MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

Science community engagement with schools: Scoping the field

Ally Bull with Rachel Bolstad and Lorraine Spiller

Science in the New Zealand Curriculum

This report is one in a series written for the Ministry of Education by The New Zealand Council for Educational Research in collaboration with Learning Media and The University of Waikato. The work was divided into three strands: Curriculum support for science, science community engagement, and e-learning in science.

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2012

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ISBN 978-1-927151-68-6

Acknowledgements

Our thanks go to the science providers and teachers who took time out from their busy schedules to answer survey questions and talk to us about this project.

A large team of people have contributed to this project in a variety of ways. NZCER team members include Alex Barnes, Jessica Hutchings, Sally Robertson, Jane Gilbert, Rose Hipkins, Edith Hodgen and Beverley Thomson. Bill McIntyre at Massey University and Pauline Waiti through CWA New Media have also collaborated with us on this project.

Finally, this work would not have been done without the funding provided by the Ministry of Education.

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1. Introduction

This report documents the first phase of a project looking at school–science community engagement initiatives. This project is funded by the Ministry of Education and is being carried out by a research partnership led by the New Zealand Council for Educational Research (NZCER) in collaboration with CWA New Media and the University of Waikato. It is one piece of a three-part research project related to improving achievement in science education.[1]

The *science community engagement* research project aims to:

- identify the range and variety of ways people and groups from the "science community"[2] interact with schools (teachers and students) to support students' learning and engagement with science
- generate evidence-based recommendations for strengthening school–science community partnerships that can support school students' science learning.

The first stage of this project involves gathering information about current programmes, projects, initiatives and partnerships involving the science community and schools. Specifically this phase of the project seeks to find out about:

- the *kinds* of connections/partnerships that exist between schools and the science community
- the aims of these partnerships/engagements
- who they are targeted at and who is involved
- how they are resourced
- the perceived benefits to schools (teachers and students) and to the science community partners
- the issues and challenges for these connections/partnerships.

This report briefly outlines the data collection methods used for the first phase of the project before presenting an overview of the findings. The summary of findings is followed by some illustrative examples of a wide range of initiatives and particular attention is given to initiatives aiming specifically to support Māori and Pasifika learners. The report then briefly outlines some international initiatives and concludes with a discussion of the emerging issues.

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[1] The related projects are Curriculum Support in Science and E-learning in Science.

[2] Here we are defining "science community" as people and organisations whose major purpose is the practice of science, and/or to provide professional support for the practice of science and/or to promote science engagement and learning among school-age learners.

2. Methodology

The first phase of the science community engagement project involved:

- A teacher survey: A set of questions about science community engagement with schools was included in an electronic survey that spans all three projects in the wider programme of work. This survey was delivered electronically via the Survey Monkey platform. Requests to complete the survey were circulated in several ways: a direct request was sent via the Royal Society's email network of science teachers; a general announcement was posted on the front page of NZCER's website and the same announcement was posted on the TKI Curriculum On-line front page. In the week before the survey closed we circulated an additional request via NZEI's principal network, with the aim of increasing the number of responses from primary teachers. (See Hipkins & Hodgen, 2012 for more details of this survey.)
- An electronic survey of science community "providers" who work with schools was also developed. Emails with a link to this survey were sent to tertiary institutions, Crown Research Institutes (CRIs) and other science research organisations, Education Outside the Classroom providers, professional associations, the Royal Society, science-based business associations, environmental and Māori science ventures and philanthropic organisations and various community trusts. Extensive use was also made of the researchers' personal networks.
- A brief literature scan was carried out. This included a Google search using the key words "scientists in schools", "school science partnerships", "science outreach", "science community" and "school partnership". A number of education databases (e.g., ERIC, Ebsco Education Research Complete, Google, Scholar, Trove, A+ Education (Australian Education index), British education index) were also searched for information about science community and school partnerships.
- Māori and Pasifika research team members used their personal networks and contacts to identify science community initiatives that were targeted specifically at Māori and Pasifika students in English-medium schools. This search proved difficult and time consuming and will require further investigation in the next stage of the project.

3. Summary of findings

Survey responses were received from 179 secondary teachers, 122 primary teachers[3] and 43 science providers.[4] This report focuses mainly on the responses from the science provider survey as the teacher survey is reported separately.[5] Responses from the teacher survey and information from a brief scan of the literature are included wherever they can provide a richer understanding of a situation.

The range of initiatives

There is a huge range of programmes and initiatives currently operating in New Zealand that are designed to link the science community with schools. These range from "one-off" events to ongoing work with schools. "One-off" events include students visiting science workplaces or universities, career information days or presentations, open days, science fairs or other competitions, road shows, and scientists visiting schools to talk about a particular topic. The ongoing work with schools includes initiatives where students are mentored by scientists or tertiary science students, internships (such as the Gateway programme) and scientists working alongside schools in local projects (which are often environmental). Some scientific institutions (such as the Liggins Institute) and many Education outside the Classroom (EOTC) providers have their own educators and classrooms, and provide "hands-on" programmes for students away from the school. Some universities also provide intensive residential courses for school students. There is also a range of Web-based initiatives. These include virtual field trips, connecting with scientists online and the provision of science resources for schools. There is also a small number of initiatives, such as the Teacher Fellowships administered by the Royal Society, that involve teachers working alongside scientists. Some institutions lend science kits to schools to support investigations.

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[3] Details relating to the kinds of schools represented in the teacher survey and teacher characteristics are reported in Hipkins and Hodgen (2012).

[4] Note: Teachers and science providers were asked different questions. The section of the teacher survey relevant to this project and the science providers' survey are included in the appendices to this report.

[5] See Hipkins and Hodgen (2012).

The initiatives vary widely in their scale. At one end of the continuum are programmes such as GLOBE[6] which involves students from several countries and at the other end are initiatives such as a school inviting parents with science backgrounds to talk to groups of children on a particular topic. Some initiatives are very complex with many partnering organisations. Some initiatives are jointly delivered by the science provider and the school, while in others either the provider or the school takes on the main role.

Aims of the initiatives

The initiatives fall into two broad categories—initiatives that aim to encourage more students to go into science careers, and initiatives that aim to engage *all* students in science learning. In our survey, science providers were asked how their initiative supported student learning and engagement. It seems that most initiatives have multiple aims. Almost all (41 out of 43) of the science providers responding to the survey said their initiative "puts science learning in a more hands-on, fun or engaging context" and "supports students to undertake science inquiry/research in a real context or for a real purpose". Approximately two-thirds of respondents also said their initiative "shows students what working scientists do/what a job in science looks like", "helps students make decisions about further study and career pathways" or "enables students to build relationships with science role models/mentors". Twenty-two of the respondents said their initiative "connects science learning with Māori culture, knowledge, values, world views, ways of doing things". Only five respondents said their initiative "connects science learning with Pasifika culture, knowledge, values, world views, ways of doing things".

Target groups

When asked "Whose learning is the initiative/partnership/programme designed to support?" the science providers responding to the survey all mentioned students (at varying levels of the school system) and many also mentioned teachers. Some initiatives targeted students at a specific level of the school system (e.g., primary or senior secondary), while others were aimed at students at all levels. A few initiatives targeted specific groups of students (e.g., Māori or Pasifika students or students who needed extension in science or were interested in careers in science). These initiatives were often aimed at senior secondary students.

[6] The Global Learning and Observations to Benefit the Environment (GLOBE) programme is a worldwide programme aimed at secondary- and primary-aged students. "GLOBE's vision promotes and supports students, teachers and scientists to collaborate on inquiry-based investigations of the environment and the Earth system working in close partnerships with NASA, NOAA, and NSF …" For more details, see www.globe.gov

Resourcing

Resourcing appeared to be a concern for many of the initiatives.[7] Universities, CRIs and other science research organisations often reported funding the initiatives themselves. Some initiatives are supported by the Ministry of Education, and others by local and regional councils, business and philanthropic groups and community trusts.

Benefits

Although providers often reported their initiatives supported both teacher and student learning, teachers surveyed were likely to see science community engagement initiatives as benefiting student learning rather than their own. For example, 52 percent of the primary teachers surveyed reported they had used parents/whānau with expertise relevant to a topic to support student learning, but none had used this resource for their own learning. While more than half of both secondary and primary teachers had used museums, science and technology centres, aquariums, zoos, planetariums (or people who worked at these centres) to support student learning, but only 5 percent and 7 percent respectively said they had used these resources for their own learning.

The majority of initiatives in New Zealand are portrayed by the science providers as being mainly beneficial to schools. Very few science providers responding to the survey mentioned benefits to the science community (although this question was not directly asked). One exception to this pattern is the Liggins Education Network for Science (LENScience)[8] programmes which explicitly acknowledge that neither the scientist nor the science educator alone can effectively communicate the work of science within society. These programmes are clearly seen as being beneficial to both scientists and educators. In fact, the recognition of the need for collaborative partnerships between scientists and educators to support greater scientific literacy in society was central to the development of LENScience.[9]

Another respondent in the science provider survey (Eastbay REAP[10]) also described an initiative that was a joint venture where schools and the science community were working *together* to benefit the whole community:

> We had a 'big brainstorm hui' at the end of last year and invited any and all professionals that work with everyday science/Putaiao in their mahi along with teachers from all our schools and kura. The purpose was to identify how schools/kura and the real world of science can work more collaboratively together to create an area of excellence in the Eastern Bay of Plenty. The hui allowed the community to suggest what they could offer to schools and what schools needed from the community to engage their students into science/Putaiao

[7] This is discussed further under "issues".

[8] See http://www.lenscience.auckland.ac.nz/uoa/

[9] See Bay, Sloboda, Vickers and Mora (2012).

[10] REAP is a not-for-profit lifelong learning Non-Government Organisation (NGO) that provides a variety of prgorammes to strengthen the wellbeing of rural communities.

> fields. Action plans and sub-committee groups were formulated and now we have a long term working plan to embark on. The first job is to get a database of local expertise collated and distributed to schools with the idea that teachers can then access science experts who are happy to work with students and classes during the year.

A third exception is the Department of Conservation's *National Education Strategy 2010–2030* (Department of Conservation, 2011) which highlights the benefits of scientists and schools working closely together for the benefit of all. The strategy:

> offers scope for creative, collaborative partnerships to inspire young New Zealanders to engage with the natural world, get involved and make a difference. Me mahitahi tātou i roto i te tiaki i te taiao. Let us work together for the benefit of the environment. (p. 5)

Issues/challenges

A number of issues and challenges were identified by the science providers, both for themselves and for schools. The most commonly cited problem was resourcing. Working with schools was often seen by the science community as worthwhile but placing considerable demands on scientists' time and the funding available to them. As one respondent put it:

> Considerable demands on individual(s) involved, plus funding costs for the organisation. I've listed above what I'm personally involved in: these are things I do because I'm personally committed to them—I think that building and maintaining these links are incredibly important to the future of science in NZ—but it's on top of my 'day job' and I do worry that if I were to leave my day job then much of this would not continue. (Science community survey respondent)

Sourcing funding for *sustaining* initiatives after the initial stages was seen as particularly difficult. Other issues/challenges mentioned were:

- finding ways of informing schools about programmes that are available
- encouraging more staff to become involved in work with schools
- developing a shared language so that schools and scientists can communicate more easily
- laboratories not being designed for school visits
- students' and teachers' negative perceptions about science
- the need for science providers who can speak te reo Māori.

Science providers also reported a number of factors that, in their view, made it difficult for schools to engage in science community initiatives. These included a crowded curriculum, school timetables, transport costs and difficulties in providing enough adult supervision. These issues were also echoed by respondents in the teacher survey.

Response patterns in the teacher survey indicate that primary teachers are much more likely than secondary teachers to access the expertise of parents/whānau and/or EOTC providers such as regional councils, Enviroschools facilitators and so on. Secondary teachers, on the other hand, were more likely than primary teachers to access support from tertiary education settings.

Teachers in high-decile schools were more likely to say they had ready access to scientists (or at least that they could access scientists given time to plan) than teachers in deciles 1 or 2 schools. Teachers in their first 2 years of teaching were more likely than all other respondents to say they had never used tertiary science students, working scientists, parents or whānau with expertise, the Fonterra science roadshow, LEARNZ virtual field trips or Royal Society resources to support their classroom programmes. Interestingly, teachers with more than 11 years' teaching experience were more likely than other teachers to say they had not recently accessed these same resources.

Despite these differences, teachers responding to the survey largely agreed that "engagement with people from the science community is essential for 21st century science education programmes" (89 percent of primary teachers and 71 percent of secondary teachers agreed or strongly agreed with this statement).[11] It appears that teachers do value engagement with the science community but for many there is a gap between what they say is important and what they report actually happens.

[11] For details, see Hipkins and Hodgen (2012).

4. Illustrative examples of the range of current initiatives

As already outlined, there is a wide range of existing initiatives and these could be categorised in a variety of ways. Below we begin by differentiating between "one-off" and ongoing initiatives. We then describe two other groups of initiatives—one group focuses on teacher professional learning and the other on student competitions and awards.

"One-off" initiatives

Many of the university staff who responded to the science providers' survey reported involvement in a large number of "one-off" initiatives. These include:

- running School Bio days for senior biology students sitting scholarship exams
- "interactive days" for Year 10 students that involve students in hands-on activities in chemistry and physics labs such as making a solar cell from blueberry extract and riding on a hovercraft
- teacher evenings where teachers are invited to the university to hear presentations about chemistry topics
- judging at science fairs
- giving talks for primary and secondary students on an ad hoc basis.

Some of these "one-off activities" can extend over several days; for example, Otago University runs "Hands-on Science" which is a programme that brings senior secondary students from all over New Zealand to the university for a week in the summer holidays. This programme provides students with opportunities to try a range of activities and get a taste of what studying science at university could be like.

Many EOTC providers are also involved with "one-off" activities. These include zoo staff providing visiting classes with hour-long learning sessions based on a particular theme such as animal adaptations or conservation, and Department of Conservation staff delivering programmes to support teachers who bring students to a particular area on school camp.

The Fonterra Science Roadshow provides interactive learning experiences targeted at students from Years 5–9. The roadshow sets up at a "host school" and other schools in the area visit for 80-minute sessions. Students at the host school have the opportunity to be "explainers" and assist with specific exhibits. A complementary classroom resource is sent to teachers when a booking is made.

Some "one-off" events appear to have the potential to "seed" ongoing initiatives. Earlier this year GNS Science, with support from the Todd Foundation and the National Aquarium in Napier, and advice from the Royal Society of New Zealand, ran a 2-week "geocamp". The programme was targeted at 10–13-year-olds in low-decile schools, their teachers and other science educators in the Hawke's Bay. The camp involved hands-on field-based investigations, supported by two scientists and a science educator from GNS Science, and culminated in the "Dinosaurs and Disasters Expo" where students shared their new knowledge with the public. Anecdotal feedback suggests this immersion experience was a powerful learning experience for students and teachers. Two of the four schools involved are planning to set up and run their own geocamps and some of the teachers involved are now keen to establish a local branch of the Primary Science Association following their experience with the geocamp.

Ongoing relationships with schools

The information we collected, via the survey and the literature scan, suggests that there are far fewer initiatives that involve the science community and schools engaging on an ongoing basis. Where this does occur, environmental education is often the theme. For example, Wellington East Girls' College has for several years worked with Massey University on the issue of sustainable water. Earlier this year five emergency water tanks were installed by Year 12 students at the college as part of this project. Another example is Kaikorai Valley College in Dunedin. Since 2004 students and teachers from the college and other local schools, undergraduate students from the university and members of the community have worked together to monitor water quality and enhance the Kaikorai Stream.[12]

Mentoring students or internships are a second example of ongoing relationships between the science community and schools. For example, the Āwhina whānau at Victoria University has been running outreach activities, including mentoring secondary students, for more than a decade. This project is described in the Pasifika initiatives section of this report. ESR has, in the past, hosted a local college student one day a week working in their laboratory as part of the Gateway programme.

Initiatives that focus on teacher professional learning and development

Teacher fellowships, funded by the Government and administered by the Royal Society of New Zealand, provide opportunities for teachers to work in research organisations for two terms. There are currently two types of fellowship and, although each has a different focus, both provide opportunities for teachers to work alongside scientists.

[12] For details of this project, see McMillan and Binns (2011).

Professional learning and support for teachers is also available online. For example, the Science Learning Hub (funded by the Government and managed by Waikato University) is developed by educators in collaboration with scientists. It provides resources for teachers of Years 5–10 that explore current scientific research and are closely linked to *The New Zealand Curriculum* (Ministry of Education, 2007). This site also has stories and videos about working scientists that teachers can use directly as resources for student learning.

There are a number of other sites operated by a range of science organisations that provide up-to-date content knowledge and frequently units of work for teachers. Some examples are Evolution for Teaching (http://sci.waikato.ac.nz/evolution) and The New Zealand Physics Teachers' Resource Bank (www.physics.school.nz). GNS Science employs a science educator who, as part of his work, designs Web-based resources to support teachers with topical events or issues (e.g., earthquakes).

Student competitions, awards and incentives

The Royal Society of New Zealand offers a range of awards and competitions to support student participation and achievement in science and technology. Some examples are: *Realise the Dream* and *Crest. Realise the Dream* is a competition for secondary school students (Year 9–Year 13) who have undertaken a piece of outstanding science research of technological development. *Crest* is an international awards scheme to encourage students of all ages to become involved in science, technology and environmental studies. It provides a model for students to work with consultants or mentors outside school. Many research organisations provide sponsorship (and sometimes hands-on support) for regional science fairs.

5. Initiatives targeting Māori students

In this project, as well as identifying the range of school–science community engagement initiatives we set out to identify initiatives that were specifically aimed at Māori students in English-medium schools. If the New Zealand education system is to improve its overall levels of student achievement, there is an urgent need to better meet the learning needs of student groups who in the past have been underserved—specifically Māori and Pasifika. The Māori Education Strategy *Ka Hikitia–Managing for Success 2008–2012*[13] emphasises partnerships—between schools and learners, between schools and whānau, hapū and iwi, and between schools and other education providers—as central to enhancing Māori development and self-determination.[14] Research shows that strong school–community connections (including the science community), combined with culturally appropriate, effective pedagogies that take account of the different knowledge and experiences students bring to their schooling, and foster learning relationships are critical to Māori achievement.[15]

In our survey of science providers, half (22 out of 43) of the respondents claimed that their initiative, "connects science learning with Māori culture, knowledge, values, world views, ways of doing things". However, it was not at all clear from the survey data what respondents meant by this. Some initiatives included a "te reo" strand. For example, LEARNZ virtual field trips now include a number of audioconferences in te reo, and the New Zealand Physics Teachers' Resource Bank (www.physics.school.nz) provides:

> some multimedia resources starring New Zealand students doing, obviously enjoying, and explaining physics to their mates in English and te reo Māori.

There were initiatives aimed specifically at low-decile schools with high numbers of Māori and Pasifika students, and others that involved mentoring of Māori and Pasifika students doing science courses at senior secondary level.[16] Some of the science providers surveyed mentioned that they collaborated with iwi groups and Māori organisations, but the nature of this collaboration was not clear.

A brief scan of the literature on school–science community collaborations identified a limited number of science community initiatives specifically targeted at Māori learners. Some of these were run from universities. For example, Otago University runs science wānanga. These marae-based science camps are run through the year, in various locations, and target Māori students in

[13] Ministry of Education (2009).
[14] See also, Alton-Lee (2003).
[15] See, for example, Bishop, Berryman, Cavanagh and Teddy (2007); Bishop, Berryman, Tiakiwai and Richardson (2003); Bishop and Glynn (1999); Wylie, Hodgen and Ferral (2005).
[16] Examples of these initiatives are discussed in the Pasifika section of this report.

Years 9–13. Students have the opportunity to work in the field and in the laboratory with scientists while participating scientists have the opportunity to stay on the marae, engage with the Māori community and learn about tikanga.

Others initiatives are run by CRIs, local or regional councils or charitable trusts in collaboration with Māori. For example, the National Institute of Water and Atmospheric Research (NIWA) has recently developed an estuarine monitoring toolkit, Ngā Waihotanga Iho, to provide tangata whenua with tools to measure environmental changes in their estuaries. The toolkit is comprised of a series of modules for use by community groups and secondary school students. The manual that accompanies the toolkit is in both English and te reo Māori.[17]

The Enviroschools Foundation aims to integrate Māori perspectives into their programmes. They also offer one programme, called Te Aho Tū Roa, in te reo Māori. Oturu School in Northland is a decile 1 full primary school where 100 percent of the students are Māori. This school is an example of an innovative Enviroschool producing olive oil from their olive trees, honey from their bees and a range of natural pharmaceuticals from their gardens. The most recent Education Review Office report on the school noted that, "the strategies and initiatives that the principal and teachers are implementing are having a very positive impact on Māori engagement and achievement" (Education Review Office, 2010, p. 4).

The Cawthron Institute, the Institute of Environmental Science and Research Ltd (ESR), Scion and Te Rūnanga o Kaikōura Inc are currently collaborating on a project called "Up-the-pipe" Solutions. This project, funded by the Ministry for the Environment's Waste Minimisation Fund, investigates how individuals in a community can work together to reduce the level of environmental contamination from household wastes. Secondary school students have been involved in the project, which will culminate with a workshop for them at the local marae. This workshop involves students making eco-friendly cleaning products, working with data to make decisions about which products are safer for the environment and thinking about what influences the decisions they make when purchasing body care products.

Other initiatives are driven by the health sector. Training for a career as a health professional has widespread support from universities, wānanga, government, non-government, iwi and pan-Māori training organisations. For instance, Kia Ora Hauora "Supporting Māori Health" is a national programme that was established in 2008 to increase the overall number of Māori working in the health and disability sector. It is funded through district health boards and has a national base in Auckland and four regional co-ordination centres. It has a website with resources and advice for students, career advisors and whānau. The regional centres also do some "face-to-face" work with schools; for example, attending gala days or running sessions for school leaders about the importance of engaging Māori students in science. Te Rau Matatini also provides online resources for secondary students.

[17] For more details, see http://www.niwa.co.nz/our-science/te-kuwaha/research-projects/all/ngA-waihotanga-iho-a-iwi-estuarine-monitoring-toolkit

6. Initiatives targeting Pasifika students

We found few examples of the science community engaging with schools with the specific aim of improving outcomes for Pasifika students.

Survey findings

The survey of science providers identified three projects with a major focus on Pasifika students:

1. Te Rōpu Āwhina whānau, based in the Faculties of Science, Technology, Engineering and Architecture Design (STEAD) at Victoria University has a comprehensive outreach programme involving a number of initiatives aimed at Māori and Pasifika students.[18] Āwhina Schools Outreach involves regular visits by mentors to local schools to work in class with teachers and students on science projects. These school visits are supplemented by visits for teachers, students and their whānau to the university campus. Āwhina Community Outreach involves 1- or 2-day local and regional community-based events held at various venues (marae, rugby club rooms, event centres) to provide participants with first-hand experiences of the various STEAD disciplines through exciting and enjoyable "hands-on" activities. These events attract mainly Māori and Pasifika participants of all age groups. For example, the "Cybrospace Summer Wānanga" is a 4-day campus-based experience for selected Year 12 and Year 13 Māori and Pasifika science and maths pupils. Participants come away from this experience with a kete of resources to share with their friends and whānau.

2. In addition to these activities, Āwhina collaborates with the MacDiarmid Institute for Advanced Materials and Nanotechnology on the Discovery Awards programme. This programme brings Year 12 and Year 13 Māori and Pasifika students to New Zealand universities and research laboratories for intensive, research-based experience in science. These students are selected for ability and interest in science by the MacDiarmid Institute in consultation with the Āwhina whānau. Since 2008, 32 students have participated.

3. The third provider offering initiatives targeting Pasifika students was the Liggins Education Network for Science (LENScience). The LENScience Summer Programme is open to Year

[18] While Te Rōpū Āwhina focuses on Years 7–13 Māori and Pasifika pupils they also include non-Māori, non-Pasifika pupils from low socioeconomic backgrounds. Their kaupapa is to produce professionals in STEAD disciplines who will contribute to Māori and Pacific community development and leadership. Their work is supported by Te Puni Kōkiri and the MacDiarmid Institute for Advanced Materials and Nanotechnology.

13 students and there are scholarships to support students who are from a decile 1–4 school or who have Māori or Pacific ancestry.

Environmental scan

Researchers made contact with approximately 30 organisations, in their search for science community/education partnerships targeting Pasifika students. The majority of the contacts led to two types of initiatives—neither of which specifically met our criteria. These were homework centres providing support in all curriculum areas (not just science) and initiatives that, because they are aimed at low-decile schools, target Māori and Pasifika students by default.

Seven initiatives focused on Pasifika students *and* the sciences. These were mainly targeted at senior secondary students. One, at Whitireia Polytechnic, now begins at the junior secondary science level. Whitireia originally aimed their programme at Years 11 and 12 students but found that they needed to start earlier, because by senior secondary level many Pasifika students had already dropped science. The programme now has two parts: it works directly with parents so they are able to support their children making choices for NCEA; and it works with teachers to develop science modules in "relevant contexts" (e.g., heat/umu for students in Years 9 and 10).

Science initiatives targeting primary-aged students appear to be even less common although there are a number of initiatives that aim to lift engagement/achievement in general, especially through developing better relationships between schools and the communities they serve. For example, Sylvia Park primary school, with funding from the ASB Community Trust, employs a project co-ordinator to facilitate a learning partnership between the school and its largely Pasifika community. An example that does have a focus on primary science is the Curious Classrooms programme and, as it involves South Auckland schools, it also has, by default, a Pasifika focus. This programme was initiated by the Todd Foundation and aims to connect schools with an external science provider to increase students' engagement with science.

To sum up then, there appear to be very few science community–school engagement initiatives that are specifically designed to support the needs of Pasifika students. Those that do exist seem to be targeted mainly at the senior secondary school and have a focus on careers in science, particularly health-related careers.

In the report, *Science Education for the Twenty First Century* , the Prime Minister's science advisor argued that science literacy is essential for all New Zealanders, and that developing closer relationships between the science community and education community is a way forward for all schools. The difficulty we experienced in identifying school–science community partnerships designed to enhance science learning for Māori or Pasifika students makes this an important area of inquiry to pursue further. Despite considerable effort we found very few examples. It is possible that they exist, but as yet we have not found them. Another possibility is that the need for such initiatives is not recognised.

Our survey of teachers (see Hipkins & Hodgen, 2012) showed that 41 percent of primary teachers and 36 percent of secondary teachers agreed with the statement that "science is the same for everyone: we do not need a specific emphasis on Māori or Pasifika students". Twenty-nine percent of primary teachers and 23 percent of secondary teachers were unsure. Given that there are initiatives in other areas that specifically target Māori and Pasifika needs, is this apparent lack of initiatives linking the science community and Māori and Pasifika learners something to do with the way that science itself is perceived? What, then, is the potential for science community–school partnerships to improve outcomes for Māori and Pasifika students?

In the next section of this report, we report on a brief scan of the international literature before turning our focus to a discussion of what this all means.

7. The international literature

A scan of the international literature provided examples of all the types of science community and school engagement initiatives found in New Zealand. Internationally there are some more intensive and larger scale initiatives that are potentially of interest. We outline four of these below.

The *Australian Science and Mathematics School (ASMS)* is an example of a university and a school working together in a close collaboration. *ASMS* is a specialist public school that caters for the three final years of schooling (Years 10–12) before entry into higher education. It draws on students from a wide range of schools, and selection is based on interest in science, rather than high levels of current achievement. This school was established in 2002 in the grounds of Flinders University, South Australia. The *ASMS* is building a science curriculum for senior secondary students that specifically connects with the new sciences such as nanotechnology, aquaculture, biotechnology, laser science and communication technologies. *ASMS s*tudents and teachers work alongside university professionals and industry researchers to develop a curriculum linked to the latest developments in the field. Students gain understanding of the traditional disciplines as well as deep insights into the new sciences. As well as providing innovative teaching and learning, *ASMS* also serves as a state-wide focal point for professional development and research into reforming science education.[19] This initiative is an example of one where the partnership between the school and the university is central to what the school does—this collaboration defines the school's special character.

Another project of interest in Australia is the *Scientists in Schools (SiS)* project. Unlike most projects of this type around the world, the Australian project involves repeated visits between partners over an extended time frame, rather than one-off visits from a scientist. *SiS* is an initiative of the Australian Government Department of Education, Employment and Workplace Relations and is managed by CSIRO. It began as a pilot project in 2007 and its success has led to ongoing funding. In this project, individual teachers are partnered with scientists and the median length of partnerships is about 18 months. The initiative has been comprehensively evaluated during its operation and teachers, scientists and students report benefits.[20]

The *Scientist in the Classroom Partnership (SCP)* in the United States establishes partnerships between science teaching fellows (graduate students and postdoctoral fellows in science) with Nashville middle school science teachers. The programme has three major components. The first is a 2-week long summer workshop where teachers and fellows develop working relationships and

[19] For more details, see http://www.asms.sa.edu.au/Pages/default.aspx

[20] For more information, see www.scientistsinschools.edu.au/evaluation.htm

plan lessons and activities for the year. The second component involves the science teaching fellows working with the teachers in their classrooms one day a week throughout the school year. The final component consists of monthly seminars for the science teaching fellows. These seminars are designed to provide a forum for feedback for the teaching fellows and provide them with reflection time. The *SCP* is a collaboration between four tertiary institutions.[21] The programme was launched in 2000. In 2010, funding was gained to evaluate its impact on students' attitudes and attainment in science, teachers' confidence in science teaching and graduate students' attitudes toward outreach programmes. The evaluation also looks at the impact that mentoring minority group students has on scientists.

Pollen: Seed cities for science in Europe provides an example of whole communities working together to support primary science education. *Pollen* was a research and development project supported by the European Commission Directorate-General for Research. It was launched in January 2006 and took place over a 3½-year period. The project focused on the creation of 12 "seed cities" throughout the European Union. A seed city is an educational territory that supports primary science education through the commitment of the whole community. In each seed city the whole community was involved—local authorities, local representatives of the central ministries, the scientific community and schools, teacher training centres, parents' representatives as well as regional firms. The project's main aim was to develop and support inquiry-based learning in science in primary schools through the provision of teaching and assessment resources and professional development. It included an interactive Web portal to encourage the exchange of ideas and provide support at local, national and European levels.

The project provided professional development for over 2,000 teachers and succeeded in developing numerous partnerships between schools and local community organisations. *Pollen* recognised that schools were part of wider communities with the potential for local stakeholders to strengthen educational innovation through interacting with schools. A review of the programme reported that it was successful in raising both teachers' and children's interest in science learning at school. It found that the programme seemed to be especially successful with students from disadvantaged groups and for girls. Schools developed lasting relationships with the scientific community.[22]

In the international initiatives described above there is a focus on sustained professional learning for teachers and clear benefits to both students and scientists have also been identified in evaluations. This emphasis on *sustained* professional learning for teachers is rare in New Zealand initiatives.

Both in New Zealand and worldwide there seems to be a consensus that collaborations between schools and the science community are a desirable thing and there is certainly a wide range of initiatives. Although New Zealand does not have the comprehensive large-scale projects, such as

[21] For more information, see www.scientistintheclassroom.org/

[22] Jasmin and Van den Berg (2010) www.elearningeuropa.info/files/media/media23255.pdf

those described above, there is no shortage of community- and school-based innovations here. The New Zealand initiatives, like the overseas examples, address different aspects of engaging students in science and many appear successful in what they set out to do (although few are supported by formal evaluations). The initiatives do, however, appear somewhat ad hoc and perhaps it is time for a more co-ordinated approach if such collaborations are really to make a difference to science education.

8. Discussion

An important first step in developing a more co-ordinated approach to engagement between the science community and schools would be to clarify exactly which types of partnerships are likely to result in more future-focused approaches to science education. There is currently a lack of data showing the long-term outcomes for students, teachers and scientists involved in New Zealand science community–school collaborations. The literature on home–school partnerships provides some useful pointers to what are likely to be the essential elements of successful partnerships between the science community and schools. For example, it is important that both partners share an understanding of the purpose of the relationship, and that they are clear about what their respective roles are. Successful partnerships also need to provide mutual benefits for the partners.[23] Hargreaves (2008) argues that the continuing development of school–community partnerships requires "system re-design": that is, we need to think differently about how schools are organised, about the roles of teachers and about their relationships with the wider community.

In the case of science education, then, it seems important that the science community and schools need to work to develop a shared understanding of, firstly, science education's purpose and, secondly, of how the collaboration could support this purpose. Attention also needs to be paid to how such collaborations, once developed, could be sustained successfully.

The purpose of science education

If teachers and scientists are to develop a shared understanding of the purpose of science education, both parties need opportunities to explore their beliefs about what science is, and why it is important for students to learn science. It is particularly important that teachers have the opportunity to participate in such discussions, because how teachers perceive both science and the purpose of science education are important factors in how the curriculum is enacted in the classroom.[24]

Science education academics identify a range of purposes for school science education. These include:

- preparing students for a career in science (pre-professional training)
- equipping students with practical knowledge of how things work (utilitarian)

[23] See, for example, Bull, Brooking and Campbell (2008).
[24] See, for example, Friedrichsen, Van Driel and Abell (2011).

- developing students' ability to make informed decisions about socio-scientific issues (citizenship)
- developing students' ability to think scientifically, and their knowledge of science as part of their intellectual enculturation (cultural/intellectual).[25]

The New Zealand Curriculum (like many other curricula) attempts to serve all of these purposes. The rationale for the inclusion of science in the school curriculum is that:

> In science, students explore how both the natural world and science itself work so that they can participate as critical, informed, and responsible citizens in a society in which science plays a significant role. (Ministry of Education, 2007, p. 17)

Although this "essence statement" signals strongly an emphasis on the citizenship purpose, later in the document, under the heading "Why Study Science?" (p. 28) all four purposes are evident. Even if teachers were to focus solely on the citizenship purpose, this is a long-term goal and, as we have argued elsewhere,[26] at different levels of the school system, this goal is best supported by different approaches. So, for example, in Years 1–6 *nurturing children's interest* in the world around them and developing *positive attitudes* toward science could be the most appropriate way of laying the foundations for developing scientifically literate citizens. For older students, exploring socio-scientific issues and the possibilities of future careers in science might be a more appropriate approach to realising this overarching goal. This mixture of possible purposes means that it is important that time is spent clarifying exactly what it is that we are trying to achieve in school science and how the partnership supports this aim.

The purpose of science community–school collaborations

If the main aim of science education for young children is considered to be building positive attitudes towards science, then the main purpose of a partnership is likely to be providing students with captivating experiences, and exposing them to people who are passionate, knowledgeable and excited about science. One-off activities such as open days, EOTC visits and roadshow-type events could be extremely valuable. See, for example, this feedback from a teacher, sent to the organiser of a recent primary science event at a university:

> The children chatted to the parents on the walk back to school and the parents were amazed at the knowledge the children had acquired after their morning—due mainly to the excitement in their voices as they told the parents what they had learned! The hands-on element was superb, and every stall held the children's interest from go to whoa! PLEASE do it again—it was a great experience for us all.

If, on the other hand, the main purpose of science education is to develop scientifically literate citizens, then a different sort of partnership is more appropriate. Recent research suggests that if

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[25] See Bull, Gilbert, Barwick, Hipkins and Baker (2010).
[26] See, for example, Bull (2011).

scientific literacy is the goal, students need to be engaged in problem solving and decision making using case studies that are both sufficiently complex, and clearly boundaried. It is important, however, that "the context is not merely background; it is the essential heart of the matter" (Allchin, 2011, p. 528).

This challenges much of current school science practice. This approach requires teachers to *start* with the context and then draw out of it whatever science ideas are a necessary basis for student problem solving and decision making. Even innovative teachers currently usually start with the science ideas (the "content" to be learned), and then find a "relevant context" to engage the students so that they learn the target content. If the context is the heart of the matter, this also means that students' interactions with science and scientists need to be central to the curriculum, not just "add ons". This more radical approach to teaching science also requires teachers to re-think their roles. The teacher becomes more of a facilitator, a learning guide or mentor, and both students and teachers would call on outside resources (e.g., scientists) for support with the necessary content knowledge. Of course assessments would also need to reflect the importance of student problem solving and decision making in "real-life" contexts.

Programmes such as those run by LENScience provide support for teaching that focuses on "citizenship" science.[27] Their programmes take a context that is important to scientists, the local community, teachers and students (such as the challenges presented by human health and disease issues such as diabetes and cancer). Recognising that learning develops over time and through a range of interrelated experiences, programmes are designed so that students have multiple exposures to a range of contexts designed to link the learner to the culture of science over the middle and senior school years of schooling. These programmes include:

- in-school modules that explore the work of scientists and the concepts relevant to a particular issue
- student visits to the scientists' place of work
- interactive e-learning events such as asking scientists questions online
- student involvement in research investigations relevant to the issue
- students (sometimes with scientists) communicating about science to the their community
- students developing community-based actions related to their findings.[28]

If the main purpose of school science education is seen as being to produce the next generation of scientists, then a range of additional approaches to engaging with the science community would be useful. These could include programmes such as Futureintech Ambassadors in schools,[29] science fairs, mentoring projects such as those operated by te Rōpu Āwhina and the university-based experiences for senior secondary students that are currently run by a number of universities.

[27] LENS programmes also provide support for preprofessional-oriented teaching programmes.
[28] See Bay et al. (2012).
[29] See www.futureintech.org.nz/inschools.cfm

Sometimes a partnership might explicitly aim to encourage particular groups (e.g., Māori or Pasifika students, or girls) to see a place for themselves in science. If this was the purpose of the partnership, then it is likely that an emphasis would be placed on finding members of the science community who could act as role models. Other partnerships might be formed with an explicit focus on professional learning.

Sustainable collaborations

As well as being clear about the aim of science education, and how a particular partnership supports this aim, there is also a need for everyone involved in the collaboration to be clear about what they *contribute* to the collaboration and how they *benefit* from it.[30] Partnerships need to be mutually beneficial if they are to be sustainable. Sometimes a local place-based issue such as the restoration of a waterway or the disposal of waste can provide a shared context that has relevance to students, teachers, scientists and others in the community.[31] The Department of Conservation's *National Education Strategy 2010–2030* (Department of Conservation, 2011), in its first stage focuses on primary school-aged students in recognition of the wide span of influence this age group has in the wider community. Working with primary school-aged students benefits the Department in that these children can carry messages about conservation across several generations, cultural groups and sectors of the community. Universities often report advantages to student mentors in terms of becoming better science communicators when they work in partnership programmes with schools.

In addition to being mutually beneficial, collaborations also need to be adequately funded if they are to be sustainable. Successful partnerships require time in the initial stages for building relationships between the partners and this can be time consuming (and consequently expensive). Universities and science research centres report that it is more difficult to obtain funding for maintaining initiatives than it is for starting them. Some institutions have science "outreach" centres or employ specialist science educators. It seems these positions are helpful in co-ordinating activities across institutions and for communicating successfully with teachers.

Where to now?

Despite a huge range of exciting initiatives that engage the science community with schools, in New Zealand, we found little evidence of long-term, adequately resourced partnerships that had been evaluated professionally to establish the extent to which the partnerships were beneficial to all involved. In the next phase of this project we plan to carry out case studies of some New

[30] See Tinker (1997) and Bouillion and Gomez (2001) for examples of the importance of mutual benefit in partnerships.

[31] See, for example, McMillan and Binns' (2011) case of the Kaikorai Stream in Dunedin.

Zealand initiatives and to convene focus groups of teachers and science providers to explore the following questions:

- What do the partners think the purpose of science education is?
- How do they think the partnership contributes to this?
- What does each partner contribute and what do they gain from the partnership?
- What are the benefits to students?
- How central to the school's curriculum is the learning from the initiative?
- What support does the partnership provide for teachers to examine their existing beliefs about science and science education?
- What is the potential for ongoing benefits from the partnership for all involved?
- Are there science education specialists involved in the initiatives and, if so, what is their role?

We think answers to these questions will be helpful in making recommendations about future support for science community–school collaborations.

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Appendix A: Science Provider Survey

1. **Name of the organisation, institution or group from the "science community".**

2. **Name or brief description of initiative/programme/partnership(s) that support school science learning** *(i.e., what is the engagement between the "science community" organisation and teachers/students?).*

3. **Which people from the "science community" are involved?** *(Select all that apply)*

    a. Tertiary science faculty
    b. Tertiary science students
    c. Organisations for "public learning" such as museums, science and technology centres, aquariums, zoos, planetariums, etc.
    d. Other working scientists (e.g., from NIWA, Liggins Institute, Manaaki Whenua/Landcare, DOC, etc.)
    e. Environmentally-focused programme providers/facilitators (e.g., regional council stream monitoring programmes, wetlands restoration, Enviroschools facilitators)
    f. Iwi groups/Māori organisations
    g. Pasifika organisations
    h. Other (describe)

4. **Whose learning is/are the initiative/partnership/programme(s) designed to support?** *(Select all that apply)*

    a. Students
    b. Teachers
    c. Science community partners
    d. Other (describe)

5. **What student year levels are targeted by the initiative/partnership/programme(s)?** *(Select all that apply)*

    a. Primary students (Years 1–6)
    b. Intermediate students (Years 7 & 8)
    c. Junior secondary (Years 9 & 10)
    d. Senior secondary (Years 11–13)
    e. Other (describe)

6. **Which (if any) students do(es) the initiative/partnership/programme(s) particularly seek to support or engage?** *(Select all that apply)*

    a. All students
    b. Māori students
    c. Pasifika students
    d. Students who need/want extension in science
    e. Students who are disengaged with science or don't yet know if it interests them
    f. Other (describe)

7. **How do(es) the initiative/partnership/programme(s) support student learning and engagement?** *(Select all that apply)*

    a. Puts science learning in a more "hands-on", fun, engaging context
    b. Supports students to undertake science inquiry/research in a real context or for a real purpose
    c. Shows students what working scientists do/what a job in science looks like
    d. Helps students make decisions about further study and career pathways
    e. Enables students to build relationships with science role models/mentors
    f. Connects science learning with Māori culture, knowledge, values, worldviews, ways of doing things
    g. Connects science learning with Pasifika culture, knowledge, values, worldviews, ways of doing things
    h. Other (describe)

8. **What is the estimated reach of the initiatives/partnerships/programme(s)?**

    1. >10 schools
    2. 11–100 schools
    3. More than 100 schools

9. **What are the issues and challenges for these connections/partnerships?**

10. **Would you be happy to be contacted if the research team arrange further interviews or visits to find out more about the science community partnerships you have described?**

    1. Yes
    2. No

11. **If you answered yes, please provide your contact details.** *(Name, email address, telephone number)*

Appendix B: Teacher Survey

Your use of community resources to support your science programme

3. Which statement best describes your *main* use of the following science community organisations in the last *12 months*?

This includes people and organisations who do science, provide professional support for science, promote science engagement and learning among school-age learners.

	Mostly used to support student learning	Mostly used to support teacher learning	Not used recently, but have in past	Never used
Tertiary education science faculty (e.g., University staff)	○	○	○	○
Tertiary science students (e.g., University students)	○	○	○	○
Museums, science and technology centres, aquariums, zoos, planetariums (or people who work at these centres)	○	○	○	○
Other working scientists (e.g., people from NIWA, Liggins Institute, Manaaki Whenua/Landcare, DOC, etc)	○	○	○	○
Environmentally-focussed EOTC programme providers (e.g., regional council stream monitoring programmes, wetlands restoration, Enviroschools facilitators)	○	○	○	○
FutureIntech Ambassadors (IPENZ)	○	○	○	○
Royal Society Scholarships/Funds: e.g., Teacher fellowships, CREST, Bayer Scholarships, FREESTA, Student Travel Awards	○	○	○	○
Fonterra Science Roadshow (Science Technology Roadshow Trust)	○	○	○	○
Virtual fieldtrips (e.g., Learnz)	○	○	○	○
Parents/whanau with expertise relevant to topic	○	○	○	○