Fresh Water Literacies

Transdisciplinary learning for place and eco justice

Kathryn Paige, David Caldwell, Katrina Elliott, Lisa O’Keeffe, Samuel Osborne, Philip Roetman, David Lloyd, Barbara Comber, Sandra Gosnell

University of South Australia
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Transdisciplinary learning for place and eco justice

Final Project Report

June 2018

This project was funded by the Research Theme Investment Scheme (RTIS), University of South Australia

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ISBN: 978-1-922046-24-6

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1. INTRODUCTION

The Fresh Water Literacies project was funded by a grant from the University of South Australia (UniSA) Research Themes Investment Scheme (RTIS). The intent of this seed funding stream is to support the formation or development of research that spans traditional disciplinary boundaries, and builds collaborative partnerships with proven outcomes. The project also had monetary support and in-kind funding from Natural Resources Management (NRM) Murray Darling Basin and NRM Adelaide/Mt Lofty branches thanks to the networks of Professor Chris Daniels, chair of the NRM Board. The funding was used for schools to purchase resources and participate in a film that documented the project. Five primary school teachers, at three different primary schools, participated in this project. While the project originally intended to use pseudonyms for both teachers and schools, the individual teachers and their principals all requested that they and the schools were identified in this report.

The aim of the Fresh Water Literacies Project was to build on primary aged students’ understanding of the importance and finite availability of natural resources. The recognition of their personal impact on living in an overdeveloped world and their ‘unfair’ ecological footprint were also central. The project focused specifically on developing scientifically and mathematically literate citizens who have the confidence to make informed decisions and participate in a democracy. The specific natural resource we focused on was fresh water.

The key research questions were:

- What would a curriculum for the Anthropocene1 look like?
- How might primary school teachers (Year 5) explore this curriculum in practice in a range of contexts?

Why fresh water?

Access to fresh water is a basic human need. As South Australia is the driest state in the driest continent, young school students need to appreciate the preciousness of the resource, understand its properties and live their lives using it responsibly and ethically. Assisting children to understand the importance of water for the functioning of healthy ecosystems is a key goal of this research. We live within ecosystems, not outside of them. And it is from these ecosystems that we meet our material, aesthetic and spiritual needs. Three key values — quality of life, human solidarity, and ecological sensibility (Raskin, 2006)—as well as a sense of global citizenship, need to permeate educational systems in order to mould our political, social, and economic institutions towards a positive future. Education needs to prepare young people for current and future challenges. One starting point towards achieving this goal is for primary teachers and their students to become involved in interdisciplinary fresh water based environmental projects (e.g. Comber, Nixon & Reid, 2008).

Louv (2008) and Suzuki (2010) have written about the importance of connecting young children to the natural world. Their research shows that spending time in wild spaces and places develops an inherent affinity to the natural world which carries over to influencing decisions about protecting the environment and behaviour. Being able to identify freshwater macroinvertebrates, analyse water quality and understand what human behaviour contributes both positively and negatively to the natural environment are all fundamental educational

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1 The Anthropocene is the current geological age, the period in which human’s impact on the Earth is the dominant influence on the environment. It is an era in which humans will need to take far more responsibility for the wellbeing of Earth systems.
outcomes for primary school students. The critical role of technology, future scenario writing, knowledge of ecosystems and humans’ role are key aspects of an education that prepares students for the challenges of the future.

In the Fresh Water Literacies project an innovative curriculum based on an interdisciplinary framework was developed in a collaboration between literacy, mathematics and science education scholars from School of Education at UniSA, ecologists from the School of Natural Built Environment at UniSA, educational officers from the Natural Resources Management Board (NRM), the SA Department for Education and a South Australian visual artist. The interdisciplinary units of work were intended to support primary teachers to be explicit about the discipline knowledge in science, mathematics and English whilst engaging students in a sustainability curriculum with a focus on possible futures.

In this report, we use the short-hand term ‘water literacies’ to refer to the range of knowledges, skills and dispositions, to which these primary-aged students were introduced as part of their studies of the ecologies of their local environments. Through transdisciplinary cross-curriculum work, teachers developed young people’s complex understandings of the relationships between people, flora and fauna and the preciousness of water. ‘Water literacies’ was derived from a related earlier study where we coined the term ‘river literacies’ to represent children’s developing understandings, attitudes and practices with respect to the Murray-Darling Basin Region (see Special Issue of the Australian Journal of Language and Literacy, Volume 30, Number 2 and Comber, Nixon & Reid, 2007). ‘Water literacies’ includes a very broad interpretation of ‘literacy’, recognising that people relate to place, and indeed to water viscerally; indeed their knowledges are embodied (Somerville, 2013).

What is citizen science and how can it engage students?
Citizen science projects are partnerships between professional scientists and the wider community, formed to contribute to research (Dickinson & Bonney, 2012). Community members can be involved in all stages of the research process, with the most common contributions being data collection (e.g. reporting bird observations to the eBird2 project) and data analysis (e.g. classifying galaxies for the Galaxy Zoo3 project). Which community participants engage in citizen science projects depends on the project, and can include school-aged children. There is a growing understanding of the benefits of citizen science, including the benefits to scientists (i.e. research outcomes) and benefits to community participants, including learning outcomes, skills development, changes to attitudes and behaviours, and further engagement in community activities. In addition, community participants can develop a sense of ownership of projects and project results and feel valued for their contributions (Bonney et al., 2009; Haywood, Parrish, & Dolliver, 2016). These outcomes for participants give citizen science projects clear potential for engagement and education of school students. Teachers and students can engage and learn with real data (Berkowitz, 1997; Moss, Abrams, & Kull, 1998; Saunders et al., 2018), which can be highly engaging to them (Paige et al., 2010; Trautmann et al., 2012; Paige, Lloyd & Smith, 2016). The Fresh Water Literacy project introduced teachers to citizen science and engaged students in one school in some data collection activities. While the outcomes of this introduction and engagement were not directly measured, positive feedback from teachers and students echoed findings and discussions in the literature.

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2 eBird https://ebird.org/home
3 Galaxy Zoo http://zoo1.galaxyzoo.org/
2. CONCEPTUAL FRAMEWORK

Transdisciplinary approach to curriculum
The educational conceptual framework for the project features a transdisciplinary approach to curriculum. Because we wanted to go beyond the generally accepted acronyms STEM (science, technology, engineering, mathematics), or STEAM (science, technology, engineering, arts and mathematics)—which we see as only partially addressing environmental issues—we adopted the acronym METALS (mathematics, environment, technology, arts, language, science) which provides a fuller conception of transdisciplinarity. A transdisciplinary approach allows for the inclusion of current issues identified by Brandt et al. (2013, 1):

Social–ecological systems currently face multiple unprecedented challenges including, but not limited to, the degradation of ecosystems, over exploitation of natural resources, climate change, wealth inequalities, and human conflicts. These interconnected challenges are threatening the sustainable development of society.

For education, Nicolescu (1997, 1) sees the challenges identified by Brandt as ‘inevitably perpetuated and deepened by a system of education founded on the values of another century, and by a rapidly accelerating unbalance between contemporary social structures and the changes which are currently taking place in the contemporary world’. These interconnected challenges are threatening the sustainable development of society (Parris & Kates, 2003; Rockstrom et al., 2009). The emergence of a new culture capable of contributing to the elimination of the tensions menacing life on our planet will be impossible without a new type of education which takes into account all the dimensions of the human being. Panizzon and Lloyd (2017, 21) argue that:

What we do know is that regardless of the pedagogy used, the student must be at the heart of our work as teachers. Discipline content knowledge matters but … a deeper understanding of why and how our world functions holistically is of most significance if we are to nurture independent thinkers who can actually create new knowledge and apply these insights in many different ways.

It is students’ ability to innovate and ‘think outside the square’ that will be required in our future workforce, but more critically, will help protect our Earth and its resources for future generations (Paige & Lloyd, 2016; Paige, Lloyd, & Smith, 2016).

In summary, in this this project on the topic of fresh water environs we adopted a transdisciplinary approach that goes beyond subject specific areas to be inclusive of the exact sciences, humanities and the social sciences, as well as art, literature, poetry and spiritual experience. That is, we adopted an integral approach (Wilber, 2006), inclusive of all aspects of knowing, feeling and doing (cognitive, affective, spiritual, and intentional) to address, in our case, the issue of sustainability and eco justice with a particular focus on fresh water. As Seaton (2002, 9) writes:

There is growing consensus that education must extend its traditional goal of student mastery of subject-centred scholastic knowledge, to include the development of individuals who can prosper in complex and changing social, cultural and economic worlds.
For this reason, the project focused on an issue—fresh water and human and other than human communities—from both within and beyond discipline boundaries, to facilitate the possibility of new perspectives. Nicolescu (1997, 1) notes that:

As the prefix "trans" indicates, transdisciplinarity concerns that which is at once between the disciplines, across the different disciplines, and beyond all disciplines. Its goal is the understanding of the present world, of which one of the imperatives is the unity of knowledge and involves an acceptance of the unknown, the unexpected and the unforeseeable.

As Balsiger (2015, 185) points out:

despite its many advantages, teaching transdisciplinary is a costly enterprise. Transferring diverse theoretical, methodological, and practical skills may require several teaching staff; developing meaningful stakeholder interaction is time-intensive; and managing the … process demands significant efforts in logistics, coordination and in costs.

This has been the case with the Fresh Water Literacy project and it poses a major challenge for schools wishing to undertake this kind of work.

Furthermore, to quote Balsiger (2015, 185):

the development, implementation, monitoring, and evaluation of transdisciplinary learning in school settings entails participation by a wide range of external supporters. Extensive time is required to establish relations, bring on board the external supporters needed to benefit the transdisciplinary learning, and make themselves available. Finally, regardless of the school setting, efforts dedicated to managing the learning such as logistics and coordination are typically demanding.

The sound teaching of transdisciplinary learning may necessitate proficiency in a range of knowledge and skills and may require team-teaching.

**Action research and practitioner inquiry**

We used an action research (Grundy 1994; Kemmis 2008) approach in our collaboration with teachers to assist them to critically examine their pedagogical practices and their students’ learning. Green (in press, 2018) has recently revisited the Deakin University legacy of curriculum studies in Australia and explained how it was underpinned by action research and practitioner inquiry. It is this tradition of curriculum studies, drawing on critical curriculum inquiry, which underlies the present study. Teachers participated in practitioner inquiry as action research to document the various curriculum and pedagogical innovations as they were undertaken and implemented within the developed learning experiences. Our approach to co-designing and enacting a curriculum for the Anthropocene was to work alongside teachers who were prepared to experiment and critically reflect on what they had been able to accomplish and negotiate with their students, the community and in their specific institutional and geographic locations. All teacher-researchers were committed to tackling complex ecological, social and ethical questions in relation to ‘water literacies’.
3. STUDY DESIGN AND METHODS

The Fresh Water Literacies project was designed as a pilot study with potential to inform the design of a larger future study. Despite its modest size, it necessitated a high degree of collaboration between a number of stakeholders and participants and this is always a complex process.

The design phase of the project and the development of an innovative, transdisciplinary school curriculum based on water literacies, futures thinking and connection to student life worlds necessitated collaboration between university scholars and education department leaders and teachers. The project team included experienced UniSA academics with different disciplinary backgrounds from the School of Education: Kathryn Paige (science and mathematics and project leader), Barbara Comber (literacy, and research mentor), David Lloyd (science and futures); and early career academics David Caldwell (literacy), Lisa O’Keeffe (mathematics), and Sam Osborne (Indigenous education); and from the School of Natural and Built Environments, Philip Roetman (urban ecology). Chris Daniels from the School of Pharmacy and Medical Sciences, UniSA also contributed to the initial design of the project and provided invaluable connections to networks and resources in the Natural Resources Management sector. The team also involved partner investigators: Natural Resource Management Board Education Officer Julian Marchant, SA Department for Education project officer and UniSA science and maths PhD candidate Katrina Elliott, research assistant Sandra Gosnell and visual artist John Whitney. Later in the project funding was gained to involve Professor Margaret Somerville, a nationally and internationally recognised scholar in the areas of place and sustainability education. Somerville had two main roles: firstly, she provided a place conscious perspective for developing curriculum for the Anthropocene, and secondly, she supported the team to document the project outcomes with a two day data analysis workshop.

The SA Department for Education project officer initially identified schools that were located close to fresh water. Three primary schools agreed to participate in the study over the course of a year; one school was located near an urban wetland and two others were located along the River Murray. Two Year 5 teachers from each site were supported to attend six full-day professional learning days. The research team led four full-day workshops for one face-to-face day per term and designed coherent learning experiences in teachers’ classrooms between workshops. The research team and teachers travelled to each rural and city location, reinforcing the value placed on specificities of place and location.

The workshop program was an intervention designed around a well-known sequence for long-term professional learning based on teacher action research (Kemmis & McTaggart, 1988), took place between Term 4, 2016 and Term 4, 2017 and included the following phases:

- Term 4 – Introduction
- Term 1 – Provocation
- Term 2 – Redesigning curriculum and pedagogy
- Term 3 – Enacting the redesigns using action research methods
- Term 4 – Evaluation and documentation (Paige, Hattam, & Daniels, 2015).

Teachers and researchers met for a whole day once a term. This phase of the research involved teacher release time. Workshops included discussion around a critical praxis teaching framework, artists’ worldview, futures scenarios, eco justice, Indigenous perspectives, the importance of the connection to place, the value of citizen science and transdisciplinary approaches to learning (see Table 1). The teachers had access to resources both intellectual
(through the diverse research team) and monetary (which included teacher release; $1000 to purchase science resources, and further funds to purchase Indigenous children’s books. The year culminated with teachers being funded to attend and present their reflections on their learning at the state based science and mathematics teachers’ conference (SASTA/MASTA).

<table>
<thead>
<tr>
<th>Structure</th>
<th>Time</th>
<th>Tasks/foci</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provocation</td>
<td>Term 4 2016 Day 1</td>
<td>Negotiating the curriculum, Indigenous content, art of water. Critical praxis model, journals. Water literacies in the Anthropocene, NRM education, thinking about essential questions, aspect of place-based pedagogies, action research.</td>
</tr>
<tr>
<td>Implementation</td>
<td>Term 2 2017 Day 4</td>
<td>Implement in classroom/school and community (sharing outcomes), visualizing desirable futures, understanding the problem and being part of the solution. Sunship Earth, eco justice, conversations between academics and Year 5 teachers re practitioner inquiry.</td>
</tr>
</tbody>
</table>

Table 1: Outline of professional learning workshops

Based on co-developed frameworks, interdisciplinary curriculum materials titled ‘Water literacies: curriculum for the Anthropocene’ were designed, trialled and implemented. Topics included global and urban water cycles and their place in ecological systems; invasive species and fresh water quality; invisible water use; local wetlands; and water’s cultural significance. Teachers incorporated transdisciplinary practices into their pedagogy which included futures work, connections with a wide range of community groups, visits to special places, and community actions.

Teachers investigated and documented their curriculum and pedagogical innovations through a practitioner inquiry approach to professional learning. It was a collaborative process between researchers and teachers in which parts of the professional learning involved researchers leading workshops and participating in on-going conversations to clarify the focus of teachers’ action research. During follow up visits to each school by university researchers and visual artist John Whitney, teachers and researchers discussed the progress around implementing a classroom inquiry/action research project about, and acting to maintain and value, a local wetland.

The input of professional artist John Whitney was important for encouraging the integration of scientific illustration and the visual arts into the curriculum. John describes the art component of the project:

> Water is our most important element; it supports all living things, be they in the water or not. To add a different component to the overall program I was invited as an artist to
work one day at each school and attend meetings to offer a different approach to the project. With each class I decided to incorporate a certain amount of drawing techniques, confidence building and observation of natural objects and then have a different main task at each school. This meant that when teachers from different schools assembled with each other they could observe each school’s projects and in turn share that with their class.

After warm-up drawing exercises (continuous line, timed drawings and not looking at the paper), I had teachers draw several natural objects relevant to the river or wetlands. They used a variety of different drawing materials to explore the detail, texture, shape and unique features of each object. Other art exercises involved environmental sculpture, (Figure 1) sketching outside (on the banks of Lake Bonney), drawing actual birds (on loan from Nature Education Centre) and also ‘drawing with scissors’ (Figure 3). One project I did with each class was the creation of one large drawing from 30 x A4 size pages that each student coloured in, not knowing at the time what they were creating. The final piece was a large pelican. Teamwork prevailed and the project proved to be a big hit (Figure 2).

I hope the art element was able to add another aspect to students’ overall outlook towards water and the wetland environment they had been studying.

The teachers had access to resources both intellectual (through the diverse research team) and monetary (which included teacher release time; $1000 to purchase science resources, and
In summary, the success of this project relied on teachers identifying an aspect of their pedagogy they wished to improve, fine tuning an inquiry question, then through observation and different data sources, identifying outcomes and changed practice. Various data sources were used, including documentation and analysis of student reflections and experiences in coming to know and take action to defend the integrity of their local wetland. Meanwhile, university researchers documented data from professional learning days, conversations, photographs, school visits, annotated student work samples, audio-taped interviews, student comments, teacher reflections, student and teacher journals, student work samples, school celebration days and expos, and PowerPoint and video-taped conference presentations.
4. CASE STUDIES

Three schools located close to fresh water agreed to participate in the study: Barmera Primary School, Burton Primary School and Goolwa Primary School. In each school a Year 5 classroom teacher worked with students on the topic of fresh water and, in two of the three classes, a second teacher provided support.

Teachers were introduced to the notion of action research in the first professional learning workshop. At each subsequent workshop conversations were held around possible classroom inquiry-based questions and approaches that could be pursued during the project. Table 2 shows the foci of the participating schools and how their inquiry questions were narrowed with subsequent conversations. The third column lists the ways that students’ learning was communicated to the local community.

<table>
<thead>
<tr>
<th>School</th>
<th>Initial question</th>
<th>Final question</th>
<th>Communication/celebration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barmera</td>
<td>How does enhanced connection to local place impact on thinking, feeling and intention in relation to living sustainably within natural environments? How does communicating science impact on visualising futures?</td>
<td>How can we change the curriculum and children’s learning from passive participation to active participation in the management of the lake systems? How can I create a connection to the lake for my class?</td>
<td>Expo Fund my community Letters to council Letters to MP</td>
</tr>
<tr>
<td>Burton</td>
<td>How does investing in scientific literacies impact on desirable futures for our local wetlands?</td>
<td>What works to develop students as activists for the local environment wetlands?</td>
<td>Expo: 90 parents/grandparents BBQ Letters</td>
</tr>
<tr>
<td>Goolwa</td>
<td>Focus is on the virus and impact of that, the clean-up of the river, and other fish affected, impact on habitat.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Teacher inquiry questions and project communication

The case studies that follow provide some background about each school, describe the school project and teacher’s inquiry question, and provide some reflections by teachers on how the project played out in their context.

Barmera Primary School
Barmera Primary School is located 220km from Adelaide on the River Murray. It is close to Lake Bonney (Figure 4), a freshwater lake that is fed and drained by the River Murray. At this school the project explored students’ understandings of Lake Bonney as integral to their ‘place’ of residence. This case study draws on teachers’ written and transcribed accounts, student material, observations by the research team, and school documents.

The Fresh Water Literacies project was implemented by two teachers, Jarrad Kilsby (classroom teacher, Year 4/5) and Joanna Whitehead (specialist science Teacher, R-7) in 2017 and supported by School Service Office (SSO) staff throughout the project. The Year 4/5 class was made up of 26 children including five Non-English-Speaking Background (NESB), four
Aboriginal students and multiple Negotiated Education Plan (NEP) students⁴, for whom extra planning and supports are provided.

![Figure 4: Lake Bonney, Barmera](image)

**Background**

Barmera is a rural school community in the Riverland region of South Australia. The region is dependent on water that flows through the region in the Murray River system and economic participation is made up mainly of families in the fruit growing and tourist industries as well as associated small businesses. Aboriginal histories of the Murray and Mallee suggest that language and cultural diversity has been significantly impacted through interactions with colonialism. Gerard Mission relocated desert and river people and remains a focal point of the Riverland Aboriginal community. Currently, the region is culturally and linguistically diverse with sports, community organisations and events, and access to the lake and river providing a focal gathering point for the wider community.

The school had a student population of 236 students at the time of the study and was a category 2 school⁵. My School (ACARA, 2018b) data shows an Index of Community Socio-Educational Advantage (ICSEA) score of 916, somewhat lower than the national mean score of 1000. The school mission is to ‘educate, inspire and assist all children to value and respect differences and achieve their full potential’ [http://www.barmeraps.sa.edu.au/](http://www.barmeraps.sa.edu.au/). Barmera Primary School supports the values of learning, respect, and friendship and aims to provide a safe environment for students which promotes positive social skills and continuous learning. The school population includes 18% Aboriginal students, 50% of students qualify for a school card (this suggests minimal family income), 20% of students speak a language other than English (predominantly Greek), and the school has a high transience rate with over 30% student turnover per year. As well as a strong focus on literacy and numeracy the school offers instrumental music, a choir, computer education, and a volunteer-supported reading program. Of particular interest to this project, the school promotes an active environmental program

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⁴ The purpose of the NEP (Negotiated Education Plan) is to support access, participation and achievement in the mandated curriculum for students with disabilities.

⁵ The Index of Educational Disadvantage is a socio-economic index, used by the education department to allocate resources to schools to address educational disadvantage related to socio-economic status. Schools are ranked according to an overall score and then separated into 7 categories using a statistical clustering technique. Schools in category 1 serve the most socio-economically disadvantaged communities, category 7 the least disadvantaged.
including Waterwatch⁶ and Weed Warriors⁷. As a result of its environmental activities the school was added as part of the town’s 2017 submission for the state Sustainability Communities Awards, which it won in 2017.

Aim of the Barmera project
The aim of the project for Barmera teachers was to build a connection between Lake Bonney and their students, and to focus on the lake as central to place-making through a transdisciplinary pedagogy. A transdisciplinary approach to curriculum and pedagogy addresses global issues and local community concerns through exploring the epistemological, ontological and axiological contexts of the social, cultural and geographic locations of the local community. This work engages the disciplines of science, mathematics, geography, history, the arts and technology to explore aspects of ourselves and our ‘place’ as local/global citizens (Assadourian, 2017).

Science specialist Joanna explained that Lake Bonney was a significant place for students, their families and the local community, both human and non-human. As she put it, their approach to designing a topic about Lake Bonney included ‘combining science, mathematics, technology and environmental learning [in an] issues-based curriculum that is being driven by student interest’. She added that the intent of the learning was ‘connecting students to the natural world, to their place in community through the study of water’. The learning was built around a local issue—the nature and well-being of the lake (the ecology).

Classroom teacher Jarrad described the focus for the project as asking ‘the students to identify some issues involving the lake and to come up with some strategies to help minimise the impact of these problems or even solve these problems’. Joanna worked in tandem with Jarrad and provided valuable curriculum knowledge and pedagogical supports. She explained that ‘we work out what the issue is that we’re looking at during the week and I run the science in-depth knowledge base [sic] whereas Jarrad works with the children’. The teachers summarised the project aim as being ‘about how to connect kids to the natural world, their natural world, their place … to tread lightly and to think about that’.

The inquiry-based questions the teachers wanted students to engage with were:
- How are we tied to the lake?
- What do we use it for?
- How has the lake been used in the past?
- How has it changed?
- How will it change?
- How will we change it?

Data collection
Jarrad and Joanna used a variety of ways to collect data for evaluation purposes. These included documenting students’ prior knowledge of the lake, recording conversations with students, documenting students’ futures scenarios and expo presentations, and collating feedback surveys.

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⁶ Waterwatch [http://www.waterwatch.org.au/]
What students did
On Monday mornings students were taken by bus to Lake Bonney to undertake their study. They took an active role in the fresh water topic as evidenced by teachers’ recorded conversations and written reports:

- In pairs or threes, students chose their own environmental subject and presented and managed activities at a public environmental expo which included thoughts on the future of the lake and actions they believed needed to be taken to look after the lake.
- Students discussed shared interests: ‘the kids actually talked to each other about shared interests’.
- Learned through interaction with the lake environment about, for example, geological processes such as erosion, the natural history of the lake and its value for humans and other species (see Figure 5).
- Asked questions such as: How has the lake been used in the past? How has it changed? How is it going to change? Who are going to be the change agents?
- Letter writing and invitations to the local council and thank you letters to presenters at the expo. Also writing grant applications.
- Took responsibility for the outdoor education centre and revitalising it for use by the community.
- After a visit by a professional artist, students made their own artistic representations.

What teachers did and connections to curriculum
A transdisciplinary place-based learning approach was seen by teachers as essential for this topic. As they explained, ‘connection creates meaning, meaning creates engagement, and engagement creates a disposition for learning—that’s where your kids are going to learn, you need them to connect’. Table 3 illustrates the curriculum framework used to manage the learning.
<table>
<thead>
<tr>
<th>Curriculum Area</th>
<th>Content</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td>Tidy Towns and other environmental projects</td>
<td>With the help of the NRM we learned about the various challenges in looking after the lake such as controlling the introduced carp fish and ensuring the health of native fish. We were winners in the National Environmental Awards with tidiest towns because of environmental education, this was showcased along with the expo and other environmental programs we have at school. We gained support from the council for students to take responsibility for, and revitalise the outdoor education centre, so it can be used with community.</td>
</tr>
<tr>
<td>Art</td>
<td>Artistic representations of the lake including landscapes and animals.</td>
<td>Jarrad did a lot of work with the artist and some amazing artistic presentations resulted. John Whitney (artist) came and worked with the kids, and one of the works that they produced, was the pelicans.</td>
</tr>
<tr>
<td>Literacy</td>
<td>Writing about the lake – what it contains and the ecology, its value, needs and importance. How it is important to the ecology? Correspondence letters.</td>
<td>Our writing was writing with a purpose: it was writing to the council, writing thank you letters, invitations, requests, grant applications. Jarrad: ‘And that’s just really spurred on the kids with the outdoor classroom, like just doing the art, going down, and wanting to go down and do more environmental sculpture’. Students become authors and illustrators.</td>
</tr>
<tr>
<td>Numeracy/mathematics</td>
<td>Measuring water volume, distances, areas</td>
<td>Numeracy skills were based around the water, the lake—volume, distance, mass, etc.</td>
</tr>
<tr>
<td>Science</td>
<td>Measuring water quality (acidity, temperature, salinity, clarity). Flora &amp; fauna of the lake. Ecosystems. Erosion and its control</td>
<td>Scientific inquiry skills: ‘I’d take the kids once a week for a very specific science lesson, if it was on water quality, on erosion, living things’.</td>
</tr>
<tr>
<td>History</td>
<td>History: local and ANZAC day.</td>
<td>We were very lucky with our history because our teacher librarian, who grew up in Barmera, was able to give us those stories from when she was little, what she had seen over the years, and she could tell them from a personal level rather than from a book. Our history lessons took place in places that were appropriate, and the kids listened, the kids were engaged, and it was a lot more solid talking about Anzac Day down at the memorial, and it wasn’t the classroom (Figure 6).</td>
</tr>
<tr>
<td>Geography</td>
<td>Geography of place–Lake Bonney</td>
<td>Fantastic way to do geography when you're actually down there … direction, space, distance … which all relates to your maths and numeracy as well.</td>
</tr>
<tr>
<td>Engineering</td>
<td>Managing erosion</td>
<td>I never realised how important erosion was going to become to these kids until we looked at all the photos that they took—they were becoming passionate about this issue.</td>
</tr>
<tr>
<td>Futures studies</td>
<td>The future of Lake Bonney</td>
<td>The children were involved in future scenarios, looking at what they wanted, what they thought was possible. They also threw the question at other people in the community that worked with us: ‘Now what do you think, what's your aim, what's your view for the future, what would you like to see?’</td>
</tr>
</tbody>
</table>
Civics | Connecting to community | The council came on board and they were absolutely wonderful. We took the kids down to the old environmental centre which has been neglected over the last I don’t know how many years, and picked up bags and bags of rubbish in an hour session; Presentations at the expo: Students worked in pairs or three and chose their own subjects e.g. weeds, rubbish around the lake, foxes, water quality, why we need trees, erosion, Murray Cod. Engagement: the kids were totally engaged in what they were doing They wrote to the council; they took responsibility and took action in the community. They loved it and they wanted to get back to the education centre, they wanted to take control, they wanted to do the work.

Table 3: Transdisciplinary curriculum framework at Barmera

| Pedagogy |
The content of learning at Barmera was based on student questions about Lake Bonney. Joanna and Jarrad assisted students to explore these questions through a number of disciplines including science, mathematics and history (see Table 3). Joanna described this approach as ‘the antithesis of high stakes testing, it’s around an issue, it’s around transdisciplinary learning’. They also saw that the ideal place to do the learning was at the lake because this allowed the elements of space and place to inform the learning. Joanna explained that ‘Jarrad and I were thinking of moving our classroom down to the lake next term (figuratively as well as practically where we can)’. While a complete relocation was not possible, they were able to work regularly at the lake (Figure 7):

…every Monday morning at 9:10 we threw all the kids on a bus, well they basically raced to the bus, and we took the kids down to the lake. We had two hours down there and that’s where we conducted our start of the week.

Joanna identified the essence of her philosophy about learning:

Throughout the year-long learning experience, I used a collaborative approach to learning. I introduced the concept that scientists don’t work alone, they usually work in teams, so they can share ideas and bounce developing ideas off each other.

Joanna and Jarrad co-managed the teaching and learning and they considered this collaborative, team-teaching approach was essential for such a diverse and active project. Joanna said:

You’ve got to work with someone else, I can't say that strongly enough —I couldn’t have done it on my own, Jarrad wasn’t able to do it on his own. We’ve actually managed to get the project through because we had each other, and you need that supportive network.
Beyond the teaching team, widening the sphere of teaching expertise and learning opportunities was identified as another vital key. Joanna said:

Bring in the experts; the experts know more than we do. Even if they don’t, the kids think they do, and anybody that wears a hard hat and an orange vest obviously knows more about machines than I do.

Connecting to Lake Bonney learning was understood as being a collaborative exercise managed not only by the teachers but also supported by many others. For example, the resource and environment teacher who had lived in the area for a long time was an extremely valuable support person who provided information about Barmera and Lake Bonney, as were other community members.

...can I acknowledge Glenys, who’s our teacher librarian, living legend, environmental guru and everything else, and my wonderful team from UniSA. Couldn’t do without Bruce and Helen, community members that came in through one of the kids, and said ‘Can we help? You can come to our property. We’ll take you down there. We’ll show you around. We’ll show you the turtles’. Our reply? ‘Sure, sounds good to us’. The council’s been fantastic. Parents and community members – I think we had 50% parent [involvement]... on our fishing trip, which was pretty awesome to us, so thank you to everybody that’s helped, definitely well worth it.

The Lake Bonney learning project was further celebrated and shared at the Barmera Primary School environmental expo (Figure 8), an event that has been running for 10 years. Joanna explained:

...normally it's the older classes involved but this year we added the Year 4/5 class as well, where all the students presented at the expo. It's a kids teaching kids philosophy (if you’ve ever worked where the kids actually present to a whole lot of other kids). We have children from right across the Riverland, from Morgan to Renmark coming to the school to be involved in the sessions, where the kids will give a talk, they will run the activities, and everything is done by them. Great session for us because we will wander around [and listen].
Teacher reflections about impact of the project
Joanna and Jarrad reflected on why the topic of fresh water had appealed to students:

… within the curriculum, what did we do that was different to anything else? Sometimes I wonder did we do anything different or was this just normal? But everything was based in real life with this project; it was real to the kids, so that was really important. They were real world problems and the kids along the way discovered that these problems actually affected them. We also helped them develop those connections within the real world, they weren’t make believe, there were real people out there that actually cared about the lake, cared about them, and they could work together. Why did we do this? Because it’s real life and it’s the real world, and that’s what actually engaged the kids.

Looking at Lake Bonney from multiple perspectives—science, literature, history, geography, mathematics, art—enhanced the learning by giving meaning to each of the areas of learning and enabling students to form a comprehensive understanding of and connection to this place. The collaborative learning with shared goals approach, in which students worked in small groups, contributed to the cohesiveness of the classroom, personal communication skills, shared responsibility and learning that was owned by the students.

Teachers also agreed that selecting a local place to study not only contributed significantly to students’ learning but also to their connection to, and responsibility for, their community. Students were able to actively communicate with the wider community through presentations and displays and with local and state government through direct contact and by way of letters.

At the end of the topic students were asked to complete a feedback survey and teachers summarised their responses as follows:

Our evidence? Their skills increased, their inquiry skills were there, they took responsibility for this outdoor education centre. We saw improvement in reading; I saw amazing changes in science and of their ability in numeracy. Teamwork – kids would actually come to school on Mondays, which was really good. I added all these photos because there was one kid who does not read, would not read [when you] give him something to read in the classroom, however the whole class was there waiting because he had to read every historical sign there was along the shore line—it was amazing …. They talked about distance, they talked about history with flood levels. It meant something to them. What did we learn? Our students learn best when they’re actually connected, they were connected to the lake, and that’s what the main thing was, that I think that we’ve learnt all along, it’s about connection. If it means something it’s worth something to the kids.

In summary, Joanna and Jarrad made the following reflections:
• Our students learn best when they are connected to the topic being studied.
• If it means something, it is worth something to the kids.
• The various curriculum areas are all connected. Connection creates meaning, meaning creates engagement and engagement creates a disposition for learning.
• With an integral approach to learning, everything flowed together. The science was connected to the English, the geography was connected to the maths, the technology was connected to the art, etc.
• We will always seek to work with other teachers, develop a supportive network, bring in experts and complete a topic with a celebration.
• A team is what is needed to support each other through the hard mornings when we don’t want to stretch ourselves.
• Experts know so much more than classroom teachers.
• If you can tell stories about what things were like 50 years ago—then you know more than we did.
• Increased students’ inquiry skills and skills in interpretation, understanding, inquiry, research.

This led teachers to make the following recommendations for similar projects in the future:
• Always work with another teacher.
• Have a supportive network.
• Bring in experts.
• Have an endpoint and celebration.

**Significant Outcomes**
Perhaps the most significant outcome of the Lake Bonney study by Year4/5 was the shift from taking the lake for granted, as ‘just a place in our area’ to being able to ask and investigate their own questions, developing a deeper understanding of, and affinity with, the lake. Joanna explained that students:

> … had a lot of prior knowledge about birds around the lake but it was difficult actually getting a lot of questions from them initially. They were keen to share their knowledge but that was it. They didn’t know where to go [from there].

This was overcome by taking the students for a walk along the edge of the lake with Glenys, the librarian and local historian, who was able to give the historical background of the lake and explain why it looked the way that it did at that time. Joanna explained that this:

> …kind of sparked the children’s interest [and] that’s when we started seeing the kids asking the questions and wanting to know why and how: Why are the trees dead? Why is the water so murky? Why is it salty? How does that affect the plants? Why did it dry out? What do you mean this was an electricity station? Why has it changed? What happened to the jetty?

**Acknowledgements**
• Glenys Matthews, teacher librarian, environmental activist and leader in the community, living local legend.
• UniSA researchers who supported us as learners, and kept our focus.
• Bruce and Helen Richter, community members who invited us to their property when they heard about the project, ran activities for the kids, were able to engage the kids in environmental, cultural, recreational and futures learning.
• Berri-Barmera Council, whose response and support for the kids and the town and the project has been amazing.
• Parents: when we took the kids fishing on the coldest and windiest day of the year, the parents were there with their kids and supporting us as teachers.
• Community members: being down at the lake made the class very public and caused a lot of interest from the community members as they enjoyed their walk along the lake.
majority of them would stop and ask questions about what the kids were doing, what they were learning and then often would take time to talk the kids.

**Burton Primary School**
Burton Primary School is located in the northern suburbs of Adelaide near a wetland called Springbank Waters Wetland Reserve. At this school the project focussed on children’s connection to this wetland. This report on the project has been constructed from written and transcribed accounts from two teachers, Bernadette Haggerty (classroom Year 4/5 teacher) and Marj Francis (a volunteer teacher); student material; observations by researchers; and school documents.

**Background**
A category 4 school, Burton Primary School has enrolments of over 470 students, many with complex learning needs. Up to 40% of students are on school card and 25% of students are from an English as an Additional Language or Dialect (EALD), making up 15 different nationalities. The primary school has an onsite preschool that caters for students from birth to five years. The school is very community minded and parents are encouraged to take an interest in their children’s learning.

Bernadette’s Year 4/5 class consisted of 28 students: 17 in Year 4, and 11 in Year 5; 17 girls and 11 boys. Marj Francis had been a close colleague of Bernadette’s in 2016. When a 2017 contract for Marj did not eventuate, having been introduced to the project the previous year, Marj decided to participate voluntarily for one day a week. Every Tuesday for a school year the teachers and students dedicated time to the water literacy project. Having an extra teacher in the class was an added bonus that enabled creative and adventurous planning. Bernadette was allocated 45 minutes per fortnight to take the students for a walk around the wetlands. SSO Cath, who was often in the class to provide support, could see how powerful this learning was. Cath therefore volunteered 135 mins per fortnight so that the class could attend the wetlands weekly for a double lesson of 90 mins. Cath was enthusiastic about the topic; she shared her knowledge with the students and encouraged them to fossick and discover.

**The study site**
The close proximity of Springbank Waters Wetland Reserve to the school meant that students had ready access to it. Visits to the wetlands on Tuesdays were usually completed in a double lesson period, however sometimes a second session was included to ensure adequate time to address a particular focus area. The class decided to use three different locations around the reserve area to collect data. Groups were organised in three teams of three students, with one group at each location. These became known as the deck, bridge and waterfall groups, with names indicating the locations where testing was done. For some of the time there was a third adult in attendance, as Bernadette mentored two pre-service teachers over the year. Because the bridge and waterfall areas were close together, Bernadette was able to oversee both areas when a third person was not available.
**Aim of the Burton project**

The aim of the Fresh Water Literacies project for the Burton teachers was to connect students with real life issues surrounding fresh water and nature in their community using:

- A student-centred learning approach to drive the inquiry and develop engagement in the learning.
- Citizen science projects focusing on the local wetland environment to provide authentic contexts.
- Expert specialists from the community and UniSA to provide scope for deeper knowledge and skills acquisition.

The teachers summarised the project aim as being focused on connecting students to their local wetlands to develop:

1. an appreciation and better understanding of the interconnectedness of nature to themselves, including thinking about the future.
2. an understanding of their role in managing local environments as citizens.
3. an understanding of how science is related to our lives and can help us to respond to issues surrounding the management of fresh water through citizen scientist projects.

In addition to the visiting artist, a key resource throughout this project was National Resources Management (NRM) Education. Project officers visited the class regularly and the students were involved in the identification of macro invertebrates, water quality testing, bird monitoring, rubbish collection, the Feather Map project\(^8\) and the Bowerbird project.

**Data collection**

Bernadette and Marj used a variety of ways to collect data for evaluation purposes and this included prior knowledge questions, student engagement activities that connected to the topic fresh water, student directed learning examples, community experts, student work stations at the culminating evening expo, and presentation of brochures to the community and customers at a local shopping centre.

**Pedagogy**

The teaching approach used by Bernadette and Marj was planned collaboratively and can be described as transdisciplinary. In relation to the wetlands topic, teachers were explicit within a range of disciplines: literacy, citizen science, mathematics, humanities and social sciences (HaSS), and futures as discussed in the previous section. It was an effective model but one that was well resourced with an extra teacher who was passionate about science and volunteered a day a week throughout the year.

An effective approach to recording students’ ideas and thoughts around the learning was the use of a reflective writing process. During Term 1 and Term 2, students completed regular reflections in their STEAM workbooks, and sometimes their science journals. In Term 3 the learning journal was introduced to provide a place for these reflections to be more easily accessed by students and the teachers. A format/ guide was also provided to scaffold students’ writing/ reflections. This was part of the focus by Bernadette to develop skills in reflecting on the learning journey. It helped demonstrate what was understood about tasks and goal setting and helped students recognise that mistakes help us question/ learn more about topics across

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\(^8\) Feather Map is a citizen science project about collecting wetland bird feathers found on the ground or in the water to help researchers create the first ever Feather Map of Australia. It is managed jointly by ANSTO, Centre for Ecosystem Science and University of New South Wales, Australia [https://feathermap.ansto.gov.au/](https://feathermap.ansto.gov.au/)
the curriculum including topics outside of the project. The shift to recognising themselves as drivers of their own learning, developing positive attitudes to making mistakes as part of the learning journey, and developing an ability to recognise learning goals helped students to become independent learners. Students’ reflections about the project work were sometimes written in a recount format, and often included their challenges in efforts to work collaboratively, and this developed as a safe communication area. This approach also allowed Bernadette to respond and provide feedback to questions or concerns in writing or to ask to talk with students if required.

Bernadette created a letter as a stimulus for a persuasive writing task based on the experiences of the wetlands and futures thinking about the wetlands. The letter was written as if it were from the local council, and written in full view of the students (it was displayed on the whiteboard as she worked on it) who were completing a different task. After the class had completed their work she read the letter out to them, stopping to ‘fix’ spelling mistakes as she went along. The letter was written in child-friendly terms and used a persuasive writing approach to suggest reasons why the wetlands needed to be filled in and housing built in its place. Reasons included many things that the students had been learning about or researching in the project such as:

- Low levels of macroinvertebrates because of pollution levels (a concern that many students expressed before they realised that macroinvertebrates breed seasonally) causing a shortage of macroinvertebrates that was hard to replace by the council.
- People slipping on duck poo because ducks were continuing to be fed bread which upset their stomachs and caused them to produce excessive waste.
- High levels of rubbish continuing to be washed into the wetlands stormwater catchment nets showing that people in the community were not caring properly for the wetlands and this was costly for the council to manage.

Once Bernadette had finished reading out the letter students sat mute, completely shocked for a prolonged period, ignoring the dismissal bell and quietly processing the ‘bad news’. Finally, one student exclaimed: ‘We should protest!’ All the other students agreed and exclaimed that they too would protest. It took some time to calm the students and reassure them that the letter was not real and filling in the wetlands would not happen. The students insisted that they should write letters anyway to explain why the wetlands were so important and should be kept. This demonstrated how invested in and protective of the wetlands the students had become. They had become proficient in their understanding of the processes of local and state government and their own role and responsibilities to their community. They had developed confidence as citizen scientists to respond to the threat of their beloved wetlands with a wide range of knowledge about the biodiversity of the wetlands and the issues of stormwater pollution, and through their own research about birds and the weekly monitoring of the water quality, macroinvertebrates and birds that were using the wetlands. They had been collecting and disposing of rubbish in their monitoring of the litter around the wetlands, and developed understandings and viewpoints about how to lower the impact of pollution in the wetlands. The response letters written by students showed that they had become great communicators, well able to use their knowledge to protect their ‘place’, and they were able to articulate how its loss would affect them as they struggled to imagine their community without a wetlands.
What students did
Burton teachers provided scope for students to explore their own questions relating to water through:

- Experiments that students chose to explore ideas about water.
- Observation walks to the wetlands.
- Providing access to internet and books.
- Lessons to explore ideas and develop scientific method and skills to equip the students with research and observation skills.
- Posing the project questions.
- Establishing the wetland context geographically/historically.
- Citizen science projects.
- Introducing mind-mapping as a shared reflection and planning tool
- Posing and sharing challenges from teachers, between schools and from students.
- Further question and reflection activities.
- Mini lessons/explicit teaching of skills related to the projects as required.

Students became quite quick at the NRM water quality testing processes, bird count and rubbish count/collection. They also collected feathers for the Feather Map Project and each group had an iPad to take photos that might be uploaded onto the Bowerbird site. Students were provided with an art book. This was used as their science journal in which they recorded data. They were also encouraged to make annotated/labelled observational drawings of interesting sightings, or things which they wanted to know more about or which made them question what they knew. Some students made videos to document their observations and questions.

Thursday visits occurred once a fortnight in the form of a well-being walk. These visits came about due to student reflections about the wetlands and, in particular, their interest in seeing the other side of the wetlands at the reserve. Many students asked for a chance to explore the wetlands walkway that circled the wetland at the reserve. Students were able to explore and compare areas of the wetlands environment and animals and create maps, and many researched questions of their own without prompting. This highlighted to teachers and students how much confidence as researchers and citizen scientists the students had gained. Students presented their findings and information to the class randomly as time allowed.

To conclude the water literacy topic the class had an expo. Groups of students set up stations in the hall and over 80 parents and grandparents attended to engage with the learning. It started with a sausage sizzle (this was free as the money was raised by selling duck food) and finished with an evening walk around the wetlands.

What teachers did and connections to curriculum
This section describes the curriculum framework used to manage the learning at Burton Primary School. Under curriculum area headings, it includes details about the content, teaching and learning activities and samples of student work.

Art
Artist John Whitney provided a day-long workshop at the beginning of Term 2 to teach observational/scientific drawing techniques. He introduced warm-up activities and sketching with pencils, sharpies, graphite and bamboo reed ink pens. Students were encouraged to draw what they observed, not what the brain thought it looked like (Figure 9). Other skills focused on were shading, pattern-making and learning to detail small areas of larger objects, including preserved wetland birds from the Nature Education Centre. This workshop was extremely
useful and beneficial to the students. Drawing and sketching became more purposeful and improved over the year. Students each had an art book called the science journal in which they recorded weekly drawings and data collected for the citizen science projects.

![Figure 9: Line art](image)

John set two challenges:

1) a bird puzzle challenge to shade in and put together a pelican and a magpie.
2) an exotic bird challenge to create a bird, its call and how its features helped it survive in its habitat; its habitat, breeding and feeding, and prey and/or predators (Figure 10).

Students created 3D models of their birds and presented these to each other and at the expo. They challenged each other to find interesting world birds and extinct birds and presented these as posters to each other and later at the expo.

![Figure 10: Exotic bird challenge](image)

Students were challenged to create line art using photographs of their own wetlands and cut these photos to create interesting effects. Bernadette taught students how to use watercolours to paint wetland landscapes and pelicans. Students used these watercolour painting skills to illustrate their citizen scientist journey book at the end of the year (Figure 11 shows the painting selected as the cover of the book).
Literacy
The content of the literacy curriculum included both receptive and expressive literacy skills. While reading and writing texts were important skills developed over the year, equally important was the development of other means to communicate learning through receptive and expressive contexts.

Receptive literacy skills were developed in collaborative groups and class discussions. These focused on active listening skills in relation to body language and spoken language, critical thinking, and respectful and productive interactions. Examples of researching and reading skills developed were comparing, questioning observations, sourcing and understanding information, note-taking, reading fluency, and developing thoughtful questions.

Students developed important skills required for learning from both the wetlands and each other in collaborative learning/working contexts. This occurred through ‘reading and responding to’ the wetlands environment and participating actively in group discussions; listening, note-taking, and responding with respect to others’ viewpoints and information. The ability to work collaboratively was enhanced by the many opportunities to talk about ideas, interests, questions and outcomes/goals. Developing research skills was important to many students as they realised how confident they became as learners. Many described how proud they were of their reading and research skills.

Expressive literacy skills were developed through the production of recounts, information texts, explanations, narratives (see Futures section), poetry and persuasive arguments (see Outcomes section). Also important were the processes of interviewing, using digital and computer software/hardware to represent information and ideas in PowerPoints, posters, brochures and the creation of books/user manuals/information books, 3D models, photography, and videos. Importantly students became very skilled at responding appropriately to each other during discussions, when moving into groups and working together. They learned to respect and use each other’s skills to become effective and collaborative learners and this created a supportive, productive, safe and happy learning environment.

Numeracy/mathematics
Numeracy and mathematics content included data collection, graphing and analysing data. Students participated in Feather Map work which involved data collection. They also undertook
scaled measurements, and developed skills in estimating and measuring with informal units, financial mathematics, and fractions.

Skill development was based around problem solving and recording accurately. This included learning how to read scaled measuring instruments (e.g. thermometer), developing an understanding of accurately communicating information when graphing and analysing data using the NRM scales, and seeking explanations and solutions for data findings. When graphing and analysing data a gap in understanding was highlighted when using decimals in recording salinity data. This resulted in some explicit teaching about decimals as fractions of a whole unit, and how to record the data that was collected. This made a significant change to the data findings, and taught the students the importance of questioning and checking the data.

Reading and using maps to find information and looking at google maps created a better understanding of the scale and location of spaces being used in relation to other areas in the community and wider world.

An opportunity to link financial maths with the project came about when research about the wetlands birds revealed that ducks were in danger of developing an illness called Angel Wings, caused by being fed bread by well-meaning people. This led to concern and a keen interest in communicating this knowledge to the community. Students decided to create duck pellet bags. They worked out the cost of the bags and measured and weighed duck pellets to sell for the expo at which they also explained the importance of not feeding ducks bread.

Students also created a brochure that was distributed at a shopping centre presentation. Students had to consider the design and layout of their brochures, including how it was to be folded (in thirds), and how information could be represented visually and effectively. One brochure included a map of the area.

**Citizen science**
The content of this curriculum area included NRM data collection, water quality testing, bird monitoring, rubbish collection, and participating in the Feather Map (Figure 12) and Bowerbird projects described earlier.

The decision to use citizen science was made in order to provide authentic contexts for students’ learning about the wetlands (Figure 13). Bernadette and Marj presented several
opportunities for involvement in citizen science projects and used those that students voted for, due to their interest in the projects themselves. These opportunities provided purposeful engagement for the students who were proud of being able to contribute to real scientific work being done across Australia. They came to view themselves as ‘real’ scientists through their involvement in the projects and this kept the interest high and maintained commitment to the project. In particular, participation in real data collection and connection to scientists were seen as integral and engaging components of the project. The connection with scientists included a meeting between scientists and teachers (to introduce the concept of citizen science) and scientists visiting one classroom at Burton to work with students. Challenges included difficulties with uploading information onto the Bowerbird and NRM sites.

Figure13: Citizen science

Resource based learning

Students participated in resource based learning (RBL) when they researched one wetland bird and created a PowerPoint about it to present to the class. After these were shared, one student pointed out that: ‘Now we know something about every bird that makes a home in the wetlands’.

Resource based learning was part of the literacy focus of the school and an RBL teacher worked with classrooms for two terms each year to support development of these skills. Bernadette requested that in RBL time students be allowed to research about the wetland birds they had become so interested in during Term 2. In Term 3 they were involved in a different RBL focus that was not related to the fresh water project. Nonetheless, students had become very interested in/ proud of their skills in researching for a purpose related to the project. This led to individual students researching according to their own interests about the wetlands and its biodiversity and setting challenges for each other such as world birds and extinct birds to research during school holidays. Their findings were presented to each other in class and at the expo.

History and social sciences (HaSS)

Curriculum content in this area included geography and history. Bernadette shared her knowledge of the Burton area based on her personal history of having lived in that area. Marj used google earth and maps to help students to develop their ideas about the scale and place of the wetlands reserve in the community and she tied this to the world through an investigation into fresh water across the world. At the beginning of Term 2 NRM project officer Julian Marchant came out to talk with students about this topic. He noted that only 3% of all the world’s water is drinkable and introduced the importance of caring for fresh water resources.
He explained the links with storm water and showed students how to use water quality testing equipment.

Philip Roetman from UniSA also visited at the start of Term 2 and provided information about the geography and history of land development in Adelaide and, in particular, the Burton area. He talked to students about the development of the Northern Connector Expressway that is being built currently and discussed its potential impact on birds in the Barker Inlet area. Discussion was started about a possible investigation into this topic and how the Springbank Wetlands might be affected. Philip also introduced the Bowerbird project and students were shown how to improve their photography to make sure their photographs would allow for good identification of species.

Students visited the Adelaide Zoo, focusing on the Australian aviary and other birds such as pelicans. This provided a close-up view of many wetlands birds. The Botanic Gardens wetland provided important background information about man-made wetlands, and how wetlands work to clean/store the storm water collected there. This provided an important comparison model for the Springbank wetlands with many students questioning the design of their wetlands and considering how it might be improved. It would have been good to have had more time to investigate this further.

Futures studies
Burton teachers used two strategies to elicit student images of possible futures for their wetland: production of an illustrated narrative/story of the wetland in 30 years’ time and a persuasive text stimulus futures scenario created by the teacher.

Bernadette, a resident of the area twenty years previously, indicated that she could not herself imagine that a wetland was possible, yet one was now established. She encouraged the students to imagine how the wetland could look in 30 years and to write and draw what they envisaged. She reflected:

We brainstormed what the wetlands could look like in 30 years. This included things like flying cars, robot rubbish collectors, Pokémon hideouts and automated ‘just about everything.’ This is more of a reflection of the cartoons they watch on Netflix.

Students could write as themselves, a fictitious person, or as an animal that lived at the wetlands. Stories ranged in their contexts with some students projecting themselves to be educators, scientists or aged versions of themselves, and some used animals to tell their stories, such as a duck that took people on a tour of the new improved wetlands and could talk because technology made it possible to fit a translator to animals so they could be understood by humans.

Students were asked to reflect on their learning near the end of Term 3 and to note any concerns and hopes they held for the future of the wetlands. Most students reflected that staying involved with the area would be the most helpful, including visiting frequently, bringing their families and trying to improve the wetlands with more trees and plants to encourage more bird and animal life. Many were fearful that the wetlands lands would be used for other purposes like farming, housing or businesses.

Marj had conversations with students who wanted to build a bridge across the wetlands so they could see ‘everything’ and many said they would love to build treehouse bird watching
platforms so they could see more. This was a common theme in many of the students’ drawings. Some students decided that the wetlands would need to be protected and made into a zoo so people could visit and it could also be preserved.

Mind maps (Figure 14) became a tool used by the students as well as teachers to quickly communicate ideas and reflect on their learning.

![Figure 14: Mind map](image)

**Science**
Science content was central to this project based on the study of fresh water wetlands. Students were involved in the scientific testing of water (Figure 15); the identification of birds based on features and adaptations; and a study of macroinvertebrates—their features and adaptation, and how they function as bio-indicators of pollution.

![Figure 15: Testing water quality](image)

Water concepts developed included those about evaporation cycle, salinity, movement of water across land, technology and supply for water, scientific testing and investigations (Figure 16). Activities to develop these ideas included student driven investigations on evaporation cycle, salinity, water movement, audits and observation walks around the school and wetlands to look at gutters, storm water drains and potential pollution issues.
Activities included introduction of observational drawing, bird counts, using ID charts, books, the internet, and Nature Education Centre preserved birds. The focus was on bird features and how these helped them to live and survive in their habitat. Students identified birds that seemed to prefer/inhabit certain areas of the wetlands and this led to further student-driven questions and investigations.

**Design technology**

Design technology activities included photography on iPads, uploading photos on to Bowerbird, producing PowerPoints, impromptu videoing, and using web search engines to research information. Time was a large factor in being able to develop these skills.

Students became highly competent at using digital technology to support and communicate their learning in PowerPoints. Bowerbird was difficult to use and access as effectively as we had hoped due to issues re uploading from school computers and difficulty in keeping student work on iPads shared by other classes. It was also difficult to access the NRM site to upload reports, largely due to a time factor in organising data. A suggestion for the future is to provide time for students to use data in computer generated programs to communicate their findings.

Students also used a range of skills to create models depicting their ideas about birds and other questions arising from Genius Hour projects, class challenges and the STEM Premiers Reading Challenge activities.

As a summative task the students created five brochures to hand out to shoppers at the local shopping centre about areas that they felt highlighted the wetland’s importance and its issues. These were three guides to the wetlands and two guides to address issues found at the wetlands:

1) a visitor’s guide to the wetlands.
2) a field guide to macroinvertebrates at the wetlands.
3) a field guide to birds found at the wetlands.
4) a guide to cleaning gutters and keeping storm water drains clear.
5) *Don’t feed the ducks bread*: a brochure to highlight the issues facing birds fed too much bread (Figure 17).

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9 Genius Hour http://www.geniushour.com/
**Student evaluation**

Students’ reflections on the project included their wonder about the wetlands, their questions, and importantly, their pride in being able to ‘do science’, work like ‘real scientists’, and be citizen scientists. They recognised that not only were they becoming experts in the wetlands, but the entire year had been a learning journey, with one boy writing in his reflection on the shopping centre presentation that ‘I told [shoppers] in one minute what took me a whole year to learn’.

During Term 1 in 2018 when interviewed by the NRM filming team, a student explained how the project had made him a better learner. He said:

> The difference in doing work for the project was that usually when a teacher just gives you work to do, you do it to get it done, and you can do really good work, but working on the project was better because you are doing work that you really want to do, because it’s interesting, and you get to really do the work you’re talking about. So the work you do is your best work because you’re proud of the work you’re doing.

Teacher Marj commented that:

> I think that this shows how much students respected this project and the student driven approach. It helped them to cross the line where they recognised that their own ideas for learning were valuable.

In summary, the teachers noted that when taking a student-led approach to learning with a transdisciplinary focus the teacher becomes a facilitator of the learning, as well as a co-learner. This can be viewed as being a lot more work for the teacher, and it demands a lot of honesty in recognising that you will sometimes be learning alongside your students. As Marj explained, the learning journal was introduced to help teachers manage the situation.

> This was due to me being bombarded every morning with their ideas and learning requests. I asked them to write their ideas down. I would read them and then introduce the topic with: 'Panayioti wrote in his journal that he wants to write a play......' And the new learning was born.
That is, the learning journal not only allowed students to reflect on their learning, but also to share their ideas and problems with the teacher and their peers.

Teachers noted the importance of being clear about the learning aims, outcomes and learning processes for each area and being ready to use students’ ideas for learning as springboards towards the Australian Curriculum (ACARA, 2018a) learning goals and achievements that can be developed from those learning experiences. Teachers also have to be aware of the alternative (mis)conceptions that students can hold about a topic and be ready to conduct mini-lessons, or to follow up with explicit teaching about aspects of the learning as the need arises.

An example of this was in the data collection and graphing when it became apparent that students were not recognising the decimal point. This affected the ways in which salinity was being recorded and graphed/ and caused confusion with the analysis of the data. Explicit teaching about the correct way to read the salinity meter and accurate recording and graphing techniques was required. This helped students to understand the importance of accuracy in data and that data told a story about what was happening in the wetlands.

In summary, Bernadette and Marj noted the successful aspects of their approach:
- Group work skills/ relationship building/ valuing each other’s knowledge.
- Continual questioning.
- Private research and sharing it/ challenging each other.
- Learning to participate in discussions.
- Reflection journal.
- Student research skills/ RBL/ Genius Hour
- Expo and presentations/ displays.

Many aspects of the wetlands study topic connected to Burton Primary School’s learning priorities of literacy, numeracy and science and technology and a focus on developing powerful learners through implementing quality teaching and learning practices. Marj and Bernadette agreed that the strength and impact of the classroom research around water literacies involved:
- Sharing and borrowing ideas among colleagues and experts.
- Challenging your own teacher practice and methods.
- Building knowledge and confidence.
- Building a network of experts.
- Covering the curriculum and more!
- Improved grades.
- Feelings of satisfaction.

Finally, Burton Primary School teachers made commitments to continue successful elements of the project. For example, as a result of an audit of the school with Dan French of French Enviro, the school made a commitment to become more eco friendly. The school is looking at ways in which to harvest water and save through solar or other green means to power the school. Bernadette’s class was involved in auditing the water use for the school but also conducted an audit of the storm water drains, grey water and sewer drains in response to students’ interest and concern about water and where it ends up, in particular the stormwater pollution in the wetlands. The audit provided scope to teach about data and graphing and for students to become analysts of data for action and purpose.

In another development, the school was offered a plant voucher to create natural gardens. Bernadette’s class had input into the type of butterfly garden that could be created and this was
completed by the end of the year. Burton also volunteered to host the next Natural Resource Management Education student voice summit and has continued to make presentations about their ongoing sustainability work to staff, parents and the wider community.

A culmination of students’ reflections occurred at the end of the year in a student-driven task to create a ‘storybook’ of all the experiences that the students considered to be most important highlights of the year as citizen scientists. They brainstormed and chose the most important aspects of the learning that had occurred and each student wrote a reflection and illustrated their own topic with a watercolour painting. This book was created in the last three weeks of school and students were editing drafts and painting their illustrations right up until the day before school finished. The book was printed, collated and stapled so that each student could take this as a memento and celebration of the learning journey over the year. A copy was given to the school library and the book was also shared with members of the UniSA project team.

**Significant outcomes**
Perhaps the most significant outcome for teachers from the Burton water literacy project was the connection of children in their class to their place: the wetlands. The students never tired of their weekly walks to the wetlands and a real sense of ownership was developed. This was demonstrated when Bernadette used a scenario-building technique that suggested that the council had decided to fill in the wetlands and build housing and also in other futures work that was done.

The following dot points summarise the perceived outcomes from using a transdisciplinary learning approach with Fresh Water Literacies as the theme
- Improved reading through research.
- Improved writing through real issues.
- Connection to local and state government processes.
- Improved maths through data collection and recording/measurement and number skills.
- Improved science skills through building knowledge about wetlands environment.
- Improved arts skills through photography/media and digital technology/observational drawing – drawing scientifically.
- Wellbeing—becoming connected/sharing with community.

**Acknowledgements**
Alison Lynch, principal, Burton Primary School
Nic Dale, deputy principal, Burton Primary School
Cath Summers, SSO, Burton Primary School
Julian Marchant, NRM Education and City of Salisbury
John Whitney, Adelaide artist and educator
Dan French, Sustainable Schools consultant and educator; French Enviro
Philip Roetman, UniSA
Jarrad Kilsby, teacher, Barmera Primary School
Joanna Whitehead, teacher, Barmera Primary School
Lorretta McMillan, teacher, Goolwa Primary School.
Goolwa Primary School

**Introduction**
Goolwa Primary School is located near to significant bodies of water: the Murray River, Hindmarsh Island and Currency Creek. During the Fresh Water Literacy project at this school, a Year 4/5 teacher explored students’ understanding of the problem of the proliferation of carp in the Murray River.

This report of the Goolwa project draws on written and transcribed accounts of one teacher, some student work, and observations of the class at work made by project researchers. However, unlike the two case studies described in previous sections, the intended outcomes of the project were not realised. As such, this report is slightly different in structure and content, particularly in relation to descriptions of the project aims, outcomes and accounts of ‘what the students did’. Instead, we foreground the teacher’s intentions, her ‘plan’, and the initial stages of ‘student work’. We conclude with a section that draws on responses of the researchers and discusses specific inhibitors to the realisation of this project.

**Background**
Goolwa Primary School is described on its website as follows:

Goolwa Primary School serves students from the local community and surrounding areas including Hindmarsh Island and Currency Creek. The school caters for students from Reception to Year 7 by delivering a broad and diversified curriculum with a focus on Literacy, Numeracy and Digital Technologies. Goolwa Primary is a community school, which exists to provide the best possible learning environment for our students.

The school is highly regarded for the programs that support the development of the whole child with particular emphasis on Critical and Creative Thinking; Ethical Understandings; Inclusivity; and Social Responsibility. Students are involved in ongoing programs that focus on environmental education and sustainability including regular work with NRM Officers and River Murray Landcare programs. (Welcome to Goolwa Primary School https://www.goolwaps.sa.edu.au/)

Of particular note with regard to the Fresh Water Literacies project is the location of the school—near significant bodies of water: the Murray River, Hindmarsh Island and Currency Creek; its focus on transdisciplinary education; and its focus on environmental education, with a specific focus on water programs.

Goolwa Primary School is a category 3 school with a 2017 enrolment of 293 students (1 NESB and 18 Aboriginal students). In their 2017 context statement, the school identifies as being made up of ‘predominantly Anglo-Saxon background’. At the time of the project, 26 students had a Negotiated Education Plan\(^\text{11}\) and 49% of families were School Card holders.

\(^{11}\) The purpose of the NEP (Negotiated Education Plan) is to support access, participation and achievement in the mandated curriculum for students with disabilities.
**Aim of the Goolwa project**

Year 4/5 teacher Loretta McMillan volunteered to be part of the research. She was on a one-year contract in the school but had previously been involved in related environmental projects as a teacher interstate. She summarised her project as follows:

The aim of this project is to develop and implement a robust interdisciplinary curriculum in science, history, mathematics/numeracy, English/literacy and the arts, focusing on ‘fresh water literacies’. Topics include global and urban water cycles and their place in ecological systems, public health and fresh water quality, invisible water use and water’s cultural significance.

**Teacher’s plan**

Given the school’s location near bodies of fresh water, there were many possibilities for conducting locally relevant research. The students had read an article about the problem of the proliferation of carp in the Murray River to the detriment of indigenous fauna and flora. Loretta wanted to be guided by students’ interests and questions and she was also very concerned to make accurate scientific information accessible. In addition, her goal was to ensure that a balance of views about carp was available. In order to fulfil these ambitious goals, she was very receptive to the idea of inviting local community members and scientists to present to her class. However, she was faced with many challenges when trying to organise this:

I sort of come up with phone calls all the time. I rang a lot of people and, ‘oh no, that’s not my department I’ll put ...you on to someone else...’ and so I found it really hard to go any further because I would have really liked someone to come and actually speak to the kids rather than me and yeah – I just – I didn’t get anywhere.

Loretta summarised her experience of trying to find the appropriate scientific expertise ‘as just dead ends’. From Loretta, we learned of the challenges of designing a responsive curriculum which attended to students’ emerging questions and local debates in ways that the teacher could be assured that she was doing justice to ‘the science’. The amount of time she spent searching for people who could help and who were prepared to speak to children was considerable and, without collegial or research support in the school, it proved very discouraging. Other ‘road blocks’ included snails eating their plants and lack of parental or collegial support to assist the class to visit the river or go fishing.

Her students were extremely interested in a proposed solution they had read about in the newspaper which was to deal with the over-abundance of carp by infecting the carp with a herpes virus. This raised a range of ethical and pragmatic concerns. On the one hand, students were unsure about ‘the fairness’ of making these fish sick. On the other hand, there were also unknowns associated with this solution. For instance, what if the virus spread across species? What if the virus killed so many fish that the dead and dying fish began to further pollute the river? Loretta typed up the students’ inquiry questions, listed below:
Will they be toxic to humans, other fish and plants?
How bad are carp for the river (they knew they were bad but they didn't know what impact they had)?
They want to know about the size and has the virus been tested and will the virus kill the eggs?
Why do they want to kill them?
Would the virus infect humans?
Will the virus make you sick if we swim in the river?
What will the virus do to the carp? Will it kill the carp?
Will the virus affect us and other animals?
Do the carp have any beneficial uses?
Impact on the bird life?
Is there another way to get rid of carp?
How does the government and scientists know the solution will not fail or further disrupt?
What biological differences do carp have to native fish that causes the virus to affect only carp?
How will thousands of fish carcasses disrupt the ecosystem?
Where and how are they putting the virus in the water?
How long will the virus take to kill the carp?
Has the virus been used before?

Figure 18: Carp questions

These questions indicate an awareness of complex ecological relationships, ethical concerns for the non-human world, and an openness to innovative problem-solving.

Loretta invited students to look at their list of questions and asked, ‘what questions are the same’? They then put the questions into categories, and presented them in poster form for display in the classroom (see Figure 18). They categorised the questions into virus, reproduction, habitat, and beneficial uses. The plan was then for students to focus on gathering information in one area in depth and to use that information to design and produce posters. As Loretta explained it:

some will be doing virus, and some doing beneficial uses, some doing other ways of controlling [the fish] like fishing competitions, and one boy wanted to do something about cleaning up after the virus.

Loretta’s aim was to reduce the range of topics and questions the students would need to investigate in order for them to achieve a depth of understanding. Their investigations would involve considerable on-line searching and reading of a range of materials, not necessarily designed for young people.

From the outset Loretta was aware that not all current and relevant information would be easy to find and she did considerable out-of-hours research in order to seek expertise. These are big questions by any standard, and questions that are crucial to designing a curriculum for the Anthropocene. However, they are not easy to answer, nor is it even easy to access reliable information that is accessible to primary aged students. This makes such questions even more important to explore.
Loretta made a number of plans in designing her integrated curriculum to examine this problem.

We are doing the poster work and from there it's getting someone who can actually come in and talk to us about the virus. I did e-mail someone and rang around, [It didn’t]... quite a fit ... different groups and organisations and they put me onto one guy who I emailed. I wanted someone other than me to talk to the kids but I haven't heard back so … I want someone to act to talk about the virus because of the questions that were asked. I had the woman come in about the carp and the food [but] the kids just wanted to bombard her with questions about the virus.

In the meantime, Loretta wanted to consider the semiotic aspects of environmental communication and the embodied experience of being in a place and relating to the non-human world.

So from here I want to actually go down to the river see what signs are there … the signage. I want them to actually catch a carp, to physically look at the carp, and then have somebody that has that knowledge of fishing … the right way to kill the fish and all that sort of stuff. That's the next thing. So talking to the boy that is doing the fishing competition, seeing images of the fish, and knowing that it looks like a lot of fish [have been caught] but it hasn't made an impact with all those fishing competitions. Does not make an impact because of all the eggs that they lay. One of the girls found it very confronting because killing all these fish, and why are they going to kill all these fish, it's not their fault. So there's that perspective as well. I think the first thing is that it has come from the children, so I think that was important. I didn't want to do anything that they haven't got an interest in or wasn't meaningful to them. This was something that they actually came up with so is relevant to them and their lifestyle around the river.

Loretta’s vision for the curriculum design was rich in its range of activities, emotions, knowledges and skills. She designed an integrated approach to deep, situated and academic research into the problem the students had identified. Her intended program was very much Deweyian:

We live in a world where all sides are bound together. All studies grow out of relations in the one great common world. When the child lives in varied but concrete and active relationship to this common world, his studies are naturally unified. (Dewey, 1902, p.88)

Loretta’s approach was to allow children to examine the problem and research their questions by visiting the river, catching the carp, and talking to different people who had different knowledges of carp. It was also informed by recent approaches to language and literacy education in its explicit focus on language forms in use in situ, such as signage, newspaper articles, and material objects.

**Student work**

Guided by the student-generated questions listed above, Loretta and her students undertook the following activities. Table 4 explains how these were connected to the curriculum.
• Carp article analysis and inquiry questions (outlined above).
• School visit by the ‘carp lady’: Loretta invited a local person, known colloquially as the ‘carp lady’, to present ways of positively and productively making use of the carp when they were caught. These possibilities included: as a food, as a fertiliser and as carp leather, a material that could be produced\textsuperscript{12}.
• Garden beds and planting: students constructed garden beds and planted native flora. As an experiment, some garden beds had the liquid fertiliser Charlie Carp added to them and there was a significant improvement of growth of plants even with reduced sunlight.
• Carp posters: students worked in pairs and independently to complete posters on a variety of topics: why are carp a pest?; what problems do they cause?; negative impacts of other introduced viruses and control methods for pests in Australia, e.g. rabbits and cane toads; introduction of the carp herpes virus; Charlie Carp fertilizer.
• Artwork: students worked with artist John Whitney to draw pelicans, as well as sketches of natural objects and rubbings.

<table>
<thead>
<tr>
<th>Curriculum Area</th>
<th>Content</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Education</td>
<td>Carp article analysis and inquiry questions</td>
<td>All of the student work listed above engaged in environmental education. In some cases there was a specific focus on carp, and its effect on the Murray River and related areas. In others, such as the artwork, the environmental education was more broadly related to the visual production of the students’ natural environment.</td>
</tr>
<tr>
<td></td>
<td>School visit by the ‘carp lady’</td>
<td></td>
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<tr>
<td></td>
<td>Garden beds and planting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carp posters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Artwork</td>
<td>John Whitney’s workshop provided students with the opportunity to visually represent their natural environment, which in some cases was then used in the carp posters.</td>
</tr>
<tr>
<td></td>
<td>Carp posters</td>
<td></td>
</tr>
<tr>
<td>Literacy</td>
<td>Carp posters</td>
<td>Multimodal text/poster production. Texts were hybrid genres, with the social purpose to inform (the community about carp), and to persuade (the community to act in a particular way regarding carp) (see Figure 19).</td>
</tr>
<tr>
<td>Numeracy/ Mathematics</td>
<td>Garden beds and planting</td>
<td>Numeracy skills were embedded in the activities of planting (e.g. quantities of Charlie Carp fertilizer), and carp posters, e.g. statistics related to the carp virus.</td>
</tr>
<tr>
<td></td>
<td>Carp posters</td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td>Carp article analysis and inquiry questions</td>
<td>All of the student work listed above scientific inquiry skills.</td>
</tr>
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<td></td>
<td>School visit by the ‘carp lady’</td>
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<td></td>
<td>Garden beds and planting</td>
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<td></td>
<td>Carp posters</td>
<td></td>
</tr>
<tr>
<td>History</td>
<td>Carp article analysis and inquiry questions</td>
<td>The carp article analysis and the school visit by the carp lady both included elements of history, in particular, the history of carp in Australian waterways, e.g. the reason for its introduction.</td>
</tr>
<tr>
<td></td>
<td>School visit by the ‘carp lady’</td>
<td></td>
</tr>
<tr>
<td>Geography</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Engineering</td>
<td>Garden beds and planting</td>
<td>The construction of the garden beds and the planting involved some basic elements of engineering, e.g. identifying appropriate areas to plant and constructing garden beds accordingly.</td>
</tr>
</tbody>
</table>

\textsuperscript{12} Carp leather is made from the skin of the fish. It is approximately six times stronger than cow hide and can be turned it into high quality articles such as handbags, purses, wallets, and key rings.
Futures studies | Carp posters | Through their carp posters, many students started to articulate future scenarios related to carp, e.g. what will happen if the carp virus spreads further; what will happen if the carp are culled?

Civics | Carp article analysis and inquiry questions, Garden beds and planting, Carp posters | The civics element of this unit was embedded into many of the activities listed above, as the students attempted to inform the broader community about carp; produce vegetation for the school community, and to engage with community experts such as the ‘carp lady’. NB: lack of community engagement from water experts was a significant inhibitor to the GPS project.

Table 4: Student work and connection to the curriculum at Goolwa Primary School

Researcher reflection
Edwards-Groves and Kemmis (2016) recently pointed out that practices inside and outside institutions limit to some degree what kinds of curriculum teachers can enact. This was very obvious in Loretta’s case. She was not limited at all in what she imagined; indeed she envisaged ambitious integrated curriculum inquiry driven by the children’s questions. However, getting out onto the school grounds to garden or beyond to the river to fish and observe remained contingent upon her being able to enlist volunteer support from colleagues or parents. As a newcomer to the school this was impossible to organise. In addition, she spent a good deal of her ‘free time’ trying to organise for experts with knowledge of the problem to visit the school. Mostly this resulted in dead-ends, even with support from the research team. Place-based environmental responsive curriculum with respect to ‘water literacies’ proved challenging to deliver.
5. RESEARCHER REFLECTIONS ON THE PROJECT

Each of the three case studies in a previous section of this report documents how teachers and their classes engaged in learning around a transdisciplinary topic focusing on fresh water. Whilst the teachers taught the same topic to the same age group of children, it was in different locations and circumstances. In one way it is the creativity associated with curriculum design and implementation in a particular place, and with a particular group of students, that makes the case studies so rich. This section makes comment about what the researchers learned and what common threads emerged from the case studies around curriculum innovation and research design and methods. It has been organised in two sections: conceptual framework, and action research and practitioner inquiry.

Conceptual framework

Transdisciplinary approach to curriculum

In the introduction section of this report we explained why we hoped to co-develop with teachers a transdisciplinary approach to curriculum that went beyond current notions of STEM or STEAM. We made the provocation that the acronym METALS—for mathematics, environment, technology, arts, and language, science—might help academics and teachers to collaboratively design a transdisciplinary approach to teaching and learning about current issues related to the sustainable development of society (Brandt et al., 2013).

Although we had introduced these concepts in professional development workshops, teachers did not specifically highlight the term transdisciplinarity in their interactions with their classes in their local places. Nonetheless, they did introduce ideas from many disciplines such as science (ecology, earth science), history of place, and mathematics (data collection about local species, mass of sandbags). Teachers talked with students about real projects and real problems in their local places and multiple people such as council workers, NRM educators, fishers, farmers, environmental activists, and passionate citizens contributed to the deep curriculum experienced by the students and were critical to the success of the learning that took place.

For example at Barmera, Joanna talked about the weekly visits to the lake and the historical focus on how the lake had been used in the past. Questions such as ‘How has it changed? How is it going to change? Where are we going and who are going to be the change agents? How are we going to change it?’ were all relevant to the history and futures curriculum. Further, everything was based in the children’s real lives: from the local community turtle man, to the carp lady, school librarian and local MP, all were involved.

Addressing the complexity of implementing transdisciplinary curriculum was facilitated by collaboration with a diverse range of community groups and academic expertise. This kind of approach to teaching and learning requires a team. But basing the learning activities in real life experiences provided motivation way beyond the initial scope of the project for both teachers and students. Involving an artist, with yet a different set of expertise, also enabled the classes to explore their place from a creative space and enabled students to accurately record observations through drawing and models.

In the initial stages of planning with each site, teachers were unsure about a) how well they could ensure they had strong discipline knowledge/ learning throughout their projects, b) whether they were genuinely student led, and c) how well they could address curriculum requirements. They expressed a particular concern about how they might integrate mathematics
effectively. However, as the projects grew at each site so did teachers’ confidence in transdisciplinary learning and integration. By the end of the project, each site was clearly able to articulate the mathematics learning for their cohort of students, with topics such as measuring volume, distance, mapping area, data collecting, graphing and analysing, scaled measurement, informal units, fractions and financial mathematics being included across the case studies.

Transdisciplinary learning, such as this, enhances student ownership of their learning and increases student motivation to learn, which in turn allows for greater opportunities to extend student learning and mathematical thinking in particular. One particular example of this was cited in the second Burton case study, where an error in recording resulted in some incorrect measurements for water salinity. The students worked out that it had to be an error as the data suggested that the wetlands had much more salt in it than expected. This provided an opportunity for teachers Bernadette and Marj to extend the students’ learning and understanding of decimals beyond the confines of year level curriculum expectations. These opportunities were noted across all cases. Indeed, each case study identified improvements in students’ mathematics proficiencies in problem solving, understanding and reasoning. Moreover, students’ personal connection to the issues being explored encouraged greater involvement in and commitment to any problem solving that was encountered along the way.

**Complexities at each site**

An overarching purpose of the project was for researchers to collaborate with teachers to co-develop a transdisciplinary approach to teaching about fresh water. Given the wide scope of this project, and the fact that learning was focused on students’ connection to fresh water in their local environment, it comes as no surprise that teachers at each of the schools faced their own challenges when trying to implement this work in their setting.

In the case of Barmera Primary School, one challenge was ensuring that sufficient resources, both human and material, were available to allow for the outdoor learning experiences at Lake Bonney. Without the dedication and collaborative effort of the teachers, members of the community and parents of children at the school, such regular place-based learning would not have eventuated. Related to this was the importance of working with locals and experts with knowledge about Lake Bonney. This was considered a crucial component in developing teacher knowledge and stimulating inquiry-based learning about the history and human impact on the lake.

Similarly at Burton Primary School, it was evident that having two teachers committed to the project was imperative to enable students to regularly visit and engage with their local wetlands. Teachers also acknowledged that working together on the project allowed for collaborative planning and reflection on learning, in addition to developing relationships with experts and members of the community.

In contrast, at Goolwa Primary School, only one teacher was involved in the water literacies project. This proved to be a major roadblock to the teacher successfully delivering her planned curriculum outcomes. In particular, a lack of response from community resulted in the cancellation of visits to the local river to investigate students’ concerns and questions.

**Integrating Indigenous and community knowledges**

Place-based inquiry provides ideal opportunities to connect students to local Indigenous communities, histories and continuing narratives and place. In many areas of Australia,
Indigenous place-making narratives and names, ways of knowing and continuing connections have been written over in the process of remaking ‘official’ accounts (including curriculum, see Zipin, 2009) of history and ‘knowing’ places. An important strategy for teachers in redressing colonial erasure of Indigenous voices and knowledges is to privilege Indigenous voices in the work of place-based inquiry. In some areas, confronting local histories of frontier violence, removal and dispersal of Indigenous people from their land, and separation of children from families and languages, can make the process of engaging with local Indigenous communities and narratives complex. Across Australia, diverse interactions with colonialism have shaped dynamic and evolving expressions of Indigenous identities and cultures, and relationships to place.

Teachers need to 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. A great starting point is to provide students with access to a wide range of Indigenous texts and authors. This does not mean simply finding a dreaming story about a place or an animal to address the cross curriculum priority of Aboriginal and Torres Strait Islander histories and perspectives. Rather, it means to introduce Indigenous authors and voices through texts of poetry, fiction, personal accounts and non-fiction texts, and contemporary narratives that showcase Indigenous narratives full of hope, humour and place-based meaning and identity-making, as well as historical narratives that have otherwise been whitewashed from official curriculum and knowledge. A list of texts that might assist in this process is provided in Appendix B (Readings, 2018). Online and digital resources are included are also invaluable in this regard. Working with Elders and the local community needs to be respectful and where teachers lack confidence or need help in locating community based resources, there are Indigenous staff based in schools and regional education offices who can provide introductions and support in working with the local community. Local Indigenous organisations including land councils can also provide guidance in developing respectful relationships with local Indigenous community members.

**Literacy and text production**

In the introduction to this report we explained that the Fresh Water Literacies project adopted a view of literacy as being a ‘social practice’ that goes beyond reading and writing. In this section we focus more specifically on the role of language (spoken, written and multimodal) as an integral part of the broader social practice of ‘literacies’ associated with learning about fresh water.

Across all three case studies, students engaged in multimodal text production. As described in the case studies, text production included the students’ writing in the form of journals and a whole class book, as well as oral presentations for a community water literacy expo. If we examine big ideas and inquiry questions generated by each school site, we can see that students demonstrated an expansive, creative semiotic repertoire in response to their respective water explorations.

Text production included both written and oral modes, as well as print based and digital forms of text production (see Figures 20, 21, 22 and 24).
Figure 20: Written text production

Figure 21: Oral text production

Figure 22: Digital text production
Students also engaged in multimodal text production (see e.g. Unsworth 2001, Walsh 2010), drawing on semiotic resources beyond verbal language, including visual images (particularly stimulated by the art component), and engaged with non-linguistic three-dimensional materials and artefacts to produce innovative and creative texts (e.g. the features and flora in the mermaid drawing in Figure 23).

![Figure 23: Natural materials for text production](image1)

A highlight of the corpus of student text production was the range of genres or ‘text-types’ (Martin & Rose 2008) produced by the students. In other words, across the three case studies, and their respective water places, students produced texts for a range of social purposes related to their respective big ideas, research, and inquiry questions—purposes such as persuading, instructing and recounting (see Figures 25, 26, 27).

![Figure 24: Students engaging with various materials for text production](image2)
Of particular note here is that the range of genres generated by the students was not simply the result of explicit, teacher-led instruction and modelling of particular genres. Instead, students generated these various genres in response to their experiential engagement with their water sites, and the resulting ideas and inquiry questions. The development, for example, of the Burton water literacies class book (titled *Our citizen scientist journey*, and comprised of at least five different genres) did not involve explicit genre instruction from their classroom teacher. Instead, the text production was contextualized as a student-led opportunity to respond to a particular highlight of their fresh water unit.
This generative approach to text production resulted in not just expansive repertoires of text-types and genres, but also creative, hybrid genres that captured the students’ intentions and the unique affordances of the students’ particular water literacies inquiry. For example, in Figure 28, the text titled *Laws and rules* (from the Burton book *Our citizen scientist journey*) is a hybrid genre that effectively combines elements of a first-person narrative with a persuasive genre, to produce an engaging, thought-provoking multimodal text. In a similar way, the Futures writing instigated in the Burton and Barmera case studies is also an exemplar of expansive, creative and purposeful text production. In the example in Figure 29, the student’s text is an atypical response genre to environmental concerns, whereby the predicted future of Lake Bonney is not dystopic, and instead, presents a hopeful, harmonious future. The point here is that the students’ text production, on the topic of water, across a range of sites, has generated a corpus of creative, responsive and ultimately unpredictable texts, that go beyond the expected (and often prescribed) semiotic repertoires of students working in upper-primary levels.

![Figure 28: Hybrid genre text production](image)

Lakes and Rules
Oh Mad, Look at all the things we have had to report! A mattress. Oh! yeah that is really unhealthy for our wildlife. We also had to report a chair covered with moss. We definitely had to report that! Leaking pipes that could make the path all slippery and people could hurt themselves, yeah, that could be really bad! Oh yeah! I also saw a mouldy mat that had brown white colour. Mad! I really loved being the people that report about the wetlands to keep it safe :)

By Hannah M

![Figure 29: ‘Futures writing’ text production](image)

Lake Bonney in 50 years
Will have more playgrounds because the lake will be cleaner and more people will visit. The lake will be dried up because they will drain it out to get all of the carp out and we will have cleaner water. They will move the lake and make a pond where the lake is now. They will make a pump station and pump all the water out. They will pump it back in once they get the carp out. They will build a massive wall across the middle so the animals can still drink and eat. They will put all the carp in the other half of the lake. They will save all the turtles.

**Action research and practitioner inquiry**

Action research has been the main professional learning model used by the research team in previous projects. Action research provides an opportunity for teachers to inquire into an aspect of their pedagogy, implement changes and reflect on their learning. This project was no different: teachers at each site undertook action research, shared and borrowed ideas from colleagues and experts, challenged their own teacher practice and methods, and built knowledge and confidence around constructing curriculum.

The Aspirations Project (2012-2015), a three-year professional learning programming that focused on developing deep curriculum connected to student life worlds for students in low SES communities of South Australia, used an action research/practitioner inquiry approach
(Paige, Hattam & Daniels, 2012). The authors identified the following key findings about the impact of action research and these were confirmed in this project:

- Modelling a pedagogical framework which encompasses contemporary practices provides early career teachers with the confidence and capacity to independently plan sequential, transdisciplinary, interactive learning experiences in science.
- Action research formalizes teachers’ reflective processes, and supports school-based curriculum and the redesigning of pedagogy.
- Participation in a research based professional learning experience provides teachers with opportunities to move from classroom technicians to pedagogical intellectuals.
- Connecting young learners to the natural world through a citizen science approach provides a meaningful context for learning about science in the primary/middle years of schooling.
- Building relationships amongst educators (classroom teachers, teacher educators, and ecologists) contributes to students’ aspirations to be successful at school, and beyond.

Long term participation in small professional learning communities that were supported by university academics proved to be a context for powerful learning for these teachers. If we are serious about democracy and social justice, schools must become a site for critical and engaged thinking about the world’s big problems including climate change, racism, hunger and water. If we truly wish to generate wisdom, we need to help young people to become more critical about the goods and values promoted by a consumer society. Action research has a positive part to play in these endeavours.

Presenting their findings at a state conference provided an opportunity for teachers to reflect on their professional learning as recorded in their journals and to share it with other committed science and mathematics teachers. The process, whilst frightening, was very rewarding professionally and personally. Burton Primary School teachers Marj and Bernadette reflected on their involvement in classroom research and highlighted the following points they valued about being involved in action research.

- Sharing/borrowing ideas with colleagues/experts
- Challenging your own teacher practice and methods
- Building knowledge and confidence
- Building a network of experts
- Covering the curriculum and more!
- Improving grades
- Feeling of satisfaction.

**Essential questions**

Inquiry is a key component of the Australian Curriculum: Science (‘involves identifying and posing questions; planning, conducting and reflecting on investigations; processing, analysing and interpreting evidence; and communicating findings (ACARA, 2018c)). Inquiry also underpins the general capabilities of creative and critical thinking, personal and social capability, ethical understanding and intercultural understanding. One aspect that is common to all literature on inquiry is that for genuine classroom inquiry, the learning must be student led and, where possible, should be connected to place. Place-based education serves to ‘strengthen children’s connections to others and to the ‘place’ in which they live as it extends beyond the classroom curriculum’ (Brown, O’Keeffe & Paige, 2017, p. 21).
Discourse on effective learning environments frequently highlights the importance of student ownership of and engagement in their learning. Acknowledgment of the importance of student driven learning is not a new phenomenon; Dewey raised this argument in the early 1900s, stating that to ‘secure interest in a given set of facts or ideas, [teachers] may be perfectly sure that the pupil will direct his energies toward mastering them’ (Dewey, 1913, p. 1). Yet, often the desire to ‘cover’ the curriculum content is prioritised.

In their work on productive discipline engagement, Engle and Conant (2002, 400-401) make reference to four key criteria listed below. They suggest that these four act as guiding principles to create a classroom environment that fosters genuine inquiry. Each of these criteria features throughout the case studies reported above:

- **Problematizing**: encouraging students to address/investigate real problems/issues.
- **Authority**: allowing students to have some authority over how to address the issue.
- **Accountability**: making students accountable for their contributions and also for the discipline norms
- **Resources**: ensuring sufficient resources are available for students to work with the above three principles.

Student led inquiry is contingent on what we call ‘essential questions’. This project encompassed three layers of essential questions: the first layer was the essential (research) questions of the researchers, the second layer was the essential questions of the teachers, and the crucial third layer was the essential questions of the students (see Table 5). It was this third layer that defined and shaped this project across all three sites. The teachers scaffolded the learning and provided a broad range of experiences around the topic of fresh water in order for students’ questions to evolve. *(Problematizing in action)*. Each class group determined the issue that they studied, with the teacher directing and guiding learning to ensure it was student led and also connected to curriculum content *(Authority in action)*.

The selection of an appropriate issue or topic was important but equally important was the construction of an essential question that could guide the planning of an integrated unit. The learning areas provided a framework for teachers to identify the learning outcomes for each way of knowing. As Jacobs (Jacobs, 1997 cited in Chiarello 2006, p.13) describes, essential questions ‘are an exceptional tool for clearly and precisely communicating pivotal points of the curriculum.’ They help to articulate the learning expectations. They suggest to students the key concepts, skills and values they will encounter in the unit. The learning sequence exposes the students to a range of experiences which results in the students being able to develop an understanding of the key concepts. The essential question also helped teachers provide a context for the content of several discipline areas (Grant & Paige, 2008, p.35).

In each of the case studies it is evident that teachers were able to maintain a student led inquiry while meeting the curriculum content needs. All student groups focused on big critical questions which were relevant and important to their local place. This problematizing was a key criterion for the success of this project as it created real interest and involvement among the various cohorts of students, who in turn demonstrated deep levels of engagement and learning beyond the boundaries of curriculum content. This was also a brave move by the teachers because at times it called for content areas that were outside their comfort zones and curriculum content that was beyond the curriculum expectations for the student year levels. However, this extension allowed for better community and local expert connections *(Resources*
A frequent note made by teachers was the value of making use of local experts and the notion of co-learning some aspects of the issue as it was encountered. This is crucial in that learning through an issues-based model can be daunting in that some unexpected content/issues may arise as the learning unfolds. However, all participant teachers noted how making use of local resources can elevate learning and provide for much richer experiences.

The development of the students’ essential questions is a complex process and the teachers needed time and intellectual support to develop them. Having the team of researchers and teachers from other schools come together to brainstorm and bounce ideas off each other also helped teachers to refine their own research questions and also broadened their thinking around what would be possible for their students. By the end of the project, teachers reflected that not only had they become researchers but so had their students. For example, Burton teachers noted that their students had researched using information texts and search engines, learnt how a wetland works at the Botanical Gardens, and observed birdlife and habitats at the wetlands and at the Adelaide Zoo.

<table>
<thead>
<tr>
<th>Researcher questions</th>
<th>Teacher questions</th>
<th>Student questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barmera</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What would a Curriculum for the Anthropocene look like?</td>
<td>How can we change the curriculum and children’s learning from passive participation to active participation in the management of the lake systems?</td>
<td>Why are the trees dead? Why is the water so murky? Why is it salty? How does that affect the plants? Why did it dry out? What do you mean this was an electricity station? Why has it changed? What happened to the jetty? How has the lake been used in the past? How has it changed? How is it going to change? Who are going to be the change agents?</td>
</tr>
<tr>
<td>Burton</td>
<td></td>
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</tr>
<tr>
<td>How might primary teachers explore it in practice in a range of contexts?</td>
<td>What works to develop students as activists for the local environment wetlands?</td>
<td>How deep is the water? Where does the water go? Why are there dry patches in the lake? What creatures are in the water? How many? Where did the wetlands come from? I wonder if there are germs in the water because it is all dirty? Does water disappear in hot days? Does this water freeze in winter? Is it salt or freshwater? How can animals drink it and not get sick?</td>
</tr>
<tr>
<td>Goolwa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How might primary teachers explore it in practice in a range of contexts?</td>
<td>What works to develop students as activists for the local environment wetlands?</td>
<td>Will they be toxic to humans, other fish and plants? How bad are carp for the river (they knew they were bad but they didn't know what impact they had)? They want to know about the size and has the virus been tested and will the virus kill the eggs? Why do they want to kill them? Would the virus infect humans? Will the virus make you sick if we swim in the river? What will the virus do to the carp? Will it kill the carp? Will the virus affect us and other animals? Do the carp have any beneficial uses? Impact on the bird life? Is there another way to get rid of carp? How does the government and scientists know the solution will not fail or further disrupt? What biological differences do carp have to native fish that causes the virus to affect only carp? How will thousands of fish carcasses disrupt the ecosystem? Where and how are they putting the virus in the water? How long will the virus take to kill the carp? Has the virus been used before?</td>
</tr>
</tbody>
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Table 5: Essential questions for researchers, teachers and students
Professional learning and collaboration
Throughout this project teachers engaged in a series of workshops and discussions with the broader research team. The collaborative process from design to implementation was a professional learning exercise in itself. While teachers made detailed and explicit notes about the students’ learning journey throughout the project, they also made subtle notes about their own professional learning and development. The research meetings provided them with the time (and deadlines) to reflect on their students’ learning, their own learning, and their methods and approaches. The workshops (see Table 1) also provided them with professional development that was targeted to their specific needs; for example, Jarrad not only made specific reference to how much he learned about art and various techniques but also how to use this approach to structure student learning when teaching a transdisciplinary unit of work.

Teachers in two of the sites made specific notes about how important collaboration and teamwork was throughout the learning journeys. For example, in one site having an extra teacher each week who volunteered her time ensured a rich curriculum, but also made it possible to go on a walk to the wetlands as there was adequate adult supervision. Collaboration in this project was also about shared planning. All of the participant teachers could be considered early career teachers. They appreciated the intellectual stimulation and access to resources both human and monetary (teacher release time; $1000 to purchase science equipment, plus funds for Indigenous children’s books, and conference registration at a state based conference).

Collaboration with researchers and peers assisted participating teachers to refine and amend their plans on an on-going basis and their presentations at the end of year conference provided a form of summative conclusion to their learning journey.
6. CONCLUSION

This section succinctly summarises the key learnings from this pilot study that could inform similar future studies. Key learnings are reported against the following headings:

- Research model
- Transdisciplinary planning: STEM and the arts
- Early career researchers (ECRs)
- The importance of time
- Indigenous perspectives.

Research model
The research model implemented in this project had several key features. Firstly, experienced late career researchers with a range of learning area expertise mentored early career academics around the conduct of effective education research. Secondly, the model used was based on a well-established practitioner inquiry/action research approach adapted from previously successful projects (Comber & Nixon, 2012; Paige, Hattam & Daniels, 2015). This particular project extended over twelve months, with teachers supported to attend six full-day professional learning days. Teachers investigated an aspect of their pedagogy with a view to effecting innovative pedagogical change. In addition, the team and teachers travelled to each rural and city location, reinforcing the value placed on specificities of place and location. For early career teachers involved in this learning, the shared experience has impacted directly on their classroom environment and teaching. This intensive, long-term approach was critical for deep learning around innovative pedagogy but of course it requires significant resources. On a practical note, having multiple sites (and more than two) for the pilot study was important. We would recommend that three schools would be a minimum to encourage collaboration between teachers and account for one site not being able to complete all aspects of the practitioner inquiry.

The teaching/ research/ nexus was very important for both teachers and academics. The action research approach ensured intellectual engagement and this resulted in rich learning experiences across the learning areas for the students and culminated in the teachers reflecting on their learning and sharing it publically at a state-based end-of-year science and mathematics middle school teacher conference. It was the teachers who selected the issue to foreground in their classroom that led to the research question to investigate. This was of critical importance to the project, as the choices were based on local, authentic concerns/issues. The academics provided support and motivation to extend and challenge their pedagogical practice throughout the project. PowerPoints prepared for the conference, transcribed teacher presentations, and reflective articles written by teachers and submitted for publication are products of the intellectual work undertaken (see Appendix A). The website, another output from the project, will be very useful for early career teachers and final year undergraduate education and environmental students, in particular. Extra intellectual resources do matter and results in powerful learning for teachers and their students.

Transdisciplinary planning: STEM and the arts
Even with all the support provided in this project, transdisciplinary programming is not easy for teachers. Two cases worked and one struggled. Working in a supportive school environment

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13 The website contains student work samples, lesson sequences and wide range of print and community resources that will be useful for early career teachers and preservice teachers. See https://www.dropbox.com/s/yi9xzq2nssm2r6c/Presentation-WaterLiteracies-v1.pdf?dl=0
with co-teachers and school leaders assisted teachers to produce successful outcomes. So whilst there were project resources available, both financial and intellectual commitment from within the schools was also needed.

In the project rationale written to secure RTIS funding, we noted that transdisciplinary approaches to teaching and learning were good primary school practice. We referred to the narrow interpretation of STEM as being little more than a way to provide jobs for growth. We think this project has something valuable to say about STEM; it was an excellent example of how to integrate learning areas around an important issue in a meaningful way. Choosing an important relevant topic (fresh water in this instance) has lots of possibilities for students to genuinely connect to their place and community. All of the disciplines contributed to this: science, mathematics, language, history, geography, design technology and the arts. Curriculum innovation is slow, and intellectual work is important. This project emphasises STEM education for innovation and deeper learning and not STEM education for jobs. It highlights the difference between education that prepares students for jobs (e.g. NAPLAN, high stakes testing) and those that prepare students to live in a liveable world through interdisciplinary studies.

A focus on the arts was an innovation for this project and a reason for looking at wetlands through a different lens. Engaging a practicing artist was hugely influential for both teachers and students. Observational drawings, environmental sculptures and natural object prints are all examples of visual art projects produced in the Year 5 classrooms. The visual arts was not an add-on, but central. We have proposed the idea that METALS (mathematics, environment, technology, arts, language and science) was a more appropriate concept for this project than STEM. The transdisciplinary approach of METALS that we proposed is about making connections between the learning areas rather than creating silos. Water literacy curriculum is about more than the cognitive and more than knowing. It is transdisciplinary, and uses different lenses to explore an issue in depth. What has also been very powerful in this project was the integral work the students and teachers did in the community; they have written letters to politicians, engaged with local council and set up displays in the main street and in shopping centres. They have made a difference!

Early career researchers

Another important aspect of the project design was that it enabled early career researchers (ECRs) (both those who have local South Australian knowledge and those learning to be part of it through both interstate and international origins) to connect to schools and classrooms through a rich research project. However, as discussed by Sutherland (2017, p. 743), the field of academia has changed and has:

moved towards a more performative culture…where what is able to be measured and counted (numbers of research outputs and citations; h-Index rankings; and student evaluation scores, for example) have become the predominant indicators for success.

In such a culture, it is important that ECRs do not become overburdened by such measures and find time to work with colleagues on meaningful projects such as this. One of the design features of this project was to embed the mentoring of early career academics throughout each phase of development, implementation and review. The ECRs made note of the research climate remaining inclusive and supportive throughout every stage of the project; at no stage was someone included or excluded based on their experience, and all viewpoints were welcomed. Such a working environment fosters academic development and is an example of effective mentoring and highlights the importance of working with colleagues on meaningful
projects such as this. Through this project not only the ECRs gained in terms of learning from mentors and meaningful collaboration with colleagues, but the more experienced researchers also gained connection to schools, teachers and classrooms and connections with organisations such as NRM and the SA Department for Education. Such connections are crucial to ECRs in teacher education but can be difficult to build in the current academic climate.

The importance of time
It is also relevant to highlight the importance of time. The teachers had time—time to learn, think, share their thoughts and plan. They had time for reflection and time for writing their presentations and, of course, time to present and share their findings. We, the research team, also had time. We had time with participating teachers and time with their students. We had time to plan and think and learn with each other and with the teachers. We also have made time for reflection, both informally as we prepared for various meetings and project stages and formally, for example the two-day data analysis meeting with Professor Margaret Somerville. This data analysis meeting, facilitated by an international expert in projects such as this, was critical in challenging our reflections and in assisting us to document outcomes in a meaningful way. We emphasise the importance of allocating time at end of a project to reflect as a group, to write up a report, to publish in high end journals, and develop resources such as a website.

Indigenous perspectives
Despite the fact that the application identified Indigenous perspectives as an area on which to focus, and Indigenous scholar Dr Samuel Osborne was a seminal member of the early career academic team, we were aware that development in the three sites around Aboriginal ways of knowing was limited. In one way it was surprising, as we foregrounded it at each session. However, it indicates the complexity of being new to a community and endeavouring to make links to traditional owners (it takes longer than a year). Secondly, whilst transdisciplinary programming is complex, it is doable when working in a team and in community, but incorporating an Indigenous cross curriculum priority is even harder. None of the teachers’ research questions focused on it directly, but there was some implicit focus through links to place and country.

Final word
In times of rapid change such as we are currently experiencing, relying on past practices is inadequate and new ways of teaching need to be explored with close attention being paid to researching and reflecting upon outcomes. Education is for far more than gaining a job/employment; it is for learning to live sustainably and making a contribution to the community. Achieving this requires new ways of looking at education. This project has demonstrated the value of transdisciplinary place-based learning and how it can contribute to community building and sustainable practices that will take us through these times of change. As commented by Raskin (2013, p. 1):

In a world at risk, those attuned to the dangers can feel a powerful temptation to sound apocalyptic alarms to awaken the somnolent. Arousing fear, though, without offering a compelling vision of a better path, awakens only dispiriting anguish and despair. Pragmatic hope is the antidote to dystopian despair.

A project like this does not come along often enough. It is adventurous curriculum innovation for teachers, students and academics. It makes us think about how to do good work in classrooms, and how to connect students to community and the natural world whilst maintaining the rigor of discipline knowledge. We are all better academics, researchers,
preservice educators, teachers, and community members as a result of participating in this project!
REFERENCES


8. APPENDIX A: RESEARCH OUTCOMES

1. Interdisciplinary framework for teaching METALS in primary classrooms with a focus on science, mathematics and English using fresh water literacies as a focus.

2. Implementation of this framework in two pilot primary school classrooms in SA.

3. Two videos that communicate key ideas around using an issue to design innovative curriculum: the first, produced by Natural Resource Management, shows teachers and students from one site; the second records academics reporting on outcomes from the RTIS grant. Videos can be accessed via the website https://www.dropbox.com/s/yi9xzq2nssm2r6c/Presentation-WaterLiteracies-v1.pdf?dl=0

4. A project website containing videos, student work samples, curriculum materials including lesson sequences, and a wide range of print and community resources that will be useful for early career teachers and preservice teachers. https://www.dropbox.com/s/yi9xzq2nssm2r6c/Presentation-WaterLiteracies-v1.pdf?dl=0

5. Conference presentations and publications have documented the innovations of the project and are available to share with other networks (e.g. Catholic Education STEM Association (CESA) Project and undergraduate teachers). To date these are:
9. APPENDIX B: INDIGENOUS NARRATIVES (Sourced from Readings, 2018)

The Shack That Dad Built: Little Hare Books
Elaine Russell

Our shack had a dirt floor, and before I swept it I would sprinkle water on it so the dust didn't fly everywhere. Then Mum would put an old piece of tino down. I thought it looked lovely. When Elaine Russell was five, her dad built the family a shack just outside the Aboriginal mission at La Perouse in Sydney.

In The Shack that Dad Built, Elaine illustrates what life was like for an indigenous kid on the urban fringes. Her recollections range from the happy memories of hide and seek in the sand dunes and hunting for bush tucker to more bittersweet memories, such as her Saddest Christmas Ever (when the charity responsible for distributing presents to the local Aboriginal kids ran out of toys just as Elaine reached the head of the queue).

Elaine's colourful, painterly illustrations vividly recreate these childhood experiences.

As I Grew Older
Ian Abdulla

Ian Abdulla’s paintings and text offer a snapshot of an Aboriginal family living on a small stretch of the Murray River in South Australia in the 1950s and 1960s. This was a time of immense of profound environmental and social change when the assimilation policy still existed and there were few employment opportunities for Aborigines.

Ian’s personal story of survival affirms the culture of rural Aborigines who despite being dispossessed have been determined to stay on the land.
Maralinga’s Long Shadow: Yvonne’s Story
Christobel Mattingley

‘Grandfather and Grandmother telling lots of stories. They had to live at Yalata. Their home was bombed. That was their home where the bomb went off. They thought it was mumu tjuta, evil spirits, coming. Everyone was frightened, thinking about people back in the bush. Didn’t know what bomb was. Later told it was poison. Parents and grandparents really wanted to go home, used to talk all the time to get their land back.’

Yvonne Edwards was just six years old when the first bombs of the nuclear tests at Maralinga were detonated in 1956. The tests continued until 1963 and their consequences profoundly affected her family and community.

This powerful book, by award-winning author Christobel Mattingley, honours Yvonne Edwards’ legacy as a highly respected artist and community elder.

No Way Yirrikpayi!
Alison Lester

Yirrikpayi the crocodile lives on the Tiwi Islands. he’s hungry. He goes hunting, chasing animals in the sea and on land. What’s for dinner? Meet the animals and learn their Tiwi names in this delightful book for all ages.

‘No Way Yirrikpayi began as a workshop idea and has grown into a fabulous picture book. You’re going to love this funny Tiwi story with its beautiful Illustrations.’ Alison Lester
Sister Heart
Sally Morgan

A young Aboriginal girl is taken from the north of Australia and sent to an institution in the distant south. There, she slowly makes a new life for herself and, in the face of tragedy, finds strength in new friendships. Poignantly told from the child’s perspective, Sister Heart affirms the power of family and kinship.

A is for Aunty
Elaine Russell

More than just an alphabet book, this title uses the letters A-Z as a framework to tell us about growing up on a mission in northern New South Wales. It is a first alphabet book with an Aboriginal theme and describes daily routines and incidents in and around the mission - including billycart racing and yabby fishing. Ages 2+.
Dream Little One, Dream
Sally Morgan, Ambelin Kwaymullina

When Moon shines and earth breathes a breath of deepest night dream, little one, dream into the peace of a wonderful world. From sunrise to night-time, celebrate the wonders of nature with this rhythmic and radiant bedtime story.

Format: Hardback
Publisher: Penguin Books Australia
Country: Australia
Published: 2 May 2016
Pages: 31
ISBN: 9780670978868

Why I Love Australia: Little Hare Books
Bronwyn Bancroft

Gorges that plummet into serpentine shadows ... Cloaks of white that drape the rocky crags of snowy mountains ... In this magnificent celebration of country, Bronwyn Bancroft uses both images and words to explore the awe-inspiring beauty of the Australian continent, and to express the depth of her feelings for it.

Format: Paperback
Publisher: Hachette Grant Eignont
Country: Australia
Published: 1 February 2016
Pages: 32
ISBN: 9781760125127
I Listened and I Looked
Sue Briggs, Donna Leslie

Dad and all the old people say there’s a Bunyip in the river but I’ve never seen her. I’ve been looking for ages.

Each month for a year a young girl checks the bend in the river. The seasons change, but there is no sign of the Bunyip. Are her family gammin her, or does the Bunyip really exist?

Our Island
Elizabeth Honey, Alison Lester

Our island lies beneath a big blue sky, surrounded by the turquoise sea. Turtles glide through the clear salt water, and dugongs graze on banks of seagrass. In this lyrical celebration of place, the children of Mornington Island explore their home in words and pictures.

This is a collaboration with much-loved children’s picture-book creators authors Alison Lester and Elizabeth Honey. All royalties from Our Island and one dollar from the sale of each copy will be donated to Mornington Island State School to fund art projects in the community.
I Open the Door...
Gregg Dreise, Ann James, Judy Watson

I Open the Door...contains nine interconnected stories, all of which begin and end with opening a door. The young authors/illustrators at the 2016 Spinifex Writing Camp were encouraged to let their imaginations run wild, and the result is a book that will simply take your breath away.

Prepare to be intrigued, surprised, fearful and delighted as you turn the pages to follow the adventures of what happens when a door is opened. The Indigenous Literacy Foundation’s motto of ‘Reading Opens Doors’ became the inspiration for the stories that were written at the 2016 Spinifex Writing Camp held once again at Tjuntjuntjara, this year with mentors Ann James, Gregg Dreise and Judy Watson.

Sally’s Story: My Place For Young Readers
Sally Morgan

My Place is Sally Morgan’s rich, zesty and moving story of her childhood and growing up in Perth, Western Australia. It tells how she gradually came to realise the truth about her family and their heritage.

In its original edition, My Place was warmly and enthusiastically received by readers and critics. This new edition has been adapted for younger readers.
**My Home Broome**
Tamzyne Richardson, Bronwyn Houston

*My Home Broome* is a beautiful new picture book that captures the heart and soul of the unique multicultural community of Broome in Australia’s north west. With a poem written by nine-year-old Tamzyne Richardson as its centerpiece, *My Home Broome* is a rich collage of interesting facts and vibrant artwork that reflects the town’s rich history and diverse ecology.

From the pristine coast to the sandy plains of Roebuck Bay, Tamzyne shares her world and takes the reader on a personal journey around Broome and its environs. I live in a place where the wader birds search for food, I live in a place where the goorilis swim in Roebuck Bay, *My Home Broome*.

**Welcome to My Country**
Laklak Burarrwanga, Family

‘We can go anywhere and see a river, hill, tree, rock telling a story.’

Laklak Burarrwanga and family invite you to their Country, centred on a beautiful beach in Arnhem Land. Its crystal waters are full of fish, turtle, crab and stingray, to hunt; the land behind has bush fruits, pandanus for weaving, wood for spears, all kinds of useful things. This country is also rich with meaning.

Here too is Laklak’s own history, from her long walk across Arnhem Land as a child to her people’s fight for land rights and for a say in their children’s schooling. She and her family stand tall, a proud and successful Indigenous community.

**REVIEW**
by Emily Gale

The Yolngu people of Bawaka – a beautiful, remote beach in the East Arnhem Land region – are said to be the most culturally intact Indigenous group in Australia. This book, a collaboration by six Indigenous women and three non-Indigenous academics, is a very thoughtful introduction to their lives and history.

The narrative offers the sort of warm personality that textbooks often lack as we...
Born to Sing
Sally Morgan

Maddie loves to sing and make up new songs. Her favourite is her humpback whale song, so she is very excited when her mum and grandma promise to take her to Shark Bay to see the whales. They set off in their car and ratty old caravan, and it looks like they might not get there at all. But with some help along the way, Maddie’s dream might still come true.

Learning From The Land
Yami Lester, Petronella Vaarzon-Morel, Julie Carter

This land is like a book - full of stories that explain how people, animals, rockholes, the hills and different plants and trees came into being. Relationship with the land is part of Aboriginal people’s lives, it holds people together and provides for every need. Culture, language, and the religious system that controls everyday life - all come from the land. This story is about the boyhood memories of Yami Lester, who grew up learning about the land from his elders. Travelling through the country of his birth, Yami shares with us how he was taught Yankunytjatjara culture through childhood games and bedtime stories.
Lowitja
Lowitja O’Donoghue

When Lowitja O’Donoghue left Colebrook Home at the age of sixteen, she was told by the Matron that she would never make anything of her life. With rich personal detail and much humour this autobiography shows just how wrong that prediction was. In the book Lowitja talks about the milestones in her life, from the time she was taken from her mother at the age of two, to the years when she was head of Australia’s peak Indigenous body, ATSIC, in the 1990s, to her current work as an advocate and ambassador for her people. Along the way, Lowitja’s story provides a snapshot of the vibrant woman behind the public persona, and puts a human face to complex issues facing Australia today, such as reconciliation and the stolen generations. A 2004 CBCA Notable Book: Eve Pownall Award

Easter Bilby

Easter Bunny is old and tired but who could do his job properly? His grandson Flash Rabbit only wants to be famous. Should Easter Bunny pass his job on to an introduced rabbit or to a native Australian?

With a gentle hint that rabbits are not ideal in this country, EASTER BILBY has helped turn the focus on our native creatures, as well as supporting the Easter message of hope and new life.


Bilby’s Ring Trilogy

Science-based, with ten years of research and writing, these first Ten Tales for 8 to 12 years will entertain and inform.

Australia and the environmental problems that plague it are investigated through light-hearted narrative, maps, apps, songs and illustrations.
There are some titles found here that would be of interest:

**You & Me, Murrawee**

_Keerti Hashmi, Felicity Marshall_

‘We walk this same brown earth - you and me, Murrawee…’ In this lyrical, beautifully observed picture book, we see through the eyes of a young girl camping on the river with her family, life as it would have been two hundred years ago.

**Noorn: An old story retold**

_Kim Scott, Ryan Brown, Wirrlomin Noongar Language and Stories Project, Alta Winmar_

This story comes from the wise and ancient language of the First People of the Western Australian south coast. Noorn is a story of alliances between humans and other living creatures, in this case a snake. It tells of how protective relationships can be nurtured by care and respect. (Series: Wirrlomin Noongar Language and Stories Project, Vol. 6) [Subject: Aboriginal Studies, Anthropology, Australian Studies, Fiction, Noongar Language, Art]

**Ngaawily Nop: An old story retold**

_Kim Scott, Joyce Cockles, Roma Winmar, Wirrlomin Noongar Language and Stories Project, Alta Winmar_

This story comes from the wise and ancient language of the First People of the Western Australian south coast. A boy goes looking for his uncle. He discovers family and home at the ocean’s edge, and finds himself as well. Ngaawily Nop is a story of country and family and belonging. (Series: Wirrlomin Noongar Language and Stories Project, Vol. 5) [Subject: Aboriginal Studies, Anthropology, Australian Studies, Art Studies, Linguistics, Noongar Language Studies]
Dingo’s Tree
Gladys Milroy, Jill Milroy

This is the story of Dingo, Wombat, Crow and their friends as they struggle to exist alongside the devastation of mining that is tearing up their beautiful homeland. This powerful children’s parable/cautionary tale on the destruction and havoc that mining causes to the land and to community is both touching and hard hitting. Book consists of four chapters: Dingo’s Tree, The Raindrop, The Tree that Walked and The Last Tree.

Once There Was A Boy
Dub Jeffler

Once There Was A Boy is a poignant, universal story of friendship, temptation and reconciliation. The disarmingly sweet, simple language in this whimsical children’s picture book belies an emotional depth that allows the author to reach out to both the young, and the young at heart.

This stunning picture book is transformed into a gently touching grown up story by the use of sophisticated allegorical elements, such as the heart as love or friendship and the sapotes as forbidden fruit.

The Lost Girl
Amelbin Kwaymullina, Leanne Tobin

The girl had lost her way. She had wandered away from the Mothers, the Aunts and the Grandmothers, from the Fathers and the Uncles and the Grandfathers. Who will show her the way home?
*Bilby and the Bushfire* By Joanne Crawford and illustrated by Grace Fielding,
Magabala Books Broome 2007

This is a very Australian book with wattle bushes, spinifex grass, eucalyptus trees, and all the birds, insects, reptiles and animals that go into make the bush environment. Of course in that community is also the koala, wombat and platypus as well.

http://splash.abc.net.au/newsandarticles/blog/-/b/2564527/6-books-for-naidoc-week