MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

28 November 2014

Alex Harris
fyi-request-2071-2293ed1a@requests.fyi.org.nz

Ref: OIA 0496

Dear Alex Harris

Thank you for your request of 2 October 2014, which stated:

> *In July, MBIE released ""A Nation of Curious Minds"", a national strategic plan for science in society. One of the proposals in this plan was that ""The Royal Society of New Zealand (RSNZ) will lead the development of a code of practice on public engagement for scientists"". I would like to request the following information under the OIA:*

1. *All communications with the RSNZ about the development of a code of practice;*
2. *All advice and communications about this specific proposal. I am aware that MBIE consulted widely on the strategy, both with business, educational and science groups and with government agencies such as MPI, MfE and DoC. Did any of them suggest or comment on it?*
3. *All draft copies (including annotations and tracked changes) of "A Nation of Curious Minds".*

As agreed by you in email communication on 14 October request 3 for all draft copies of "A Nation of Curious Minds" has been refined to the final drafts provided to other agencies, Ministers and stakeholders for their feedback.

You also confirmed that your query *"I am aware that MBIE consulted widely on the strategy, both with business, educational and science groups and with government agencies such as MPI, MfE and DoC. Did any of them suggest or comment on it?"* refers specifically to the Code of Practice.

The documents I am releasing in response to your request are listed below. In relation to your requests for all advice and communications about the Code of Practice (requests 1 and 2) all information that is outside the scope of the request has been removed from the documents.

I have withheld personal and contact details of non-senior officials from email communications "to protect the privacy of natural persons" (section 9 (2) (a) of the Official Information Act).

I am withholding one sentence from document 10 under section 9(2)(g)(i) of the OIA to protect information which resulted from the free and frank expression of opinion.

1. *Communications with the RSNZ about the development of a code of practice*

Item	Date	Document description
1	28 May 2014	Excerpt from Science for, by and with New Zealanders

		Summary response from Richard Meylan, Senior Manager Public Engagement, The Royal Society of New Zealand (not the official view of the Royal Society)
2	8 July 2014	RE: Update on the Science in Society strategic plan (emai communication between Caroline Taylor and Richard Meylan)

2. *Advice and communications about the development of a code of practice.*

Item	**Date**	**Document description**
3	15 May 2014	Excerpt from Re: Science in Society draft strategic plan - feedback process (email from Peter Griffin)
4	17 March 2014	Excerpt from MBIE assessment of initiatives to government agencies (sent with draft strategic plan)
5	14 May 2014	Excerpt from Comments (email from Evan Brenton Rule)
6	20 May 2014	Excerpt from Re: Science in Society strategic plan (email from Elf Elridge)
7	20 May 2014	Excerpt from Summary of feedback received from stakeholders on the draft Science in Society strategic plan (sent to Ministry of Education and Prime Minister's Chief Science Advisor's (PMCSA) Office)
8	9 June	Excerpt from Proposed response to feedback from key stakeholders (sent to Ministers)
9	30 June 2014	Excerpt from FW: Update on discussion with Hon Joyce on the draft Science in Society strategic plan (email from Caroline Taylor)
10	30 June 2014	Excerpt from FW: Notes on Science in Society (emails from Ian Thompson and Richard Walley)
11	8 August	Excerpt from RE: Draft papers for the Science in Society steering group meeting on Friday 15 August (email from PMCSA Office)

I am aware that MBIE consulted widely on the strategy, both with business, educational and science groups and with government agencies such as MPI, MfE and DoC. Did any of them suggest or comment on it?

The information that relates to this query is contained in the table above. Three members of the Science in Society Reference Group commented on the Code of Practice (documents 3,5 and 6). The Code of Practice was included in the first draft prepared by the PMCSA's Office (document 12 below).

3. Final drafts of “A Nation of Curious Minds” provided to other agencies, Ministers and stakeholders for their feedback.

Item	**Date**	**Document description**
12	13 February 2014	FIRST DRAFT prepared by Prime Ministers Chief Science Advisor for discussion with the Reference Group on 13 February 2014
13	17 March 2014	Draft Strategic Plan for Comment (sent to Government agencies)
14	28 March 2014	DRAFT for approval by Ministers to seek feedback from key stakeholders
15	9 May 2014	DRAFT approved by Ministers for seeking feedback from key stakeholders Draft first sent out to ref group on 9 May then subsequently same draft sent to other stakeholders.
16	5 June 2014	DRAFT for consultation with government agencies
17	19 June 2014	Initial Science in Society strategic plan (sent to Ministers 19 June 2014)
18	4 July 2014	Initial Science in Society Plan (provided to PMCSA Office)
19	9 July 2014	Initial Science in Society strategic plan (sent to Minister’s office 9 July)
20	16 July 2014	Initial Science in Society strategic plan MASTER (Sent to Minister’s Office 16 July and other Agencies 21 July)
21	21 July 2014	Science in Society Plan - Near Final Draft (incorporating Minister’s changes - Sent to Minister’s office)

I trust you find this information useful. You have the right to seek an investigation and review of our response by the Ombudsman, whose address for contact purposes is:

The Ombudsman
Office of the Ombudsman
PO Box 10-152
The Terrace
Wellington 6143

Yours sincerely

R Walley

Richard Walley
Manager, Science & Innovation System, People Science & Enterprise Policy
Science, Skills and Innovation.

Document 1

Science for, by and with New Zealanders

Summary response from Richard Meylan, Senior Manager Public Engagement, The Royal Society of New Zealand.

NB A full response is being prepared by the Royal Society but needs to be approved by the Council of the Royal Society before it can be read as such. This includes the action around the development of a Code of Practice for Scientists.

Out of scope

Out of scope

Out of scope

Document 2

From: Richard Meylan s9(2)(a)
Sent: Tuesday, 8 July 2014 8:57 a.m.
To: s9(2)(a)
Cc: s9(2)(a) Anne Berryman; Richard Walley
Subject: RE: Update on the Science in Society strategic plan

Hi s9(2)(a)

Confirming that the Royal Society is comfortable with leading this work and with the text below.

Regards

Richard

Richard Meylan *Senior Manager - Public Engagement*

s9(2)(a)

Royal Society of New Zealand | Te Apārangi

s9(2)(a)
www.royalsociety.org.nz

From: s9(2)(a)
Sent: Monday, 7 July 2014 12:31 p.m.
To: Richard Meylan
Cc: s9(2)(a) Anne Berryman; Richard Walley
Subject: RE: Update on the Science in Society strategic plan

Hi Richard

Thanks for your reply.

Out of scope

We'd like to check the following text in the latest draft of the plan with you. Professor Sir Peter considers that the Royal Society is best placed to lead the work on developing the proposed Code of Practice. By COP tomorrow can you please confirm you are comfortable with this and the text below.

"The Royal Society of New Zealand will be asked to develop a Code of Practice on public engagement for scientists

The Royal Society of New Zealand will be asked to work with the scientific community and consult widely including with Universities, CRIs and the network of departmental science advisors and the PMCSA to develop a Code of Practice for Scientists on public engagement that enshrines their public responsibilities.

A recent model of such a commitment is the Japanese Council of Science's recently updated Code of Conduct of Scientists, which outlines not only the responsible conduct of research but also the social responsibility of science organisations and scientists to engage with the public and policy makers based on their expert knowledge."

Thanks very much

Kind regards

s9(2)(a)

Document 3

ANNEX ONE: MBIE DRAFT ASSESSMENT OF INITIATIVES FOR DELIVERING ON DRAFT ENGAGING NEW ZEALANDERS OUTCOMES IN SCIENCE AND SOCIETY STRATEGIC PLAN

MBIE has completed a draft assessment of existing and potential initiatives for increasing engagement by New Zealanders in science and technology. These initatives are summarised and prioritised below.
The prioritisation below has been agreed by the project steering group.

NO	EXISTING INITIATIVES	PURPOSE	ALIGNMENT WITH OUTCOMES AND STRATEGIC ACTION AREAS IN INTERVENTION LOGIC	TIMING	Effective in delivering on outcomes and strategic action areas	Represents value for money	Appropriate role for government	Feasible	Affordable	Part of a coherent programme	Options and implications	Source and estimated cost for 2014/15

Out of scope

Out of scope

Out of scope

NO	POTENTIAL NEW INITIATIVES	PURPOSE	ALIGNMENT WITH OUTCOMES AND STRATEGIC ACTION AREAS IN INTERVENTION LOGIC	TIMING	Effective in delivering on outcomes and	Represents value for money	Appropriate role for government	Feasible	Affordable	Part of a coherent programme	Options and implications	Source and estimated cost for

					strategic action areas							2014/15

Out of scope

13	Code of Practice for Scientists in their public responsibilities	Ensure that publicly funded scientists continue to employ emerging knowledge and international best practice mechanisms to engage relevant public(s) in identifying priority research questions and usefully disseminating results	***Improved quality and professionalism of the communication of science by scientists contributes to building a nationally supportive environment for public engagement in science and technology.*** This may contribute to increased public STEM competencies, greater public value in science and technology and the public more engaged in science and technology.	2014/15	International experience (eg Japan) is that Codes are out of date and need to be refreshed.	Relatively low cost (time of PMCSA, RSNZ and MBIE)	4 - Government role to facilitate industry codes of conduct where needed	Depends on relative priority	Relatively low cost (time of PMCSA, RSNZ and MBIE)	Could link with 13, 14, 15 and 16	Commence in 2014/15	NA - within agency funding

Out of scope

Out of scope

Out of scope

Out of scope

1 = not at all 2 = some 3 = okay 4 = good 5 = excellent

DRAFT 17/3/2014

Document 4

From: Elf Eldridge s9(2)(a)
Sent: Wednesday, 14 May 2014 1:49 p.m.
To: s9(2)(a)
Cc: s9(2)(a)
s9(2)(a)
s9(2)(a)
s9(2)(a) Richard
Walley; Anne Berryman
Subject: Re: Science in Society strategic plan

Hi Everyone,

Out of scope

2. Do you think the proposed priority actions will support the strategic action areas and are they the right actions?

The priority actions of 1. and 3. I agree with wholeheartedly (particularly the code of practice and training of scientists in communication) with the possible addition of allowing scientists to use means other than themselves to communicate their science (be it the science media centre or advertising firms - sometimes scientists just aren't the right people to communicate their science)

Out of scope

Kind regards

Elf Eldridge

Document 5

From: s9(2)(a) **On Behalf Of** Peter Griffin
Sent: Thursday, 15 May 2014 11:06 a.m.
To: s9(2)(a)
Subject: Re: Science in Society draft strategic plan - feedback process

Hi s9(2)(a)

Out of scope

Out of scope

Page 17: Code of Practice for scientists

Very supportive of this idea and is something that should be endorsed at a high level and recognised across publicly-funded scientific institutions. The ability of scientists to speak publicly about their science is under threat due to the increased commercialisation of science. This reality needs to be acknowledged while at the same time creating ground rules that allow for scientists to communicate the science they are expert in, particularly when the public most needs that information.

Out of scope

Out of scope

Document 6

From: Evan Brenton-Rule s9(2)(a)
Sent: Tuesday, 20 May 2014 11:22 a.m.
To: s9(2)(a)
Subject: Comments

Hi s9(2)(a)

Out of scope

Finally, I like the idea of a **Code of Practice** for scientists. Articulating at a high level the responsibility of scientists (especially publicly funded ones) to engage with the public is important. Is there a way of incentivising scientists to do this? Peter mentioned something similar in his comments.

Out of scope

Cheers

Evan

Document 7

Summary of feedback received from stakeholders on the draft Science in Society strategic plan

Stakeholder Group	**Individual**	**Summary of feedback received**
Science in Society Reference Group	Out of scope	Out of scope
	Out of scope	Out of scope

		Out of scope
	Out of scope	Out of scope
	Out of scope	Out of scope
	Evan Brenton-Rule	Out of scope Out of scope • Supports idea of a Code of Practice for scientists. Articulating at a high level the responsibility of scientists (especially publicly funded ones) to engage with the public is important. Is there a way of incentivising scientists to do this?
	Out of scope	Out of scope

		Out of scope
	Out of scope	Out of scope
	Peter Griffin	Out of scope • Page 17: Code of Practice for scientists - Very supportive of this idea and it should be endorsed at a high level and recognised across publicly-funded scientific institutions. The ability of scientists to speak publicly about their science is under threat due to the increased commercialisation of science. This reality needs to be acknowledged while at the same time creating ground rules that allow for scientists to communicate the science they are expert in, particularly when the public most needs that information. Out of scope
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Document 8

Annex 2 - summary of feedback on draft plan and proposed response

Out of scope

Part of Strategic plan	Subpart of strategic plan	Draft summary of feedback received	Stakeholder/s	Proposed response	Proposed to draft Science in Society strategic plan to be confirmed
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Strategic Action Area 3: publicly engaged science sector	Out of scope ap and	Out of scope	Out of scope	Out of scope
	Supports Code of Practice for scientists. Scientists should be incentivised to do this (eg endorsed at a high level and recognised across publicly-funded scientific institutions).	Peter Griffin/Evan Brenton-Rule	MBIE to consider after Code developed	No change needed
	Out of scope			
	Supports priority actions (particularly the code of practice and training of scientists in communication) with the possible addition of allowing scientists to use means other than themselves to communicate their science (eg science media centre or advertising firms).		Already allowed.	No change needed
	Out of scope	Out of scope	Out of scope	

Out of scope

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Out of scope

Document 9

From: s9(2)(a)
Sent: Monday, 30 June 2014 4:39 p.m.
To: Paul Stocks; s9(2)(a) Peter Crabtree; s9(2)(a)

Cc: s9(2)(a)
s9(2)(a) Anne Berryman; Richard Walley; s9(2)(a)
s9(2)(a)
s9(2)(a)

Subject: FW: Update on discussion with Hon Joyce on the draft Science in Society strategic plan

Good afternoon

This afternoon Richard discussed the draft Science in Society strategic plan with Minister Joyce. Out of scope

Out of scope

The Minister asked for specific changes to a couple of the new initiatives:

- Out of scope

- The Code of Practice is to be focused on science in society and led by the Royal Society of NZ (on behalf of the science sector) with input from the PM's Chief Science Advisor.

Out of scope

Thanks very much
s9(2)(a)

Science and Innovation Policy, Science, Skills and Innovation

Ministry of Business, Innovation & Employment
s9(2)(a)

Document 10

From: Richard Walley
Sent: Monday, 30 June 2014 4:12 p.m.
To: s9(2)(a) Anne Berryman; s9(2)(a)
Subject: FW: Notes on Science in Society

Hi all,

s9(2)(a) notes from this afternoon below. The one part he mentions that I missed in my feedback is around the code of practice. To be clear –

The Minister's thinking was that he wanted the code to be more specifically focused on public engagement. E.g. a code of practice for science communication, *not* a code for science as a whole.

Paul's thinking, after the meeting, was that we needed to be careful about the extent to which the Minister/Government was associated with mandating a code. We might want to feature it, but not as an action on Government. It needs to be bottom-up; led by the Royal Society seems perfect. And definitely not e.g. disciplinary, but a voluntary sort of thing.

Cheers,

R

From: s9(2)(a)
Sent: Monday, 30 June 2014 4:05 p.m.
To: Richard Walley
Subject: Notes on Science in Society

Hi Richard,

Here are the notes I took for the Science in Society item:

Out of scope

- s9(2)(g)(i) Reword so that it does what it says e.g. "Code of practice for science in society"

Out of scope

Thanks,

s9(2)(a)

Office of Hon Steven Joyce | Minister of Science and Innovation
s9(2)(a)

s9(2)(a) W: http://www.beehive.govt.nz and http://www.parliament.nz

Document 11

From: s9(2)(a)
Sent: Friday, 8 August 2014 4:19 p.m.
To: s9(2)(a)
Cc: Peter Gluckman
Subject: RE: Draft papers for the Science in Society steering group meeting on Friday 15 August

Hi s9(2)(a)

Out of scope

Out of scope

In practical terms, we can be the intermediary for a number of initiatives such as liaising with the science community and the RSNZ for the science sector code of practice and helping to develop programme documents and structure for the Participatory Science platform etc.

Out of scope

s9(2)(a)

CONFIDENTIAL NOT GOVERNMENT POLICY

Science for, by, and with New Zealanders

Responding to the Science in Society Challenge

DRAFT STRATEGIC PLAN FOR COMMENT

FIRST DRAFT prepared by Prime Minister's Chief Science Advisor for discussion with the reference group on 13 February 2014

Contents

Ministers' foreword

[To come]

Steven Joyce
Minister of Science and Innovation

Hekia Parata
Minister of Education

Executive summary

1. Background

The National Science Challenges and the Leadership Challenge

Following significant public engagement in early 2013, the National Science Challenges Panel recommended 12 potential science challenges that would justify new investment to address our most pressing health and environmental issues, and to advance our economy through innovation.. The Panel also recommended a challenge for New Zealand's leadership entitled 'Science in Society'.

This Science in Society Challenge asked government to take a lead in facilitating better engagement with science in New Zealand. Indeed, the Panel considered the Science in Society challenge to be "the most important challenge to address" if New Zealand is to advance through the responsible application of science and innovation.

The Panel identified issues in four distinct but interrelated areas:

1. Science, technology, engineering and maths (STEM) education in primary and secondary schools.
2. 'Public understanding of science', including both the potential and the limits of scientific knowledge and managing uncertainties. Here, 'public' is understood in a pluralistic sense and necessarily includes the elected representatives and civil servants that work in the interest of the New Zealand public.
3. National capacities in technology assessment, risk forecasting and in using this in developing societal consensus in using and limiting technologies
4. Early engagement by citizens and other knowledge users on the implications of new technologies and novel applications of existing technology, and to help ensure the public relevance of New Zealand's science and research agenda

Taken together, these 4 areas represent a national opportunity to lift and apply New Zealand's science savvy – whether it is to address societal needs and economic gaps that could benefit from new approaches, or to make democratic decisions about the research we fund and the science we want.

In May 2013, the Government formally accepted this challenge, with the Ministers of Science and Innovation and of Education subsequently announcing the joint development of this strategic plan.

2. Objective

As a response to the Science in Society challenge, the principal objective of this strategic plan is to:

> **Encourage and enable better engagement with science across all sectors of New Zealand society, for a meaningful public and sectoral role in generating, acquiring, assessing and applying scientific knowledge to meet New Zealand's 21st century needs.**

This means creating a more scientifically engaged public and public sector, along with a more publicly engaged science sector with the aim of augmenting what has been called the 'science capital' of New Zealanders. That is - the interest and value that New Zealanders place on scientific knowledge and its potential application for both social and economic advancement.

In many ways the roots of scientific knowledge and application run deep in New Zealand; this is a nation built by navigators, problem-solvers and entrepreneurs. The Science in Society Challenge is designed to harness and augment that spirit.

This ambitious objective is complex and multi-faceted, and it won't happen overnight. It requires clarity of purpose through well-defined terms, audiences and timeframes, which are outlined in this plan.

Terminology

What do we mean by 'engagement'?

Over the past two decades, the field of social studies of science has produced a vast body of scholarship that analyses the place of science in modern societies, including in everyday life, in government decision-making and as an important economic driver. The assumptions and discourse in this area have changed considerably over the years. Where once there had been the assumption of an undifferentiated 'public' that was illiterate, apathetic or hostile toward science and technology, there is now a much more nuance and critical awareness of multiple contextualised audiences for science and the distinct ways that they might engage with it at different times and for different reasons.

There is also a better understanding of how and why to promote better public engagement with science. No longer is it through a uni-directional focus on remediating the presumed public knowledge deficit, but rather through context appropriate opportunities for dialogue and input into decisions about what we want science to do for us. Indeed, we now know that perceived apathy or hostility toward research or technology is more about social values and citizens' trust than it is about their knowledge of scientific facts. This is why the concept of 'public understanding of science' no longer seems adequate or appropriate to describe current goals.

Yet, undeniably, it is more important than ever to ensure that New Zealanders have some basic understanding of how science works. This might be an everyday science literacy to understand and take commensurate action regarding the probabilities and uncertainties we face in a seismically active region, for instance, or toward the adoption of a new technology. Or it might be the kind of pre-career scientific competency that young people may develop in order to help drive the country's economy to new heights in a knowledge-driven world.

Thus, this strategy is aimed at developing a fresher approach through a necessary mix of what has been traditionally called 'science literacy' and of 'public engagement in science'. We use the term 'engagement' to mean the acquisition and application of multiple types of knowledge[1], by multiple kinds of audiences and applied to various purposes. It is a kind of short-hand to imply an improved and productive social relationship with science that will lead to its responsible application for the social, health, environmental and economic benefit of New Zealanders.

[1] We use the OECD definition of 'science knowledge' to mean knowledge *of* science and knowledge *about* science. Certain audiences will specialise in knowledge 'of', but basic knowledge 'about' science is broader and is an important tool of 21st century citizenship for engaged and equitable civic discourse on today's most pressing societal concerns. We also acknowledge that 'knowledge' may also mean the science community's knowledge of various public audiences and how to connect with these to make their science relevant.

Thus, engagement in...

- generating knowledge is about knowledge users, including the public, being enabled to help identify issues requiring science input so that public science research is more relevant and stands to have more meaningful impact. It is also about the public being part of the research itself, including through citizen science.

- acquiring knowledge is about the public, including and especially compulsory level students acquiring the STEM[2] skills and knowledge needed to develop a career in science and/or engage in much needed and ongoing civic discourse about the application of scientific knowledge.

- assessing knowledge is about is about applying an increasingly sophisticated understanding of the what science can (and cannot) provide in the search for solutions to today's pressing problems. Assessment requires an understanding of risk and probabilities associated with both the issues themselves and their scientific responses. Citizens, businesses and governments and the science community are all stakeholders in these critical debates.

- applying knowledge is about is about making the best use of what we know, including the responsible and evolving use of or limiting of new technologies or novel applications of extant technology.

Audience

The strategy addresses multiple audiences, each of which is important stakeholders and agents of positive change in our ineluctable social relationship with science and technology. It's addressed to:

- *Students, teachers and the compulsory learning sector*: because we need a continual pipeline of talent to push the boundaries of enquiry and innovation in an increasingly knowledge-led global economy, and because today's students are tomorrow's decision-makers who will engage in increasingly complex societal issues where science and technology may be either a cause or a solution.

- *Parents, whanau and communities:* because young learners are a product of their learning environments and the most important learning environments are in homes and communities across New Zealand, where an engagement with science and technology is role-modelled to our young people.

- *Journalists, bloggers and the multi-platform media sector*: because responsible, accessible and sophisticated science reporting and analysis is an essential ingredient if New Zealand is to cement its place as a knowledge-led world economy. We need the facts, context and analysis to enable civic discourse, as much as we need stories that capture the imagination and inspire academic excellence in our young people. We don't need a flood of questionable 'breakthroughs' or manufactured controversies.

- *The public sector and government*: because one way in which the public engages with science is through the decision-makers it elects. The social compact between elected

[2] STEM is the internationally recognised term that denotes Science, Technology, Engineering and Maths education

officials, public servants and New Zealand citizens is built on the trust that decision-makers consider the best available evidence on public policy decisions.

- *The science community:* because teachers, students, the public, the media, public servants and government decision-makers should not be expected to source, digest, analyse and act on raw scientific knowledge that is the domain of experts. To be relevant and useful, knowledge needs to be made accessible and contextualised. The science community (including funders, researchers and trainees) needs to be enabled to disseminate better and in some cases 'translate' the knowledge it is producing. Knowledge translation efforts need to be part and parcel of the public science funding envelope.

This strategic plan outlines a **comprehensive suite of priority action areas** that are designed to address the various needs and capabilities of these multiple audiences. With a necessary focus on the compulsory education sector to help lay the groundwork for knowledge-derived prosperity, the plan acknowledges that progress on this front cannot happen without adjusting levers in all areas of the science-society relationship.

3. Strategic domains (SD) and priority action areas

MBIE, MoE and the PMCSA have identified 3 strategic domains, each with priority action areas, making up a comprehensive suite of activities. The strategic domains, with their associated priority action areas are the following:

SD1: STM[3] Education

This strategic domain (SD) is necessarily focused on the compulsory years as these are important precursors to establishing life-long interests and career aspirations. As such, the education sector needs to think critically about the purpose of science (STM) education at the compulsory level and respond accordingly. Already, the Ministry of Education has done considerable work in assessing both the achievement and attitudes of learners and some important patterns are emerging (see annex 4 for latest data).

At the primary level, we know that learners are curious about the science all around them and this is built into an integrated science curriculum. But we also know that, as talented generalists, primary teachers may not feel confident to deliver and augment science learning. At the secondary level, the Ministry of Education has rightly recognised two distinct learning pathways in science and has built a curriculum that can support diverse cadres of learners accordingly. Some will be interested in specific pre-tertiary and pre-career science competencies, while others will focus more on basic science literacy as a 'life skill' for the 21st century.

The Government's recent commitment of learning infrastructure through the Network for Learning and the (Angela: fill in more initiatives here), for instance, are a step toward

[3] While the term 'STEM' is an internationally recognised phrase in science education, this strategy concentrates on STM because the focus is at the compulsory education level where Engineering is not a specific subject.

entrenching not just the digital literacy (and....) that today's students need, but also the right attitudes toward it.

Similarly, learning opportunities outside the classroom are increasingly being accessed by schools to develop the relevancy and interest that learners require. Specialised environments like LENS Science, the Mind Lab, Science Alive and a variety of museum and university-based outreach programmes across the country are now recognised as an important way for teachers to augment science curriculum delivery.

To supplement this ongoing effort, and especially to develop teacher confidence and contemporary science competencies, this strategy proposes the following priority action areas in the STM domain.

Priority action areas:

1. *Improve initial STM teacher education*: Partnerships between ITEs and schools to ensure teacher training meets the needs of the education industry. Science and technology organisations have a role to support better quality STM teacher training when teachers are gaining their qualifications – as well as ongoing support through professional development. (NOTE: need to reflect different needs of primary and secondary teachers in training)

   Actions include:

   - ....

2. *Strengthen quality teaching, learning and assessment in STM*: Teachers need support with professional learning opportunities to so that their teaching practice is current and reflects principles of effective teaching and latest curriculum developments. This combined with access to scientists and technologists will enable them to act with the wider knowledge that research is making available. This will enhance the efficacy of their teaching. The access to scientists and technologists, if extended to students, also creates opportunities for them to engage with science that is relevant and of interest to them, and to see themselves in those roles. Outcome 1 of the MOE strategy for science education is: Teachers are confident and capable of teaching 'Nature of Science' and value the role of science for citizenship purposes.

   Actions include:

   - Science professional learning development, Ngati Whakaue – Matakokiri project which focuses on Māori learners seeing themselves as scientists.

3. *Improve STM-specific teaching resources and how to use them*: MOE uses the 'iterative Best Evidence Synthesis (BES) programme to determine and explain what works and why in education. This will focus particularly on what makes a bigger difference for Māori and Pasifika learners.

   Actions *include:*

   - ...

4. *Encourage youth into STEM careers*: Develop more responsive STEM educational pathways and raising awareness about the impacts of student subject choices, including on entrepreneurial thinking in the science and innovation sector. The relevance of

STEM, particularly science, to future careers options needs to be more clear and potential STEM careers more visible. Pathways to careers should be made more visible, and the variety of careers possible should be similarly made clear. CareersNZ should be supported to have meaningful engagement with schools' careers services to promote careers that will benefit NZ, to pupils well before subjects become optional. Actions include: designing strong and coherent educational pathways in years 1-13 and supporting a science education leadership and coordination role – as a pilot in 2014.

Actions include:

- ...

5. *Improve linkages between STM educators, scientists, technologists and learners:* This is a cross-over priority between SD1 and SD3. Partnerships with Universities, CRIs, science organisations (museums, science centres, zoos, aquaria, observatories, etc) can be created for learning outside the classroom. These opportunities have to be followed up by class teaching resources that build on the experience outside the classroom to make the experience deeper and better understood. The deeper engagement results in meaningful knowledge and capability development.

Actions include:

- enhance links with non-traditional learning environments

SD2: Public engaging with science

This strategic domain addresses the need to develop 'science capital' within the public sphere as both a tool of citizenship and as economic driver. It is aimed at both the need to build better public understanding of the potential uses and the limitations of science, and to lift our collective expectations for a truly knowledge-based economy in New Zealand. It is closely linked with SD3 'Science engaging with the public', and acknowledges the necessary efforts to be undertaken across sectors to ensure that our entire society can play a critical role in determining the direction and application of science and technology for New Zealanders.

Taken together, SD2 and SD3 have as their objective to increase opportunities to develop legitimate social licence for innovative science and technology in New Zealand. We cannot take for granted that values are shared or that all sectors view problems and solutions in the same way. Nor can we assume that any decision-making is the straightforward application of available evidence. There is as much a need for the public (including government and the public sector) to become knowledgeable about what science can and cannot offer, as there is for the science community to become more knowledgeable and responsive to New Zealanders' social and economic expectations of science.

Priority action areas:

6. *(cross-over priority) Support parents and whanau to further develop their relationship with science as a key contributing factor to both society's science capital and student achievement*: The key initiative is the promotion of school –based citizen science activities. As a cross-over priority action between SD2 and SD1, the development of parental/whanau and community involvement is seen to have multiple desired outcomes. It acknowledges and builds on the importance of parents and families and young learners' first mentors, while also providing an opportunity to support parents' own science capital through community collaborative research opportunities that bring

together practicing scientists with schools and community members on real-world questions.

Actions include:

- description of 'citizen science' platform

7. *Journalists and bloggers in the multi-platform media:* The Science Media Centre is a valuable national resource and one of xx such centres in jurisdictions worldwide. It should be supported to provide enhanced training and outreach to science journalists to encourage responsible and insightful science news reporting and long-from analysis that is relevant to the New Zealand media consumer.

   Actions include:

   - enhance the work of the SMC to…

SD3: Science engaging with the public

As described above, SD3 is the reciprocal complement to SD2. There cannot be a scientifically engaged public without there also being a publicly engaged science sector. This strategic domain recognises the important role that the science sector plays in ensuring the public relevance of research, whether through commercialisable innovations or policy-relevant results. Not all science will have immediate application, but all publicly funded scientists and collaborators have a social responsibility to share some level of knowledge where it's applicable.

We note the Japanese Council of Science's recently updated Code of Conduct of Scientists, which outlines not only the responsible conduct of research but also the social responsibility of scientists to engage with the public and policy makers based on their expert knowledge.

Priority action areas:

8. *Ensure robust science advice to government*: Government is implementing the recommendations of the Prime Minister's Science Advisor on the use of evidence in policy formulation[4].

Actions include:

- Establish select departmental science advisory positions to lift policy capabilities and ensure the use of robust and reputable research derived knowledge in public policy decisions.
- Develop and implement across-government guidelines for the procurement of external scientific expertise

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[4] The Use of Evidence in Policy Formulation and Implementation. Prime Minister's Science Advisor. September 2013 http://www.pmcsa.org.nz/wp-content/uploads/The-role-of-evidence-in-policy-formation-and-implementation-report.pdf

9. *Ensure that publicly funded scientists, particularly through the National Science Challenges the CoREs and other research structures, continue to employ emerging knowledge and international best practice mechanisms to engage relevant public(s) in identifying priority research questions and usefully disseminating results.*

Actions include:

- Public research funding bodies (Marsden, MBIE, HRC…) to establish translational expectations of grantees and create commensurate funding opportunities available to publicly funded researchers to engage relevant public in planning and dissemination activities.
- Royal Society NZ and PMCSA to jointly convene the scientific community to jointly develop a Code of Practice for Scientists in their public responsibilities

10. *Ensure that emerging scientists have the basic communication skills to make their research accessible to relevant audiences beyond their peer community.*

Actions include:

- With universities, explore the possibility of core science ethics and communication credits included in graduate science degrees.

4. Implementing the strategy

A bold strategy requires a bold approach to implementation. We cannot afford to continue in a business-as-usual way with either the significant educational-related actions or those focused on multi-sectoral science literacy.

Note: need input here about whether new comnmitteees/positions will be established within MoE and or MBIE or elsewhere (PMCSA, RSNZ etc) to implement this strategy… New positions in schools (such as champion teachers for clusters of schools???) Role of accrediting organisations for teachers???? Etc

5. Timeframe

This strategy is proposing neither a business-as-usual approach nor quick-fix tinkering to address what the NSC Peak Panel saw as a major factor in New Zealand's potential to advance socially, economically and environmentally through the responsible application of science and technology. Rather, it requires a sustained commitment that creates sustained change and addresses the unique situation of each of the audiences described above.

Citizen science offers a unique opportunity to address all three SDs in parallel and a detailed plan including consultation will bedeveloped in 2014 for piloting in 2015.

In some areas, such as education, progress toward positive outcomes in STEM are already well on track with robust evidence about the changes we know we need to make in the teacher training and the learning environments. Likewise, recent work spear-headed by the Prime

Minister's Science Advisor to advance the use of research-derived evidence in all areas of public policy has begun to strengthen the public sector's engagement with science through the appointment of departmental science advisors and the development of a community of practice.

But even where interventions are in place, it will take time for results to be felt. Changing the traditional approaches of various sectors, and creating the opportunities and structures to enable the public(s) -- including within the compulsory education system and the public service – to have a more direct stake in science is nothing short of a cultural shift for New Zealanders. Consequently, the proposed comprehensive suite of actions will be implemented over the short-, medium- and longer terms.

In the medium term (Year 1-4), the implementation of recommendations on evidence-based policy by the Prime Minister's Science advisor will help lift capabilities in the application of science to public policy.

Finally, proposed action areas for the education sector will require a longer term (Year 1-6) approach to address root issues such as systemic changes that address identified issues with teacher training and the need to link classrooms to the professional science community to help inspire and provide novel learning opportunities.

Annex 1: Description of proposed new activities

This section will include details on the novel activities.

- Teach professional development opportunities
- Structures to link scientists/technologists with teachers
- 'Citizen Science' platform (appropriate term sought)
- Proposed code of conduct for scientists and its implementation
- Proposed university courses in science communication/ethics(?)
- etc...

Annex 2: Intervention Logic

[To be summarised from the presentation sent to the reference group on the draft intervention logic)

Annex 3: Evaluation Framework

How we will know if we are succeeding in Education (SD1)

[To come probably from draft list of indicators sent to reference group]

How we will know if we are succeeding in Science Engagement across all sectors (SD2)

[To come probably from draft list of indicators sent to reference group]

How we will know if we are succeeding in publically engaged science (SD3)

[To come probably from draft list of indicators sent to reference group]

Annex 4: The State of Play

[To come from latest data]

Annex 5: What we're already doing?

New Zealand has already instigated several policies and initiatives to address these problems.

Education initiatives

[To come]

Public engagement in science initiatives

[To come]

Glossary

[To come]

Set out more detail on existing science and society activities

References

[add hyperlinks in webpage]

1. Public Engagement in Science and Innovation
   http://mako/OTCS/llisapi.dll?func=ll&objaction=overview&objid=9352461

2. Science Education
http://mako/OTCS/llisapi.dll?func=ll&objaction=overview&objid=8973336

3. STEM skills and careers

   Briefing: http://mako/OTCS/llisapi.dll?func=ll&objaction=overview&objid=12685437

   International policies paper:
   http://mako/OTCS/llisapi.dll?func=ll&objaction=overview&objid=12684225

Science for, by, and with New Zealanders

A national strategic plan to promote science in society 2014-2017

DRAFT STRATEGIC PLAN FOR COMMENT

Contents

Ministers' foreword

[To come]

Steven Joyce
Minister of Science and Innovation

Hekia Parata
Minister of Education

Executive summary

There is a general acknowledgement of the increasing importance of science and technology in assisting societies to progress economically and to enhance their environmental and social wellbeing[1]. In turn this requires a society that is well equipped to both seize the opportunities posed by such technological and scientific innovation, and at the same time to critically assess options and decide whether social license should be given for a particular application of a technology or whether societal constraints on its use may still be needed. Across the world[2], countries are putting emphasis on enhancing their national capacity in science, technology and engineering both for their transformative potential on the economy, but also for their importance to social understanding of our rapidly changing world and complexity of decisions required. As scientific and technological innovation become central to responsible development and economic growth, addressing the educational needs in science and technology of the future and current work force becomes critical.

Relative to comparable countries, New Zealand has low investment in R&D. There is also a shortage of New Zealanders in STEM-related careers and only half of New Zealanders have an active interest in science.

These are long standing issues that will take time to address. This plan identifies actions for the next three years to build on the steps that have already been taken to redress these gaps.

This plan identifies three distinct but interdependent strategic domains that need to be addressed if we are to raise New Zealand's overall engagement with science and make the best use of technology for our sustainable prosperity.

Firstly, it is generally accepted that science and technology education (whether as pre-career training or simply for 21st century citizenship) needs to be enhanced[3]. Already, a number of innovative steps have been taken by the Government to do this. The government has identified additional steps to accelerate and augment work that is already underway. The advice of the reference group is that any action in the education sector must be complemented by support to the context in which science and technology learning takes place.

In the second strategic domain a number of initiatives have been identified to enhance public engagement with science. But these cannot be separated from the third strategic domain; namely to promote initiatives that encourage scientists to engage effectively with the public. Therefore, this plan necessarily addresses the barriers and enablers to creating a more 'publically engaged' science sector together with a more 'scientifically engaged' public.

The strategic plan highlights distinct recommendations within each of these strategic domains, but in reality they are all interconnected. Specifically, one common activity cuts across all three strategic domains to address multiple goals for multiple audiences: A **Platform for Participatory Science** will link professional scientists, schools, parents, youth, and community science and other organisations to identify and scientifically address the questions that are most important to localities across New Zealand. As the logical extension of the Great New Zealand Science Project, this platform will be carefully developed under coordinated scientific and pedagogical direction and will focus on projects of true value to society and with clear scientifically and pedagogical value. It will provide an opportunity for all New Zealand communities to be involved in identifying the projects that are important to them and in helping to undertake them in partnership with practicing scientists. While the platform will be focused on schools, it must necessarily involve the broader local community through NGO and service

[1] Footnote to be added.
[2] For example, Inspiring Australians; UK and EU.
[3] Footnote to be added

organisations, municipal offices, regional councils and other science-focused institutions. Projects undertaken will need to be embedded within the core STEM curriculum.

Many of the priority actions in this strategic plan are low cost or represent changes of emphasis within current activities. Many involve non-governmental organisations such as Teachers' Colleges, museums, school boards, universities and the Royal Society, all of which are key to building and sustaining New Zealand's engagement with science and thus, to the success of this plan. Some activities currently funded by the Crown have been assessed and resources can be strategically redeployed to support newly proposed actions in this plan.

As this is the first Science in Society strategic plan in 2015 the reference group will assess progress on the plan and advise government on any modifications needed to the actions to better deliver on the outcomes.

PART 1. Background

The National Science Challenges and the Leadership Challenge

Following significant public engagement in early 2013, the National Science Challenges Panel recommended 12 potential science challenges that would justify new investment to address our most pressing health and environmental issues, and to advance our economy through innovation. The Panel also recommended a challenge for New Zealand's leadership entitled 'Science and Society'.

This Science and Society Challenge asked government to take a lead in facilitating better engagement with science in New Zealand. Indeed, the Panel considered the Science and Society challenge to be "the most important challenge to address" if New Zealand is to advance through the responsible application of science and innovation.

The Panel identified issues in four distinct but interrelated areas:

1. Science, technology, engineering and maths (STEM) education in primary and secondary schools.
2. 'Public understanding of science', including both the potential and the limits of scientific knowledge and managing uncertainties. Here, 'public' is understood in a pluralistic sense and necessarily includes the elected representatives and civil servants that work in the interest of the New Zealand public.
3. National capacities in technology assessment, risk forecasting and in using this in developing societal consensus in using and limiting technologies.
4. Early engagement by citizens and other knowledge users on the implications of new technologies and novel applications of existing technology, and to help ensure the public relevance of New Zealand's science and research agenda.

The Panel saw these 4 areas as central to the success of the National Science Challenges and for New Zealand to benefit optimally from its investment in scientific research.

In May 2013, the Government formally accepted the 'Science and Society leadership challenge', with the Ministers of Science and Innovation and of Education subsequently announcing the joint development of this strategic plan in November 2013. The Minister of Science and Innovation decided that technology assessment and risk forecasting would not be addressed in the plan at this stage. Annex 1 sets out the process for developing this plan.

PART 2. Making the Case

2.1 Why Science in Society matters

21st century life is driving the need to increase our engagement with science and technology

Many of today's toughest decisions at local, national and international levels – about public health; natural resources stewardship or communications technology for instance – require all of us to weigh both scientific evidence and social values. The National Science Challenges are science priorities that respond to the most important, national scale issues and opportunities identified by science stakeholders and the New Zealand public. Many of the challenges we face today and into the future will require creative and innovative solutions that have a basis in scientific discovery and technological application[4].

Science, technology, engineering and maths (STEM) skills are increasingly important for all New Zealanders. The pace of technological change and nature of employment in the future means that these skills will be important for everybody[5].

The goal of an 'innovation-led' economy is driving the need for an increasingly STEM competent workforce

New Zealand's economic and social wellbeing depends on the productivity and competitiveness of the economy. Innovation that leads to productivity growth is increasingly being seen around the world as an important way to generate economic growth and improved living standards[6].

The Government is committed to materially lifting New Zealand's long-run productivity growth rate while maintaining our high rate of labour force participation. To do this, New Zealand needs a high performing and responsive innovation system and skilled people who can create and deliver high-value products and services, cultivate new markets and sell to the world. Our science system, particularly the tertiary education organisations that undertake research-led teaching, has a vital role in educating a future generation of scientists, and advanced science skills that will be used in high-technology businesses. New Zealand has to be seen internationally as an 'innovation destination'. We must be able to attract the right talent at the right time to contribute to our vital science. Attracting overseas investment in our research is also important for our economic growth.

An entrepreneurial culture and a wide range of skills are needed for innovation, societal advancement and efficient environmental stewardship. These include science, technology, engineering and mathematics (STEM) competencies. Internationally STEM skills underpin the development of new technologies and new, high-value products and STEM skills and competencies underlie growth in many industries, such as IT-related industries. STEM skills and competencies are highly transferable across industries.

STEM skills, like other kinds of skills, are acquired by individuals over time and in a wide range of ways. They need to be developed as part of the key competencies for life-long learning[7]. An individual with low levels of competency has a much greater likelihood of experiencing both economic and social disadvantage than an individual with high competency levels[8].

Students' career choices are influenced beyond school by family, whānau, iwi and the wider community, with parents being the most important influences[9]. Greater community engagement with science and technology could increase valuing the opportunities STEM subjects offer as career pathways.

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[4] Programme for International Student Achievement *Draft Science Framework.p3,*
[5] Programme for International Student *Achievement Draft Science Framework, p3.*
[6] New Zealand Government *Business Growth Agenda: Progress Report 2013; Madsen, JB. 2010. The Anatomy of Growth in the OECD since 1870. Journal of Monetary Economics, v57(6) pp 753-67,*
[7] New Zealand Curriculum 2007.
[8] *Better Skills, Better Jobs, Better Lives: A Strategic Approach to Skills Policies'* OECD Publishing, 2012. http://dx.doi.org/10.1787/9789264177338-en,
[9] http://www.careers.govt.nz/plan-your-career/helping-young-people-make-decisions/what-things-influence-a-young-persons-career-decisions/ and 'STEM Careers Awareness Timelines: Attitudes and ambitions towards science, technology, engineering and maths' Jo Hutchinson, Peter Stagg and Kieran Bentley, University of Derby, 2009. www.derby.ac.uk/files/icegs_stem_careers_awareness_timelines.pdf

The Ministry of Education is focused on ensuring that the education system delivers on the Government's key goals of improved outcomes for all New Zealanders, and stronger economic growth for New Zealand. It is the lead agency on boosting skills and employment. Our ultimate goal is to equip young people with the skills to live a fulfilling life and contribute to New Zealand's economic prosperity.

2.2 Objectives of the plan

The principal objective of this strategic plan is to:

> Encourage and enable better engagement with science and technology across all sectors of New Zealand [MBIE/MoE to consider use of ST, STM and STEM]

This means:

- a more scientifically and technologically engaged public and a more publicly engaged science sector
- more science- and technology- competent learners choosing STEM-related career pathways .

Outcome 1:

A more scientifically and technologically engaged public and a more publicly engaged science sector

We will know we're making progress on this when a greater proportion of New Zealanders are engaged with science and technology. [MBIE/PMCSA to consider indicators].

Outcome 2:

More science- and technology- competent learners choosing STEM-related career pathways

We know we're making progress on this when we achieve greater levels of teacher confidence in teaching to STM outcomes, and when teachers have greater accessibility to the resources they need to teach STM subjects and links between the STM curriculum and career pathways are clarified.

Outcome 3 - long term view

In the longer term, we expect that meeting these objectives will contribute to New Zealand's economic growth and social and environmental wellbeing through:

- More New Zealanders with the skills needed to support creativity and innovation
- Science and technology that responds to the needs of New Zealanders and decision-making for 21st century life [MBIE/MoE to consider wording].

The objective of this plan and its related are outcomes are ambitious. This plan outlines actions that can be taken over the next three years and built on over the longer term.

2.3 The State of Play – what we know and what we don't know

Scientifically and technologically engaged public and a publicly engaged science sector

There is currently no measure of public engagement in science or technology or adult STEM literacy

It is difficult to measure public engagement in science and technology and there is no internationally accepted metric to capture it[10].

A 2010 survey of public attitudes to science in New Zealand identified that about half of New Zealanders were actively interested in science. It also found that the other half of New Zealanders were a mainstream group with a detached interest in science[11] (44%) and a disengaged group (9%). Similar surveys have been done in other countries however it is difficult to draw comparisons given differences in the questions[12]. The Government has not surveyed public attitudes to technology outside this survey.

There is currently no New Zealand data on adult STEM competencies. From 2016 New Zealand will assesses adult competencies in reading, mathematics and problem solving in technology-rich environments. 35% of New Zealand adults have a secondary qualification and a further 21% have a tertiary qualification[13]. This is relatively high internationally. There is no data on the proportion of these qualifications that are in STEM subjects.

There is limited data on the engagement of the science sector with the public

In 2013/14 the Government invested [$1.072b[14] MBIE checking] in scientific research by science organisations and universities. A proportion of that expenditure is expected to be spent on communication and public education but it is difficult to estimate the proportion.

There are also many local government and private sector organisations, such as zoos, museums, charities and businesses, who engage with the public on science and technology for education, cultural and marketing reasons. The Government also invests [$167m MCH to check] in funding regional museums and public broadcasting services[15]. It is inherently difficult to evaluate the quality of the impact of public engagement activities[16].

Since the Science Media Centre was established in 2008, 'science' in the media has increased by 75%[17].

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[10] [To come]

[11] Rosemary Hipkins, '*Public Attitudes to Science: rethinking outreach initiatives' New Zealand Science Review* 67.4, 2010, p109.

[12] For example, Eurobarometer 73.1: Science and Technology Report 2010, European Commission, 2010 and Public Attitudes to Science 2011: Main Report. Ipsos Mori Social Research Institute/Department of Business, Innovation and Skills (UK), May 2011. http://ipsoso-mori.com/Assets/Docs/Polls/sri-pas-2011-main-report.pdf

[13] New Zealand Census 2013

[14] The appropriations in Vote Tertiary Education for 2013/14 are $31.69m (for Centres of Research Excellence) and $268.75m (for performance-based research); the appropriations in Vote Primary Industries are $7.628m (climate change research), $8m (sustainable farming fund) and $78.04m (primary growth partnerships) and the appropriations in Vote Science and Innovation are $201.622m (Crown Research Institutes), $42.1m (National Science Challenges, $51.755m (Marsden Fund), $79.347m (Health Research Council) and $303m (contestable funding of research and research applications).

[15] The appropriations in Vote: Culture and Heritage for 2013/14 for museum services are $33.094m and public broadcasting are $134,417m.

[16] Rowe et al, 'Difficulties in evaluating public engagement initiatives: reflections on an evaluation of the UK GM Nation public debate about transgenic crops' *Public Understanding of Science,* v14 (2005), pp331-352.

[17] [To come].

More STEM competent learners are choosing STEM-related career pathways

There are STEM skills shortages

There are currently skills shortages for many kinds of scientists, engineers, technologists, health and ICT professionals[18]. Demand for workers in many STEM occupations is expected to grow due to a variety of factors[19]. Many other jobs require STEM competencies. Internationally it is estimated that up to 75% of high-growth jobs require STEM skills and competencies[20] [MBIE checking].

NZ graduates are going overseas

The numbers of people graduating with a degree-level qualification has remained constant while the numbers of degree-level engineering places funded by the government has recently increased [TEC to check].

There is a global demand for STEM-educated people, so those who do gain the qualifications required for job-shortage areas can be lost from New Zealand to the global job market. Many New Zealand graduates with the skills matched to the New Zealand market go overseas to work. Much of this skills loss is replaced by high-skilled immigrants from Asia. It will become increasingly difficult to attract these individuals as wages rise in increasingly knowledge-intensive Asian economies [TEC to check].

New Zealand school student performance in science and mathematics has declined

New Zealand has a highly respected education system, which leads in many areas. The World Economic Forum's Global Competitiveness Index for 2013[21] noted that New Zealanders spend the most time in education from primary to tertiary education at 19.67 years and ranked New Zealand seventh for overall education indicators out of 142 countries.

Despite this, there is a slight gradual reduction in the proportion of students enrolled in science-related subjects in years 11 to 13[22] [MoE checking and adding data for mathematics].

New Zealand student's performance in science and mathematics has also declined and it accelerates as students move through schooling. For example, the average results of year 4 students in science aligned with the expected curriculum level for that group, but the average year 8 results were below the expected curriculum23. The average performance of New Zealand year 5 students for science and mathematics in 2010/11 was significantly lower than in 2002/3[24] and there was no significant change in performance for year 9 students since 1994/5. New Zealand student performance for 15 year olds (most are in year 10) in mathematics and

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[18] Immigration NZ: www.immigration.govt.nz/essential skills.htm.
[19] Ministry of Business, Innovation and Employment *Occupation Outlook 2014*, p8.
[20] *Inspiring Australians*
[21] http://www.wipo.int/export/sites/www/freepublications/en/economics/gii/gii_2013.pdf, page 290 School life expectancy, primary to tertiary education (years) | 2010
[22] From 2008-2010 students with more than 14 credits in science rose from 73.2% to 73.5% and then dropped in 2011 and 2012 to 71.4% and 71.6% respectively.
[23] National Monitoring Study of Student Achievement, Science 2012, Educational Assessment Research Unit, Otago University and the New Zealand Council for Educational Research.
[24] TIMMS.

science remained relatively stable up to 2009 and declined between 2009 and 2012 in mathematics and science[25].

[MoE to insert graph or diagram showing PISA and TIMMS changes]

NMSSA and PISA results also show growing inequity in student performance in mathematics and science. NMSSA found that on average the performance of Māori and Pasifika students and students with special needs was lower than that of all students, but there is also wide variation.

There is limited data on school student performance in technology

There is limited data on student performance in technology because it is not measured by PISA and TIMMS and NMSSA is yet to assess it. [MoE to check and add any other data].

What is causing the student performance decline?

Research suggests that student achievement in maths and science is dropping relative to other countries because science teachers are not confident in their ability to teach science and maths, particularly to diverse groups, they do not have access to appropriate resources and students lack confidence in their ability to succeed in STEM subjects and lack support for deciding on senior secondary school subjects[26].

2.4 The challenges and how what we can best address them

The challenges are:

- Increasing the proportion of New Zealanders, across all sectors, who consider science and technology are important in their everyday lives
- Increasing the numbers of learners with STEM competencies to meets the needs of their everyday lives and the 21st century labour market.

To address these challenges we need to:

- Build a nationally supportive environment for public engagement in science and technology and, equally, for the science sector's engagement with the public through encouraging effective public engagement in science and supporting the science sector to more effectively engage with the public.
- Improve teacher confidence through high quality STM teacher education, support quality teaching, learning and assessment in STM, and develop STM-specific curriculum materials and support teachers to use them; improve the visibility and coherence of STEM career pathways which are well-matched to the needs of the labour market; and improve linkages between STM educators, scientists, technologists and learners. These are the key levers that national and international research on effective teaching and learning in science and technology[27] have identified as critical for improving student engagement and achievement. A comprehensive and coherent programme of

[25] OECD, *Programme for International Student Assessment 2012*.
[26] Hipkins, R and Bolstad R. 2005. Staying in Science. Students' participation in secondary education and on transition to tertiary studies; and the follow-up study Staying in Science 2 (by Hipkins, R, Roberts, J, Bolstad R and Ferral H. 2006) NZ Council for Educational Research. Also ERO Report and NMSSA.
[27] Staver, J.R. (2007) *Teaching Science* – Educational Practices Series 17, International Academy of Education/UNESCO. Gilbert, J. and Bull, A. (2013) *Building a future-oriented science education system in New Zealand: How are we doing?*, NZCER.

improvement that drives these levers and utilises all of the existing resources and expertise across the science and technology education systems is needed to meet the challenge of increasing the STEM competencies of New Zealand's young people.

2.5 What we're already doing

New Zealand has already put in place several policies and initiatives to help address these problems.

STEM Education initiatives

The New Zealand Curriculum (2007) is being implemented across all schools (at different rates). It addresses both problems: STM skills development and building a science-literate population more generally. It identifies five key competencies which are to be developed through the opportunities afforded students in the eight learning areas of the curriculum. Science literacy is valued as an outcome at the heart of the science learning part of the curriculum. It is supported by students developing the key competencies as well as by other resources in other education and community contexts.

Continuing STEM education for teachers

The Ministry of Education provides professional learning development (PLD) in both English-medium and Māori-medium to build teacher capability and confidence to deliver learning programmes in science/pūtaiao, technology/hangarau and mathematics/pāngarau. PLD is designed to enhance teachers' professional practice for improved student achievement.

Curriculum support materials

Quality teaching, learning and assessment are supported through a range of online and print publications. These focus on how to deliver personalised learning, develop authentic learning experiences for students and build partnerships between schools, teachers, students, families and whanau and communities to ensure diversity of STEM education and success for all learners. A growing body of literature signals the case for integrating quality teaching practices, technology and change knowledge[28]. The newly developed Science Capability Framework and supporting suite of resources available from TKI/Science Online are a recent example of how this is being done.

Science Learning and Change Networks

Learning and Change Networks are communities of practice which have provided an environment to build sustainable partnerships between families, whānau, iwi schools and kura to listen to student voice about what matters most for their learning and achievement. Together these communities co-construct responses to a learning challenge to enable accelerated progress towards equitable outcomes for priority groups and student achievement. In 2014 new networks will be established with a dedicated focus on student achievement in science.

Strategic leadership and coordination

A visible coordinator to identify and develop sustainable linkages between the science education community and schools was identified as critical to make the most of New Zealand's collective strengths and resources, and improve learner engagement and achievement in science. A pilot running through to July 2014 will build school science community partnerships that support school students' science learning, and test such a leadership and coordination role for strategic effectiveness to inform a wider system change in 2015-16.

The Matakōkiri Project is an initiative that supports students to engage with science by linking science/pūtaiao to Māori language, culture and identity through students' local tikanga,

[28] For example, Fullan, M. 2012 Stratosphere.

whakapapa and stories. The project is an iwitanga-based science programme run by Te Taumata o Ngāti Whakaue Iko Ake Trust in their rohe for their students, whanau, teachers and schools.

Promoting STEM-related careers

In the 2013 Occupation Outlook MBIE included a STEM feature that identified the current and future demand for STEM-related careers. The Tertiary Education Commission has been working with the tertiary sector to increase the number of engineering graduates. [MoE to add text on Vocational Pathways] Callaghan Innovation[29] also expects to spend $1.2m in 2013/14 on promoting STEM careers to students through Future In Tech [Callaghan Innovation to check].

Initiatives that promote better engagement between science and the public

A number of current policies for research are designed to promote public access to the knowledge produced by New Zealand's publicly funded researchers. For example, the Government expects researchers receiving public funds to make their research available to the public. There are requirements in the Government contracts for publicly funded researchers, such as the Marsden Fund and Health Research Council, to make research public and provide public engagement and outreach.

Secondly, the participatory approach that was used to develop the National Science Challenges has increased the public understanding of how science contributes to the nation's wellbeing and encouraged a more scientific approach to the challenges facing us. Also, the request for proposals for the first ten National Science Challenges further encourages engagement by the science sector with the public by requiring submitters to outline: how they will involve the public in their proposed research; how they intend to engage the public with their proposed research; and the outreach, communication, and education activities they intend to undertake.

Thirdly, the Government funds initiatives through the 'Engaging New Zealanders with Science and Technology' appropriation. In 2013/14 this appropriation ($8.969m) funds:

- Science/Biotechnology Learning Hubs – an online repository of New Zealand science for use by teachers and other New Zealanders.
- Science, Maths and Technology Teacher Fellowships – six month fellowships for primary and secondary teachers.
- The Prime Minister's Science Prizes and the Rutherford Medal – prizes for scientific research or technological practice that raise the profile and prestige of science.
- The Science Media Centre – a centre that translates science and technology issues for the media and educates scientists on engaging with the media to improve the quality and professionalism of science and technology reporting.
- Talented School Students Travel Awards – awards for high-achieving secondary schools students to travel to science and technology events outside New Zealand to promote STEM-related careers.
- Supporting Young Achievers – awards that recognise and supported high achieving school students in science (including social sciences), mathematics and technology to promote STEM-related careers.
- NZ Science and Technology Journals – online New Zealand science journals that provide an opportunity for New Zealand authors to publish their research and make it publicly available.

The Tertiary Education Commission also released an Adult Literacy and Numeracy Implementation Strategy in 2012. The Strategy [TEC to complete].

Other government initiatives

[29] Describe Callaghan Innovation.

Various other government initiatives will also contribute to delivering on the draft strategic plan.

[The Government has helped to close the gap between the science community and the public(s) through creating the institution of the Chief Science Advisor. This role has helped to bring into sharp focus the social contract of public scientists, in particular through a recent investigation of the use of research-based evidence in policy making in New Zealand[30]. Findings of this study pointed to the pressing need to facilitate and structure the relationship between knowledge producers (scientists) and knowledge users (in this case the public service, on behalf of the public). As a result, the role of Departmental Science Advisors has been established and many Ministries are in the process of filling these positions with a view to lifting the public services capabilities to ensure the use of robust and reputable research-derived knowledge in decisions that are important to the public.

The Government has also released the Tertiary Education Strategy [TEC to complete]

[MBIE to add text on Māori Economic Development Panel 2012's Strategy to 2040]

The recent announcement by the Prime Minister of Investing in Educational Success – Teaching and Leadership career pathways initiative which targets raising achievement through quality teaching and professional leadership, and the Ministry of Education's 2014 PLD policy review offer an expanding environment in support of the principal objective of this strategic plan.

PART 3. Strategic Domains and Priority Actions

Section 2.5 outlined what the government is already doing to encourage and enable engagement by New Zealanders with science and technology. This section sets out 3 strategic domains (SDs), each with a set of priority actions over the next three years. Together, the SDs focus actions on the medium and longer term horizons that will support New Zealanders' understanding, engagement, assessment and use of science and technology.

In addition, at the heart of this strategy is a priority action that cuts across all three SDs: the Participatory Science Platform. This platform (see annex one) is especially designed to simultaneously:

- Meet the needs of the compulsory education sector by offering a unique way to make learning about science interesting, engaging and practical for multiple levels of learners and by connecting classroom teachers with practicing contemporary scientists (SD1)
- Enable and foster the public's understanding of and engagement in real-world science through research that is relevant to local communities (SD2)
- Offer opportunities for practicing scientists to become better engaged with the public by contributing both to science education and to filling knowledge gaps that are locally relevant and scientifically interesting (SD3)

The following sections outline the SDs in turn, along with details of their respective and cross-cutting priority actions.

SD1: The Education Sector

The goal of SD1 is to contribute to the creation of informed and capable New Zealanders, who are resilient learners, with future-proofed skills to grasp, assess and apply rapidly changing science and technology knowledge. SD1 will contribute to this goal by focusing on support to quality teaching. That is, ensuring teachers have opportunities to enhance competencies, confidence, and disposition for imparting not just scientific knowledge, but importantly, curiosity and creativity in students at the compulsory level.

SD1 is necessarily focused on the compulsory years as these are important precursors to establishing life-long interests and career aspirations. In addition, it is deliberately limited to the role of science education specifically, while maintaining a view toward broader STEM-based career options for learners. This is because the common practice of bundling an approach to Technology, Engineering and Maths education ignores the fact that each of these disciplines requires distinct methods and it would be inappropriate and unjust to treat them as an homogenous domain.

Instead, by focusing on the purpose and methods of science education primarily, SD1 remains perfectly aligned to the goal of the Science in Society challenge. Naturally, the early establishment of knowledge of and about science is absolutely foundational to its application in technology education, which is also a concern for SD1 as it seeks to lay the foundation for technological skills, innovation and creativity in learners. This framing of the issue will allow the education sector to do some much needed critical thinking about the purpose of science education at the compulsory level, and to respond accordingly. The activities in SD1 are designed to do just that.

<u>Approach</u>

To supplement the Ministry of Education's ongoing effort, and especially to help develop teacher confidence and contemporary science competencies, SD1 priority actions address:

1) Initial teacher training;

2) Continuing professional learning and development; and

3) Better links between practicing scientists and schools.

Actions in these areas are focused on three key intervention sites: primary level education; secondary level education, and science leadership within schools and centrally within government.

<u>Priority actions</u>

1. *Improve initial teacher education for increased science teaching competencies and competence.* ITE for science and technology teaching competencies has gone through a number of changes in the past decades and it is time to review what is working and where improvements are needed. For instance, while we know that primary teachers are necessarily generalists, new research has also shown that primary education is an important window of opportunity for imparting foundation curiosity and learning behaviours for learners' future attitudes and practices toward science and technology. It is imperative that new primary teachers feel confident to maximise this opportunity and that secondary teachers can maintain momentum through relevant, engaging subject matter and methods.

   Specifically:

- The Ministry will continue to work with universities and the accrediting body to explore policies and practices in ITE for science and technology at primary and secondary levels.

2. *Improve the quality and relevance of continuing professional learning and development opportunities for teachers in science and technology.* Teachers need support with professional learning opportunities to so that their teaching practice is current and reflects not only the principles of effective teaching and curriculum developments, but also contemporary knowledge and methods in scientific research. High quality PLD, combined with access to scientists and technologists, will enable teachers to bring contemporary knowledge to the classroom in an engaging and relevant way. This is consistent with and can accelerate Outcome 1 of the MoE strategy – “Teachers are confident and capable of teaching ‘Nature of Science’ and value the role of science for citizenship purposes.”

   Specifically:

   - Refocus and restructure the Science, Mathematics and Technology teacher fellowship programme to include a ‘school science leadership’ component with a focus on science and technology teaching and leadership competencies.

   - Review and refocus the Science/Biotechnology Hubs to improve their delivery and accessibility for teachers.

3. *Encourage youth into science or technology-based careers*: Develop more responsive educational pathways and raise awareness about the impacts of student subject choices, including on entrepreneurial thinking in the science and innovation sector. The relevance of science and technology learning to future careers options needs to be made clearer at an earlier stage for learners and potential careers should be highlighted.

   Specifically:

   - Ensure CareersNZ has meaningful engagement with schools’ careers services to promote science and technology careers well before subjects become optional.

   - continue to support talented school students through young achievers and travel awards

   - exploring more strategic targeting of the Future In Tech programme, and other potential changes to increase its impact [Callaghan Innovation to check]

   - review and evaluate the pilot of the Science Education Leadership and Coordination role for merit to expand

4. *Build and maintain meaningful linkages between science and technology educators and learners, and practicing scientists and technologists, both in the classroom and through opportunities that engage the larger community:* This action cuts across SDs 1, 2 and 3. Partnerships with Universities, CRIs, science organisations (museums, science centres, zoos, aquaria, observatories, etc) can be created for learning outside the classroom. These opportunities have to be followed up by class teaching resources that build on the experience outside the classroom to make the experience deeper and better understood. The deeper engagement results in meaningful knowledge and capability development.

Specifically:

- Build and strengthen links between teachers, learners and practicing scientists by ensuring access to quality Learning Environments Outside the Classroom through the existing LEOTC funding scheme.
- Provide a **platform for Participatory Science** that engages schools, community-based organisations and practicing researchers in questions that are scientifically rigorous, locally relevant and pedagogically innovative. The platform includes central coordinator roles that will oversee the platform and be a conduit between learning environments and scientists. (See annex 1 for a full description of the cross cutting Participatory Science Platform that is at the heart of this strategy).

SD2: Public engaging with science

The goal of SD2 is to build a nationally supportive environment for public engagement in science and technology as both a tool of citizenship and as economic driver. It is aimed at both the need to build better public understanding of the potential uses and the limitations of science and technology, and to lift our collective expectations for a truly knowledge-based economy in New Zealand. It is closely linked with SD3 'Science engaging with the public', and acknowledges the necessary efforts to be undertaken across sectors to ensure that we can all play a role in determining the direction and application of science and technology for New Zealanders.

Taken together, SD2 and SD3 have as their objective to increase opportunities to develop legitimate social licence for innovative science and technology in New Zealand.

<u>Approach</u>

SD2 operates on two time horizons and in tandem with SD3 to help move toward 'a scientifically engaged public' and a 'publically engaged science sector'. In the immediate term, it will enhance the quality, breadth and depth of science communication to the public, including through the conduits of the Science Media Centre and organisers of national science and technology public events and directly by scientists through the Participatory Science Platform. In the longer-term, SD1 recognises that true culture change necessary for building high science capital must start with young learners, their teachers, their families and their communities. Thus the Participatory Science Platform has the long-term goal of inspiring learners through engagement in research that can truly make a difference to their communities.

<u>Priority actions</u>

1. *Support quality science journalism and blogging in the multi-platform media:* Print, television and online media are powerful tools of thought influence. In particular, socially networked media and blogging can be equally powerful in making science and its methods more understandable and accessible as it is in spreading dangerous rumours and urban myths. This priority action will harness the positive power of the media to help make science and the complexities of risk and scientific uncertainty more accessible.

   Specifically:

- Enhance the role and reach of the Science Media Centre to support more training and outreach to science journalists to encourage responsible and insightful science news reporting and long-from analysis that is relevant to the New Zealand media consumer.

- Continue to build on the success of the Great New Zealand Science Project campaign by refocusing it on opportunities presented with the new Participatory Science Platform through a 'sequel' campaign via both traditional and social media. The campaign will both raise awareness of New Zealanders' achievements in science, while also encouraging people to think critically about today's pressing knowledge gaps and places where community involvement in science could make a difference.

2. *Support quality national public events on science and technology:* Events that bring science and technology to the general public have the potential to engage the public in science and technology in captivating and relevant ways. This priority action will support these events with a broad reach beyond a local area that would not otherwise proceed.

   Specifically:

   - Establish a contestable fund for nationally delivered one-off events that target the general public and would not proceed without government support.

3. ***Cross-referenced with SD1, priority action 4,*** *support young people, parents and whanau to further develop their involvement with science as a key contributing factor to both society's science capital and student achievement*: The development of parental/whanau and community involvement is seen to have multiple desired outcomes. It acknowledges and builds on the importance of parents and families and young learners' first mentors, while also providing an opportunity to support parents' own science capital through community collaborative research opportunities that bring together practicing scientists with schools and other community organisations on real-world questions.

   Specifically:

   - Provide a **platform for Participatory Science** (See annex 1 for a full description of the cross cutting Participatory Science Platform that is at the heart of this strategy).

SD3: Science engaging with the public

SD3 is the reciprocal complement to SD2. There cannot be a scientifically engaged public without there also being a publicly engaged science sector. This strategic domain recognises the important role that the science sector plays in ensuring the public relevance of research, whether through commercialisable innovations or policy-relevant results. Not all science will have immediate application, but all publicly funded scientists and collaborators have a social responsibility to share some level of knowledge where it's applicable. Publically funded scientists are signatories to a social contract, the expectations of which reach beyond generating scientific publications. We look to 'our' scientists for useful new technologies and evidence-based guidance on society's most pressing issues

Priority actions

1. *Ensure that publicly funded scientists continue to employ leading edge knowledge and international best practices to engage relevant public(s) in identifying priority research questions and usefully disseminating results.*

   Specifically:

   - Public research funding bodies will review and update the knowledge translation (KT) expectations attached to grants and contracts, and assess the current state of publically-relevant KT practice among funding recipients. Results of this exercise can be used to inform training material for grantees and future decisions about the research funding architecture [MBIE considering this initiative].
   - Royal Society of New Zealand and the Prime Minister's Chief Science Advisor will convene the scientific community to jointly develop a Code of Practice for Scientists that enshrines their public responsibilities We note the Japanese Council of Science's recently updated Code of Conduct of Scientists, which outlines not only the responsible conduct of research but also the social responsibility of scientists to engage with the public and policy makers based on their expert knowledge.
   - Assess the nature, scope and impact of the New Zealand Science and Technology Journals.

2. *Ensure that emerging scientists have the basic communication skills to make their research accessible to relevant audiences beyond their peer community.*

   Specifically:

   - [Through the Tertiary Education Commission, assess the potential for the development and implementation of an online course dealing with science ethics and communication for core credit in graduate science degrees at NZ universities. Modules of the online course could be developed with input from leading science communicators, ethicists, entrepreneurs and policy experts. The goal of the online course would be to instil key knowledge and skills in emerging researchers early in their careers. The online delivery of the course would facilitate and ongoing community of practice in communication and socially responsible conduct of research among emerging scientists [TEC to consider this initiative].

4. ***Cross-referenced with actions SD1 and SD2,*** *support scientists to contribute meaningfully to schools and communities, while advancing their scientific output, by enabling their involvement in participatory research.*

   Specifically:

   - Provide a **platform for Participatory Science** (See annex 1 for a full description of the cross cutting Participatory Science Platform that is at the heart of this strategy).

PART 4. Implementing and evaluating the strategy

A bold strategy requires a bold approach to implementation. We cannot afford to continue in a business-as-usual way with either the significant educational-related actions or those focused on multi-sectoral science engagement.

Addressing the challenges described in the plan are longer term issues that will require a sustained commitment that creates sustained change. It will also require us to learn and modify as we go. For these reasons the government has asked the Reference Group that was established to assist the government to develop this plan to reconvene in 2015 to review progress and advise on any modifications to the strategic actions.

4.1 Timeframe

As this is the first government Science in Society strategic plan it proposes actions for the next three years from 2014 to 2017.

The actions in the plan include some initiatives that are already being progressed as they continue or enhance effective existing actions. Enhancing the role of the Science Media Centre and the Ministry of Education's pilot of a strategic leadership and coordination role are examples of these actions.

The plan also includes actions that can be implemented in the medium term. For example, the participatory science programme and the contestable fund for nationally delivered one-off events can be developed in 2014/15 for implementation in 2015/16.

Finally, proposed action areas for the education sector will require a longer term (Year 1-6) approach to address root issues such as systemic changes that address identified issues with teacher training and the need to link classrooms to the professional science community to help inspire and provide authentic learning opportunities of relevance and interest to students.

4.2 Evaluation Framework

The Participatory Science initiative will include an evaluation programme. [MBIE and MoE to add text around rest of monitoring and evaluation programme]

Annex 1: Process for developing this plan

[To come]

Annex 2: Participatory Science Platform

"Learning and working together on the problems that matter to us."

What is Participatory Science?

Participatory Science is a method of undertaking scientific research whereby volunteer members of the public (young and old) can be meaningfully involved in research under the supervision of a professional scientist. Participatory science can be done in any number of disciplines, but some of the most popular projects that are amenable to this type of collaboration include: environmental monitoring; crowd-sourced data processing; community and urban mapping and online technology assessment to name a few.

Inspired by the best of Citizen Science and Community-Based Participatory Research concepts and methods

Conducting professional research with members of the public has often been labelled 'Citizen Science,' with typical examples seen on the website of the magazine *Scientific American*: http://www.scientificamerican.com/citizen-science/. This website is a repository of citizen science projects in which anyone can take part, in accordance with a set of parameters and expectations defined by the projects' scientific principal investigator, who is usually a university-based scientist.

Citizen science has indeed been praised for its potential to ignite scientific interest in young people (where classrooms or whole schools participate in projects, for instance) and to transmit scientific concepts in a way that is seen as relevant. Projects can provide much-needed variety and exciting 'science-in-action' applications to the science curriculum delivered in the compulsory education years. In addition, it can offer lay science-enthusiasts unprecedented opportunities for hands-on involvement at a level that local science centres may not be able to accommodate alone. It also offers an opportunity to bridge the home/school boundary, with the potential to engage learners not just through their classrooms, but within their families, whanau and larger communities and by incorporating multiple community organisations including the private sector. Additionally, for scientists, citizen science can provide a ready and enthusiastic 'work force' for data collection and/or processing. It can also be a useful pipeline for local universities and technology institutes to draw talented learners into pre-professional STEM pathways.

Any criticisms of the citizen science concept are largely due to inappropriate expectations and confusion as to what it is. Some academic theorists of 'science in society' have commented that citizen science perpetuates an expert/lay imbalance and does not help to democratise the science enterprise because it does not allow for citizen engagement in decision-making about the research. In fact, rarely has this been the engagement goal of conventional citizen science.

The idea of 'engaging' lay members of the public in the science enterprise can have a number of meanings along a spectrum of engagement types. In some sectors, the notion of better engagement is simply about publically communicating science in a more accessible way. By contrast, practitioners of Community-Based Participatory Research seek to involve citizens in the identification and shaping of research questions and (in some cases) in the use and governance of research outputs. The latter type of engagement lends itself particularly well to work in public health and environmental stewardship, and it has been hailed as a method that helps to make science more democratic and relevant to the public.

What we're proposing: the best of both worlds

Our proposal for a Participatory Science platform is a hybrid model that builds on some of the popular momentum of citizen science, but ensures that is enhanced with the most influential aspects of citizen engagement inspired by community-based participatory research. Our model is grounded in the following governing concepts:

- Better public understanding of science through better communication and participation;
- A focus on the school-based learning environment with strong links to other (out-of-school) learning environments in the community. This will help structure the program; ensure both pedagogical and scientific quality; and forge a link from the learner to the family and the wider community.
- Inspiring the public through hands-on involvement in science;
- Providing meaningful opportunities for the public to identify research goals of local and regional importance.

An important innovation in this hybrid model is the ability for citizens (classrooms and other local groups/organisations) to themselves identify research that would be valuable to their communities. This will make their engagement in science considerably more meaningful than one-way involvement in data-collection that characterises most citizen science programmes worldwide.

How it works

The Participatory Science platform is built on four core components:

1. A public engagement process that seeks ideas from the community and from practicing researchers;
2. A process for evaluating these ideas for pedagogical and scientific quality and for ensuring their practicality and relevance to the participating community (eg that the activity can span multiple school years and/or involve other community-based partners such as museums, zoos, community associations etc.);
3. A web based match-making process between interested community-based partners and practicing (university or CRI-based) scientists
4. A resource for teachers and other learning leaders to assist in developing their projects to robust standards.

These core components of the platform will be supported by two additional enabling features:

- A limited number of seed-grants for community/scientist project planning and equipment
- A simple but supportive policy change within the PBRF scheme

Proposing a project

The website will serve as a match-making tool between scientists and members of the schools or community organisations seeking to take part in a research project by offering a platform for:

1) Community-initiated research: approved projects that schools, museums, or other community groups/establishments would like to see undertaken in collaboration with experts in the field;
2) Scientist-initiated research: projects that professional scientists identify according to their expertise and the potential for a community-based component of the work.

A proposal template will be developed for use by scientists or community groups/schools. The proposal will include a description of the problem and the proposed research, as well as a justification for community involvement and at what stages of the work (data collection, analysis, knowledge translation and subsequent actions). In addition, community-based proponents should outline what they can offer the researcher (space, volunteers, site monitoring, access to data, combined computational power etc.), while researcher proponents should make clear why their proposed projects are suitable for the school/community based participatory science platform.

The goal is to identify projects with broad appeal, having both scientific value, pedagogical rigour, and that resonate with the community. Both the educational and scientific objectives must be clear. Even if, in some cases, the science is primarily of local interest, it must demonstrate scientific principles. Ideally the project should be one that can engage teachers (and learning leaders in out-of-school settings), learners and their families at multiple levels. For example learners in one school-year might collect the data and those in another school-year undertake the statistical analysis. Projects might involve multiple schools, schools and other community organisations, or even be national in scope with multiple community-based partners. Indeed, while schools are a focus site for the program, they are encouraged to engage with museums, zoos, conservation and park authorities or the private sector in proposing a project.

Management of the platform

It is critical that this endeavour is quality controlled from the outset. A multi-sectoral management and review panel will be established for this purpose. This panel can also advise on any research ethics requirements, which must be overseen by the scientist's home institution through the extant ethics review processes

All projects must have an institutional home which is the responsible coordinator. Generally this will be a school but it may be a museum, a zoo, a science centre, and of course, a research institute or a university would all be eligible.

Funding

In general, it is expected that these projects will be of minimal cost. These projects will be offered as opportunities for schools and their communities to participate in undertaking scientific research. This provides an avenue for them to enhance their science learning programmes through stronger links to out-of-school learning environments and expertise, and improve the relevance and value of science learning to students. Schools would self-direct their involvement and fund this in the same way that they currently do curriculum support resource or, in the case of scientist-initiated projects, funded through scientists' own research funds. However, to enable more sophisticated projects, limited one-time seed grants will be made available to help foster a meaningful level of community involvement, where a suitable match is made.

The aim of the seed-grants is to provide an opportunity for professional researchers and community groups to plan together the research question, data collection, analysis and knowledge translation strategy for the work. This is a key step in making science accessible, understandable, interesting and, importantly, relevant to communities. It has the added benefit of assisting scientists to meaningfully demonstrate the social relevance and impact of their research.

It is important to note that the seed grants are not designed to fund research projects in their entirety, but can (in a limited number of cases) support the collaborative planning and the provision of selected equipment or consumables that the community members may not have at their disposal to undertake the work. Examples of eligible items for a seed grant budget could include:

- Meeting expenses: for researchers and community members/teachers and learners to meet and identify/refine research questions; analytical frameworks and data collection strategies;
- Equipment/consumables such as water testing kits; digital media for recording data etc.

Any further research expenses would be expected to be covered by the researchers' own funding on the assumption that the project is part of their overall body of professional work, or from the school/community partner.

Media support

A multi-media campaign will accompany the launch of Participatory Science platform, and a dedicated website/social media site will provide a sustained channel of communication for ideas that continue to emerge. A consultant will be hired to develop a comprehensive media strategy that builds on the momentum created by the *Great New Zealand Science Project* and leverages the legacy of that project, including its Facebook page.

The campaign will include both a public approach (radio social media) and a targeted approach to key sectors including:

- Scientists, through their universities and associations;
- Teachers and principals through their professional associations;
- Public science institutions such as universities, zoos, aquaria etc.
- Youth-focused learning and service organisations such as the scout movement.

Links to other initiatives

The Ministry of Education has done considerable research in the past two years to identify some of the major obstacles in the science teaching and learning environments at the compulsory levels. For instance, we know that in primary school, teacher confidence is a major issue, and at secondary school, there is a drop in student enthusiasm for science, which may be attributed to the perceived lack of relevancy to their lives. We also know that parents and whanau have a deep influence on compulsory level learners, so any intervention needs to be able to bridge schools and families for full engagement. Finally, we know that there are resources in the community, such as museums, science centres, zoos, citizen groups etc., that are invaluable learning opportunities if they are appropriately harnessed and accessed in order to bridge the formal and informal sites of learning.

Strategic Domain 1 (SD1) of the Science in Society strategic plan points to the need for teachers to be better connected to the science community in a sustained way. This can be achieved in part by refining the criteria and expectations of the RSNZ teaching fellowships, but there is also a need for a sustained liaison and coordinator role within the ministry. Such a liaison would be able to link schools, communities, community science organisations and practicing scientists. A significant vehicle for achieving this is in coordinating and overseeing the Participatory Science Platform. The proposed 3-year budget allows for three such coordinators to ensure regional and ethnic diversity.

In addition, the introduction by the Ministry of the Network for Learning (N4L) across schools nationally, offers unprecedented opportunities for schools to work collaboratively on projects in a networked manner, and for scientists to be involved with multiple schools from a distance.

Finally, it is proposed that the Participatory Science platform be as responsive as possible to the research themes identified through the National Science Challenges process, without being constrained by these and allowing for maximum community input into specific research questions. Both Community-based and Science partners will be encouraged to consider questions that are linked to the identified NSCs and Platform coordinators will help proponents to link with NSC principle investigators where appropriate.

Draft Budget

The proposed project is low cost and has the potential for high impact. The entire budget can be absorbed by a reallocation of existing funds for projects that will be discontinued or whose mandate area can now be covered by this proposal.

	2014/15	2015/16	2016/17	3-year maximum investment
Website development and maintenance	$30,000	$10,000	$10,000	$50,000
Management and review panel expenses	$150,000	$150,000	$150,000	$450,000
community-school-scientist liaisons and platform coordinators (N.I. / S.I. / Mãori)	$270,000	$270,000	$270,000	$810,000
Media campaign	$150,000	$100,000	$50,000	$300,000
One-time seed grants of up to $8K/project	$250,000	$550,000	$800,000	$1,600,000
Evaluation	$100,000	$50,000	$100,000	$250,000
Total	**$865,000**	**$1,050,000**	**$1,350,000**	**$3,460,000**

Sponsorship Opportunities

It goes without saying Participatory Science platform is the type of project that is likely to appeal to a range of private sector partners wishing to engage in activities that promote and demonstrate their corporate social responsibility. Thus, it may be possible to augment the seed grants component through appropriate sponsorship agreements between funders (which would be more efficient and more easily managed from a governance and ethics perspective than sponsorship for individual projects). However local schools are likely to find projects that engage sponsors directly.

Evaluation

From the outset the platform will be monitored and evaluated for its pedagogical value and for its impact on the local community, as well as for its scientific value. It is important to conduct a formal evaluation of the program as too often, lack of impact measures is seen as a weakness of the traditional citizen science concept. However, the dearth of evaluative studies should not imply lack of positive impact. Any evaluation must be carefully constructed in accordance with stated objectives. What is needed is a clear set of goals and objectives that are appropriate to the context in which it is applied. An allocation of $250,000 over the three years will support a formal evaluation by educational and social scientists, with project data collected by the coordinators via password-protected space on the website.

References

[add hyperlinks in webpage]

1. Public Engagement in Science and Innovation
http://mako/OTCS/llisapi.dll?func=ll&objaction=overview&objid=9352461

2. Science Education
http://mako/OTCS/llisapi.dll?func=ll&objaction=overview&objid=8973336

3. STEM skills and careers

Briefing: http://mako/OTCS/llisapi.dll?func=ll&objaction=overview&objid=12685437

International policies paper:
http://mako/OTCS/llisapi.dll?func=ll&objaction=overview&objid=12684225

Glossary

What do we mean by 'engagement'?

We use the term 'engagement' to mean the acquisition and application of multiple types of STEM knowledge[31], by multiple kinds of audiences and applied to various purposes. It implies an improved and productive social relationship between the science sector and society that will lead to its responsible application for the social, environmental and economic benefit of New Zealanders.

Engagement in…

- *generating knowledge* is about knowledge users, including the public, being enabled to help identify issues requiring science input so that public science research is more relevant and stands to have more meaningful impact. It is also about the public being part of the research itself, including through citizen science.

- *acquiring knowledge* is about the public, including and especially compulsory level students acquiring the STEM skills and knowledge needed to develop a career in science and/or engage in much needed and ongoing civic discourse about the application of scientific knowledge.

- *assessing knowledge* is about is about applying an increasingly sophisticated understanding of the what science can (and cannot) provide in the search for solutions to today's pressing problems. Assessment requires an understanding of risk and probabilities associated with both the issues themselves and their scientific responses. Citizens, businesses and governments and the science community are all stakeholders in these critical debates.

- *applying knowledge* is about is about making the best use of what we know, including the responsible and evolving use of or limiting of new technologies or novel applications of extant technology.

This definition of engagement reflects a fresher approach through a necessary mix of what has been called 'public understanding of science' or 'science literacy' and of 'public engagement in science'.

Over the past two decades, the place of science in societies has changed from a focus on an undifferentiated 'public' that was illiterate, apathetic or hostile towards science and technology (known as "public understanding of science[32]) towards an awareness of multiple contextualised audiences for science and the distinct ways that they engage with it (known as "public engagement in science) [33].

In the USA and Europe in the [1980's and 1990's] there was a one-directional focus by governments on remediating the presumed public knowledge deficit. In recent years those countries have identified that public perceived apathy or hostility toward research or technology is more about social values and citizens' trust than it is about public knowledge of scientific

[31] We use the OECD definition of 'science knowledge' to mean knowledge *of* science and knowledge *about* science. Certain audiences will specialise in knowledge 'of', but basic knowledge 'about' science is broader and is an important tool of 21st century citizenship for engaged and equitable civic discourse on today's most pressing societal concerns. We also acknowledge that 'knowledge' may also mean the science community's knowledge of various public audiences and how to connect with these to make their science relevant.

[32] Kristiann to identify fgotnote

[33] Kristiann to identify footnote

facts. They have shifted their focus on creating context appropriate opportunities for dialogue and input into decisions about what society wants science to do for us all[34]. For example [MBIE to complete].

Science includes social sciences. The role of scientists is to interrogate the "real things" or phenomena of the natural world in order to construct explanations of them, that is, to know the world.35

Technology. The role of technologists is to intervene in the world to solve problems, meet needs or desires, that is, to create part of the made world36.

STEM is the internationally recognised term that refers to subjects or areas of learning, namely Science, Technology, Engineering and Maths, which are used broadly and are inclusive of all levels of learning.

STM refers to school subjects (science, technology and mathematics) because engineering is taught only at tertiary level.

Science knowledge means knowledge of science and knowledge about science[37]. Certain audiences will specialise in knowledge 'of', but basic knowledge 'about' science is broader and is an important tool of 21st century citizenship for engaged and equitable civic discourse on today's most pressing societal concerns. We also acknowledge that 'knowledge' may also mean the science community's knowledge of various public audiences and how to connect with these to make their science relevant.

[34] Kristiann to identify footnote
[35] France and Compton *Bringing Communities Together*.
[36] See footnote 33.
[37] Kristiann to identify footnote

CONFIDENTIAL NOT GOVERNMENT POLICY

Science for, by, and with New Zealanders

A national strategic plan for science in society 2014-2017

DRAFT STRATEGIC PLAN FOR COMMENT

Contents

Ministers' foreword

[To come]

Steven Joyce
Minister of Science and Innovation

Hekia Parata
Minister of Education

Executive summary

This plan responds to the Science in Society 'leadership challenge'[1] recommended by the National Science Challenges Panel. The Panel saw it as "the most important challenge to address" and central to the success of the National Science Challenges. In May 2013, the Government formally accepted the leadership challenge.

Many of today's toughest decisions (e.g. on public health, natural resources stewardship and communications technology) require us all to weigh scientific evidence and social values. New Zealanders need to be supported, equipped and given the opportunity to engage in the key questions facing our society now and in the future. The Government's goal of economic growth through an innovation-led economy drives the need for an increasingly science, technology, engineering and maths (STEM) competent workforce.

The government's primary objective for Science in Society is to 'encourage and enable better engagement with science and technology across all sectors of New Zealand' in order to deliver:

- a more scientifically and technologically engaged public and a more publicly engaged science sector; and
- more science and technology competent learners choosing STEM-related career pathways.

In the longer term it is anticipated that progress towards these outcomes will contribute to New Zealand's economic growth and social and environmental well-being through:

- a greater number of New Zealanders with the skills needed to support creativity, innovation and knowledge uptake and use; and
- publicly funded science and technology which responds to the needs of New Zealanders and New Zealanders make more informed decisions on issues of importance to 21st century life.

A survey of public attitudes to science identifies that about half of New Zealanders are actively interested in science and the other half did not recognise the relevance of science in their everyday lives (44%) or were disengaged (9%). There is limited evidence on the level and effectiveness of the engagement of the science sector with the public.

Demand for STEM skills (for scientists, technologists, engineers, health and ICT professionals[2]) is expected to grow strongly. More students are graduating with degrees in natural and physical sciences and engineering. New Zealand school student performance in science is declining.

The challenges ahead are:

- increasing the engagement of New Zealanders, across all sectors, with science and technology and increasing the effectiveness of the science sector's engagement with the public; and
- increasing the numbers of learners with STE competencies to meet the needs of their everyday lives and the 21st century labour market.

These are long-standing challenges that will take time to address.

Many initiatives are already underway which are key to the success of the plan and being led by government agencies and the broader community at national, regional and local levels, such as museums, school boards, universities, businesses and the Royal Society. This plan includes a combination of new initiatives and some changes of emphasis within current activities to build on these initiatives and continue progress.

This plan will focus on three Strategic Action Areas:

- ***Strategic Action Area one***: education sector
- ***Strategic Action Area two***: public engagement with science and technology
- ***Strategic Action Area three***: science sector engaging with the public.

The three Strategic Action Areas are interconnected. The advice of the Science in Society Reference Group is that any action in the education sector must be complemented by support from the wider school community. Enhancing public engagement with science and technology cannot be separated from encouraging scientists to engage effectively with the public. This plan addresses the barriers and enablers to creating a more 'publically engaged' science sector together with a more 'scientifically engaged' public.

This plan acknowledges and recognises the importance of mātauranga Māori (traditional knowledge) to build cultural confidence and identity, and how, through this, New Zealand can grow its skills and generate innovation and creativity. Each of the three Strategic Action Areas will be developed in ways that respect whānau, hapū and iwi as the key conduits of mātauranga Māori, and focus on building Māori capability in science and technology to support their management of their natural resources and overall development.

This plan sets out actions under each of the Strategic Action Areas over the next three years. As this is New Zealand's first Science in Society strategic plan in 2015 the Science in Society Reference Group will assess progress on the plan and advise government on any modifications needed to the actions to better deliver on the outcomes.

The plan recognises the importance of maths skills as part of the overall package of STEM skills. It does not specifically address increasing the supply of students with maths competencies as this is being addressed by the literacy and numeracy taskforce.

PART 1 Background

The National Science Challenges and the Leadership Challenge

Following significant public engagement in early 2013, the National Science Challenges Panel recommended a set of national science challenges to address our most pressing health and environmental issues, and to advance our economy through innovation. The Panel also recommended a 'Science in Society leadership challenge' that they saw as "the most important challenge to address" if New Zealand is to advance through the responsible application of science and innovation and benefit optimally from its investment in scientific research. The Panel considered the 'Science in Society leadership challenge' to be central to the success of the National Science Challenges.

The 'Science in Society leadership challenge' asked government to take a lead in facilitating better engagement with science in New Zealand in four distinct but interrelated areas:

1. Science, technology, engineering and maths (STEM) education in primary and secondary schools.
2. 'Public understanding of science', including both the potential and the limits of scientific knowledge and managing uncertainties. Here, 'public' is understood in a pluralistic sense and necessarily includes the elected representatives and civil servants that work in the interest of the New Zealand public.
3. Early engagement by citizens and other knowledge users on the implications of new technologies and novel applications of existing technology, and to help ensure the public relevance of New Zealand's science and research agenda.
4. National capacities in technology assessment, risk forecasting and using this in developing societal consensus in using and limiting technologies.

In May 2013, the Government formally accepted the 'Science in Society leadership challenge, with the Minister of Science and Innovation and the Minister of Education subsequently announcing development of this strategic plan in November 2013. In order to manage the scope of the plan the technology assessment and risk forecasting area is not addressed in the plan at this stage. Annex 1 sets out the process used for developing this plan.

Methodology for developing this plan

This is the first Government strategic plan for Science in Society.

The plan sets out the objectives and outcomes the Government wishes to achieve for Science in Society over the longer term. It sets out the available evidence on where New Zealand is at now and identifies the challenges that need to be addressed. It sets out the Government's progress so far in addressing these challenges. It concludes by identifying the tasks that remain and by setting out a three-year plan of action to make further progress towards the objectives and outcomes.

PART 2 Making the Case

2.1 Why Science in Society matters

21st century life is driving the need to increase our engagement with science and technology

Many of today's toughest decisions at local, national and international levels – about public health; natural resources stewardship or new and emerging technologies for instance – require all of us to weigh both scientific evidence and social values. The National Science Challenges are science priorities that respond to the most important, national scale issues and opportunities identified by science stakeholders including the New Zealand public. Many of these and other challenges we face today and into the future will require creative and innovative solutions that have a basis in scientific discovery and technological application[3]. New Zealanders must be supported, equipped, and given the opportunity to engage in the key questions facing our society now and in the future.

Science, technology, engineering and maths (STEM) skills are increasingly important both globally and for all New Zealanders. The pace of technological change, the ability to engage with modern society and nature of employment in the future means that these skills will be important for everybody[4].

The goal of an 'innovation-led' economy is driving the need for an increasingly STEM competent workforce

New Zealand's economic and social wellbeing depends in large part on the productivity and competitiveness of the economy. Innovation that leads to increased productivity and wellbeing is increasingly being seen around the world as an important way to generate economic growth and improved living standards[5].

The Government is committed to materially lifting New Zealand's long-run productivity growth while maintaining our high rate of labour force participation[6]. To do this, New Zealand needs a high performing and responsive innovation system and skilled people who can problem-solve and create and deliver high-value products and services, cultivate new markets and sell to the world. We also need businesses, policy makers and citizens that are ready to absorb and apply new ideas and approaches.

Our science system – particularly the tertiary education organisations that undertake research-led teaching – has a vital role in educating a future generation of scientists with the advanced science skills that are needed in leading-edge businesses. New Zealand has to be seen internationally as an 'innovation destination'. We must be able to attract and retain the right talent at the right time to contribute to our vital science. Attracting overseas investment in our research is also important for our economic growth.

A creative and innovative culture and a wide range of skills are needed for innovation, societal advancement and sound environmental stewardship. Internationally STEM skills underpin the development of new technologies, the application of existing technologies and the development of new, high-value products[7]. STEM skills and competencies also underlie growth in many industries, such as IT-related industries[8] and are highly transferable across industries[9].

STEM skills, like other kinds of skills, are acquired by individuals over time and in a wide range of ways. They need to be developed as part of the key competencies for life-long learning[10]. An individual with higher levels of competency has a much lower likelihood of experiencing both economic and social disadvantage than an individual with lower competency levels[11].

Students' career choices are influenced beyond school by family, whānau, iwi and the wider community, with parents providing the most important influences[12]. Greater community engagement with science and technology could increase the value students and their family or whānau place on the opportunities STEM subjects offer as career pathways.

The Ministry of Education is focused on ensuring that the education system delivers on the Government's key goals of improved outcomes for all New Zealanders, and stronger economic growth for New Zealand. It is the lead agency on boosting skills and employment. Our ultimate goal is to equip young people with the skills to live a fulfilling life and contribute to New Zealand's economic prosperity.

2.2 Scope of the plan

The plan focuses on supporting and equipping New Zealanders to engage in the key questions facing society and the supply of STE skilled people through the primary, secondary and tertiary education system. The plan does not cover the supply of maths skills and demand for STEM skills as these issues are being addressed through the Business Growth Agenda and the literacy and numeracy taskforce. It also does not address adult maths literacy as the Government is addressing these issues through the Tertiary Education Strategy and the Tertiary Education Commission's Adult Literacy and Numeracy Implementation Strategy.

2.3 Objectives of the plan

The principal objective of this strategic plan is to:

> Encourage and enable better engagement with science and technology across all sectors of New Zealand.

This means:

- a more scientifically and technologically engaged public and a more publicly engaged science sector
- more science and technology competent learners choosing STEM-related career pathways.

Outcome 1: a more scientifically and technologically engaged public and a more publicly engaged science sector

We will know we're making progress on this when:

- a greater proportion of New Zealanders are engaged with science and technology
- there is more in-depth media reporting on science and technology based on robust scientific evidence
- there are increased opportunities for the public to learn and be involved in scientific research and uptake continues to grow across all tiers of society
- there are more opportunities for the public to engage in discussion about societal use and limits of new technology and applications for existing technology

- publicly funded research reflects topics of importance to New Zealanders recognising the diverse needs and issues of communities.

Outcome 2: more science and technology competent learners choosing STEM-related career pathways

We will know we're making progress on this when:

- we achieve greater student demand for STEM courses and qualifications at all levels of the qualifications framework (1-10)
- we have developed greater teacher confidence in teaching for STM outcomes
- teachers have improved access to the resources they need to teach STM subjects and links between the STM curriculum and career pathways are clarified.

Outcome 3: more skilled workforce and more responsive science and technology

In the longer term, we expect that progress towards outcomes one and two will contribute to New Zealand's economic growth and social and environmental wellbeing through:

- a greater number of New Zealanders with the skills needed to support creativity, innovation and knowledge uptake and use.
- publicly funded science and technology which responds to the needs of New Zealanders and New Zealanders make more informed decisions on issues of importance to 21st century life.

2.4 The State of Play – what we know and what we don't know

How scientifically and technologically engaged are the public and how publicly engaged is the science sector?

There is no current comprehensive measure of public engagement in science or technology or adult STEM literacy

It is difficult to measure public engagement in science and technology and there is no internationally accepted metric to capture it. The best New Zealand evidence is a survey of public attitudes to science in New Zealand[13]. The survey identified that about half of New Zealanders were actively interested in science and the other half did not recognise the relevance of science in their daily lives[14] (44%) or were disengaged in science (9%). Similar surveys have been done in other countries. However it is difficult to draw comparisons given differences in the questions[15]. The Government has not surveyed public attitudes to technology outside this survey.

Relative to comparable countries, a relatively high proportion of New Zealand adults have a secondary or tertiary qualification[16]. There is no data on the proportion of these qualifications that are in STEM subjects. From 2016 New Zealand will assess adult competencies in reading, mathematics and problem solving in technology-rich environments through the Programme for the International Assessment of Adult Competencies.

There is limited data on the level and effectiveness of the engagement of the science sector with the public

In 2013/14 the Government will invest $1.36b[17] to support science and innovation in New Zealand. A proportion of that expenditure is expected to be spent on by universities and science organisations on making research more accessible to end-users through communication, public outreach and public education, but it is difficult to estimate the proportion. Other government investment in these organisations may also be spent on communication, public engagement and education.

There are also many local government and private sector organisations, such as industry training providers, zoos, museums, charities and businesses that engage with the public on science and technology for education, cultural and marketing reasons. The Government also invests $167m in funding regional museums and public broadcasting services[18].

It is inherently difficult to evaluate the impact of public engagement activities[19].

Since the Science Media Centre was established in 2008, 'science' in the media has increased by 75%[20].

How competent are STEM learners and how many are choosing STEM-related career pathways?

There are STEM skills shortages

There are currently skills shortages for many kinds of scientists, engineers, technologists, health and ICT professionals[21]. Demand for workers in many STEM-related occupations is expected to grow due to a variety of factors[22]. In addition, many jobs not directly STEM-related require STEM competencies. Internationally it is estimated that up to 75% of high-growth jobs require STEM skills and competencies[23].

The number of NZ graduates is growing, but international demand is growing faster

The number of domestic students completing bachelor degrees across all fields of study has increased from 19,596 in 2005 to 25,350 in 2012. In the natural and physical sciences the increase has been from 1,937 in 2005 to 2,649 in 2012. The numbers of degree-level engineering training places funded by the government has recently increased. The industry training providers are facing difficulties in growing engineering at technician and technology qualification levels[24].

There is a global demand for those with STEM qualifications. Those who gain STEM qualifications required for job-shortage areas can be lost from New Zealand to the global job market or other careers. Many New Zealand graduates with the skills matched to the New Zealand market go overseas to work. Much of this skills loss is replaced by highly skilled immigrants. However, it is expected to become increasingly difficult to attract these immigrants as wages rise in increasingly knowledge-intensive Asian economies.

New Zealand school student performance in science has declined

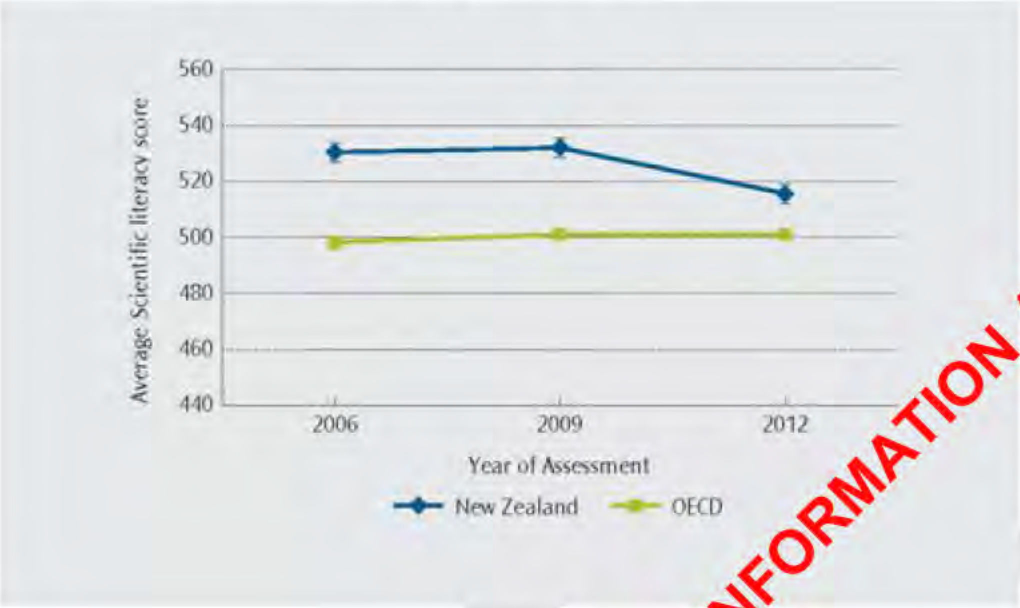
New Zealand has a highly respected education system. The World Economic Forum's Global Competitiveness Index for 2013[25] noted that New Zealanders spend the longest time in education from primary to tertiary, at 19.67 years and ranked New Zealand seventh for overall education indicators out of 142 countries.

Despite this, there is a gradual decline in the proportion of students enrolled in science-related subjects in years 11 to 13[26].

New Zealand students' performance in science has also declined, and the decline is more marked in the later years of schooling. The average performance of New Zealand year 5 students for science in 2010/11 was significantly lower than in 2002/3[27] and there has been no significant change in performance for year 9 students since 1994/5. The performance of New

Zealand students at age 15 years (most students are in year 10 at this age) in science remained relatively stable up to 2009 and declined between 2009 and 2012[28].

Figure One: Graph showing changes in the average science literacy score for New Zealand students at 15 years between 2006 and 2012 compared to the OECD average[29]



The National Monitoring Study of Student Achievement (NMSSA) and the Programme for International Student Assessment (PISA) results also show growing inequity in student performance in science, particularly for Māori students and Pasifika students.

There is limited data on school student performance in technology

There is limited data on student performance in technology because it is not measured by PISA or TIMMS, and NMSSA is yet to assess it.

What is causing the student performance decline?

Research suggests that student achievement in science is declining because science teachers are not confident in their ability to teach science, particularly to diverse groups. Teachers do not have access to appropriate resources, and students lack confidence in their ability to succeed in STE subjects and lack support for deciding on senior secondary school subjects[30].

2.5 The challenges and how we can best address them

The challenges are:

- Increasing the engagement of New Zealanders, across all sectors, with science and technology and increasing the effectiveness of the science sector's engagement with the public
- Increasing the numbers of learners with STE competencies to meet the needs of their everyday lives and the 21st century labour market.

To address these challenges we need to:

- *Build a nationally supportive environment for public engagement in science and technology and, equally, for the science sector's engagement with the public.*

  This needs to focus on identifying, encouraging and supporting the most effective ways for the science sector and other science and technology communicators (such as the media, museums and event organisers) to engage with the public, particularly the proportion of New Zealanders that are disengaged or do not see the relevance of science in their daily lives. The environment needs to encourage two-way dialogue between practitioners of science and technology and the New Zealand public. There is already significant activity in these areas so encouraging good practice and greater coordination could have benefits.

- Improve teacher confidence through high quality science and technology teacher education, support quality teaching, learning and assessment in science and technology;
- Develop science and technology-specific curriculum materials and support teachers to use them;
- Improve the visibility and coherence of STEM career pathways which are well-matched to the needs of an evolving labour market; and
- Improve linkages between STM educators, scientists, technologists and learners and the community

  These are the key levers that national and international research on effective teaching and learning in science and technology[31] have identified as critical for improving student engagement and achievement. A comprehensive and coherent programme of improvement that drives these levers and utilises all of the existing resources and expertise across the science and technology education systems is needed to meet the challenge of increasing the STEM competencies of New Zealand's young people.

2.6 What we're already doing

New Zealand has already put in place several policies and initiatives to help address these challenges.

Initiatives that promote better engagement between science and technology and the public

Expectations on publicly funded researchers to make research public

A number of current policies for research are designed to promote public access to the knowledge produced by New Zealand's publicly funded researchers. For example, the Government expects researchers receiving public funds, such as through contestable science and research funding, the Marsden Fund and Health Research Council, to make research public and provide public engagement and outreach.

The Crown Research Institute's (CRIs) Statement of Core Purpose includes high level statements on engagement with key stakeholders including government, industry and Māori and to transfer technology and knowledge to key stakeholders.

Expectation of public engagement in National Science Challenges

The participatory approach that was used to develop the National Science Challenges has increased the public understanding of how science contributes to the nation's wellbeing and encouraged a more scientific approach to the challenges facing us. Also, the request for proposals for the first ten National Science Challenges further sets expectations for engagement by the science sector with the public by requiring submitters to outline the following:

- how they will involve the public in their proposed research;
- how they intend to engage the public with their proposed research; and
- the outreach, communication, and education activities they are looking at implementing.

Raising the profile of science and technology and improving reporting of science by the media

MBIE also funds initiatives that encourage the science sectors engagement with the public in science through the 'Engaging New Zealanders with Science and Technology' appropriation[32]:

- The Prime Minister's Science Prizes and the Rutherford Medal – prizes for scientific research or technological practice that raise the profile and prestige of science.
- The Science Media Centre – a centre that translates science and technology issues for the media and educates scientists on engaging with the media to improve the quality and professionalism of science and technology reporting.
- Science/Biotechnology Learning Hubs (provides an online repository of New Zealand science for use by teachers and other New Zealanders) and Science, Maths and Technology Teacher Fellowships (six month fellowships for primary and secondary teachers). Both provide science teachers with tools to enhance the teaching of STEM.

STEM Education initiatives

The New Zealand Curriculum (NZC) and Te Marautanga o Aotearoa address STM skills development and building a scientifically and technologically engaged population more generally. The NZC identifies five key competencies which are to be developed through the opportunities afforded students in the eight learning areas of the curriculum.

Science literacy is valued as an outcome at the heart of the science learning part of the NZC. It is supported by students developing the key competencies as well as by other resources in other education and community contexts.

Strategic leadership and coordination

This aims to build school and science-community partnerships that support school students' science learning through the identification and development of sustainable links between schools and the science community to make the most of New Zealand's collective strengths and resources.

The Matakōkiri Project is an initiative that supports students to engage with science by linking science/pūtaiao to Māori language, culture and identity through students' local tikanga, whakapapa and stories. The project is an iwitanga-based science programme run by Te Taumata o Ngāti Whakaue Iko Ake Trust in their rohe for their students, whānau, teachers and schools.

A pilot will run through to July 2014 to build school science community partnerships that support school students' science learning, and test such a leadership and coordination role for strategic effectiveness to inform a wider system change in 2015-16. The aim is to develop sustainable linkages between the science education community and schools to make the most of New Zealand's collective strengths and resources.

Science Learning and Change Networks

Learning and Change Networks are communities of practice that provide an environment for the building of sustainable partnerships between families, whānau, iwi schools and kura to listen to student voice about what matters most for their learning and achievement. Together these communities co-construct responses to a learning challenge to enable accelerated progress towards equitable outcomes for priority groups and student achievement. In 2014 new networks will be established with a dedicated focus on student achievement in science.

Continuing STEM education for teachers

The Ministry of Education provides professional learning development (PLD) in both English-medium and Māori-medium to build teacher capability and confidence to deliver learning programmes in science/pūtaiao, technology/hangarau and mathematics/pāngarau.

Curriculum support materials

Quality teaching, learning and assessment are supported through a range of online and print publications. These focus on how to deliver personalised learning, develop authentic learning experiences for students and build partnerships between schools, teachers, students, families and whānau and communities to ensure diversity of STEM education and success for all learners. A growing body of literature signals the case for integrating quality teaching practices with technology to change knowledge[33].

Promoting STEM-related subjects and careers

There is a range of government activity in promoting STEM related subjects and careers.

- The 2013 Occupation Outlook included a STEM feature that identified the current and future demand for STEM-related careers.
- The Tertiary Education Commission (TEC) has worked with the tertiary sector to increase the numbers of skilled engineering technicians and engineering university graduates.
- TEC released its Youth Transitions Framework that focuses on more young people participating in learning areas of high growth and demand (eg STEM subjects).
- The Ministry of Education and TEC are working on the identification of STEM-related Vocational Pathways credits that will enable secondary and tertiary students to achieve foundation level credits for progression towards higher level STEM-related qualifications.
- Te Puni Kōkiri has increased Māori awareness of opportunities that exist in STEM and architecture and design through partnering with Te Rōpū Āwhina in the Victoria University on-campus support group for Māori and Pasifika students and producing the Māori Future Makers website which profiles Māori and whānau in non-traditional, knowledge intensive sectors.
- Callaghan Innovation[34] expects to spend $1.2m in 2014 on promoting STEM careers to students and their families through the Futureintech programme.

Publicly funded-activity to support science in schools

Universities, polytechs/institutes of technology and other tertiary education institutions have extensive relationships with schools, with a range of current initiatives between the tertiary sector and schools. Te Puni Kōkiri is also partnering with Auckland Uniservices through the LenScience programme to support teachers in up to 20 secondary schools in Auckland with high numbers of Māori students to deliver tailored science curriculums to meet the needs of Māori students.

Other government initiatives support the plan

Other government initiatives will contribute to delivering on this plan such as.

- Investing in Educational Success – Teaching and Leadership career pathways initiative which targets raising achievement through quality teaching and professional leadership offers an expanding environment in support of the principal objective of this plan.
- The New Zealand Qualifications review of qualifications – mandatory reviews of science qualifications and the review of tertiary teaching qualifications are taking place during 2014.
- Tertiary Education Strategy (TES) - The two most relevant strategic priorities in the TES for this plan are: Priority 1, delivering skills for industry; and Priority 5, strengthening research-based institutions. The TES emphasises the importance of tertiary institutions being more outwardly focussed, in particular, connecting learning to employment outcomes and encouraging providers to be more connected to industries and communities. The TES also prioritises science and technology.
- The Office of the Prime Minister's Chief Science Advisor (CSA), established by the government in 2009, helps to close the gap between the science community and the public. Analysis by the CSA[35] has resulted in the establishment of Departmental Science Advisors to lift the public services capabilities to ensure the greater use of robust and reputable research-derived knowledge in decisions that are important to the public.
- MBIE's Vision Mātauranga policy states that unlocking the science and innovation potential of Māori knowledge, people and resources will benefit New Zealand. For this reason the Vision Mātauranga policy is embedded across all priority investment areas. This plan supports the theme of building the capability of Māori individuals, businesses, incorporations, rūnanga, trusts, iwi, hapu, and marae to engage with science and innovation as an important step in unlocking the potential of Māori knowledge people and resources.

PART 3 Strategic Action Areas and Priority Actions

While section 2.6 outlined the government's progress towards encouraging and enabling engagement by New Zealanders with science and technology, more needs to be done.

In particular, further support is needed to help develop teacher confidence and science competencies through initial teacher training; continuing professional learning and development; and better links between practicing scientists and schools.

Continued support is also needed to encourage effective ways for the science sector and other science and technology communicators to engage with the public at all levels, including through two-way dialogue; and further support is needed for good practice, greater impact and improved coordination.

This section sets out 3 Strategic Action Areas (SAAs), each with a set of priority actions over the next three years to address these remaining gaps.

Strategic Action Area 1: The Education Sector

The principal goal of Strategic Action Area 1 is to support all young New Zealanders to be resilient learners with future-proofed skills to understand, assess and apply rapidly changing science and technology knowledge to their everyday lives. In addition, the Action Area is also designed to increase the number of such learners who move toward STEM-related career pathways. Strategic Action Area 1 will contribute to those related goals through a focus on quality teaching and learning, and providing additional opportunities to enhance competencies, confidence and dispositions that grow scientific knowledge, curiosity and creativity in students in partnership with schools and kura, families, whānau and iwi and the science community.

The activities in Strategic Action Area 1 are focused on four key intervention sites: primary level education; secondary level education; the transition to further study/training or employment; and science leadership.

1. *Improve initial teacher education for increased science teaching competencies and competence*. Primary teachers are necessarily generalists. New research has shown that primary education is an important window of opportunity for imparting foundation curiosity and learning behaviours for learners' future attitudes and practices toward science and technology. To maximise this opportunity new primary teachers need the confidence and content knowledge to sustain student engagement and progress.

   Actions

   - The Ministry will work with initial teacher education providers, qualification accreditation bodies and relevant professional bodies to identify ways to lift the level of science content in initial teacher education. This could form a component of under-graduate qualifications for primary education, and would be targeted to lift the confidence of graduating teachers to teach science (teachers currently report limited confidence, particularly at years 7-8).

2. *Improve the quality and relevance of continuing professional learning and development opportunities for teachers in science and technology.*

   The Government spends more than $70 million every year on professional learning and development to support the development of a highly capable profession, and a professional learning and development system that builds the skills of teachers and education leaders, which in turn delivers measurable gains for students in science/pūtaiao, technology/hangarau and mathematics/pāngarau. The Minister of Education has appointed an Advisory Group with representatives from across the education sector to provide advice on the design of future professional learning and development across the compulsory schooling sector. The group will provide advice on what improvements should be made to the targeting of PLD to achieve a system-wide lift in student achievement; and provide advice on how changes could be implemented to achieve the maximum impact.

   Actions

   - Update the Science, Mathematics and Technology teacher fellowship programme to include a 'school science leadership' component with a focus on science and technology teaching and leadership competencies
   - Increase the uptake and utilisation of the Science/Biotechnology Learning Hubs as a high-quality online repository of New Zealand science for teachers and students
   - Create a Science Skills in Education Initiative, which will support teachers to undertake science education and develop ideas for teaching science in a way that is both exciting and relevant to their learners. The network will coordinate support from local industry, and local and national government to support schools and teachers to undertake approved training from providers with a proven record of excellence in science teaching, for example primary teachers study courses in

primary science teaching or expanding the current Sir Paul Callaghan Academy initiative and schools receive a small subsidy to participate. This would boost teachers confidence in teaching science

- Create a Science in Industry programme where, during the school holidays, teachers who volunteer are invited to visit and work in local industries that represent likely science and technology employers for their students. Participants would be supported to reflect on the practical application of science in industry for their lessons plans, upscale Learning and Change Networks for science, and explore the development of virtual learning networks for science teachers on the Network 4 Learning portal. This will enable groups of schools to connect with the broader community whilst focussing on raising science literacy

3. *Encourage youth into science and technology-based careers*: Continue to develop more responsive educational pathways and raise awareness about the impacts of student subject choices, including on entrepreneurial thinking in the science and innovation sector. The relevance of science and technology learning to future careers options needs to be made clearer at an earlier stage for learners and potential careers should be highlighted.

   Actions:

   - ensure CareersNZ has meaningful engagement with schools' careers services to promote science and technology careers well before subjects become optional
   - continue to support talented school students through young achievers and travel awards
   - explore more strategic targeting of the Futureintech programme, and other potential changes to increase its impact
   - review and evaluate the pilot of the Science Education Leadership and Coordination role for merit to expand
   - continue work to develop and promote the uptake of information provision for learners about science careers
   - explore using the Youth Guarantee Networks to promote links between science industry and education providers to encourage young people towards careers in science
   - support schools, through Vocational Pathways, to redesign curriculum to recontextualise learning in a way that better meets learners needs, including science education
   - consider how to strengthen science literacy in senior secondary schooling
   - consider the future of the STEM feature in the occupational outlook
   - establish mechanisms to connect industry, local government, educators and the science community at a regional, industry or sector level

4. *Build and maintain meaningful linkages between science and technology educators and learners, and practicing scientists and technologists, both in the classroom and through opportunities that engage the wider community:* This action cuts across Strategic Action Areas 1, 2 and 3. Partnerships with universities, CRIs, private bodies, science organisations (such as museums, science centres, zoos, aquaria, observatories) and secondary-tertiary programmes that enable participants to experience tertiary-level educational activities, are all key for learning outside the classroom. These learning

experiences outside the classroom need to be integrated meaningfully within teaching and learning programmes.

Actions:

- Build and strengthen links between teachers, learners and practising scientists by promoting quality Learning Experiences Outside the Classroom.
- Identify the assessment standards on the National Qualifications Framework (levels 2 and 3) that will;
    - o improve students access to experiential applied STEM learning opportunities
    - o enable students to make informed choices about progression to higher level STEM related pathways
    - o improve the visibility of STEM capabilities within assessment standards
- Provide a platform for Participatory Science that engages schools, community-based groups and organisations and practicing researchers in questions that are scientifically rigorous, locally relevant and pedagogically innovative. The platform includes central coordinator roles that will oversee the platform and be a conduit between learning environments and scientists (see annex 2 for a more detail on the new platform).

Strategic Action Area 2: Public engaging with science

The goal of this Strategic Action Area is to build a nationally supportive environment for public engagement in science and technology. It operates with Strategic Action Area 3 to encourage greater dialogue between the science sector and the public by helping move toward 'a more scientifically engaged public' and 'a more publically engaged science sector'.

In the immediate term, it will enhance the quality, breadth and depth of science communication to the public by the media, scientists, and organisers of national science and technology public events. In the longer-term, Strategic Action Area 2 recognises that the true culture change necessary to encourage and enable public engagement in science must start with young learners, their teachers, their families/whanāu and their communities.

1. *Support quality science journalism and blogging in the multi-platform media:* Print, television and online media (including socially networked media and blogging) are powerful tools for engagement with the public. This priority action will continue to harness the positive power of the media to help make science and the complexities of risk and scientific uncertainty more accessible.

   Actions:

   - Enhance the role and reach of the Science Media Centre to support more training and outreach to science journalists to encourage responsible and insightful science news reporting and long-form analysis that is relevant to the New Zealand public.

2. *Support quality national public events on science and technology:* Events that bring science and technology to the general public have the potential to engage the public in science and technology in captivating and relevant ways. This action will support such events with a broad reach, extending beyond a local area.

   Action:

   - Establish a contestable fund for nationally delivered one-off events that target the general public and would not proceed without government support.

3. ***Cross-referenced with Strategic Action Areas 1 and 2**, support parents and whānau to increase their engagement with science*: The development of parental/whānau and community involvement acknowledges and builds on the importance of parents and families/whānau and local communities as young learners' first mentors, while also providing an opportunity to encourage parents' engagement with science through community collaborative research opportunities that bring together practising scientists with schools and other community organisations on real-world questions.

   Action:

   - Provide a platform for Participatory Science (see annex 2 for more detail on the new platform). The platform will offer schools and their communities opportunities to participate in scientific research in projects with broad appeal, scientific value and pedagogical rigour that resonate with the community.

Strategic Action Area 3: Science engaging with the public

Strategic Action Area 3 complements Strategic Action Area 2 because there cannot be a scientifically engaged public without there also being a publicly engaged science sector. This Strategic Action Area recognises the important role that the science sector plays in ensuring the public relevance of research, whether through saleable innovations or policy-relevant results. Publicly funded scientists have a social responsibility to share some level of knowledge where it's applicable. We also look to science for useful new technologies and evidence-based guidance on society's most pressing issues.

1. *Ensure that publicly funded scientists continue to employ leading edge knowledge and international best practices to engage relevant public(s) in identifying priority research questions and usefully disseminating results.*

   Actions:

   - Public research funding bodies will review and update the knowledge translation expectations attached to direct purchase /grants for research and contracts, and assess the current state of publicly-relevant knowledge transfer practice among funding recipients. Results of this exercise can be used to inform training material for grantees and future decisions about the research funding
   - Build on the success of the public engagement process used to identify the National Science Challenges by considering the the adoption of a similar approach to engaging the public in the implementation phase of the National Science Challenges
   - Royal Society of New Zealand and the Prime Minister's Chief Science Advisor will work with the scientific community to develop a Code of Practice for Scientists that enshrines their public responsibilities. A recent model of such a commitment is the Japanese Council of Science's recently updated Code of Conduct of Scientists, which outlines not only the responsible conduct of research but also the social responsibility of scientists to engage with the public and policy makers based on their expert knowledge.
   - Continue to ensure that scientists' excellence is acknowledged and showcased through the Prime Minister's Science Awards.

2. *Ensure that emerging scientists and technology researchers have the basic communication skills to make their research accessible to relevant audiences beyond their peer community.*

Action:

- Work with the tertiary sector to identify ways to ensure that all emerging science and technology researchers have access to training that supports engagement and the dissemination of their knowledge to non-academic audiences.

3. ***Cross-referenced with Strategic Action Areas 1 and 2**, support scientists to contribute meaningfully to schools and communities, while advancing their scientific output, by enabling their involvement in participatory research.*

   Action:

   - Provide a platform for Participatory Science (see annex 2 for more detail on the new platform). The platform will match scientists and members of schools or community organisations seeking to take part in community-initiated and scientist-initiated research.

PART 4 Implementing and evaluating the strategy

Addressing the challenges described in the plan are longer term issues that will require a commitment to sustained change. It will also require us to learn and modify as we go. For these reasons, the government has asked the Science in Society Reference Group to reconvene in 2015 to review progress and advise on any modifications to the priority actions.

4.1 Timeframe

The plan proposes actions for the next three years from 2014 to 2017.

Some actions are already being progressed as they continue or enhance effective existing actions. Enhancing the role of the Science Media Centre and the Ministry of Education's pilot of a strategic leadership and coordination role for better connecting schools and the science sector are examples of these actions.

The plan also includes actions that can be implemented in the short to medium term. For example, the participatory science platform and the contestable fund for nationally delivered one-off events can be developed in 2014/15 for implementation in 2015/16.

Finally, some of the proposed action areas for the education sector require a longer term (Year 1-6) approach. This will ensure that there is sufficient time to address changes around, for example, initial teacher education, and linking classrooms to the professional science community. These actions will help inspire and provide authentic learning opportunities of relevance and interest to students.

4.2 Evaluation Framework

A monitoring and evaluation programme will be developed to track progress in delivering on this plan and inform further development.

Annex 1: Process for developing this plan

This plan was developed by the Ministry of Business, Innovation and Employment, the Ministry of Education and the office of the Prime Minister's Chief Science Advisor on behalf of the Government.

A Science in Society Reference Group of experts provided advice to assist the government to develop this plan. The members of the Group are:

Professor Sir Peter Gluckman (Chair)	Professor Sir Peter Gluckman is the Prime Minister's Chief Science Advisor. He was the founding Director of the Liggins Institute and is one of New Zealand's best-known scientists. He is internationally respected for his work promoting the use of evidence in policy formation and the translation of scientific knowledge into better social, economic, and environmental outcomes. Professor Sir Peter is a Fellow of The Royal Society (London), the Commonwealth's most prestigious scientific organisation. He is the only New Zealander elected to the Institute of Medicine of the National Academies of Science (USA) and the Academy of Medical Sciences of Great Britain. In 2009 he became a Knight of the New Zealand Order of Merit for services to medicine. In 2001 he received New Zealand's top science award, the Rutherford Medal.
Professor Jim Metson (Deputy Chair)	Professor Jim Metson is Chief Science Advisor to the Ministry of Business, Innovation and Employment. He has a PhD in Chemistry from Victoria University of Wellington and is Deputy Dean of Science at the University of Auckland, Professor in its School of Chemical Sciences, and Associate Director of the University's Light Metals Research Centre. He has a background in building science capability, and has led the formation of several major interdisciplinary research centres at the University.
Professor Alister Jones	Professor Alister Jones is Deputy Vice-Chancellor of the University of Waikato. He was Dean of Education and Research Professor and Director of the Wilf Malcolm Institute of Educational Research at the Faculty of Education. He has managed and directed research projects that have informed policy, curriculum, science and technology education and teacher development in New Zealand and internationally. He was awarded the New Zealand Science and Technology Medal. He is Co-Director of the Science Learning Hubs and co-chairs an APEC working group on science and mathematics education.
Jacquie Bay	Jacquie Bay is the founding Director of LENScience, an innovative science education programme within the Liggins Institute. She co-developed the award winning LENScience Connect learning platform for science education.
Hikitia Ropata	Hikitia Ropata is the General Manager Strategic Development at Careers NZ. She is also a member of the Export Industry Skills Analysis Advisory Group. She has worked across both social and economic policy and delivery spaces. Her specific interest is in getting more New Zealanders interested and participating in science and technology careers, particularly Māori and Pasifika. She is of Ngāti Toa, Ngāti Raukawa, Te Ati Awa, Ngāti Porou descent.
Peter Griffin	Peter Griffin is the founding manager of the Science Media Centre and the founder and editor of Sciblogs. He was Technology Editor of the New Zealand Herald, technology columnist for the Herald on Sunday and a commentator for TVNZ, Radio New Zealand and Radio Live. In 2012 Peter was a Fulbright-Harkness Fellow undertaking research in the US looking at centres of excellence in public interest journalism.
Richard Meylan	Richard Meylan is Senior Manager Public Engagement and Education at the Royal Society of New Zealand and formerly was Principal Adviser to the New Zealand Ministry of Research, Science and Technology. He is a former teacher and in 2011 spent nine months on a sabbatical to the International Council for Science in Paris.

Lee Parkinson	Lee Parkinson is a communications consultant. A Chartered Marketer and Fellow of the Chartered Institute of Marketing, he was recently Managing Partner of Ikon Communications. Lee attended the Transit of Venus forum and was consulted in the development of communications approach for Great New Zealand Science Project.
Dr Steven Sexton	Dr Steven Sexton is President of the New Zealand Association of Science Educators. He is a senior lecturer in Science Education at the College of Education at the University of Otago. He was a primary school teacher.
Dr Jan Giffney	Dr Jan Giffney is Head of Science at St Cuthbert's College, Auckland. She was honoured with a prestigious professional award – the Independent Schools of New Zealand Excellence in Teaching Award for Exceptional Professional Performance for Years 11–13. She is also an experienced chemistry teacher with a long history of involvement in the NZ Chemistry Olympiad programme.
Ally Bull	Ally Bull leads the science education team at New Zealand Council for Educational Research. She has expertise in research on science education and is co-convenor of the NZ Association for Research Education Science education Special Interest Group.
Angela Christie	Angela Christie is Director – Schools at the Institution of Professional Engineers of NZ. She is responsible for the development and implementation of the Futureintech Project – a government-funded careers promotion initiative. She also manages the IPENZ school programmes.
Evan Brenton-Rule	Evan Brenton-Rule is winner of the 2013 Eureka Award for Young Science Orators for his presentation about a solution to the threat posed by invasive species in New Zealand. Evan is studying towards law and science degrees at Victoria University of Wellington.

The National Science Challenges Panel and [to come] provided feedback on a draft of the plan.

Annex 2: Description of new initiatives

Participatory Science Platform

The Participatory Science platform builds on citizen science approaches and enhances them through aspects of citizen engagement used in community-based participatory research. Participatory Science is a method of undertaking scientific research where volunteers can be meaningfully involved in research in collaboration with a professional scientist and builds on international models of engagement.

The Participatory Science platform is built on four core components and incorporates Matauranga Māori:

1. A public engagement process that seeks ideas for participatory science projects from the community and from practicing researchers;
2. A managed process for evaluating these ideas for pedagogical and scientific quality and for ensuring their practicality and relevance to the participating community;
3. A web-based match-making process between interested community-based partners and university or CRI-based scientists; and
4. A resource for teachers and other learning leaders to assist in developing their projects to robust standards.

The goal is to involve schools and their communities in projects with broad appeal, having both scientific value, pedagogical rigour, and that resonate with the community. We are testing several ideas for projects of national significance that would integrate with the National Science Challenges and be national in reach.

The website will serve as a match-making tool between scientists and members of the schools or community organisations seeking to take part in a research project by offering a platform for community-initiated and scientist-initiated research.

A multi-sectoral management and review panel will be established to maintain quality control over the programme and advise on any research ethics requirements.

All projects must have an institutional home which is the responsible coordinator. This could be a school, museum, zoo, science centre, research institute or university.

In general, it is expected the projects will be of minimal cost. However, to enable more sophisticated projects, limited one-time seed grants will be made available to help foster a meaningful level of community involvement. The seed-grants will part-fund professional researchers and community groups together planning the research question, data collection, analysis and knowledge translation strategy for the project.

The projects will be offered as opportunities for schools and their communities to participate in scientific research as a way to enhance their science learning programmes through stronger links to out-of-school learning environments and expertise, and more relevant and valuable science learning for students. Schools would self-direct their involvement and fund it in the same way that they currently fund curriculum support resource or, in the case of scientist-initiated projects, funded through scientists' own research funds.

A multi-media campaign will accompany the launch of programme, and a dedicated website/social media site will provide a sustained channel of communication for ideas that continue to emerge. It will build on the momentum created by the *Great New Zealand Science Project* and leverages the legacy of that project, including its Facebook page.

References

[add hyperlinks in webpage]

1. Public Engagement in Science and Innovation
http://mako/OTCS/llisapi.dll?func=ll&objaction=overview&objid=9352461

2. Science Education
http://mako/OTCS/llisapi.dll?func=ll&objaction=overview&objid=8973336

3. STEM skills and careers

Briefing: http://mako/OTCS/llisapi.dll?func=ll&objaction=overview&objid=12685437

International policies paper:
http://mako/OTCS/llisapi.dll?func=ll&objaction=overview&objid=12684225

Glossary

What do we mean by 'engagement'?

We use the term 'engagement' to mean the acquisition and application of multiple types of STEM knowledge[36], by multiple kinds of audiences and applied to various purposes. It implies an improved and productive social relationship between the science sector and society that will lead to its responsible application for the social, environmental and economic benefit of New Zealanders.

Engagement in…

- *generating knowledge* is about knowledge users, including the public, being enabled to help identify issues requiring science input so that public science research is more relevant and stands to have more meaningful impact. It is also about the public being part of the research itself, including through citizen science.

- *acquiring knowledge* is about the public, including and especially compulsory level students acquiring the STEM skills and knowledge needed to develop a career in science and/or engage in much needed and ongoing civic discourse about the application of scientific knowledge.

- *assessing knowledge* is about is about applying an increasingly sophisticated understanding of the what science can (and cannot) provide in the search for solutions to today's pressing problems. Assessment requires an understanding of risk and probabilities associated with both the issues themselves and their scientific responses. Citizens, businesses and governments and the science community are all stakeholders in these critical debates.

- *applying knowledge* is about is about making the best use of what we know, including the responsible and evolving use of or limiting of new technologies or novel applications of extant technology.

This definition of engagement reflects a fresher approach through a necessary mix of what has been called 'public understanding of science' or 'science literacy' and of 'public engagement in science'.

Over the past two decades, the place of science in societies has changed from a focus on an undifferentiated 'public' that was illiterate, apathetic or hostile towards science and technology (known as "public understanding of science[37]) towards an awareness of multiple contextualised audiences for science and the distinct ways that they engage with it (known as "public engagement in science) [38].

In the USA and Europe in the [1980's and 1990's] there was a one-directional focus by governments on remediating the presumed public knowledge deficit. In recent years those countries have identified that public perceived apathy or hostility toward research or technology is more about social values and citizens' trust than it is about public knowledge of scientific facts. They have shifted their focus on creating context appropriate opportunities for dialogue and input into decisions about what society wants science to do for us all[39].

Science includes social sciences. Science interrogates the "real things" or phenomena of the natural world in order to construct explanations of them, that is, to know the world.[40]. The New Zealand Curriculum describes ***science*** as "a way of investigating, understanding and explaining our natural, physical world and the wider universe." It involves generating and testing ideas, and gathering evidence through various means which include observation, investigation, modelling and communication and debate with others to develop scientific knowledge, understanding and explanations.

Technology. Technology intervenes in the world to solve problems, meet needs or desires, that is, to create part of the made world[41]. The New Zealand Curriculum describes ***technology*** as "intervention by design: the use of practical and intellectual resources to develop products and systems that expand human possibilities by addressing needs and realising opportunities. Adaptation and innovation are at the heart of technological practice...which is never static".

STEM is the internationally recognised term that refers to subjects or areas of learning, namely Science, Technology, Engineering and Maths, which are used broadly and are inclusive of all levels of learning.

STM refers to school subjects (science, technology and mathematics) because engineering is taught only at tertiary level.

Science knowledge means knowledge of science and knowledge about science. Certain audiences will specialise in knowledge 'of', but basic knowledge 'about' science is broader and is an important tool of 21st century citizenship for engaged and equitable civic discourse on today's most pressing societal concerns. We also acknowledge that 'knowledge' may also mean the science community's knowledge of various public audiences and how to connect with these to make their science relevant.

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[1] The 'leadership challenge' recommended by the National Science Challenges Panel in its report *Report of the National Science Challenges Panel, 27 March 2013* was called the 'Science and Society leadership challenge. This plan uses 'Science in Society' is intended to convey the message that science is part of, as opposed to additional to, society.

[2] Immigration NZ: www.immigration.govt.nz/essential skills.htm.

[3] Programme for International Student Achievement *Draft Science Framework.p3.*

[5] *Madsen, JB. 2010. The Anatomy of Growth in the OECD since 1870. Journal of Monetary Economics, v57(6) pp 753-67.*

[6] New Zealand Government *Business Growth Agenda: Progress Report 2013.*

[7] Ministry of Business, Innovation and Employment *Occupation Outlook 2014, p7.*

[8] Ministry of Business, Innovation and Employment *Occupation Outlook 2014, p8.*

[9] Ministry of Business, Innovation and Employment *Occupation Outlook 2014, p7.*

[10] New Zealand Curriculum 2007.

[11] *Better Skills, Better Jobs, Better Lives: A Strategic Approach to Skills Policies'* OECD Publishing, 2012. http://dx.doi.org/10.1787/9789264177338-en,

[12] http://www.careers.govt.nz/plan-your-career/helping-young-people-make-decisions/what-things-influence-a-young-persons-career-decisions/ and 'STEM Careers Awareness Timelines: Attitudes and ambitions towards science, technology, engineering and maths' Jo Hutchinson, Peter Stagg and Kieran Bentley, University of Derby, 2009. www.derby.ac.uk/files/icegs_**stem**_careers_awareness_timelines.pdf

[13] This survey, *Science and the General Public 2010,* was commissioned by the Ministry of Research, Science and Technology. Similar surveys were also commissioned in 2002 and 2005.

[14] Rosemary Hipkins, *'Public Attitudes to Science: rethinking outreach initiatives' New Zealand Science Review* 67.4, 2010, p109. The 44% of New Zealanders with a detached interest in science are described in the survey as a 'mainstream group'. This group understands that science is important, but they do not consider it is relevant to their busy, everyday lives. They perceive that: science information lacks relevancy; they receive too much or too little information; they lack trust in scientists and lack understanding of career pathways for their children / young relatives.

[15] For example, Eurobarometer 73.1: Science and Technology Report 2010, European Commission, 2010 and Public Atitudes to Science 2011: Main Report. Ipsos Mori Social Research Institute/Department of Business, Innovation and Skills (UK), May 2011. http://ipsoso-mori.com/Assets/Docs/Polls/sri-pas-2011-main-report.pdf

[16] 35% of New Zealand adults have a secondary qualification and a further 21% have a tertiary qualification *New Zealand Census 2013.*

[17] This includes: $927m from Vote Science and Innovation; $313m from Vote Education; $98m from Vote Primary Industries and $18m from other government Votes.

[18] The appropriations in Vote: Culture and Heritage for 2013/14 are $33.094m (for museum services) and $134,417m (for public broadcasting services).

[19] Rowe et al, 'Difficulties in evaluating public engagement initiatives: reflections on an evaluation of the UK GM Nation public debate about transgenic crops' *Public Understanding of Science,* v14 (2005), pp331-352.

[20] [To come].

[21] Immigration NZ: www.immigration.govt.nz/essential skills.htm.

[22] Ministry of Business, Innovation and Employment *Occupation Outlook 2014*, p8.

[23] *Inspiring Australians*

[24] www.ipenz.org.nz/ipenz/forms/pdfs/**NEEP**_Project_**Report**.pdf.

[25] http://www.wipo.int/export/sites/www/freepublications/en/economics/gii/gii_2013.pdf, page 290 School life expectancy, primary to tertiary education (years) | 2010

[26] From 2008-2010 students with more than 14 credits in science rose from 73.2% to 73.5% and then dropped in 2011 and 2012 to 71.4% and 71.6% respectively.

[27] Trends in International Mathematics and Science Study.

[28] OECD, *Programme for International Student Assessment 2012*.

[29] **Prepared by the Ministry of Education from data from the Programme for International Student Assessment.**

[30] Hipkins, R and Bolstad R. 2005. *Staying in Science. Students' participation in secondary education and on transition to tertiary studies*; and the follow-up study *Staying in Science 2* (by Hipkins, R, Roberts, J, Bolstad R and Ferral H. 2006) NZ Council for Educational Research. Also NMSSA and Education Review Office *Science in Years 5 to 8: Capable and Competent Teaching* (May 2010): 01/05/2010.

[32] In 2013/14 this appropriation was $8.969m.

[33] For example, Fullan, M. 2012 Stratosphere.

[34] Callaghan Innovation is a Crown Agent. Its main objective is to support science and technology-based innovation and its commercialisation by businesses, primarily in the manufacturing sector and services sector, in order to improve their growth and competitiveness.

[36] We use the OECD definition of 'science knowledge' to mean knowledge *of* science and knowledge *about* science. Certain audiences will specialise in knowledge 'of', but basic knowledge 'about' science is broader and is an important tool of 21st century citizenship for engaged and equitable civic discourse on today's most pressing societal concerns. We also acknowledge that 'knowledge' may also mean the science community's knowledge of various public audiences and how to connect with these to make their science relevant.

[37] Jasanoff, S. *A mirror for science*. In: Public Engagement in Science: Special Issue Vol. 23(1) 21-26. 2014

[38] Jasanoff, S. *A mirror for science*. In: Public Engagement in Science: Special Issue Vol. 23(1) 21-26. 2014

[39] Jasanoff, S. *A mirror for science*. In: Public Engagement in Science: Special Issue Vol. 23(1) 21-26. 2014

[40] France and Compton *Bringing Communities Together.*

[41] See footnote 33.

Science for, by, and with New Zealanders

A national strategic plan for science in society 2014-2017

DRAFT STRATEGIC PLAN FOR COMMENT

Contents

Ministers' foreword

[To come]

Steven Joyce
Minister of Science and Innovation

Hekia Parata
Minister of Education

Executive summary

This plan responds to the Science in Society 'leadership challenge'[1] recommended by the National Science Challenges Panel. The Panel saw it as "the most important challenge to address" and central to the success of the National Science Challenges. In May 2013, the Government formally accepted the leadership challenge.

Many of today's toughest decisions (e.g. on public health, natural resources stewardship and communications technology) require us all to weigh scientific evidence and social values. New Zealanders need to encouraged and equipped to engage in the key questions facing our society now and in the future. The Government's goal of economic growth through an innovation-led economy drives the need for an increasingly science, technology, engineering and maths (STEM) competent workforce.

The government's primary objective for Science in Society is to 'encourage and enable better engagement with science and technology across all sectors of New Zealand' in order to deliver:

- a more scientifically and technologically engaged public and a more publicly engaged science sector; and
- more science and technology competent learners choosing STEM-related career pathways.

In the longer term it is anticipated that progress towards these outcomes will contribute to New Zealand's economic growth and social and environmental well-being through:

- a greater number of New Zealanders with the skills needed to support creativity, innovation and knowledge uptake and use; and
- publicly funded science and technology which responds to the needs of New Zealanders and New Zealanders make more informed decisions on issues of importance to 21st century life.

A survey of public attitudes to science identifies that about half of New Zealanders are actively interested in science and the other half did not recognise the relevance of science in their everyday lives (44%) or were disengaged (9%). There is limited evidence on the level and effectiveness of the engagement of the science sector with the public.

Demand for STEM skills (for scientists, technologists, engineers, health and ICT professionals[2]) is expected to grow strongly. More students are graduating with degrees in natural and physical sciences and engineering. New Zealand school student performance in science is declining.

The challenges ahead are:

- increasing the engagement of New Zealanders, across all sectors, with science and technology and increasing the effectiveness of the science sector's engagement with the public; and
- increasing the numbers of learners with STE competencies to meet the needs of their everyday lives and the 21st century labour market.

These are long-standing challenges that will take time to address.

Many initiatives are already underway which are key to the success of the plan and being led by government agencies and the broader community at national, regional and local levels, such as museums, school boards, universities, businesses and the Royal Society. This plan includes a