SUMMARY 1

SCHOOLS & THE SCIENCE COMMUNITY

A RATIONALE FOR FUTURE-ORIENTED ENGAGEMENTS

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ABOUT THE RESEARCH

A research project for the Ministry of Education explored how connections between schools and the science community could support more future-oriented science learning for all New Zealand learners. The research comprised surveys of teachers and members of the science community; case studies; focus group interviews with scientists and science educators; and a synthesis of New Zealand and international literature. The project was carried out by the New Zealand Council for Educational Research (NZCER) in collaboration with Learning Media and the University of Waikato. The full report is available at www.nzcer.org.nz/research/publications/strengthening-engagements-between-schools-and-science-community

WHO IS PART OF THE "SCIENCE COMMUNITY"?

The "science community" broadly includes:

- working scientists and those who manage science organisations
- tertiary science educators and students
- science communicators
- professionals in science museums, science and technology centres, zoos, aquariums
- other people and groups that provide professional support for science or promote public science engagement.

The more inclusive term STEM (science, technology, engineering, and mathematics) is often used to represent the interconnected work of these different but overlapping communities.

SUMMARY 1: FUTURE-ORIENTED ENGAGEMENTS

WHY SHOULD SCHOOLS ENGAGE WITH THE SCIENCE COMMUNITY?

Schools' engagement with the science community is widely perceived as being a "good" thing.[1] But what *sorts* of engagements should schools be aiming for, and why? This summary considers how school science education is changing in response to 21st century learning needs, and presents a case for strengthening engagements between the education and science communities to support *future-oriented* science education for all learners.

"BUSINESS AS USUAL" OR TRANSFORMATIVE CHANGE?

School engagements with the science community can extend and enrich learning in a variety of ways. They often aim to do one or more of the following:

- provide access to up-to-date science knowledge, expertise, resources or environments and help learners see science in authentic contexts
- provide opportunities to learn in different ways (for example, experiential, practical, whole-body learning)
- support learners to form positive relationships with people in the science community
- provide role models that inspire learners or help them to "see themselves" in science.

For some schools, access to the science community and its resources may be an issue (see Summary 2). It is also possible for these engagements to be an occasional "add-on" while school science teaching and learning otherwise remains largely "business as usual".

What if closer engagements between the education and science communities (as well as the wider community) were central to shaping science learning in schools?

Our research suggests schools' engagement with the science community could sit alongside more transformative shifts in thinking, planning, design, resourcing, and support for future-oriented school science learning.

Left: Dr Marc Schallenberg (University of Otago) shows Ngāti Porou secondary school students how to take a mud core sample from the Uawa River. (Science Wānanga case study)

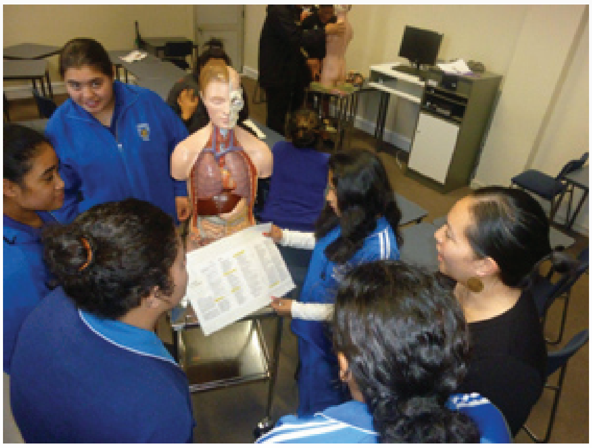
FUTURE-ORIENTED SCIENCE EDUCATION IS RELEVANT, AUTHENTIC, AND ENGAGING

Future-oriented science education should be engaging, relevant, and open doors to future possibilities. It should contribute to young people's intellectual development as well as their capacity to continue to learn and engage with science in their later lives. Connecting with the science community is one way to help learners to experience more authentic and relevant science. However, there are at least three perspectives on what is "authentic" and "relevant":

- the perspective of the science community
- the perspective of the learner
- the perspective of community/society.

Overlooking any of these perspectives could lead to missed opportunities for future-oriented science learning. For example, if science teaching fails to connect with learners, students may not understand or feel engaged by the science it is hoped they will learn. (See next page "Science and learner identity".) Conversely, if science teaching doesn't provide learners with the ability to engage with contemporary science knowledge, or situate learning in the context of current and projected challenges for society, they may leave school ill-prepared to engage with science issues in their future personal and professional lives. (See next page "Science learning to engage with 'wicked problems'?".) Our research suggests an ideal scenario might involve schools, the science community and perhaps members of the wider community collaborating to shape science learning opportunities that are relevant and meaningful from all three perspectives. All the partners involved would need to see the benefits of their connections to each other: learners, teachers, science community partners, and people from the wider community. Learning opportunities would be personalised to support the needs of students on pathways to further study and careers in science, as well as those who might not pursue these pathways. Case study examples of school–science community engagements illustrate how these sorts of connections and partnerships can work in practice. (See Summaries 2 and 3 in this series.)

Students at Ngaio School explore chemistry with parents and scientists in their community. (The Clinic case study)



Students at James Cook High School find pathways into the health sciences. (Health Science Academies case study)

Science and learner identity

Theorists argue that school science needs to change to better reflect the identities that young people wish to build for their future selves, against a backdrop of local, national and global issues and concerns. Research suggests that students who remain interested in science and pursue science pathways later in life have often developed science interests, and can imagine themselves in particular kinds of careers, prior to the age of 14.[2] It is thought that a diverse range of science role models can appeal to a diverse range of learners, and that seeing "people like them" involved with science can help learners to imagine this possibility for themselves. Research also points towards the changing nature of youth identity in "late-modern" society.[3] Theorists argue that young people in the 21st century are increasingly driven by an intrinsic search for personal meaning, while at the same time are expected to make appropriate choices and actively participate in constructing their own lives and careers. There is a growing mismatch between these aspects of today's youth identity, and traditional systems and structures of schooling. In the past, society has tended to value attributes such as obedience, conscientiousness and humility, while in late-modern society youth are more likely to be motivated by an appeal to the contribution of the individual, and to value such things as care for the environment, democracy, care for others, creativity and self-realisation. Research suggest that some young people may not associate school science with the kinds of activities that offer the potential for self-realisation or other values they believe will give meaning to their lives.[4]

Science learning to engage with "wicked problems"?

The challenges of the 21st century world span multiple domains: social, economic, political, environmental, legal and moral. Climate change, biodiversity loss, economic crises and persistent poverty are just a few examples. Some theorists call these "wicked problems",[5] to signal that they cannot be solved using straightforward puzzle-solving or solutions from only one knowledge domain. Science and technology are deeply implicated in many of these problems, but even they on their own can't provide the complete solutions. However, theorists believe there is a way forward. They suggest that wicked problems must be addressed by bringing together disparate perspectives on the problem and seeking to find opportunities for "clumsy solutions" that, while imperfect, at least provide a way forward and create space for further small solutions to be generated. A world of entangled "wicked problems" has implications for thinking about how school learning can support "budding scientists" and "budding citizens" to actively develop the capabilities they need to productively engage in 21st century wicked problem solving.

SCIENCE EDUCATION MUST MEET DIFFERENT NEEDS

Theorists identify a range of different purposes for school science education.[6]
For example:

- All learners need opportunities to make sense of science and how it relates to their lives.
- All learners should leave school with the ability to engage with important science-related issues in their lives, work, and communities.
- Some learners will go on to further studies and jobs that relate directly to science.

For a long time, people have wondered how school science education can effectively support all of these different needs.

TRADITIONAL APPROACHES TO SCHOOL SCIENCE EDUCATION: NO LONGER SUFFICIENT?

Some features of traditional science curriculum and teaching:

- School science has traditionally been organised into subject areas (for example, physics, chemistry, biology, earth sciences) which broadly reflect divisions of science knowledge in universities and science research environments.
- A curriculum based around these ways of organising knowledge helped teachers decide what, and how, to help students develop particular kinds of science understandings.
- Science learning is often organised into unit topics that focus on building science knowledge and understanding, as well as practical skills for science activities.
- Secondary school science teachers are often specialists in one or more science subjects.
- In primary schools, science is one of many curriculum areas taught by generalist teachers who may or may not have additional science backgrounds.
- The science community—particularly science academics—have always had some input into deciding which science knowledge school students ought to be learning.
- The science community has also provided other forms of support for teachers and learners, sometimes on an ad hoc basis, and sometimes as a result of systemic supports that enable schools to connect with the science community (for example, LEOTC).

Traditional approaches to school science education have been effective for many learners, particularly those who develop an interest in science that spurs them to keep wanting to learn more. However, some learners became disengaged or can't see how science connects with their lives, interests, and experiences. It has always been somewhat difficult for school science teaching to reflect the dynamic realities of real science practice. For example, science work often combines expertise and knowledge from many different disciplines. Science knowledge is constantly expanding. New areas of specialisation and new technologies are developing all the time. Science knowledge also interacts with other bodies of knowledge in complex ways as humans seek to better understand our world, solve problems, and create new things. Knowing all of these things can help people make sense of science and see how it relates to their lives.

The Nature of Science strand of the science learning area in the New Zealand Curriculum (NZC) reflects this need for students to explicitly learn about science as well as learning science content knowledge and skills. The NZC provides an enabling framework, but this alone may not be enough to help schools generate contexts and experiences that support future-oriented science learning that engages all learners. This is where new forms of support and engagement with the science community—as outlined in this summary series—may help.

WHERE TO NEXT?

Our research suggests it is time to take a whole-system perspective on the future of school engagements with the science community with a view to supporting effective future-oriented learning for all New Zealand students. The other summaries in this series look at what schools, science communities, and policy makers can do to make this happen.

Year 11 students from Onehunga High School involved in research into the effect of fibre in adolescent boys' diet on insulin resistance share their experience with students throughout New Zealand during an interactive e-event. (LENScience case study—"Diabetes in My Community" programme)

Notes

[1] In the survey phase of this study, 89 percent of primary teachers and 71 percent of secondary teachers agreed that "engagement with people from the science community is essential for 21st century science education programmes". See p. 54 in Hipkins, R., & Hodgen, E., (2012). *Curriculum support in science. Patterns in teachers' use of resources. Report prepared for the Ministry of Education. Wellington.* http://www.nzcer.org.nz/research/publications/curriculum-support-science

[2] See Tytler, R., Osborne, J. F., Williams, G., Tytler, K., & Cripps Clark, J. (2008). *Opening up pathways: Engagement in STEM across the primary–secondary school transition. A review of the literature concerning supports and barriers to Science, Technology, Engineering and Mathematics engagement at primary–secondary transition*. Canberra: Commissioned by the Australian Department of Education, Employment and Workplace Relations.

[3] See Kress, G. (2008). Meaning and learning in a world of instability and multiplicity. *Studies in Philosophy and Education, 27*(4), pp 253–266.

[4] See Hipkins, R., & Bolstad, R. (2008). *Seeing yourself in science. The importance of the middle school years.* Wellington: The Royal Society of New Zealand. http://www.nzcer.org.nz/research/publications/seeing-yourself-science

[5] See Rayner, S. (2006, July). *Wicked problems: Clumsy solutions—diagnoses and prescriptions for environmental ills*. Jack Beale Memorial Lecture on Global Environment, University of New South Wales; also Frame, B. (2008). 'Wicked', 'messy', and 'clumsy': Long-term frameworks for sustainability. *Environment and Planning C: Government and Policy, 26*, 1113–1128.

[6] See Bull, A., Gilbert, J., Barwick, H., Hipkins, R., & Baker, R. (2010). *Inspired by science.* A paper commissioned by the Royal Society and the Prime Minister's Chief Science Advisor. http://www.nzcer.org.nz/research/publications/inspired-science