**Figures 1-3:** Students working on location at the beach.

# GROWING A PRIMARY SCIENCE SPECIALISM

## ASSEMBLING PEOPLE, PLACES, MATERIALS AND IDEAS

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**This paper derives from the authors' experiences of the development of a successful science specialism implemented in a large primary school in regional Victoria, Australia, since 2012. We discuss how diverse resources—people, spaces, equipment, materials and ideas—were brought together to support a science specialism that focuses on positioning students as burgeoning experts; leveraging and enhancing connections with community; and, developing positive dispositions towards science and the environment. Our discussion is supported by illustrative excerpts from interviews, focus groups and meetings with school and university staff members. We conclude by identifying characteristics that might suggest principles for success in other contexts.**

## INTRODUCTION AND BACKGROUND

This article explores the response of an Australian primary school to incentives to teach science in a context in which grant funding was provided to support the establishment of a school-wide science specialism. The school—situated in a regional location on the coast of Victoria—since late 2011, has undertaken a partnering agenda whereby resources and expertise found within the local community have been recruited in the service of establishing a science program. The development of the program has been founded on principles aiming to develop a science specialism that is sustainable, makes authentic connections between 'in school' and 'out of school', and leverages the affordances of local environments and issues. The authors are positioned as 'insiders' (Adler & Adler, 1994) to this curriculum innovation and include a university researcher (Lynch), two specialist science teachers (Frankel and McCarthy), and the school principal (Sharp). Several grants have supported the establishment of the science program, including state government grants specifically intended to support school science, and university grants intended to support university–school partnerships. The data drawn upon in this paper was collected as part of an ongoing research project that is documenting the initiative, and which is approved by the Deakin University Human Ethics Committee.

Part of the broader policy context of the work reported here includes national curriculum frameworks and guidelines, and the accountability context includes funding agreements and reporting processes. However, we do not proceed from a view of teachers and schools as simple 'receivers' and 'implementers' of such documents. Instead, we see schools, teachers, students, parents and community members as active 'producers' of material and semiotic effects, whose interaction with such documents and frameworks is necessarily a process of 'translation' (after Law, 1992). From this perspective, teachers are seen as active 'curriculum makers' (Craig & Ross, 2008) who translate policy agendas and documents emanating from government and organisational levels into local school and classroom contexts. Thus, we deliberately take a teacher-centric view of curriculum reform where teachers' curriculum work sees teachers' own agendas, beliefs and desires—and their perceptions of local issues and resources and the needs of their own students—as interacting with external aims and agendas.

Other entities involved in the science program (other individuals, groups, organisations, documents, artefacts) also exert forces as they are brought into the program—pushing against some boundaries, establishing others, and contributing to the rewriting of what the program is and might be. In describing some of these entities, relationships and emergences, we hope that some of the characteristics of what by many measures (e.g., student outcome data, student and parent attitudes, state curriculum awards and grants, media coverage and community awareness) is a successful program, will be identified as principles for success that might have implications for other sites and contexts.

## RESEARCH CONTEXT—AN ETHNOGRAPHIC CASE STUDY

Since November 2011, a diverse range of data has been generated in an attempt to document the development of the various faces of the science specialism. These include documents (e.g., grant applications, school newsletters, newspaper articles, school promotional material and school-wide reports), transcribed audio files (e.g., interviews and focus groups), photographic and video recordings (e.g., of science resources, classroom activities, field trips, displays, and student work), and copies of online text and multimedia files (e.g., posts from the school or classroom blog pages and website). These data have been collected with a view to answering the largely ethnographic question: What is going on here? Following the methodology of scholars such as Hammersley and Atkinson (2007) we characterise the research as ethnographic. This characterisation alludes to characteristics of the research such as:

- our relatively open-ended approach to the inquiry in contrast to other potential approaches that might attempt to assess practice against an existing framework or hypothesis;
- our focus on developing an intimate understanding of one site rather than employing a more quantitative approach to sampling and inquiry;
- our involvement with the site over an extended period of time, coupled with our complex insider–outsider roles; and
- our attempts to access the meanings constructed through participants' talk and other representations (Frankham & MacRae, 2011).

The data have been subject to numerous purposes, including reporting impacts and issues to funding bodies, preparation of further grant applications, and analysis for professional and academic publication such as this one. This paper results from a writing collaboration between authors who are positioned differently with respect to the data. Although all have been interviewed at times and thus are included amongst the research participants, only Lynch has full access to all data sets due to ethical considerations and the desire for participating teachers and students to provide candid, honest accounts. This desire has been supported by data collection and management procedures that are intended to maximise confidentiality and to minimise the inherent risks in such work. In this way, the university researcher in our team is privy to information to which the others are not. Conversely, however, although we are all noted above as 'insiders' to the innovation, we have different levels of access to different aspects of the innovation, with the teachers and principal positioned closer to 'the inside' than the researcher, and with their standpoints also varying depending on what aspect of the innovation is designated as the centre. Indeed, as might be expected within the complex assemblage that is a school, and within the dynamic machine that is a school-wide curriculum innovation, there are many 'centres' to the story told here. And our multiple positioning—which also includes being members of the parent community and members of the local community—afford a diverse range of affordances and constraints in terms of what views they provide and what insights might be gleaned and indeed shared.

Our treatment of the data in preparation for the writing of this account was driven by discussions and artefacts (particularly a concept map developed within a meeting of the authors) focused on teasing out the key features and principles of the program. The resulting aspects of the innovation identified in the body of this paper are supported by data excerpts specifically selected to illustrate these features and principles.

## ASPECTS OF THE INNOVATION

At the time of writing, science is taught in the school from Prep through to Grade 6, with each class group involved in one hour of science per week. Science lessons are taught by one of two science specialist teachers, whose journeys as specialist science teachers might be said to have begun at the inception of the program and have been supported via self-initiated learning, formal and informal professional learning sessions and the experience of the past three years, in part supported by an external grant. Drawing on existing resources and their site-specific experiences, the teachers have developed a scope and sequence chart covering all grades and including biological science, earth and space science, physical science and chemical science. The curriculum and pedagogy enacted as these fairly conventional content areas are taught is influenced by input from multiple sources, and by a desire to position students as active stakeholders in their own learning and active citizens whose labour makes a contribution to their community. These desires and some of the manifestations of the program might be seen as aligning with the characteristics associated with 'knowledge producing schools' (Rowan & Bigum, 2010), where students engage in learning processes that produce truly useful products or performances that are valued by their community, and where partnerships between the school and groups in the local community are used as a source of authentic problems or questions to which the school can respond. In this way, the community is an authentic site, audience and 'consumer' of the knowledge produced by the students. These desires also draw on principles of 'place-based education' (Smith, 2002; Gruenewald, 2008), where students undertake embodied encounters with a particular locale in support of cross-curricular learning, as well as other outcomes, such as, intergenerational learning, critical thinking, connection with community and citizenship education.

In what follows, we attempt to map the various aspects of the program under the headings, *Resources*, *Partnerships*, *Community involvement*, *Places and locations* and *Program promotion*, but we do this knowing that the attempt belies the interrelationships between the many components that together present as the science specialism. The science specialism is a dynamic creature which—like a sea star—has changed and continues to change as it grows arms and legs over time, as new entities are absorbed into it, and as some parts solidify as other parts waste away or are discarded.

## RESOURCES

This school's science program can be considered resource-rich. It has been supported by external grants as well as by the school's internal resources, supported as one of three specialist subjects offered in the school. Resources specifically funded as part of the science program include a laboratory teaching and learning space, digital equipment (e.g., digital microscopes, probes, stopwatches, iPads™ and cameras), non-digital equipment (e.g., microscopes, glassware, torches, lasers), classroom animals, and a marine touch tank.

**Figure 4:** Students exploring a marine touch tank.

The selection and purchasing of these resources was done with advice from partner organisations, including the following:

- university aquatic scientists advised on suitable specialist scientific equipment and materials;
- university teacher educators advised on suitable digital devices; and
- a university architecture lecturer—together with members of the parent community—advised on the refurbishment of a room.

This advice was provided within a broader context of partnering, where conversations included discussion of possible learning activities and possible sites for learning, both in and out of school. There are many examples of how the resourcing of the program, manifesting in material investments and relations, has supported student learning in science and beyond, student engagement with schooling and with the community, and community engagement with the school. The following interview excerpt illustrates how investment in a marine touch tank provided a nexus for 'in' and 'out' of school, connecting people and places.

> *The touch tank's been extraordinary in the way we use that and link that to the natural environment and then when they go on their excursions and research they can then make the links back to home base and they'll sometimes bring creatures back too. We've got some terrific hermit crabs in there at the moment and there's also people bringing creatures in; fishermen and things … the touch tank's been particularly successful. (Principal interview)*

Over the life of the specialism thus far, material resources have exerted their own influence on the program, with some emerging at times as more central than others, with some not being utilised to the extent anticipated, and with some playing roles that differ from what was expected. For example, the classroom animals, initially purchased as a means of extending science into other curriculum areas and other spaces, and to bring the teaching staff as a whole into the science program, have emerged with other properties. The animals have played a central role in the school's symbolic work as it presents itself to the parent and wider communities. Classroom animals—which include a range of amphibians, reptiles, fish and large invertebrates—have featured photographically and in textual representations in school newsletters, school advertising and promotional material, and in promotional activities such as a 'creature crawl' tour targeting prospective students. The classroom animals *have* served as the object of science learning, with teachers and students involved in research and observation of their animals. However, as illustrated in the following interview excerpt, in terms of establishing and sustaining this school-wide program, their role in the symbolic work of the school is arguably more important in that it has gained the attention of students, parents and the wider community and has stimulated interest and conversations outside of classrooms about the science program at the school.

> *We have a Creature Crawl as part of Education Week, [a teacher] started it last year and I suppose it was to … have us start to be known in the community as a science specialist school. So we decided that we'd start with getting the kinder kids up and just seeing our environment, seeing the school celebrate education, so we had a Creature Crawl last year, we had a number of kinders, this year obviously word of mouth got round that you had to go to the Creature Crawl, it was a great event—we had 470 kinder children through this year … It was extraordinary and so each group came in and they … saw the creatures and then they did activities, they did some drama and things … they'd have a play and then they headed off … and then when they'd come back to enrol [with their parent(s)] it was really interesting when I'd take them on a tour: they knew where all the animals were 'The tortoises are down there' … So they just had this vision of the school layout in terms of creatures. (Principal interview).*

The examples of the marine touch tank and the classroom animals demonstrate how material resourcing of the science curriculum can serve multiple, complementary agendas. Equipment and materials purchased ostensibly to support the teaching and learning of science can become hubs and symbols of supra-curricular activities and connections, which in turn work towards the sustainability of the science specialism through their symbolic force—*what a school becomes known for.*

## PARTNERSHIPS

The program was founded upon, and continues to be supported and enriched by, partnerships with other organisations and individuals. Founding grants were based upon a partnership with a local university—with staff and students from both education and science faculties. Other partnerships have been developed as the program has grown and become known, including a partnership with the Melbourne Zoo and with an environmental monitoring project (Fluker Post Project (n.d.)—a citizen science system that allows community members to contribute towards the ongoing care of natural environments by taking photographs from fixed photo points, which contribute to longitudinal photo collections.) These partnerships have provided the impetus for a close engagement with the local environment and relevant environmental science and environmental management issues. They have also served as a source of expertise, where both teachers and students have benefited from professional learning activities, informal advice, classroom assistance, incursions and excursions.

These partnerships have provided opportunities for the pursuit of outcomes consistent with the 'knowledge producing schools' approach noted above, where students have initiated and contributed to authentic projects in their community, have worked alongside experts and, indeed, have been positioned as experts themselves. For example, students in Grades 5 and 6 have engaged with the local council's draft coastal management plan. This work has complemented these students' involvement in the Fluker Post Project (n.d.), where students have sought advice from local environmental organisations and university scientists on the placement of two Fluker Posts, which they now monitor. Student learning through these activities provided the capacity and impetus to make a submission to the council on the draft plan, and to recommend work that the council might undertake as part of their coastal land management duties. The following excerpts point to the types of work that the partnerships have supported and provide insights into outcomes such as student engagement, community engagement, and citizenship education.

*So the kids have … used the [local Council's] Draft Coastal Management Plan and they've used the Catchment Management Authority's management plan as well… We handed in [feedback to the Council] … most of the kids wrote … They said "The signage is not big enough." They said, "We don't know these things because we don't look at the signs; we're too busy getting to the beach." (Teacher interview)*

*[The students] came up with criteria … on what they think that we need in the area that a Fluker Post goes in. So they said we have to look for erosion, we have to look for if there's any flora and fauna … If there's a lot of people that go past … And then what will we get out of putting one in this area and then at the bottom, do you recommend this 'yes' or 'no'. (Teacher interview)*

*The [Catchment Management Authority] have got two photo points they want … on this side of the [river] mouth looking down towards the actual mouth to see pretty much whether it's opened or closed … [Some students] wanted to sit there and survey how many people walk past when we go on our bus trip which we won't have time to do, but I can tell them they can do that on the weekends if they want to go and sit there for an hour … But it's great because not only is it local issues and real environmental issues but they've got to think about the pros and cons of these sort of decisions around management and around collecting data. (Teacher, meeting between science teachers and academics)*

These excerpts also suggest cross-curricular learning opportunities, for example, in mathematics and in the humanities. In relation to the science curriculum, these types of undertakings have supported scientific literacy (e.g., thinking scientifically, appreciating science as a human endeavour) (Tytler, Symington, Kirkwood, & Malcolm, 2008; Campbell, 2012), and engagement with socio-scientific issues (Sadler, 2004; Russell & Hodson, 2002), as well as supporting scientific understandings in earth sciences and biological sciences. Using local, familiar places as foci for incorporating a combination of foundational science understandings, scientific literacy and socio-scientific issues, can increase the relevance of the curriculum to students' personal contexts (Calabrese Barton & Osborne 2001; Smyth, Angus, Down & McInerney, 2008); thus, increasing the meaningfulness of learning activities through a critical engagement with curriculum content and processes (McInerney, 2009). This approach is also more likely to speak to marginalised learners by offering a challenge to academic subjectivities that objectify knowledge and disavow links with students' lives (Kincheloe 2001, 2004; Bayne 2009; Tytler, Symington, Kirkwood, & Malcolm, 2008). These multiple connections, relations and outcomes contribute to the sustainability of the program as it becomes increasingly entangled with the trajectories of other people, projects and places.

## COMMUNITY INVOLVEMENT

Further to formal partnering, the school has actively sought to connect with the wider school community, local community groups and individuals, as a way of enriching the program, building sustainability and accruing mutual benefits. Strategies to involve the school community include events such as family science nights and science fairs, as well as drawing parents/guardians into excursion and incursion activities to promote mutual interest, to share learning and to share expertise. Community groups and organisations, such as Estuary Watch, Parks Victoria, and local 'Friends of' environmental groups have also been informally recruited into the program, participating in excursions and incursions and resource sharing.

*We got a phone call from Melbourne Zoo asking us if we'd come on board with this project called Seal the Loop. And it's all about marine entanglement. They knew about [a university student who was volunteering in our science program] … So they thought they'd try us first. And of course we said, "yes please!" … So we're going to have, on the community day—*

> *basically we run three activities at the beach … We've got two [ideas for activities]; you [directed at academics] might be able to help us with the third activity. (Teacher, meeting between science teachers and academics)*

This excerpt illustrates the school's enthusiasm for partnering and community engagement. This is more than just an interest in getting others involved and taking advantage of established projects and external resources. The capacity to respond positively to such opportunities also requires a flexible approach to curriculum, where curriculum is seen as a fluid entity that can respond productively to new entities.

## PLACES AND LOCATIONS

Further to people and resources, places and locations have also been incorporated into the science program as sites of student and teacher learning and as sites or objects of study. Local beaches, dunes, estuaries and waterways have been appropriated as sites of learning. Student excursions regularly include observations of, interactions with and collecting samples from local environments. Local environments have also been positioned as entities that must be taken care of, with the school, teachers and students taking up positions of custodians and advocates. Places such as the university campus, the Melbourne Zoo and other environmental education sites have also served as locations for student learning and teacher learning.

The appropriation of places affords generative connections with out-of-school locations, adding to the experience of authenticity and bringing other people into conversations about science. For example, early in the life of the program, a professional learning session was provided by a university aquatic scientist to the specialist science teachers. The teachers and the university staff member visited rock pools at a local marine sanctuary. During this session, the teachers learned about life forms that might be observed in this environment. One learning involved a rule of thumb for identifying whether a sea snail is a herbivore or a carnivore. Since that session—now almost three years past—numerous student excursions have visited the marine sanctuary. Late in 2013, at a Seal the Loop community day, where Grades 3 and 4 students were running activities intended to engage the wider community with issues associated marine life entanglement, a Grade 4 girl was overheard explaining to a group of participants how to identify whether a sea snail is a herbivore or carnivore. This explanation was given spontaneously by the student while people in attendance were waiting for the next pre-organised activity to begin. This is one of many examples where the bringing together of local environments and authentic audiences, coupled with a positioning of teachers and students as burgeoning experts, leads to ownership of learning, and to student advocacy for science and the environment.

## PROGRAM PROMOTION

An important part of the program, which has served to fuel further growth and to solidify various aspects, is ongoing promotion through the school newsletter, local media items, school promotional material, social media, as well as school and public events. Many overlapping strategies have been implemented in order to talk, write and photograph the program into existence. The symbolic importance of entities such as the classroom animals has already been mentioned above, as have public events that have brought the wider community into the program. Those mentioned thus far are only a small part of the ongoing activities that communicate the program, and indeed science, within and beyond the school and its parent community. Others include regular online dissemination of photographs, videos and text via the school's Facebook™ account, website and blog. In many ways, these channels effectively set the innovation loose, freed from particular geographical locations and accessible by a potentially unknown audience who might in turn take opportunities to speak back to the innovation. Emergences where someone from outside of the school is then recruited to the program may seem serendipitous, but they emerge within a network of activities and objects and channels where an active dissemination and opening up of the program to outsiders and an openness to shifting the centre of the program—or to developing multiple centres—is an integral part of how the program has been implemented and has evolved.

For example, the partnership with the Fluker Post Project emerged after the leader of this environmental monitoring project who lives 300 kilometres from the school visited the town, happened to notice a media item that appeared in the local newspaper that day featuring the school–university partnership, and then emailed one of the authors. We believe that such seemingly unlikely coincidence of text, person, place and interest, is indeed no coincidence at all. Those involved in this program—the principal, the teachers, the students, the parents, partnering organisations and community members—promote the project so actively that approaches from those on the 'outside' who desire to be on the 'inside' are a regular occurrence.

## CONCLUSIONS: PRINCIPLES OF SUCCESS

We have provided a description of the science specialism in terms of the type of resources, people, places and other entities that are involved, and also in terms of the character of the program 'in motion'—how it moves and grows and sustains itself. Four interrelated characteristics are identified below which we believe could be translated into guiding principles for the establishment and maintenance of similar school-wide curriculum innovations.

1. *Enabling expertise, responsibility and advocacy*—Both teachers and students involved in the science specialism have been positioned as burgeoning experts who have a sense of responsibility for the environment and who can draw on scientific learnings and understandings to monitor and advocate and act for the improvement of the ecological life of local places. This has been achieved through multiple and diverse encounters with particular locales and through connections and conversations with others about relevant issues, observations and actions. Through these encounters, students have been positioned as *scientists* as they make authentic and sustained links between the curriculum and worlds outside of school.
2. *Generating conversations*—Many channels have been used to communicate the science specialism and its activities to teachers, students, parents, other organisations and groups, as well as to the wider community. This symbolic work is critical to the maintenance of a curriculum innovation that seeks to connect with, and to recruit input

## TIPS TO GET STARTED

- Explore funding options—even very small grants can help to build up resources, interest and momentum, and they can be used as leverage when applying for further funding.
- Invite others to help—look to your parent community, local community, and local organisations to see what expertise is available.
- Communicate, communicate, communicate—let the school community, the local community and the world know what you are up to. Use multiple channels and media for sharing. Science learning is very photogenic, so take advantage of that to attract attention and input. Run whole-school science events that promote awareness and involvement of the school community.
- Don't stick to plan—be flexible and drive decisions based on sound principles rather than preconceived ideas.

from, the community. Ongoing communication on multiple fronts enables the diverse activities and entities that constitute the science specialism to hang together and to be seen to hang together, and this work supports the recruitment of resources, ideas and the labour of others.

3. *Openness to others*—Interest from other people, groups and projects has been met with enthusiasm. This requires a level of comfort with the risk and labour involved in working with people from outside of the school and with existing projects that have their own interests and trajectories. This type of work requires a flexible view of curriculum that sees it as emergent and able to respond productively to opportunities as they present.
4. *View of curriculum innovation as dynamic and changing*—Solidification of programs in schools usually signal the beginnings of their decline. The ongoing generation of enthusiasm and interest, the symbolic work involved in this, and the ongoing recruitment of other people, resources and ideas, requires a flexible approach to curriculum planning and pedagogy, driven by principles and frameworks that are constantly under review and themselves open to change and growth.

These characteristics imply the conception of curriculum innovation as ongoing work and as an entity that morphs overtime in order to flourish.

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