared space for humans and wildlife (Figure 1).

The teaching foci came from the teachers asking students to write about their experiences, with one teacher giving them the *sentence starter* “I love the garden because... Their responses included their environment, the plants, seasons, and sustainability. The teacher wrote, “They loved their time in the garden and really enjoyed finding out about their place. As you can see the garden makes an impact in many ways”. The data used in this paper has been collated from the comments of young people reflecting on their community garden experiences.



FIGURE 2
Community Garden wicking beds.

¹ <https://greenleafcommunities.org/the-many-benefits-of-community-gardens/>

Transdisciplinary learning in the community garden

The garden is an ideal site for young people to learn about their local environment and how to manage it sustainably. In the Australian Curriculum, the concept of sustainability is a “cross-curriculum priority” from Reception to Year 10 and this, in itself, is indicative of the transdisciplinary nature of learning for sustainable and harmonious interaction with the environment.

For teachers bringing their students to TOSCG, the pedagogy used is transdisciplinary, connected to place, and consistent with the agreed garden objectives (Balsiger, 2015; Mochizuki and Yarime, 2016; Paige et al., 2018a). The activities are also transgenerational. The teachers and students work with senior members of TOSCG team, including David Lloyd, one of the authors of this paper. The older Year 4 students act as mentors for the younger Year 1 students.

The central activity for students is planting vegetables in wicking beds, and planting trees at the site as well as at school and home (see Figure 2). In the process, students plant seeds and learn to identify the needs of the plants. They work in twos and threes to dig holes or trenches and then space their seedlings or seeds equal distance as indicated on the seed packet information. We explain that plants, just like us, need nutrients and we introduce them to community garden generated mulch and purchased fertilizers that have explanations on how and how much to use for vegetables. They are thinking mathematically when measurements are made using calibrated spoons and for liquid fertilizers, how to dilute if required. An important piece of chemistry is pH—acidity, alkalinity and neutrality. They connect to these ideas through their own eating—bitter, sour and neither—alkaline, acidic and neutral. We introduce students to pH meters which they can use to measure acidity and alkalinity. At the garden we explain that some plants like acidic soil but most vegetables like alkaline or neutral soil which leads onto soil management and the needs of particular vegetables. The students cover their garden beds with netting to keep out the feral rabbits and white butterflies that lay eggs on their plants. Snails also need to be managed, although snail races are not uncommon, and students love the worms! Back at school the teachers connect this process to students’ own diets, explaining that all living things need feeding and the vegetables they eat provide them with what their body needs to live and to grow. Plant nutrition is connected to human nutrition through the in class curriculum. Making the connections between the needs of human, plants and animals, while talked about at the garden is addressed more thoroughly in class.

As a “Learning Place” (Objective 3), TOSCG promotes multiple ways of knowing (Gardener, 1983) including the development and sharing of values and visions—a cultural perspective. Through their participation in TOSCG, the students learn more about living sustainably, as the TOSCG

team demonstrate, practice, and promote the sustainable use of resources. Participants are provided with rich opportunities for learning including organic gardening, plant propagation, pest control/weed control, composting, and wicking bed construction. There is also a focus on biodiversity and local knowledge—specific to the Adelaide Hills conditions and microclimates—as part of the curriculum in Year 4. Engaging students in the decision-making process has added to the democracy agenda. As students aren’t often aware exactly how their food is produced and where it comes from, growing and cooking food have been welcomed and are now integrated into the school curriculum.

Student experiences at the garden are taken back to school, interrogated and further researched. The produce is either taken home or cooked and eaten at school, providing an opportunity for cooking lessons. Students continue their garden studies in the classroom to develop their literacy skills by researching and writing stories about their garden experiences. These stories are shared with fellow students, teachers, instructors, and parents. The student experiences are supportive in connecting them to Earth, their curriculum, and the interconnectedness of the subjects they do at school—transdisciplinary learning (Brown et al., 2017). The learning is good for your body, mind, soul, and spirit. TOSCG is a place of rest, reflection and physical exercise, a place of connection to nature, and a place for companionship, discussion and collective decision making.

Participant reflections

As part of their learning back at school the teacher assisted students to reflect, record, write, and illustrate their experiences in the community garden. These were collected and a copy was forwarded to the research team. Permission was granted by the parents to use the work samples and pseudonyms have been used to de-identify the children. The researchers analyzed the work samples for common themes and these are used to organize the children’s personal comments on their community garden experience (provided in Table 1). What is interesting is the variety of reasons students give for being at the garden. Common themes include (1) the science of gardening e.g., learning about growing plants, planting seeds, putting out pea straw, and pulling out weeds. A second theme is helping people less fortunate, for example growing food for people in need. Thirdly, being outside, walking to the garden, and spending time with their buddies. Both the learning and social aspects were identified by the students.

Student stories, comments and notes can be seen as young people preparing themselves and their community for a sustainable future, not necessarily in a deliberate way but by students seeing the value of community gardens.

TABLE 1 Students' comments on the value of the garden.

Connection to nature/gardening	Francis: "I love going to the community garden because it helps us become connected to nature." Frankie: "I think that the community garden is a great place if you don't have a garden" Faye "I love going to the community garden because we get to water the plants"
Food production	Estia: "More people should visit the Community Garden because people can get vegetables." Veronica: "I like going to the garden to learn how to grow fruit and vegetables to eat and so they don't have to pay money for it."
Companionship	Faye "I love going there with my buddy"
Contributing to wellbeing (personal/community)	Anna: "I like going to the garden because I like being able to plant whatever I want and be able to help the community. I think our class trips to the garden are fun and also, we can get more exercise walking there"
The whole story	Bianca: "I like going to community garden; we get to take the vegetables we have planted. I am learning how to plant. We got to go with our buddies. We would pull out the weeds and put them in the big mulch pile. I think this will help the community if we plant our own vegetables and don't use packaging, so it is better for the environment"

One of the teachers commented on the important role of children mentoring younger ones and the interdisciplinary nature of the learning, identifying both mathematics and science. "As the Year 4 class are working with Year 1s, they are able to develop mentorship skills, model social skills as well as learning all the benefits of participating in a local sustainability enterprise. They acquire knowledge about soil preparation, seedling growing and seed germination. They will gain the expertise of caring for their plants and later will reap the rewards and will be able to cook and eat their produce. It is also beneficial for the students to get to know an older citizen guiding them through the process."

Learning to live locally

TOSCG is very much about connecting to place—to the local. Many readers will be familiar with playing in the backyard when younger, or going to the park with friends, or to the garden, to play or just relax. TOSCG has become a second home for some locals particularly when needing a break from the "dishes." Aizenstat (1995) puts it well: "The rhythms of nature underlie all of human interactions: religious traditions, economic systems, cultural and political organizations. When these human forms betray the natural psyche pulse, people and societies are sick, nature is exploited, and entire species are threatened" (p. 93).

TOSCG can nurture a unique and special sense of place, and students can find an outlet for their biophilic needs (Orr, 1992; Gruenewald, 2003; Louv, 2008, 2011; Suzuki, 2010; Camerona et al., 2011; Arvay, 2018). Barrows (1995, p. 107) hypothesizes that "the attraction children have for fairy tales set in nature and populated with animal characters may be explained by children's instinctually based feelings of continuity with the natural world." The garden is symbolic of a desired and holistic community—for both the local and the global, economically and environmentally—in striving for a sustainable world (Assadourian, 2012, 2017; Cardinale et al., 2012; Buxton and Butt, 2020). This links students' environmental connection to place to their economic needs in particular access to organic food. In support Berry (1999, p. 160) argues "As regard economics we need. subsistence economies where the variety

of human groups become acquainted with the other species in the local bioregion" and "It would be philosophically unrealistic, historically inaccurate, and scientifically unwarranted to say that the human and the Earth no longer have an intimate and reciprocal emotional relationship," p. 175). Bowers (1995) adds that "This bio-conservatism is concerned with the forms of community, agriculture, work, and art that improve the quality of human life by living more in harmony with natural systems" (p. 39).

Connecting to place isn't a trivial disposition. Familiar pleasant places provide for relaxation and exercise, but can also act as outlets for the cognitive, the affective and particularly the spiritual. The wonder of our Earth becomes distinct to us when resting under a tree or in a shelter at any time of the year—although perhaps not when a bushfire warning siren is heard!

In our support in creating naturally sensible systems of schooling, Bekoff argues our psyche is, souls, and bodies cannot heal without also healing our ecosystems and our relationship to other species. Similarly, planetary healing cannot be achieved without healing ourselves (Arvay, 2018, p. xi). We have been formed by our interaction is nature. We should therefore be considered a part of nature, like all other forms. The same life force in us also operates in animals and plants. We are a part of the "Web of life," as Wilson expressed it (Arvay, 2018, p. 3).

Eco-justice principles and sustainable communities

The term eco-justice is used in this paper as a form of justice that considers the rights of organisms and the natural environment in addition to those of human beings. Drawing on research and shared practices in science teacher education, we (Paige et al., 2016) identified eight principles that underpin eco-justice education. The community gardening experience illustrates how such principles can be learned through social action.

- *Listen, learn and challenge* worldviews and behaviors.
- Develop a *community of learners*: with knowing and valuing with compassion natural and human systems (the cultural

TABLE 2 Practical examples for community gardens and science education.

Eco-justice principles	Examples of practice and action	
	Community garden	Science education
Listening, learning and challenging current world view values and behaviors.	Locally grown food Planting and managing native flora Empathizing with and loving native flora and fauna Friendships with people and environment Living locally when possible	Reducing ecological footprint (water, energy, food, clothing, etc.). Reducing waste. Studying and supporting native Australian bees. Re-attaching humans to Earth.
Develop a community of learners with a disposition to value with compassion natural and human systems (the cultural commons) in the geosphere and biosphere, and elements of the noosphere supportive of natural systems.	Undertaking physical exercise Learning and teaching gardening with the young, the older, and the old	Active in the interests of all Earth citizens, humans and other-than-humans Looking after local environments Such as wetlands and river systems. Boundary crossing, e.g., school and community collaboration on community gardens and local native environments
Engage collaboratively toward creating socially and ecologically just and sustainable communities.	Sharing food with those in need Protecting natural places, plants and animals Sharing grown food with neighbors	Place-based experiences such as volunteering for “Trees for Life” Environmental pledges Inclusive of all aspects of knowing, feeling and doing
Develop students as role models who value the commons, partnerships, quality of life, creativity, and material adequacy.	Schooling at the community garden—environmental behavior, growing and harvesting and cooking self-grown food	Observational drawing, environmental sculptures. Visiting/taking part in environmentally connected businesses/institutions. Managing school and community recycling. Activist role Application of learning as members of community, charity and environmental groups
Foster eco-social wisdom—ways of thinking, feeling and acting within places which they inhabit.	Connecting to the animals and natural and grown plants. Understanding and appreciate the needs of plant, and animals—the ecology	Citizen science projects. Spending time in the natural world with humans and other-than-humans Rewilding: using senses Guerrilla gardening
Develop respect for long-term rather than short-term thinking through historical and futures studies.	Take to heart the history of the land and its human past and develop utopic scenarios for its future	Historical studies of the places we live Futures scenarios to explore possible, probable and preferred futures Transdisciplinary learning and acting
Provide opportunities for critical reflection	Evaluate the season’s successes and failures and plan for the next season	Slow pedagogy Planning, enacting and engaging knowledges, including Indigenous narratives
Prioritize culturally responsive pedagogies and Indigenous perspectives.	Decide on at least one method of improving growing conditions and one different or variant vegetable to grow next season	Plan for a long-term view of building relationships and trust with communities, allowing Indigenous communities and Elders to share their knowledge and narratives of local histories and environments on their own terms Learning in local places

commons) in the geosphere and biosphere, and elements of the noosphere supportive of natural systems.

- Engage collaboratively toward creating socially and ecologically just and sustainable communities.
- Develop as *role models* who value the commons (including Indigenous perspectives), partnerships, quality of life, and material adequacy.
- Foster *eco-social wisdom*—ways of thinking, feeling and acting within places which they inhabit.
- Develop respect for long-term thinking through historical and *futures* studies.
- Provide opportunities for *critical reflection on student learning*.
- Prioritize *culturally responsive* pedagogies and Indigenous perspectives

The principles focus on enhancing socially and ecologically just communities, include challenging assumptions around growth and development, valuing natural and human systems, promoting knowing our place, developing a respect for long-term (futures) thinking, being culturally responsive, and taking an activist role. These principles, already used with undergraduate teacher education students, provided direction for planning student activities at TOSCG and at school.

These principles combine with the objectives of TOSCG to provide a focus for further planning and introducing new members to sustainability values. Unpacking the principles can become valuable conversation starters at garden meetings and in science education in classrooms. These discussions can help advance sustainability, futures and science education aims, as discussed above.

Bowers (2009) points out that “while many indigenous cultures have understood for hundreds of years the need to adapt cultural practices to what is sustainable over the long term, it has only been in the last thirty or so years that the exploitation of the environment has become the concern . . .” (p. 114). As we illustrate here, community gardens can create conversations of hope and action for liveable futures.

In Table 2, we invoke eco-justice principles and align them with practical examples and actions that are able to be enacted in the community garden and thus included in science curriculum.

The examples show how educators and community members can provide experiences critical for connecting children to the natural world through science, such as growing plants, harvesting, cooking self-grown food and connecting to animals. All of these are recognizable in the garden activities and student reflections. The experiences build on how we currently understand humans should be thinking and acting in order to bring about sustainable futures. The 6th principle in particular relates to futures by focusing on the long-term rather than short-term thinking through historical and futures studies. This is an evolving set of understandings and actions that will very likely change as we shift toward living more in harmony with Earth.

Developing desired futures images, working with eco-justice principles, and enacting them ensures sustainable environments. Psychological/cultural and material/natural-social systems are integrated in such future visions and plans. Integral wellbeing and sustainability are intimately connected in this process. Futures planning requires:

- Connecting to place and nature
- Respecting Earth's boundaries and
- Caring for country with the assistance of new understandings and the wisdom of the past.

Raskin et al. (2002, p. ix) argues that by developing students' understanding of community gardens and futures scenario writing they will be able to plan for sustainable futures and work toward them. These are described as a work of analysis, imagination and engagement. As analysis, it describes the historic roots, current dynamics, and future perils of world development. As imagination, it offers narrative accounts of alternative long-range global scenarios, and considers their implications. As engagement, it aims to advance one of these scenarios. By identifying strategies, agents for change and values for a new global agenda (p. ix).

Conclusion

We have attempted to illustrate through the case study how primary science learning can be done when studied as part of a transdisciplinary curriculum in the community garden. We argue that transdisciplinary learning can contribute to enabling

us to live in harmony with a whole Earth system and that, as pointed out by Snoek (2003, np):

- Humans are in a better place with the opportunity to gain experience from pandemics,
- Reflections on the impact of futures thinking and its place in environmental science education can create futures thinkers and actors
- Humans can create a world worth living in for their grandchildren

The educative focus provides a vehicle for students to connect science learning to their personal, community and their future professional lives. The learning, knowing, behaving, cooperating, and valuing of TOSCG, and community gardens all over the world, provides a motivating and highly important area of learning and sustainable community living. The learning is local and necessary for productivity. It is an integral learning area, particularly needed for an understanding of the biology, geology and chemistry of plant growth and can be readily connected to other areas of the curriculum –a transdisciplinary/interconnected learning. Hence the decision to include our voice and illustrate our commitment as citizens and educators through our short biographies.

Many teachers and students are, to a large degree, illiterate when it comes to an understanding of ecology and the lives of individual members of the ecosystem. This community garden study aimed to help teachers and students acquire an understanding of the basic ecology of plants and animals such as bees and snails in their local area and their value/place in the ecosystem. The teachers were empowered to take their students' learning about their environment into the outdoor classroom and were excited by the students' enthusiasm and energy for science learning and connection to the natural world. It was a memorable experience for teachers and students. The garden project has provided an opportunity for like-minded community groups and schoolchildren to work together to enhance the social and environmental resilience of the human and broader natural environments to “enable future generations of humans and non-humans to meet their own needs” (Kopnina, 2014, p. 6). The time spent learning science in a natural laboratory enables teachers and students to explore scientific concepts in context. This is an example of meaningful science education where the outcome is for students to be informed and knowledgeable which will contribute to an utopic view of the future and active participation in constructing a liveable world.

Another group involved in this life project is primary middle pre-service teachers who enroll in a science and mathematics professional pathway course in their final year. Throughout the course they undertake assessment and between workshop tasks that endeavors to prepare them for teaching science using the eco-justice principles. One example is planning a transdisciplinary unit of work which include

using an environmental issue to plan student learning across several learning areas including mathematics and science. There is an expectation that they include Aboriginal and Torres Strait Islander perspectives, place based experiences, authentic assessment tasks, pledges of green and journaling (Paige et al., 2019). Through planning the transdisciplinary unit of learning pre-service teachers become familiar with embedding the cross curriculum priority of sustainability with the science understanding substrand of the Australian curriculum (Australian Curriculum Assessment and Reporting Authority [ACARA], 2022). It is important preparation for beginning teachers to be confident planning meaningful experiences for their students. As Ferreira et al. (2019) argue the curriculum and pedagogical processes of embedding education for sustainability (EFS) in teacher education are both structural and organic. The importance cannot be overemphasized of ongoing collaborative inquiry and critical reflection as teacher educators develop knowledge of and practices in EFS along with their understandings of the impact of these practices on pre-service teachers.

On a final note, community gardens, as illustrated in the case study TOSCG, can become part of the solution of transitioning to a low energy economy that can adapt to, and assist in the mitigation of, climate change and other challenges such as over-population, environmental degradation, adequate quality food, ozone depletion and social inequality (Hopkins, 2008, 2010; Urry, 2013; Lloyd, 2015). In the future, sustainability will be integrated in all aspects of our lives. It won't be an afterthought or something we do on the side. We'll have more sustainable companies, products, and even towns and cities. The vision is to develop a sustainable community with leadership coming from today's well-informed students, teachers and pre-service teachers. We hope this vision will include local food growing, as well as home gardens and new community gardens. The broader vision is long term: to support the transition of the community to a low carbon, self-managing, and steady state economy within vibrant, resilient, and sustainable communities and a 1,000-year future. This vision cannot come about unless there is a change in understanding of a stable Earth and behaviors that connects us to place. For such a transition, education from birth and schools and community gardens, have a central role to play. The encouraging thing is that students endorsed "the

community garden as a place of happiness, production, and companionship."

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

Both authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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