6. Build greater connectivity with museums, zoos and science centres: Non-traditional learning environments, such as those provided by museums, zoos and science centres, can play an important part in encouraging STEM competencies and innovations. Reaching millions of New Zealanders each year, museums and other science organisations facilitate engagement and lifelong learning, and are ideally placed as community spaces or forums.

   Activities include:

   - Work with organisations such as museums, zoos and science centres to build greater connectivity and agree their role in delivering on the plan.

7. *Build the evidence base on public attitudes to, and engagement with, science and technology. Improved evidence on public attitudes to, and engagement with science and technology, will assist in targeting future actions. It will form part of the monitoring and evaluation framework for the plan.*

   Activities include:

   - Regularly survey public attitudes to, and engagement with, science and technology.

3.3 Strategic Action Area 3: Science sector 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 publically 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. Publically funded science organisations and 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 scientists and science organisations, as appropriate, continue to employ leading edge knowledge and international best practices to engage relevant public(s) in identifying priority research questions and usefully disseminating results for publically funded research.

   Activities include:

   - Public research funding bodies will review and update the knowledge translation expectations for research contracts, and assess the current state of publically-relevant knowledge transfer and end-user engagement practice among funding recipients, including with Iwi and Māori organisations. Results of this exercise can be used to inform future expectations
   - Build on the success of the public engagement process used to identify the National Science Challenges by considering an approach and opportunities to engage the public in the implementation phase of the National Science Challenges
   - Royal Society of New Zealand and the PMCSA 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

science organisations and scientists to engage with the public and policy makers based on their expert knowledge.

- Continue to implement recommendations of the PMCSA on the use of science-based evidence in policy formation, by creating opportunities, through new Departmental Science Advisors, for the science sector to engage with government and share relevant results with policy makers.

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

   Activities include:

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

   - Continue to ensure that scientists' excellence is acknowledged and showcased through the Prime Minister's Science Awards.

3. *Increase the profile of the work of researchers who are Māori in science/ pūtaiao and of all researchers engaged in* mātauranga Māori.

   Activities include:

   - Increase the profile of the work of researchers who are Māori in science/ pūtaiao and of all researchers engaged in mātauranga Māori by engaging with researchers who are Māori, iwi and Māori organisations about their mātauranga Māori and science knowledge and science projects to build greater connectivity.

4. *Support scientists to contribute meaningfully to schools and communities, while advancing their scientific output, by enabling their involvement in participatory research.*

   Activities include:

   - Develop and implement a Participatory Science Platform (described below at 3.4). The platform will match scientists and members of schools or community organisations seeking to take part in community-initiated and scientist-initiated research.

3.4 Integrating Action: The participatory science platform

While the three SAAs described above each target specific sectoral goals, they are nonetheless interconnected. A unique feature at the heart of this strategic plan is an integrating activity that simultaneously addresses important objectives in all three SAAs. The Participatory Science Platform has the potential to: offer inspiring and relevant learning opportunities for students and teachers; engage learners and participants beyond the school / kura community to reach parents, whanau and wider communities; and offer researchers the opportunity to become involved in locally relevant lines of enquiry, where data can be enriched by the local knowledge and contribution of citizens.

The Participatory Science platform builds on traditional concepts in citizen science and enhances these through collaborative approaches more common to community-based participatory research. Participatory Science is a method of undertaking scientific research where volunteers can be meaningfully involved in research in collaboration with practising

scientists (including post-graduate students or researchers and private sector scientists) and builds on international models of engagement.

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

1. A process that seeks ideas for participatory science projects from both the community (including Early Childhood Education Service and kōhanga, schools / kura, museums and other organisations, iwi authorities or community associations) and from practising researchers (from post-graduate students to principal investigators in both the public and private sectors);
2. A managed process for evaluating these ideas for both pedagogical potential (in the case of schools / kura) and scientific quality, and for ensuring their practicality and relevance to the participating partners (science sector and community-based);
3. A web-based match-making process between interested community-based partners and practising researchers; and
4. A resource for teachers and other community or learning leaders to assist in developing their projects to robust standards.

The goal is to involve schools / kura and/or community-based organisations such as museums and associations in projects with broad appeal, having both scientific value, pedagogical rigour, and that resonate with the community. In addition, 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 potential community-based partners 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 will provide a coordination role. This could be a school, museum, zoo, science centre, iwi office or research institute, university or other tertiary organisation.

To enable more sophisticated projects, a limited number of one-time seed grants will be made available to help foster a meaningful level of community involvement. The seed-grants will part-fund practising researchers and community/school groups to plan together the research question, data collection, analysis and knowledge translation strategy for the project. In addition, eligible costs could include research tools or consumables that would not otherwise be accessible to community partners.

The projects will be offered as opportunities for community based partners to participate in scientific research as a way to enhance their local input, their science knowledge and their interest, and (in the case of schools) to strengthen learning programmes through stronger links to relevant learning environments and expertise.

Once matches are made between community based partners and scientists, these partners would self-direct their involvement in carrying out the research according to an agreed plan and approach.

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.

3.5 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 Authority review of qualifications – Mandatory reviews of levels 1-6 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, including in areas of new and emerging shortage such as science and technology; 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 State Service's Commission's efforts to include action for better use of evidence in public policy formation. This is being operationalised through the creation of a number of Departmental Science Advisor roles and the creation of a network of these advisors chaired by the PMCSA. This plan recognises the role of scientists to better connect with the public service through the DSA network and other opportunities to bring evidence into policy formation.
- The Office of the PMCSA was established, in part, to address the role of science in society. Positioned at the nexus of the science sector, government, and the public, a central focus of the Office is to help establish better communication of concepts in science and research to the public and to government. This plan recognises the uniqueness of the PMCSA model internationally and can leverage the channel of public communication that the Office provides.
- MBIE's Vision Mātauranga policy aims to unlock the science and innovation potential of Māori knowledge, people and resources for the benefit of New Zealand. The four themes of the Vision Mātauranga policy are:
    - Indigenous innovation: contributing to economic growth through distinctive science and innovation
    - Taiao/environment: achieving environmental sustainability through iwi and hapū relationships with land and sea
    - Hauora/health: improving health and social wellbeing
    - Mātauranga: exploring indigenous knowledge and science and innovation

  For this reason the Vision Mātauranga policy is embedded across all science investments, and as such forms a core component for the implementation of MBIE's approach to supporting outcomes for Māori and New Zealand.

PART 4 Implementing and evaluating the plan

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, modify as we go and continue engaging with stakeholders.

4.1 Implementation approach

As this is the first Science in Society plan, the government has asked the Science in Society Reference Group to reconvene in 2015 to review progress and advise on any modifications to the actions to better deliver on the outcomes. MBIE and MoE together with the PMCSA will oversee implementation of the plan by government agencies, iwi and other sectors including the education, science, business and museum sectors. The two agencies will also lead a process of engagement with the public on the plan and the actions in it.

Central to the terms of reference of the PMCSA is to support an improved and productive relationship between science and society. As such, the PMCSA and the network of Departmental Science Advisors will continue to be active in implementation of the plan.

4.2 Timeframe

While the challenges are long-term, the plan sets out a direction for the next ten years and actions for the next three years from 2014 to 2017. The actions may be modified and enhanced as we learn more over the life of the plan.

Some actions are already being progressed as they continue or enhance effective existing actions. Enhancing the role of the Science Media Centre and MoE'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 sector. These actions will help inspire and provide authentic learning opportunities of relevance and interest to students.

4.3 Monitoring and evaluation framework

A monitoring and evaluation programme will be developed to measure baselines and track progress in delivering on this plan and inform further development. Monitoring and reporting will include analysis by gender and ethnicity to track the participation rates of females in STEM.

Annex 1: Process for developing this plan

This plan was developed by the MBIE, MoE and the office of PMCSA 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 PMCSA. 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 MBIE. 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 career 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 membership of the Science in Society Reference Group will be reviewed before it is reconvened in 2015.

The Reference Group, the National Science Challenges Panel, Business New Zealand; Science New Zealand; the New Zealand Association of Scientists; municipal museums; the Royal Society of New Zealand, the Chambers of Commerce, Callaghan Innovation, the Secondary School Principals Association; New Zealand Principals Federation; the Post-Primary Teachers Association; the New Zealand Education Institute; the leadership of Universities, Polytechnics and Wānanga; the Tertiary Education Union; the New Zealand Union of Students Association; stakeholders from Society of Māori Astronomy and Research Traditions and Ngā Pae o te Māramatanga and the National Science-Technology Roadshow Trust provided feedback on a draft of the plan.

Annex 2: Description of initiatives

KEY: Existing action continuing | Changed existing action | New project

Strategic Action Area	Goal	Action	Status	Lead agency	Other agencies	Comment
Education Sector	Improve initial teacher education	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	New project	MoE		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).
	Improve the quality and relevance of continuing professional learning and development opportunities for teachers in science and technology	MoE 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	Existing action continuing	MoE		
		Provide primary and secondary school teachers with opportunities to work with research organisations and develop leadership skills to enhance the teaching of science within school communities	Changed existing action	MBIE		In 2014/15, reframe the teacher fellowship programme to further imbed the leadership responsibilities within the school community, enhance leadership competencies and align with Ministry of Education initiatives.
		Promote the Science/Biotechnology Learning Hubs to provide an online repository of New Zealand science for use by teachers, students and communities	Changed existing action	MBIE		In 2014/15, promote the Science/Biotechnology Learning Hubs as a high-quality online repository of New Zealand science and resources to support science education.
		Create a Science Skills in Education Initiative to support schools and teachers to build confidence and access resources to develop rich, contextualised science programmes that are exciting for students	New project	MoE		The initiative will be developed with education and industry stakeholders to create a network between local industry, local and national government and schools to assist teachers to continue their science education with providers who have a proven record of excellence in science teaching. Examples include access to courses for primary teachers with a focus on developing science skills and knowledge that reflect science/pūtaiao in the national curriculum, and expanding the availability of the Sir Paul Callaghan Academy initiative. This initiative focuses on teacher learning, and will explore links to the Science in Industry Programme as appropriate.
		Create a Teachers in Industry Project for teachers, to connect schools with science intensive businesses to enable teachers to spend a period of time in the businesses to bring business relevant content into their science lesson plans	New project	MoE		This initiative focuses on building the currency of programmes, and will explore links to the Science Skills in Education initiative as appropriate. 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.

	Develop science and technology curriculum materials and support teachers to use them	The New Zealand Curriculum (NZC) and Te Marautanga o Aotearoa address STM skills development and building a scientifically and technologically engaged population more generally Te Whāriki – Strand 5: Exploration Children experience an environment where they develop working theories for making sense of the natural, social, physical and material worlds		MoE		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.
		The Matakōkiri Project supports students to engage with science by linking science/pūtaiao to Māori language, culture and identity through students' local t kanga, whakapapa and stories		Te Taumata o Ngāti Whakaue Iko Ake Trust		The project is an iwitanga b sed science programme run by Te Taumata o Ngāti Whakaue Iko Ake Trust in their rohe for their students, whānau, teachers and schools.
		Establish Learning and Change Networks with a dedicated focus on student achievement in science		MoE		These a e communities of practice that provide a environment for the building of sustainable partnerships between amilies, 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.
		A range of online and print publications to support quality teaching, learning and assessment		MoE		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.
	Build and maintain meaningful linkages between science and technology educators and learners, and practicing scientists	Explore equitable funding mo e s to enable schools / kura to ee the costs of students attending Learning Experiences Outside The Classroom		MOE		
		Identify the as essment standards on the Nati nal Qualifications Framewo k (levels 2 and 3) that will improve the visibility of STEM capabilit es within assessment standards		MoE		
		School, science sector partnerships that support school students' science learning. 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		MoE		A pilot will run through to July 2014 to build school, science sector 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.
	Review the positioning and content of digital technology within the framework of the New Zealand Curriculum and Te Mauratanga o	The Ministry of Education will work alongside sector partners to review the positioning and content of digital technology within the framework of the New Zealand Curriculum and Te Mauratanga o Aotearoa		MOE		It is intended this will result in additional guidance and support materials exemplifying ICT provision across primary and secondary years and will complement the National Certificate of Educational Achievement (NCEA) review and maintenance programme.

	Aotearoa					
Public engaging with the science sector	Support quality science journalism and coverage in the multi-platform media	The Science Media Centre – a centre that provides an interface for the media with the science and technology sectors and educates scientists on engaging with the media to improve the quality and professionalism of science and technology reporting		MBIE		In 2014/15, enhance the role and reach of the Science Media Centre to support more training and outreach to science journalists to encourage respons ble and insightful science news reporting and long-form analysis that is relevant to the New Zealand public.
	Support quality targeted initiatives on science and technology	Establish a contestable fund for targeted initiatives that deliver on the plan for harder to reach groups, which could not proceed without government support		MBIE		To be designed and piloted in 2014/15 and, subject to the results of the pilot, implemented in 2015/16.
	Support youth into science and technology-based careers	The STEM feature in the 2014 Occupation Outlook identified the current and future demand for STEM-related careers		MBIE		To consider its future in 2014/15.
		Youth Transitions Framework that focuses on more young people participating in learning areas of high growth and demand (eg STEM subjects)		TEC		
		Identification of STEM-related credits within the Vocational Pathways that support students to progress to higher level STEM-related education and training		MoE, TEC		
		Māori Future Makers website which profiles Māori and whānau in non-traditional, knowledge intensive sectors		TPK		
		Work with Careers NZ to explore and develop ways to raise awareness of science and technology careers on the Careers NZ website		Careers NZ		
		Supporting Young Achievers Awards		MBIE		Awards to continue.
		Talented School Students Travel Awards		MBIE		In 2014/15, extend the programme to intermediate students and provide additional flexibility to reach more low decile students.
		Continue work to develop and promote the uptake of information provision for learners about science careers		MoE		
		Use Vocational Pathways to support schools and tertiary providers to contextualise STEM-related learning in ways that are relevant to further study and career options		MoE		
		Consider how to strengthen science literacy in senior secondary schooling particularly at year 11		MoE		
		Promoting STEM careers to students through the FutureinTech programme		Callaghan Innovation		In 2014/15 explore more strategic targeting of the programme, and other potential changes to increase its impact
		Consider how to increase girls' participation and achievement in science and ICT		MBIE and MoE		
	Build and maintain meaningful	Explore opportunities to better connect business, local government, educators, learners and the science		MBIE		To be considered in 2014/15 and, subject to the results, implemented in

	links between science and technology-led businesses, educators and learners and practising scientists and technologists	sector at a regional, industry or sector level				2015/16.
	Build greater connectivity with museums, zoos and science centres	Work with organisations such as museums, zoos and science centres to build greater connectivity and agree their role in delivering on the plan		MBIE, MCH		To begin in 2014/15
	Build the evidence base on public attitudes to, and engagement with, science and technology	Regularly survey public attitudes to, and engagement with, science and technology		MBIE		Survey to be carried out in 2014 and a regular programme agreed.
Science sector engaging with the public	Ensure publically funded scientists employ leading edge knowledge and international best practices to engage relevant public(s) in identifying priority research questions and usefully disseminating results	Government expectations on researchers receiving public funds to make research public and provide public engagement and outreach		MBIE, TEC		From 2015/16 to review and update the knowledge translation expectations for research contracts, and assess the current state of publically-relevant knowledge transfer practice among funding recipients. Results will be considered to inform future expectations.
		The Crown Research Institute's (CRIs) Statement of Core Purpose in the Crown Research Institutes Act 1992 includes expectations on engagement with key stakeholders and to transfer technology and knowledge to key stakeholders		MBIE, CRIs		No changes proposed.
		Request for proposals for the first ten National Science Challenges sets a key objective for engagement by the science sector with the public		MBIE		In 2014/15 build on the success of the public engagement process used to identify the National Science Challenges by considering an approach and opportunities to engage the public in the implementation phase of the National Science Challenges.
		Work with the scientific community to develop a Code of Practice for Scientists that enshrines their public responsibilities		PMCSA	RSNZ	To begin in 2014/15. 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.
	Ensure emerging scientists and technology researchers have the basic communication skills to make their research accessible to relevant audiences beyond their peer group	Work with the tertiary sector to identify ways to ensure that all emerging and established science and technology researchers have access to training that supports engagement and the dissemination of their knowledge to non-academic audiences		MBIE, MoE, TEC		To begin in 2014/15.
		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		MBIE		Prizes to continue.
	Increase the profile of the	Increase the profile of the work of researchers who are Māori in		MBIE,		To begin in 2014/15.

	work of Māori researchers in science/pūtao and of all researchers engaged in mātauranga Māori	science/ pūtaiao and of all researchers engaged in mātauranga Māori by engaging with researchers who are Māori, iwi and Māori organisations about their mātauranga Māori and science knowledge and science projects to build greater connectivity		PMCSA		
Across all strategic action areas		Develop and implement a Participatory Science Platform		MBIE, MoE		To be designed and piloted in 2014/15 and, subject to the results of the pilot, implemented in 2015/16.

Annex 1: Initial Science in Society strategic plan

A nation of Curious Minds

- A national strategic plan for science in society

[Māori translation to come]

Contents

Ministers' foreword

Science is all around us. From our families and communities to the natural world, science permeates our daily lives. The role and influence of science is set to increase in the years ahead.

New Zealanders have curious minds. It is essential that New Zealanders feel encouraged and equipped to deal with the challenges and opportunities presented by science and technology, and capable of participating in the debates involving science. We also need an environment that helps New Zealanders carefully weigh the complex trade-offs that sometimes arise in producing and applying scientific knowledge and new technologies.

New Zealand is a small country. To overcome the disadvantages of modest size, we must harness our curiosity and cultivate our ability to be competitive. If we are to be a world leader, our workforce must be skilled in science and technology to develop new high value products, meet the demands of business, and adapt to new and changing technologies.

Government has a key role to play in facilitating better engagement in science across all sectors. This strategic plan presents an approach to the transformation of New Zealand into a society actively engaged with science. The plan provides Government's view of the main issues involved in fostering greater engagement in science, summarises available evidence, and outlines a number of actions to be developed.

The Science in Society plan is one of a number of Government initiatives that recognises the importance of science to New Zealand's future. The project emerged from the National Science Challenges and sits alongside other initiatives such as the establishment of the Office of the Prime Minister's Chief Science Advisor, the formation of Callaghan Innovation, and the recently-released draft National Statement of Science Investment.

Developing stronger connections between science and society is a long-term project. For these reasons, this plan puts special emphasis on our young people and science education. Science literacy is fundamentally important to the future of young New Zealanders. It gives our students a platform to meet challenges and compete, here at home and internationally. This plan accepts the challenge of building innovation, creativity and increased science literacy across the education sector. Lifting engagement and achievement in science education is absolutely vital. The education profession must prepare all New Zealanders to be participants, and leaders, in a 21st century economy, and society.

Community, iwi, and whānau engagement in science and technology education is critical to the success of our learners. The plan engages schools/kura, the community and scientists in partnerships that acknowledge the place of science/pūtaiao and technology/ hangarau within and beyond the New Zealand Curriculum and Te Marautanga o Aotearoa.

The plan also identifies ways to increase engagement between the science sector and New Zealanders as publicly funded science is for the benefit of us all.
Governments in other countries—most recently Australia through the Inspiring Australia initiative—are seeking to lead the growth of public engagement with science. This plan draws together the key issues around growing engagement in science in New Zealand and presents them as the start of a conversation about the role of science in this country.

The task of creating a more publicly engaged science sector and a more scientifically engaged public is a collaborative process that will occur over time. It will require action from a wide range

of stakeholders including government, research organisations, schools, non-government organisations and business. We encourage you to consider the ideas proposed in this plan and provide your feedback into the review of the plan in 2015.

Steven Joyce
Minister of Science and Innovation

Hekia Parata
Minister of Education

Executive summary

Science and the knowledge and innovation that flow from scientific progress have a central role in creating and defining our future

Many of today's most complex decisions (e.g. on public health, natural resources stewardship and communications technology) require us all to weigh scientific evidence and our values. New Zealanders should feel 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 society drives the need for an increasingly science, technology, engineering and mathematics (STEM) competent workforce.

This plan arose from the National Science Challenges and was considered by the National Science Challenges Panel to be central to the success of all the Challenges.

The Government's objective in this area is to 'encourage and enable better engagement with science and technology across all sectors of New Zealand' in order to deliver the outcomes of:

- more science and technology competent learners choosing STEM-related career pathways.
- a more scientifically and technologically engaged public and a more publicly engaged science sector; and
- more informed New Zealanders, a more skilled workforce and more responsive science and technology sectors.

These are long-standing challenges that will take time to address. This plan sets out a strategic direction for the next 10 years and actions for the next three years.

While actions are underway to encourage and enable New Zealanders to engage with science and technology, more is needed if we are to make the objectives and outcomes of this plan a reality.

This plan focuses on three Action Areas and one Integrating Action, each of which incorporates specific actions:

- ***Action Area one:*** further enhancing the role of the education system
  - Improve initial teacher education through increased science teaching competencies and confidence
  - Better professional learning and development for science and technology teachers
  - Building stronger links between science and technology educators and learners, and between scientists and technologists, in the classroom and in the community
- ***Action Area two:*** public engagement with science and technology
  - A contestable fund for educational community outreach initiatives that focus on science and technology
  - Supporting young people into careers in science and technology
  - Supporting parents and whānau to engage with science
  - Supporting high quality science journalism and media coverage

  - Building stronger links between science and technology businesses, educators and learners, and between scientists and technologists to better connect business with science and interest more young people in studying science
  - Connect science centres with museums and zoos
  - Collect evidence about public attitudes to and engagement with science and technology
- ***Action Area three:*** science sector engaging with the public
  - Support scientists to contribute to education while advancing their work
  - Ensure that scientists use leading edge knowledge to engage the public in identifying research questions and sharing the results
  - Ensure that scientists know how to make their research accessible to wider audiences
  - Increase the profile of Māori science/ pūtaiao researchers and of all researchers engaged in mātauranga Māori
- ***Integrating Action:*** Participatory Science Platform:
  - Integrating all three Action Areas through a platform to engage students, communities and scientists in participatory science.

This plan recognises and acknowledges the importance of mātauranga Māori to build cultural confidence and identity, and how, through this, New Zealand can grow its skills and generate innovation and creativity. Mātauranga Māori is Māori knowledge that is dynamic, building from earliest traditions to future knowledge. Each of the three Action Areas and the Integrating Action will be developed in ways that respect whānau, hapū and iwi as the key conduits of mātauranga Māori, and focus on realising the potential gain for New Zealand through building Māori capability in science and technology to support Māori development and management of natural resources.

The Ministry of Business, Innovation and Employment and the Ministry of Education, together with the Office of the Prime Minister's Chief Science Advisor, will oversee implementation of the plan by government agencies, iwi and other sectors including the education, science, business and museum sectors.

This Initial Science in Society strategic plan will be subject to ongoing evaluation and monitoring. It will respond to changing needs and contexts by adapting and extending initiatives that are making a measurable contribution to the expected outcomes.

The Science in Society Steering Group will reconvene in 2015. Also in 2015 the Ministry of Business, Innovation and Employment and the Ministry of Education will engage with stakeholders and the public to incorporate wider views into a final Science in Society Strategic Plan.

PART 1 Setting the Scene

Science and technology are critical for enhancing living standards through economic growth and better social conditions, while protecting the environment. Today, science is embedded in the many decisions public policy, business, individuals and societies must make. Societies with strong "science capital[1]" sustain more innovative economies, and have a greater awareness of both the opportunities and limits of science in development and wellbeing. Science is central to the many global challenges we face (from environmental challenges to an aging and increasingly urban population, for instance).

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' as central to the success of the National Science Challenges and the most important challenge if New Zealand is to responsibly apply science and innovation and benefit optimally from its investment in scientific research.

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. Annex 1 sets out the process for developing this plan.

The plan sets out the objective and outcomes the Government wishes to achieve to strengthen the place of science in society over the next 10 years. It sets out the available evidence on where New Zealand is now and identifies the challenges that need to be addressed. It concludes by setting out a three-year plan of action to make progress towards the objective and outcomes.

The plan does not cover the supply of mathematics skills and demand for STEM skills as these are being addressed through the Business Growth Agenda and literacy and numeracy taskforce.

The plan is addressed to all New Zealanders. To be effective, it is important to be specific about target audiences where actions can make the most difference. In particular, the plan recognises that there are certain stakeholders in our social relationship with science that are important 'agents of change.' These are:

- Students, teachers and the compulsory learning sector
- Parents, whānau and communities
- Business, especially science and technology-led businesses

[1] Science capital refers to science-related qualifications, understanding, knowledge (about science and 'how it works'), interest and social contacts (e.g. knowing someone who works in a science-related job). This definition is from *Aspires Young people's science and career aspirations, age 10-14,* Department of Education and Professional Studies and King's College London: 13.

- The public sector and government
- Communicators of science and technology, including media, internet, museums, zoos, science centres and industry organisations
- The science sector.

The initial plan presents a coherent approach to addressing the challenge of strengthening the role of science in our society. The actions in the plan involve wide engagement to deliver on the plan's objective 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[2]. New Zealanders should feel encouraged and equipped to engage in the key questions facing our society now and in the future.

The production and application of scientific knowledge and new technologies often imply trade-offs that we need to weigh carefully: how to prioritise research investment and the potential for unintended consequences. These are complex issues which no single group, such as scientists, government or businesses, should make on behalf of New Zealanders without their input.

However, addressing these trade-offs requires 'social licence'. 'Social licence' is never guaranteed and depends upon an environment of mutual understanding and transparent and deliberate communication between the public and science sector. This plan is the Government's initiative to create the environment needed for social licence to exist.

We need an increasingly STEM-competent workforce to have an 'innovation society'

New Zealand's economic and social wellbeing depends on the productivity and competitiveness of the economy and the knowledge we have to help make informed decisions as a society. Innovation that leads to increased productivity and promising solutions to society's most pressing concerns is increasingly being seen around the world as an important way to generate economic growth and improved living standards[3].

Improving policies and practices will enable the development of an 'innovation society'. To do this, New Zealand needs a high performing and responsive science and innovation system and skilled people who can solve problems and create and deliver high-value products and services for sustainable economic, social and environmental wellbeing. 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 and domestic investment in our research is also important for 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 practices and technologies, the application of existing technologies and the

[2] *Programme for International Student Achievement Draft Science Framework.p3.*
[3] *Madsen, JB. 2010. The Anatomy of Growth in the OECD since 1870. Journal of Monetary Economics, v57(6) pp 753-67.*

development of new, high-value products[4]. STEM skills and competencies also underlie growth in many industries, such as IT-related industries[5] and are highly transferable across industries[6].

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 higher levels of competency has a much lower likelihood of experiencing both economic and social disadvantage than an individual with lower competency levels[8].

Students' career choices are influenced beyond school / kura by family, whānau, iwi, business and the wider community, with parents providing the most important influences[9]. 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 (MoE) 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. Its ultimate goal is to equip young people with the skills to live a fulfilling life and contribute to New Zealand's economic prosperity.

The Ministry of Business, Innovation and Employment (MBIE) aims to grow New Zealand for all. New Zealand's economic and social wellbeing depends on the productivity and competitiveness of our economy and the knowledge we have to help make informed decisions as a society. Science provides that knowledge and informs those decisions. The science system contributes know-how for economic growth, helps to identify and manage risks in the natural world, and provides skilled researchers and workers to support an innovation economy. MBIE aims to increase the economic contribution of the skills, science and innovation systems.

2.2 Objectives and outcomes

The objective of this strategic plan is to:

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

We expect progress towards the objective will contribute to three expected outcomes:

- 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
- more informed New Zealanders, a more skilled workforce and more responsive science and technology sectors.

[4] *Ministry of Business, Innovation and Employment Occupation Outlook 2014, p7.*
[5] *Ministry of Business, Innovation and Employment Occupation Outlook 2014, p8.*
[6] *Ministry of Business, Innovation and Employment Occupation Outlook 2014, p7.*
[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*

2.3 The state of play

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

There are STEM skills shortages

There are skills shortages for many kinds of scientists, engineers, technologists, health and ICT professionals[10]. Demand for workers in many STEM-related occupations is expected to grow due to a variety of factors[11]. 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[12].

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

There is global demand for those with STEM qualifications. Those who gain the STEM qualifications required to resolve shortages can often either be lost from New Zealand to the global job market or pursue alternative careers. MBIE estimates that fewer than half of New Zealand graduates work in the field in which they studied and highly skilled immigrants are often required to fill the gaps. However, it is expected to become increasingly difficult to attract these immigrants as wages rise in increasingly knowledge-intensive Asian economies.

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. For example, 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 has recently increased. The industry training providers are facing difficulties in growing engineering at technician and technology qualification levels[13]. In 2012, 15,560 domestic students, or 37% of domestic students, completed qualifications at bachelor's level and above in health; natural and physical sciences; engineering and related technologies, IT, and architecture and building[14]. Girls and women are under-represented in studying and working in STEM, apart from in the health and biological sciences[15].

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[16] 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.

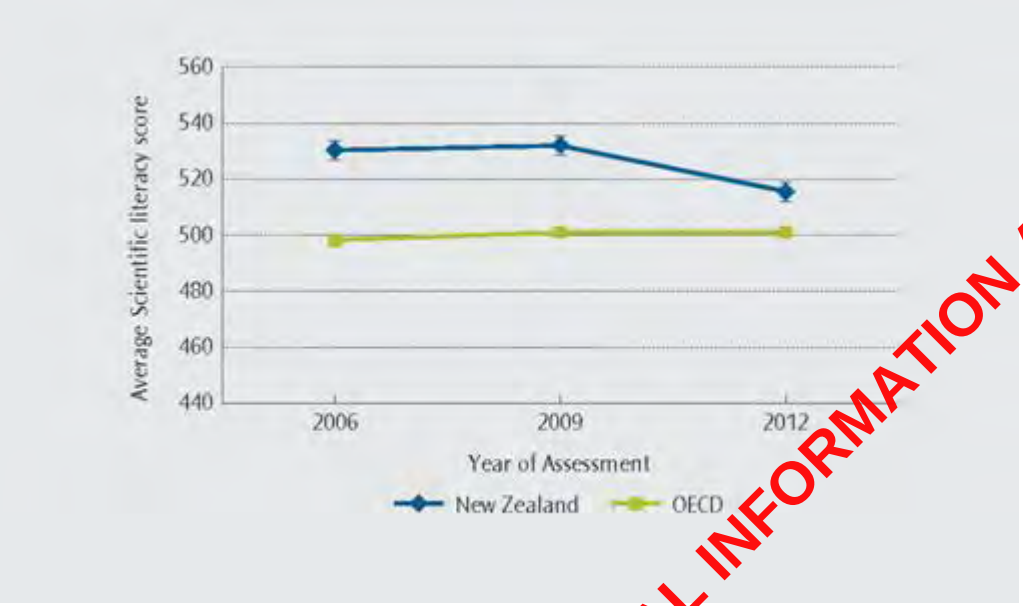
Despite this, there is a gradual decline over years 11 to 13 in the proportion of students enrolled in science-related subjects[17].

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

[10] *Immigration NZ: www.immigration.govt.nz/essential skills.htm.*
[11] *Ministry of Business, Innovation and Employment Occupation Outlook 2014, p8.*
[12] *Inspiring Australians*
[13] *www.ipenz.org.nz/ipenz/forms/pdfs/NEEP_Project_Report.pdf.*
[14] Ministry of Education 2012 SDR data: *New Zealand's Tertiary Education Sector, http://www.educationcounts.govt.nz/publications/series/2531/profile-and-trends-2012.*
[15] *Association for Women in Science Snapshot: Encouraging women to use and develop their scientific abilities to achieve their full potential, 2011.*
[16] *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*
[17] *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.*

students for science in 2010/11 was significantly lower than in 2002/3[18] 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[19].

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[20]



The National Monitoring Study of Student Achievement (NMSSA) and the Programme for International Student Assessment (PISA) results show growing inequity in student performance in science. This is consistent with other findings that Māori and Pasifika students were less confident about science than Pakeha and Asian students.

There are limited data on school student performance in technology

There are limited data on student performance in technology because it is not measured by PISA or the Trends in International Mathematics and Science Study (TIMMS), and NMSSA is yet to assess it.

What is causing the student performance decline?

Research suggests that student achievement in science is declining in part because science teachers are not always confident in teaching science, particularly to diverse groups. Teachers do not always have access to the appropriate resources. Furthermore, some students lack confidence in their ability to succeed in STE subjects and lack support for deciding on senior secondary school subjects[21].

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

[18] *Trends in International Mathematics and Science Study.*
[19] *OECD, Programme for International Student Assessment 2012.*
[20] *Prepared by the Ministry of Education from data from the Programme for International Student Assessment.*
[21] *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.*

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[22]. 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[23] (44 percent) or were disengaged from science (9%). Similar surveys have been done in other countries although comparisons are difficult given differences in the questions[24].

Relative to comparable countries, a relatively high proportion of New Zealand adults has a secondary or tertiary qualification[25]. There are 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 are limited data on the level and effectiveness of the engagement of the science sector and science and technology communicators with the public

There is increasing recognition of the broader social responsibility of scientists to engage with the wider public in meaningful ways[26]. It is difficult to track and measure this engagement, in part because it can take place in a great variety of venues and with various goals. Two main ways that scientists engage with the public is by conveying knowledge to governments to ensure science-informed policy and decision making, and through more direct engagement with the public.

Despite the clear objectives, it is still difficult to measure the impact of these types of engagement[27]. It is also difficult to estimate the proportion of government expenditure on public engagement by science organisations. However, a proportion of the $1.4 billion[28] invested by Government in supporting science and innovation in New Zealand was spent by universities and science organisations on making research more accessible to end-users through communication, public outreach and public education. Other government investment in these organisations may also be spent on communication, public engagement and education.

Many local government and private sector organisations, such as industry training providers, zoos, museums, science centres, charities and businesses engage with the public about

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[22] *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.*

[23] *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.

[24] *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*

[25] *35% of New Zealand adults have a secondary qualification and a further 21% have a tertiary qualification New Zealand Census 2013.*

[26] *THe National Academy Press, On Being a Scientist 2009.*

[27] *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.*

[28] This includes: $967m from Vote Science and Innovation, $335 m from Vote Tertiary Education, $90m from Vote Primary Industries and $18m from other government areas.

science and technology for education, cultural and marketing reasons. The Government also invests $167 million in public broadcasting services and funding museums[29].

Since the Science Media Centre was established in 2008, 'science' in the media has increased by 75 percent[30].

Use of evidence in policy development

The State Services Commission recently reviewed government agencies to identify where departmental science advisors could lift internal capabilities to take up research and new knowledge. A network of advisors chaired by the PMCSA will grow in responsibility as additional Science Advisors are appointed. These changes are expected to help strengthen the channels of communication with the science sector and progress will be monitored as departmental science advisor positions are filled. The network is to report on progress to the State Services Commissioner in 12 months.

PART 3 Action Areas and Priority Actions

This section sets out three Action Areas (AAs), each with a set of priority actions for the next three years. These actions also maintain a view on the 10-year horizon, commensurate with the National Science Challenges.

In addition to these Action Areas, at the heart of this plan is a Priority Action that spans all three AAs: the Participatory Science Platform. This platform (described in section 3.4) is designed to simultaneously:

- Work with the education sector to make it easier to bring "real-world" science into the classroom by connecting teachers with practising scientists (AA1)
- Enable and foster the public's understanding of and engagement in real-world science through research that is relevant to local communities (AA2)
- Offer opportunities for practising 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 (AA3).

3.1 Action Area 1: Further enhancing the role of the education ~~sector~~ sytem

The principle goal of 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. This goal will contribute to building creativity, innovation and increased critical science literacy. Action Area 1 will include 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 / kura, families, whānau, iwi and the business and science communities.

[29] *The appropriations in Vote: Culture and Heritage for 2013/14 are $134,417m (for public broadcasting services) and $33.094m (for museum services). The $33.094m (for museum services) funds the Museum of New Zealand Te Papa Tongarewa.*
[30] *Meltwater Statistics http:/www.sciencemediacentre.co.nz/five-years-of-science-in-the-media.*

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

Actions will explicitly focus on enabling a future-oriented science and technology education system. Integrative thinking for improving science and technology teaching and learning, skills and dispositions for innovation, and changes to pedagogical practice as e-learning and ICT evolves will be central. This will include how the focus of science education should differ at the different levels of schooling.

1. ***Improve initial teacher education with increased science teaching competencies and confidence***

New action

- **Lifting the science content in initial teacher education**

  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 early childhood and 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).

  New research has shown that early childhood and 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.

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

The Minister of Education has appointed an Advisory Group with representatives from across the education sector to provide advice on the design of future PLD across the compulsory schooling sector. The group will provide advice on what improvements should be made to the targeting of centrally funded PLD to achieve a system-wide lift in student achievement; and provide advice on how changes could be implemented to achieve the maximum impact.

The Government spends more than $80 million every year on PLD to support the development of a highly capable profession, and a PLD system that builds the skills of teachers and education leaders. This investment is intended to deliver measurable gains for students across the curriculum, including science/pūtaiao, technology/hangarau and mathematics/pāngarau.

In 2014 about $5.7 million was appropriated to science and technology PLD. This figure does not include the science and technology PLD included in other contracts, and that schools can apply for on the basis of need.

New actions

- **Science Skills in Education Initiative**

This initiative will support schools and teachers to build confidence and access resources to develop rich, contextualised science programmes that are exciting for students, including assisting teachers to continue their science education, focusing on skills that reflect science/pūtaiao in the national curriculum, and expanding the availability of the Sir Paul Callaghan Academy initiative. This initiative focuses on teacher learning, and will explore links to the Teachers in Industry Project as appropriate.

- **Teachers in Industry Project**

  This project is for teachers, and connects schools with science-intensive businesses to enable teachers to spend a period of time in the businesses to bring business-relevant content into their science lesson plans. Establishing this programme would likely require a coordinator to connect businesses and schools, with the coordinator connected to both MBIE and MoE.

- **Create a Practical Science Vocational Tool**

  We will develop an online tool that allows teachers to link the standards from the Vocational Pathways booklets to career examples and skill applications in lessons. The tool will allow educators to answer the question 'Why am I learning this?' by demonstrating a short video that shows the real-life applications of the skills and knowledge learnt in the classroom and highlights how science credits for NCEA link to career possibilities.

Supporting actions

- Providing teachers of science in years 1 to 10 opportunities to work with research organisations to develop leadership skills and enhance the teaching of science within school communities.
- Promoting the Science/Biotechnology Learning Hubs to provide a high-quality online repository of New Zealand science and resources to support science education for teachers, students and communities.

3. Provide a variety of opportunities for learners to engage with science and technology

New actions

- **Support Science Inquiry pilots**

  This initiative will assist a small number of schools to engage in a process of intensive inquiry to improve student outcomes in science. The school's inquiry process will involve teachers reflecting on their science teaching practise, involve the school's leadership, and foster the development of deep content knowledge in science.

- **Extend the Matakōkiri Project**

  The Matakōkiri Project is an iwi lead science program that links pūtaiao/hangarau with English medium schools and local science-based industries. The programme provides Māori students with out-of-school science wānanga and excursions and builds teacher knowledge and understanding of tikanga in the science curriculum.

- **Establish a science confidence and curiosity initiative**

  This initiative will grow primary teacher confidence and student engagement in science and/or technology by developing curious minds in Years 1-8 through practical, classroom based investigations. This includes the development of practical kits of science and technology equipment appropriate to the primary curriculum alongside classroom support on flexible ways to link the resources to the needs and interests of students

4. ***Build and maintain meaningful linkages between science and technology educators and learners, and practising scientists and technologists, both in the classroom and through opportunities that engage the wider community***

Partnerships with Tertiary Education Organisations, 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.

New actions

- **Equitable models to fund students to attend Learning Experiences Outside The Classroom**

  This work will identify the assessment standards on the National Qualifications Framework (levels 2 and 3) that will improve the visibility of STEM capabilities within assessment standards.

- **Develop and implement a Participatory Science Platform**

  This Platform (described below at 3.4)will engage schools / kura, community-based groups and organisations and practising 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.

5. ***Reviewing the position and content of digital technology within the New Zealand Curriculum and Te Mauratanga o Aotearoa***

We will work alongside sector partners to review the positioning and content of digital technology within the framework of the New Zealand Curriculum and Te Mauratanga o Aotearoa.

3.2 Action Area 2: Public engaging with science

Improved evidence on public attitudes to, and engagement with science and technology, will assist in targeting future actions. It will form part of the monitoring and evaluation framework for the plan.

The goal of this Action Area is to build a nationally supportive environment for public engagement in science and technology. In addition, the Action Area is also designed to increase the number of learners with an interest in STEM-related career pathways. This action area recognises the changing demographic of New Zealand including the increasing iwi and hapū asset base and the partnership model of service delivery. It operates with 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 publicly engaged science sector'.

The immediate objective is to 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, support youth into science and technology-based careers and build greater connectivity across sectors. In the longer term, Action Area 2 recognises that the culture change necessary to encourage and enable public engagement in science must start with young learners, their teachers, families, whanāu and their communities.

1. ***Support quality targeted initiatives on science and technology for traditionally harder-to-reach audiences***

New actions

- **A contestable fund for science outreach and engaging harder-to-reach groups**

  We will establish a contestable fund which will fund educational community outreach initiatives that focus on science and technology.

  There is a growing international recognition that efforts to engage the public in science and technology find their greatest success with people who are engaged in science. The challenge is to reach and inspire a broader base of New Zealanders through initiatives that bring science and technology to groups that are generally considered harder to reach. This action will support initiatives with a broad reach.

2. ***Support youth into science and technology-based careers***

Actions in this area will develop more responsive educational pathways, including the impacts of student study choices, and to develop entrepreneurial thinking in the science and innovation sector. The relevance of science and technology learning to future career options needs to be made clearer at an earlier stage for learners, and the education and training pathways leading to these potential careers should be clarified.

New actions

- **Increasing girls' participation and achievement in science and ICT**

  This work will involve actions aimed at influencing girls' subject choices to increase their participation and achievement in science and ICT areas of study.

Supporting actions

- Working with Careers NZ to raise awareness of science and technology careers on the Careers NZ website
- Working to develop and promote the uptake of information provision for learners about science careers
- Supporting talented school students through young achievers and travel awards
- Exploring more strategic targeting of the FutureinTech programme, and other potential changes to increase its impact
- Reviewing and evaluate the pilot of the Science Education Leadership and Coordination role for merit to expand

- Using the Vocational Pathways to design programmes that use real world contexts to deliver science and technology education in ways that engage learners' needs and interests
- Considering how to strengthen science literacy in senior secondary schooling particularly at Year 11
- Considering the future of the STEM feature in the Occupational Outlook.

3. ***Support parents and whānau to increase their engagement with science*:**

New action

- **Develop a Participatory Science Platform**

  (The platform described below at 3.4). will offer Early Childhood Education Services, schools / kura and their communities opportunities to participate in scientific research in projects with broad appeal, scientific value and pedagogical rigour that resonate with the community.

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.

4. ***Build and maintain meaningful linkages between science and technology-led businesses, science and technology educators and learners, and practising scientists and technologists***

New action

- **Connecting business, local government, educators with the science sector**

  We will explore opportunities to connect science and technology-led businesses with learners, educators, local government and the wider science sector.

  Improving connections between science and technology-led businesses and learners at a regional, industry or sector level will give more learners real world understanding of potential STEM career pathways. It will enable more science and technology-led businesses to promote STEM careers and build early connections with future employees and deliver growth and economic outcomes.

5. ***Support quality science journalism and coverage 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.

Supporting action

- We will 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.

6. ***Build greater connectivity with museums, zoos and science centres***

Supporting action

- We will work with organisations such as museums, zoos and science centres to build greater connectivity and agree their role in delivering on the plan.

  Non-traditional learning environments, such as those provided by museums, zoos and science centres, can play an important part in encouraging STEM competencies and innovations. Reaching millions of New Zealanders each year, museums and other science organisations facilitate engagement and lifelong learning, and are ideally placed as community spaces or forums.

7. ***Build the evidence base on public attitudes to, and engagement with, science and technology.***

Supporting action

- We will regularly survey public attitudes to, and engagement with, science and technology.

3.3 Action Area 3: Science sector engaging with the public

Action Area 3 complements Action Area 2 because there cannot be a scientifically engaged public without there also being a publicly engaged science sector. This 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. Publically funded science organisations and 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. ***Support scientists to contribute meaningfully to schools and communities, while advancing their scientific output, by enabling their involvement in participatory research***

New action

- **Develop and implement a Participatory Science Platform**

  The platform (described below at 3.4) will match scientists and members of schools or community organisations seeking to take part in community-initiated and scientist-initiated research.

2. ***We will ensure that scientists and science organisations continue to employ leading edge knowledge and international best practice to engage relevant public(s) in identifying priority research questions and usefully disseminating results for publicly funded research.***

New actions

- **Engaging the public in implementing the National Science Challenges**

  As the National Science Challenges are implemented, we will consider an approach and opportunities to engage the public in the implementation. This project builds on the success of the public engagement process used to identify the National Science Challenges.

- **The Royal Society of New Zealand will develop a Code of Practice on public engagement for scientists**

  The Royal Society of New Zealand will work with the scientific community 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.

Supporting actions

- Public research funding bodies will review and update the knowledge translation expectations for research contracts, and assess the current state of publicly-relevant knowledge transfer and end-user engagement practices among funding recipients, including with Iwi and Māori organisations. Results of this exercise can be used to inform future expectations
- We will continue to implement recommendations of the PMCSA on the use of science-based evidence in policy formation, by creating opportunities, through new Departmental Science Advisors, for the science sector to engage with government and share relevant results with policy makers.

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

New action

- **Public engagement training for science and technology researchers**

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

Supporting actions

- We will continue to ensure that scientists' excellence is acknowledged and showcased through the Prime Minister's Science Awards.

4. ***Increase the profile of the work of researchers who are Māori in science/ pūtaiao and of all researchers engaged in mātauranga Māori.***

New action

- **Increasing the profile of researchers in science/pūtaiao and mātauranga Māori**

  We will work with researchers who are Māori, iwi and Māori organisations about their mātauranga Māori and science/ pūtaiao knowledge to increase their profile.

3.4 Integrating Action: The participatory science platform

1. ***Develop and implement a Participatory Science Platform***

While Action Areas 1, 2 and 3 target specific sectoral goals, they are nonetheless interconnected. A unique feature at the heart of this strategic plan is an integrating activity that simultaneously addresses important objectives in all three Action Areas.

The Participatory Science platform builds on traditional concepts in citizen science and enhances these through collaborative approaches more common to community-based participatory research. Participatory Science is a method of undertaking scientific research where volunteers can be meaningfully involved in research in collaboration with practising scientists (including post-graduate students or researchers and private sector scientists) and builds on international models of engagement.

The goal is to involve schools / kura and/or community-based organisations such as museums and associations in projects with broad appeal, having both scientific value, pedagogical rigour, and that resonate with the community. In addition, we are testing several ideas for projects of national significance that would integrate with the National Science Challenges and be national in reach.

The Participatory Science Platform has the potential to:

- offer inspiring and relevant learning opportunities for students and teachers
- engage learners and participants beyond the school / kura community to reach parents, whanau and wider communities; and
  We will offer researchers opportunities to become involved in locally relevant lines of enquiry, where data can be enriched by the local knowledge and contribution of citizens.

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

1. A process that seeks ideas for participatory science projects from both the community (including Early Childhood Education Service and kōhanga, schools / kura, museums and other organisations, iwi authorities or community associations) and from practising researchers (from post-graduate students to principal investigators in both the public and private sectors);
2. A managed process for evaluating these ideas for both pedagogical potential (in the case of schools / kura) and scientific quality, and for ensuring their practicality and relevance to the participating partners (science sector and community-based);
3. A web-based match-making process between interested community-based partners and practising researchers; and
4. A resource for teachers and other community or learning leaders to assist in developing their projects to robust standards.

The Platform's website will serve as a match-making tool between scientists and potential community-based partners 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 will provide a coordination role. This could be a school, museum, zoo, science centre, iwi office or research institute, university or other tertiary organisation.

The projects will be offered as opportunities for community based partners to participate in scientific research as a way to enhance their local input, their science knowledge and their

interest, and (in the case of schools) to strengthen learning programmes through stronger links to relevant learning environments and expertise.

Once matches are made between community based partners and scientists, these partners would self-direct their involvement in carrying out the research according to an agreed plan and approach.

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.

To enable more sophisticated projects, a limited number of one-time seed grants will be made available to help foster a meaningful level of community involvement. The seed-grants will part-fund practising researchers and community/school groups to plan together the research question, data collection, analysis and knowledge translation strategy for the project. In addition, eligible costs could include research tools or consumables that would not otherwise be accessible to community partners.

3.5 Other government initiatives support the initial 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 Authority review of qualifications – Mandatory reviews of levels 1-6 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, including in areas of new and emerging shortage such as science and technology; 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 State Service's Commission's efforts to include action for better use of evidence in public policy formation. This is being operationalised through the creation of a number of Departmental Science Advisor roles and the creation of a network of these advisors chaired by the PMCSA. This plan recognises the role of scientists to better connect with the public service through the DSA network and other opportunities to bring evidence into policy formation.
- The Office of the PMCSA was established, in part, to address the role of science in society. Positioned at the nexus of the science sector, government, and the public, a central focus of the Office is to help establish better communication of concepts in science and research to the public and to government. This plan recognises the uniqueness of the PMCSA model internationally and can leverage the channel of public communication that the Office provides.

- MBIE's Vision Mātauranga policy aims to unlock the science and innovation potential of Māori knowledge, people and resources for the benefit of New Zealand. The four themes of the Vision Mātauranga policy are:
    - Indigenous innovation: contributing to economic growth through distinctive science and innovation
    - Taiao/environment: achieving environmental sustainability through iwi and hapū relationships with land and sea
    - Hauora/health: improving health and social wellbeing
    - Mātauranga: exploring indigenous knowledge and science and innovation.

For this reason the Vision Mātauranga policy is embedded across all science investments, and as such forms a core component for the implementation of MBIE's approach to supporting outcomes for Māori and New Zealand.

PART 4 Implementing and evaluating the plan

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, modify as we go and continue engaging with stakeholders.

4.1 Implementation approach

As this is an initial Science in Society plan, the government has asked the Science in Society Reference Group to reconvene in 2015 to review progress and advise on any modifications to the actions to better deliver on the outcomes. MBIE and MoE together with the PMCSA will oversee implementation of the plan by government agencies, iwi and other sectors including the education, science, business and museum sectors. The two agencies will also lead a process of engagement with the public on the plan and the actions in it.

Central to the terms of reference of the PMCSA is to support an improved and productive relationship between science and society. As such, the PMCSA and the network of Departmental Science Advisors will continue to be active in implementation of the plan.

4.2 Timeframe

While the challenges are long term, the plan sets out a direction for the next ten years and actions for the next three years from 2014 to 2017. The actions may be modified and enhanced as we learn more over the life of the plan.

Some actions are already underway as they continue or enhance effective existing actions. Enhancing the role of the Science Media Centre and MoE'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 initiatives focused on science outreach and engaging harder-to-reach groups will 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 sector. These actions will help inspire and provide authentic learning opportunities of relevance and interest to students.

4.3 Monitoring and evaluation

The monitoring and evaluation activities will be proportional to the funding available for the Science in Society project. The emphasis will be on monitoring and making the best use of existing data.

Monitoring will comprise:

- A survey of public attitudes toward science, complemented by in-depth qualitative research with the general public
- Analysis and synthesis of education and skills data, for example student achievement in science and maths
- Analysis and synthesis of administrative data, for example monitoring of MBIE science contracts and science communications measures and indicators
- Formal and informal stakeholder consultation.

MBIE has developed an intervention logic to inform the monitoring activities (Annex 1). The intervention logic details the links between the challenges that Science in Society seeks to address, the activities being undertaken within the action areas and their intended impacts and outcomes. These impacts and outcomes include short-term changes in awareness, medium-term changes in behaviour, and long-term changes in terms of a responsive science and technology sector and a skilled workforce. The intervention logic model will inform the selection of indicators and measures for monitoring purposes.

Work to date has included MBIE commissioning (in June 2014) a survey of public attitudes towards science and technology and the ways in which the public conceptualises science. This survey will retain some questions asked in previous studies for comparability, and thus will identify changes in public attitudes from those previous studies. Responses to questions in the survey will form part of the baseline measures for monitoring the initial plan.

The Ministry of Education is able to utilise existing data collection and analysis to monitor the impact of the plan. The Ministry regularly publishes data about student achievement in science and mathematics through Public Achievement Information (PAI) which is available on www.educationcounts.govt.nz. This reporting covers all levels of the curriculum, and draws on information about National Standards, NCEA and Early Childhood participation. Information is provided by ethnicity and gender, and is measured against Government targets. This reporting is able to provide a robust measure of the direct impact of the plan on student achievement.

The performance framework for the National Science Challenges will include some assessment of public engagement in science.

Monitoring and evaluation will establish a baseline and track progress against the initial plan's outcomes. It will also assess the performance of specific action areas. In response, initiatives that are making a measurable contribution to the expected outcomes will be continually adapted and extended.

The monitoring and evaluation activities for this plan are founded on the plan's three expected outcomes as follows.

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 across all sectors of society are engaged with, and value, 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 about, and be involved in, scientific research and uptake continues to grow across all tiers of society
- there are more opportunities for the public and the science sector to engage in discussion about societal use and limits of new technology and applications for existing technology
- publicly funded research responds to the needs of New Zealanders and recognises 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 informed New Zealanders, a more skilled workforce and more responsive science and technology sectors

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
- New Zealanders make more informed decisions on issues of importance to 21st century life.

Annex 1: Intervention logic

[to come]

Annex 2: Process for developing this plan

This plan was developed by the MBIE, MoE and the office of PMCSA 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 PMCSA. 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 MBIE. 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 career 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 membership of the Science in Society Reference Group will be reviewed before it is reconvened in 2015.

The Reference Group, the National Science Challenges Panel, Business New Zealand; the Chief Executive of Science New Zealand; the New Zealand Association of Scientists; municipal museums; the Royal Society of New Zealand, the Chambers of Commerce, Callaghan Innovation, the Secondary School Principals Association; New Zealand Principals Federation; the Post-Primary Teachers Association; the New Zealand Education Institute; the leadership of Universities, Polytechnics and Wānanga; the Tertiary Education Union; the New Zealand Union of Students Association; stakeholders from Society of Māori Astronomy and Research Traditions and Ngā Pae o te Māramatanga and the National Science-Technology Roadshow Trust provided feedback on a draft of the plan.

Annex 3: Key definitions

What do we mean by 'science', technology and STEM?

Science is a set of formal processes that interrogates the "real things" or phenomena of the natural and social world in order to construct explanations of them, that is, to know the world.[31] It describes a way of thinking about the world, a creative process which generates knowledge and the ability to think critically about that knowledge. *The New Zealand Curriculum* describes ***science*** as "*a way of investigating, understanding and explaining our natural, physical world and the wider universe*."[32] 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.

Science knowledge means both knowledge of the processes, methods, and facts of science on one hand, and knowledge about science's applications and limitations on the other. Certain audiences will specialise in knowledge 'of' science, but basic knowledge 'about' science is broader and is an important tool of 21st century citizenship and public discussion on today's most pressing societal concerns. This has been referred to as 'civic science literacy[33]'. We also acknowledge that 'knowledge' may also mean the science sector's own knowledge of various public audiences and how to connect with these to make their science relevant.

Technology intervenes in the world to solve problems, meet needs or desires, that is, to create part of the made world[34]. *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*".[35]

STEM is the internationally recognised term that refers to subjects or areas of learning, namely science, technology, engineering and mathematics, which are used broadly and are inclusive of all levels of learning. Often, the acronym is used as shorthand to denote the family of numerate subjects, even when one or more are not considered. In the plan, we distinguish deliberately between **STEM** and **STM**, which refers to compulsory level subjects (science, technology and mathematics) because engineering is taught only at tertiary level. **STE** refers to science, technology and engineering subjects.

What do we mean by 'engagement'?

Engagement can and should be a range of things for different people and different times, and is dependent upon purpose.

The goal of 'engagement' in the plan is to recognise and enable the role that we all have in understanding, becoming informed and questioning what we need science to address and what we do with the new knowledge that science produces.

In some instances, this is through the opportunity to learn in a more hands-on and relevant way that can help shape our attitudes and decisions. In other situations, it is a participatory tool for a more open approach to research and for making decisions about how to use the information it

Bringing Communities Together.

Know to Make Sense of Science, Bulletin of Science Technology & Society 2013 33: 138
See footnote 33.

produces. This is one way that a stronger relationship between science and society can be developed.

For the public (including government) 'engagement' means the acquisition and application of multiple types of STEM-knowledge by multiple kinds of audiences for various purposes.

For the science sector it involves communicating new knowledge clearly for different users, as well as undertaking research and responding to the knowledge needs of society.

Taken together these characteristics of 'engagement' imply an improved and productive social relationship between the science sector and wider society that will lead to the responsible application of knowledge for the social, environmental and economic wellbeing of New Zealanders.

Thus, in the plan, the focus is on engagement in:

- *acquiring knowledge*, which is about the public, including and especially compulsory level learners acquiring the STE skills and knowledge needed to develop a career in science and/or to engage in much needed and ongoing public conversations about the application of scientific knowledge and technology.

- *generating knowledge*, which 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 opportunities in Participatory Science.

- *applying knowledge*, is about being enabled to make the best use of what we know, including the responsible and evolving use of or limiting of new technologies or novel applications of existing technology.

This definition of engagement reflects a fresh approach through a necessary mix of what has in the past been called 'public understanding of science' or 'science literacy' and of 'public engagement in science'[36].

Annex 4: Description of initiatives

KEY: Existing action continuing | Changed existing action | New project

Action Area	Goal	Action	Status	Lead agency	Other agencies	Comment
Education Sector	Improve initial teacher education	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		MoE		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).
	Improve the quality and relevance of continuing professional learning and development opportunities for teachers in science and technology	MoE 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		MoE		
		Provide primary and secondary school teachers with opportunities to work with research organisations and develop leadership skills to enhance the teaching of science within school communities		MBIE		In 2014/15, reframe the teacher fellowship programme to further imbed the leadership responsibilities within the school community, enhance leadership competencies and align with Ministry of Education initiatives.
		Promote the Science/Biotechnology Learning Hubs to provide an online repository of New Zealand science for use by teachers, students and communities		MBIE		In 2014/15, promote the Science/Biotechnology Learning Hubs as a high-quality online repository of New Zealand science and resources to support science education.
		Create a Science Skills in Education Initiative to support schools and teachers to build confidence and access resources to develop rich, contextualised science programmes that are exciting for students		MoE		The initiative will be developed with education and industry stakeholders to create a network between local industry, local and national government and schools to assist teachers to continue their science education with providers who have a proven record of excellence in science teaching. Examples include access to courses for primary teachers with a focus on developing science skills and knowledge that reflect science/pūtaiao in the national curriculum, and expanding the availability of the Sir Paul Callaghan Academy initiative. This initiative focuses on teacher learning, and will explore links to the Science in Industry Programme as appropriate.
		Create a Teachers in Industry Project for teachers, to connect schools with science intensive businesses to enable teachers to spend a period of time in the businesses to bring business relevant content into their science lesson plans		MoE		This initiative focuses on building the currency of programmes, and will explore links to the Science Skills in Education initiative as appropriate. 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.
	Develop science and	The New Zealand Curriculum (NZC) and Te Marautanga o Aotearoa		MoE		The NZC identifies five key competencies which are to be

	technology curriculum materials and support teachers to use them	address STM skills development and building a scientifically and technologically engaged population more generally Te Whāriki – Strand 5: Exploration Children experience an environment where they develop working theories for making sense of the natural, social, physical and material worlds				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.
		The Matakōkiri Project supports students to engage with science by linking science/pūtaiao to Māori language, culture and identity through students' local tikanga, whakapapa and stories		Te Taumata o Ngāti Whakaue Iko Ake Trust		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.
		Establish Learning and Change Networks with a dedicated focus on student achievement in science		MoE		These 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.
		A range of online and print publications to support quality teaching, learning and assessment		MoE		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.
	Build and maintain meaningful linkages between science and technology educators and learners, and practicing scientists	Explore equitable funding models to enable schools / kura to meet the costs of students attending Learning Experiences Outside The Classroom		MOE		
		Identify the assessment standards on the National Qualifications Framework (levels 2 and 3) that will improve the visibility of STEM capabilities within assessment standards		MoE		
		School, science sector partnerships that support school students' science learning. 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		MoE		A pilot will run through to July 2014 to build school, science sector 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.
	Review the positioning and content of digital technology within the framework of the New Zealand Curriculum and Te Mauratanga o Aotearoa	The Ministry of Education will work alongside sector partners to review the positioning and content of digital technology within the framework of the New Zealand Curriculum and Te Mauratanga o Aotearoa		MOE		It is intended this will result in additional guidance and support materials exemplifying ICT provision across primary and secondary years and will complement the National Certificate of Educational Achievement (NCEA) review and maintenance programme.

Public engaging with the science sector	Support quality science journalism and coverage in the multi-platform media	The Science Media Centre – a centre that provides an interface for the media with the science and technology sectors and educates scientists on engaging with the media to improve the quality and professionalism of science and technology reporting		MBIE		In 2014/15, 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.
	Support quality targeted initiatives on science and technology	Establish a contestable fund for targeted initiatives focused on science outreach and on engaging harder-to-reach groups		MBIE		To be designed and piloted in 2014/15 and, subject to the results of the pilot, implemented in 2015/16.
	Support youth into science and technology-based careers	The STEM feature in the 2014 Occupation Outlook identified the current and future demand for STEM-related careers		MBIE		To consider its future in 2014/15.
		Youth Transitions Framework that focuses on more young people participating in learning areas of high growth and demand (eg STEM subjects)		TEC		
		Identification of STEM-related credits within the Vocational Pathways that support students to progress to higher level STEM-related education and training		MoE, TEC		
		Māori Future Makers website which profiles Māori and whānau in non-traditional, knowledge intensive sectors		TPK		
		Work with Careers NZ to explore and develop ways to raise awareness of science and technology careers on the Careers NZ website		Careers NZ		
		Supporting Young Achievers Awards		MBIE		Awards to continue.
		Talented School Students Travel Awards		MBIE		In 2014/15, extend the programme to intermediate students and provide additional flex bility to reach more low decile students.
		Continue work to develop and promote the uptake of information provision for learners about science careers		MoE		
		Use Vocational Pathways to support schools and tertiary providers to contextualise STEM-related learning in ways that are relevant to further study and career options		MoE		
		Consider how to strengthen science literacy in senior secondary schooling particularly at year 11		MoE		
		Promoting STEM careers to students through the FutureinTech programme		Callaghan Innovation		In 2014/15 explore more strategic targeting of the programme, and other potential changes to increase its impact
		Consider how to increase girls' participation and achievement in science and ICT		MBIE and MoE		
	Build and maintain meaningful links between	Explore opportunities to better connect business, local government, educators, learners and the science sector at a regional, industry or		MBIE		To be considered in 2014/15 and, subject to the results, implemented in 2015/16.

	science and technology-led businesses, educators and learners and practising scientists and technologists	sector level				
	Build greater connectivity with museums, zoos and science centres	Work with organisations such as museums, zoos and science centres to build greater connectivity and agree their role in delivering on the plan		MBIE, MCH		To begin in 2014/15
	Build the evidence base on public attitudes to, and engagement with, science and technology	Regularly survey public attitudes to, and engagement with, science and technology		MBIE		Survey to be carried out in 2014 and a regular programme agreed.
Science sector engaging with the public	Ensure publicly funded scientists employ leading edge knowledge and international best practices to engage relevant public(s) in identifying priority research questions and usefully disseminating results	Government expectations on researchers receiving public funds to make research public and provide public engagement and outreach		MBIE, TEC		From 2015/16 to review and update the knowledge translation expectations for research contracts, and assess the current state of publicly-relevant knowledge transfer practice among funding recipients. Results will be considered to inform future expectations.
		The Crown Research Institute's (CRIs) Statement of Core Purpose in the Crown Research Institutes Act 1992 includes expectations on engagement with key stakeholders and to transfer technology and knowledge to key stakeholders		MBIE, CRIs		No changes proposed.
		Request for proposals for the first ten National Science Challenges sets a key objective for engagement by the science sector with the public		MBIE		In 2014/15 build on the success of the public engagement process used to identify the National Science Challenges by considering an approach and opportunities to engage the public in the implementation phase of the National Science Challenges.
		Work with the scientific community to develop a +of Practice for Scientists that enshrines their public responsibilities		RSNZ		To begin in 2014/15. 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.
	Ensure emerging scientists and technology researchers have the basic communication skills to make their research accessible to relevant audiences beyond their peer group	Work with the tertiary sector to identify ways to ensure that all emerging and established science and technology researchers have access to training that supports engagement and the dissemination of their knowledge to non-academic audiences		MBIE, MoE, TEC		To begin in 2014/15.
		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		MBIE		Prizes to continue.
	Increase the profile of the work of Māori researchers in	Increase the profile of the work of researchers who are Māori in science/ pūtaiao and of all researchers engaged in mātauranga		MBIE, PMCSA		To begin in 2014/15.

	science/pūtaiao and of all researchers engaged in mātauranga Māori	Māori by engaging with researchers who are Māori, iwi and Māori organisations about their mātauranga Māori and science knowledge and science projects to build greater connectivity				
Across all action areas		Develop and implement a Participatory Science Platform		MBIE, MoE		To be designed and piloted in 2014/15 and, subject to the results of the pilot, implemented in 2015/16.

Annex 1: Initial Science in Society strategic plan

A Nation of Curious Minds

- A national strategic plan for science in society

[Māori translation to come]

Annex 1: Initial Science in Society strategic plan

Contents

Ministers' foreword

New Zealand has always been proud of its "do-it" attitude. From the very first humans to land here, generations of us have seen a problem and come up with an ingenious way to deal with it – from how to grow warm temperature kumara in a much colder climate to a novel piece of farm equipment put together in the barn. We can thank curious Kiwi minds for these examples of science and innovation, and the need for them is set to increase in the years ahead.

All New Zealanders should feel encouraged and equipped to deal with the challenges and opportunities presented by science and technology, and capable of participating in the debates involving science. We also need an environment that helps New Zealanders to use their natural curiosity to interrogate, decide on and make the most of new developments and technologies.

New Zealand is a small, geographically isolated and well educated country. To overcome the disadvantages of modest size, we must maximise opportunities to harness our curiosity and cultivate our ability to be competitive and improve social and environmental outcomes. Our workforce must be skilled in science and technology to develop new high value products, meet the demands of business, and mitigate and adapt to the challenges of a quickly changing world.

This Science in Society strategic plan is one of a number of Government initiatives that recognises the importance of science to New Zealand's future. The project emerged from the National Science Challenges and sits alongside other initiatives such as the establishment of the Office of the Prime Minister's Chief Science Advisor, the formation of Callaghan Innovation, and the recently-released draft National Statement of Science Investment.

Developing stronger connections between science and society is a long-term project.

This plan puts special emphasis on our young people and science education. Science literacy is fundamentally important to the future of young New Zealanders. It gives our students a platform to meet challenges and compete here at home and internationally. This plan accepts the challenge of building innovation, creativity and increased science literacy across the education sector. Lifting engagement and achievement in science education is absolutely vital. The education profession must prepare all New Zealanders to be participants, and leaders, in a 21st century economy, and society.

Business, community, iwi, and whānau engagement in science and technology education is critical to the success of our learners. The plan engages schools/kura, the community and scientists in partnerships that acknowledge the place of science/pūtaiao and technology/ hangarau within and beyond the New Zealand Curriculum and Te Marautanga o Aotearoa.

Government has a key role to play in facilitating better engagement in science across all sectors. This plan draws together the key issues around growing engagement in science in New Zealand, summarises available evidence and outlines a number of innovative actions to be developed, and presents them as the start of a conversation about the role of science in this country.

The plan also identifies ways to increase engagement between the science sector and New Zealanders as publicly funded science is for the benefit of us all.

Developing a more publicly engaged science sector and a more scientifically engaged public is a collaborative and long term process. It will require action from a wide range of stakeholders

including government, research organisations, schools, non-government organisations, families/whānau, communities and businesses. We believe the ideas in this plan will get us a considerable way down that track. We also know that New Zealand is a nation of curious and creative people with great ideas. As the new actions in the plan are tested, reviewed and adjusted, we encourage you to get involved while also thinking about what could be done better. Your feedback will be most welcome when progress on the initial plan is reviewed in 2015.

Steven Joyce
Minister of Science and Innovation

Hekia Parata
Minister of Education

Executive summary

Science and the knowledge and innovation that flow from scientific progress have a critical role in creating and defining our future

Many of today's most complex decisions (e.g. on public health, natural resources stewardship and communications technology) require us all to weigh scientific evidence and our values. This will be even more so in future years as the world becomes increasingly connected and technology and knowledge advance. As New Zealanders we should all feel encouraged and equipped to engage in the key questions facing our society now and in the future. Improving New Zealand's economic, social and environmental outcomes through growing an innovative society drives the need for an increasingly science, technology, engineering and mathematics (STEM) competent workforce.

This plan responds to the science and society challenge for government considered by the National Science Challenges Panel to be central to the success of all the Challenges.

The Government's objective in addressing this challenge is to 'encourage and enable better engagement with science and technology across all sectors of New Zealand' society in order to deliver the outcomes of:

- more science and technology competent learners, and more choosing STEM-related career pathways
- a more scientifically and technologically engaged public and a more publicly engaged science sector
- a more skilled workforce, more informed New Zealanders and more responsive science and technology.

These are long-standing challenges that will take time to address. While some actions are underway to encourage and enable better engagement with science and technology, more are needed if we are to make the objective and outcomes of this plan a reality. This plan sets out a strategic direction for the next 10 years and actions for the next three years.

This plan focuses on three Action Areas and one Integrating Action, each of which incorporates specific actions:

- ***Action Area one*** further enhancing the role of the education system
  - Improve initial teacher education through increased science teaching competencies, leading to increased confidence
  - Better in-service professional learning and development for science and technology teachers
  - Building stronger links between science and technology educators, learners, technologists and scientists, in the classroom and in the community
- ***Action Area two:*** public engagement with science and technology
  - Establishing a contestable fund for education and outreach initiatives on science and technology for harder to reach sectors of the community
  - Supporting young people into careers in science and technology
  - Supporting parents and whānau to engage with science
  - Supporting high quality science journalism and media coverage

  - Building stronger links between businesses, educators and learners, and between scientists and technologists to better connect business with science and interest more young people in studying science
  - Build stronger links between the science and education sectors and science centres, museums and zoos
  - Monitor data about public attitudes to and engagement with science and technology
- ***Action Area three:*** science sector engaging with the public
  - Support scientists to contribute to broader science education while advancing their work
  - Support scientists and science organisations to continue to use leading edge practices and standards to engage the public in identifying research questions and sharing the results
  - Ensure that scientists know how to make their research accessible to wider audiences
  - Increase the profile of Māori science/ pūtaiao researchers and of researchers engaged in mātauranga Māori
- ***Integrating Action:*** Participatory Science Platform:
  - Integrating all three Action Areas through a platform to engage students, communities and scientists in participatory science.

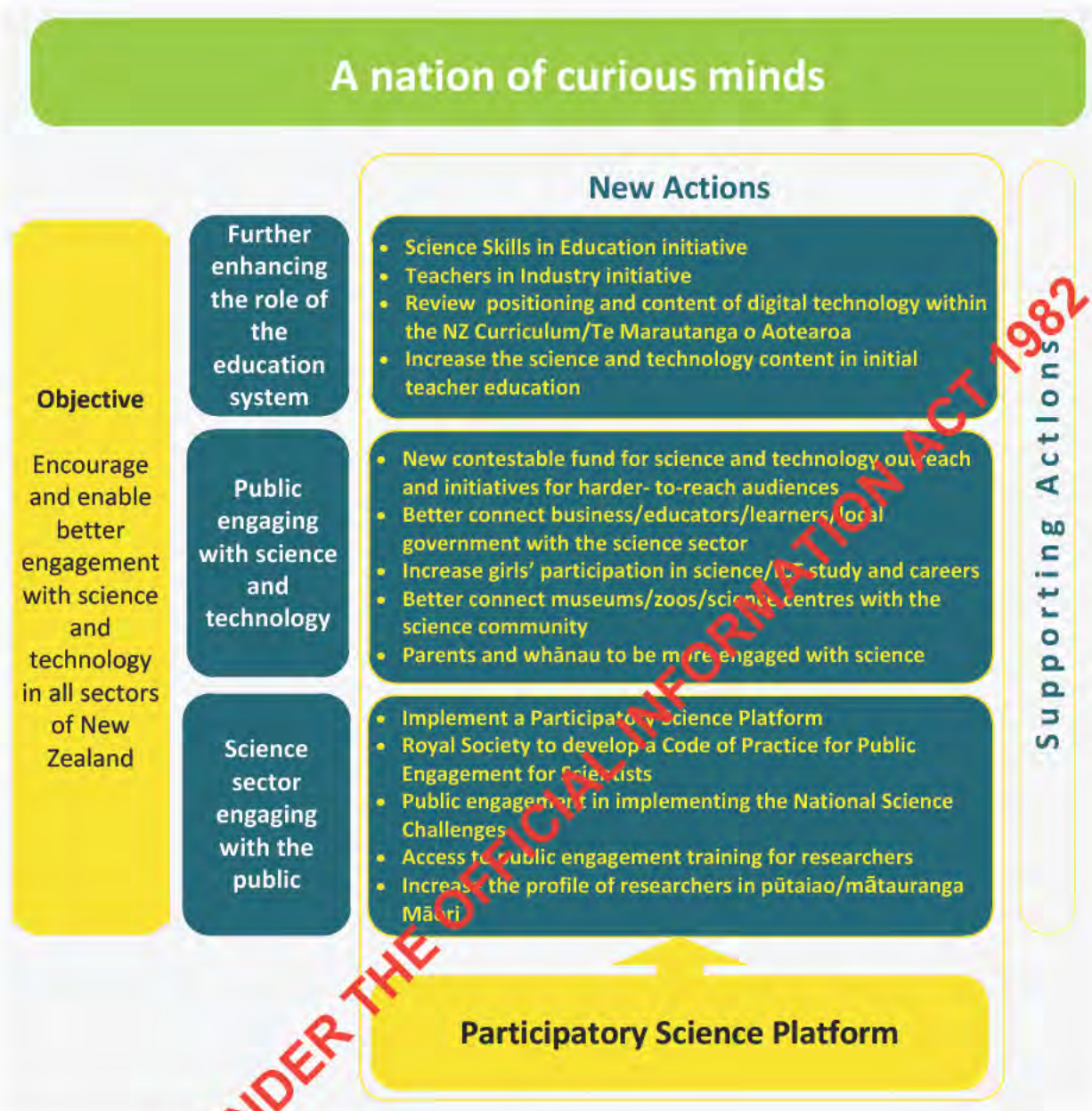
This plan recognises and acknowledges the importance of mātauranga Māori to build cultural confidence and identity, and how, through this, New Zealand can grow its skills and generate innovation and creativity. Mātauranga Māori is Māori knowledge that is dynamic, building from earliest traditions to future knowledge. Each of the three Action Areas and the Integrating Action will be developed in ways that respect whānau, hapū and iwi as the key conduits of mātauranga Māori, and focus on realising the potential gain for New Zealand through building capability in science and technology to support Māori economic development and management of natural resources.

The Ministry of Business, Innovation and Employment and the Ministry of Education, together with the Office of the Prime Minister's Chief Science Advisor (PMCSA), will oversee implementation of the plan by government agencies, iwi and other sectors including the education, science, business and museum sectors.

This Initial Science in Society strategic plan will be subject to ongoing monitoring and evaluation. It will respond to changing needs and contexts by adapting and extending initiatives that are making a measurable contribution to the expected outcomes.

The Science in Society Reference Group will reconvene in 2015 to consider progress in delivering on the objective and outcomes and to incorporate wider stakeholder views into its ongoing development and implementation.

The following diagram summarises the initial plan's approach in responding to the challenges of better engagement with science and technology.



1. Setting the Scene

Science and technology are critical for enhancing living standards through economic growth and improving social and environmental outcomes. Today, science is embedded in the many decisions policy makers, business, individuals and societies must make. Societies with strong "science capital[1]" sustain more innovative economies and have a greater awareness of both the opportunities and limits of science in development and wellbeing. Science is central to the many global challenges we face (from environmental challenges to an aging and increasingly urban population, for instance).

Following significant public engagement led by Government 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' as central to the success of the National Science Challenges and the most important challenge if New Zealand is to responsibly apply science and innovation and benefit optimally from its investment in scientific research.

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. Annex 1 sets out the process for developing this plan.

The plan sets out the objective and outcomes the Government wishes to achieve to strengthen the place of science in society over the next 10 years. It sets out the available evidence on where New Zealand is now. It concludes by setting out a three-year plan of action to make progress towards the objective and outcomes.

The plan does not cover the supply of mathematics skills and demand for STEM skills as these are being addressed through the Business Growth Agenda and the literacy and numeracy taskforce.

The plan is addressed to all New Zealanders. To be effective, it is important to be specific about target audiences where actions can make the most difference. In particular, the plan recognises that there are certain stakeholders in our social relationship with science who are important 'agents of change.' These are:

- Students, teachers and the compulsory learning sector
- Parents, whānau and communities
- Science sector including technology
- Business, especially science and technology-led businesses
- The public sector and government
- Communicators of science and technology, including traditional and online media, museums, zoos, science centres and industry organisations

[1] Science capital refers to science-related qualifications, understanding, knowledge (about science and 'how it works'), interest and social contacts (e.g. knowing someone who works in a science-related job). This definition is from *Aspires Young people's science and career aspirations, age 10-14,* Department of Education and Professional Studies and King's College London: 13.

The plan presents a coherent approach to addressing the challenge of strengthening the role of science in our society. The actions in the plan support wide engagement to deliver on the plan's objective and outcomes.

Curious minds case study
How could surgery be improved?
New Plymouth nurse Lorraine Parthemore invented a traction device for patients undergoing surgery to correct a damaged disc in the neck.

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. These encompass environmental, societal, health and economic goals. 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[2]. New Zealanders should feel encouraged and equipped to engage in the key questions facing our society now and in the future.

The production and application of scientific knowledge and new technologies often imply trade-offs that we need to weigh carefully such as how to prioritise research investment and the potential for unintended consequences. Addressing these trade-offs requires 'social licence' because these are complex issues which no single group, such as scientists, government or businesses, should make on behalf of New Zealanders without their input. Social licence' exists where there is an environment of mutual understanding and transparent and deliberate communication between the public and science sector. This plan includes actions to create the environment needed for 'social licence' to exist.

We need an increasingly STEM-competent workforce for an 'innovation society'

New Zealand's economic and social wellbeing depends on the productivity and competitiveness of the economy and the knowledge we have to help make informed decisions as a society. Innovation that leads to increased productivity and promising solutions to society's most pressing concerns is increasingly being seen around the world as an important way to generate economic growth and improved living standards[3].

Improving policies and practices will enable the development of an 'innovation society'. To do this, New Zealand needs a high performing and responsive science and innovation system and skilled people who can solve problems and create and deliver high-value products and services for sustainable economic, social and environmental wellbeing. We need businesses, policy makers and citizens who are able to create, absorb and apply new ideas and approaches.

[2] *Programme for International Student Achievement Draft Science Framework.p3.*
[3] *Madsen, JB. 2010. The Anatomy of Growth in the OECD since 1870. Journal of Monetary Economics, v57(6) pp 753-67.*

Our science system – particularly the tertiary education organisations that undertake research-led teaching – has a vital role in educating a future generation of scientists, technologists and innovators 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 and domestic investment in our research is also critical for economic growth.

A creative culture and a wide range of skills are needed for innovation, societal advancement and sound environmental stewardship. Internationally, it is recognised that STEM skills underpin the development of new practices and technologies, the application of existing technologies and the development of new, high-value products and services[4]. STEM skills and competencies also underlie growth in many industries[5], and are highly transferable across industries[6].

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 higher levels of competency has a much lower likelihood of experiencing both economic and social disadvantage than an individual with lower competency levels[8].

Students' career choices are influenced beyond school / kura by family, whānau, iwi, business and the wider community, with parents providing the most important influences[9]. 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 (MoE) 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. Its ultimate goal is to equip young people with the skills to live a fulfilling life and contribute to New Zealand's economic prosperity.

The Ministry of Business, Innovation and Employment (MBIE) aims to grow New Zealand for all. It is focused on improving the productivity and competitiveness of our economy and the knowledge we have to help make informed decisions as a society. The science system contributes know-how for economic growth, helps to identify and manage risks in the natural world, and provides skilled researchers and workers to support an innovation economy. MBIE aims to increase the economic contribution of the skills, science and innovation systems.

Curious minds case study

Could you invent a robot capable of climbing walls?

A team of engineers from the University of Canterbury have come up with technology for robots that can walk up walls and across ceilings.

[4] *Ministry of Business, Innovation and Employment Occupation Outlook 2014, p7.*
[5] *Ministry of Business, Innovation and Employment Occupation Outlook 2014, p8.*
[6] *Ministry of Business, Innovation and Employment Occupation Outlook 2014, p7.*
[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*

2.2 Objective and outcomes

The objective of this strategic plan is to:

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

We expect progress towards the objective will contribute to three expected outcomes:

- more science and technology competent learners, and more choosing STEM-related career pathways
- a more scientifically and technologically engaged public and a more publicly engaged science sector
- a more skilled workforce, more informed New Zealanders and more responsive science and technology.

Curious minds case study

What if there was a safer way to cut kindling?

An Inglewood teenager invented a safer way to cut kindling after her mother cut herself with an axe. The device won a prize at the New Zealand Innovators Awards.

2.3 The state of play

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

There are STEM skills shortages

There are skills shortages for many kinds of scientists, engineers, technologists, health and ICT professionals[10]. A number of factors are expected to lead to increasing demand for workers in many STEM-related occupations[11]. In addition, many jobs not directly STEM-related require STEM competencies. Internationally it is estimated that up to 75 percent of high-growth jobs require STEM skills and competencies[12].

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

There is global demand for those with STEM qualifications. Those who gain the STEM qualifications required to resolve shortages are often either lost from New Zealand to the global job market or pursue alternative careers. MBIE estimates that fewer than half of New Zealand graduates work in the field in which they studied and highly skilled immigrants are often required to fill the gaps. However, it is expected to become increasingly difficult to attract these immigrants as wages rise in increasingly knowledge-intensive Asian economies.

[10] *Immigration NZ: www.immigration.govt.nz/essential skills.htm.*
[11] *Ministry of Business, Innovation and Employment Occupation Outlook 2014, p8.*
[12] *Inspiring Australians*

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. For example, 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 has recently increased. The industry training providers are facing difficulties in growing engineering at technician and technology qualification levels[13]. In 2012, 15,560 domestic students, or 37% of domestic students, completed qualifications at bachelor's level and above in health; natural and physical sciences; engineering and related technologies, IT, and architecture and building[14]. Girls and women are under-represented in studying and working in STEM, apart from in the health and biological sciences[15].

New Zealand school student performance in science has declined

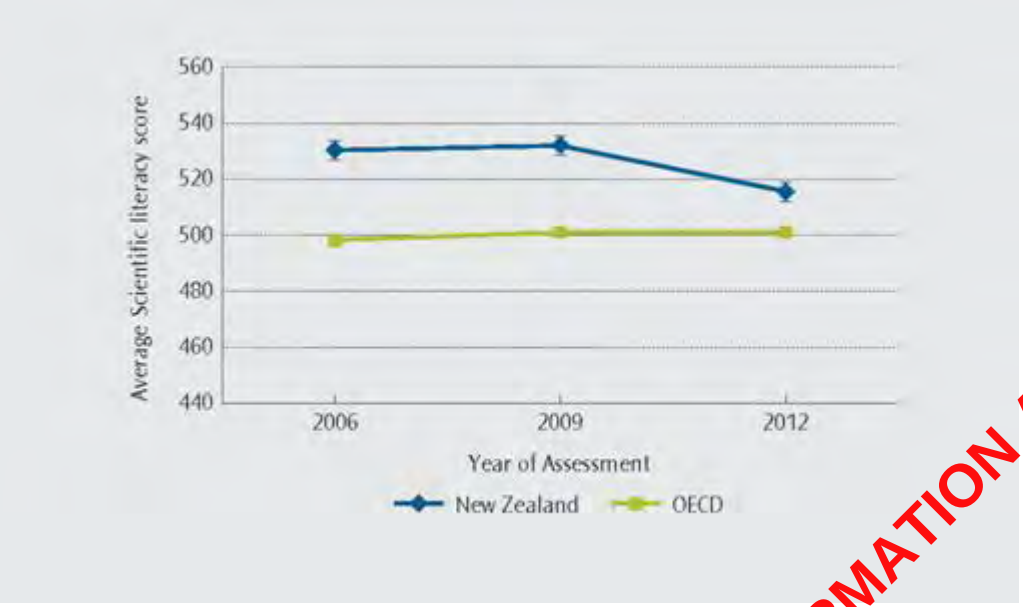
New Zealand has a highly respected education system. The World Economic Forum's Global Competitiveness Index for 2013[16] noted that New Zealanders spend the longest time in education from primary to tertiary, at 19.67 years and ranked New Zealand seventh for overall education indicators out of 142 countries.

Despite this, there is a gradual decline over years 11 to 13 in the proportion of students enrolled in science-related subjects[17]. New Zealand is not unique in this, as declines have been seen in many other developed countries.

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[18] 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[19].

[13] *www.ipenz.org.nz/ipenz/forms/pdfs/NEEP_Project_Report.pdf.*
[14] Ministry of Education 2012 SDR data*: New Zealand's Tertiary Education Sector, http://www.educationcounts.govt.nz/publications/series/2531/profile-and-trends-2012.*
[15] *Association for Women in Science Snapshot: Encouraging women to use and develop their scientific abilities to achieve their full potential, 2011.*
[16] *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*
[17] *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.*
[18] *Trends in International Mathematics and Science Study.*
[19] *OECD, Programme for International Student Assessment 2012.*

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[20]



The National Monitoring Study of Student Achievement (NMSSA) and the Programme for International Student Assessment (PISA) results show growing inequity in student performance in science in New Zealand.

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 the Trends in International Mathematics and Science Study (TIMMS), and NMSSA is yet to assess it.

What is causing the decline in student performance?

Research suggests that student achievement in science is declining in part because science teachers are not always confident in teaching science, particularly to diverse groups. Teachers do not always have access to the appropriate resources. Furthermore, some students lack confidence in their ability to succeed in STE subjects and lack support for deciding on senior secondary school subjects[21].

How scientifically and technologically engaged is 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 in

[20] *Prepared by the Ministry of Education from data from the Programme for International Student Assessment.*
[21] *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.*

2010 of public attitudes to science[22]. 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[23] (44 percent) or were disengaged from science (9%). Similar surveys have been done in other countries although comparisons are difficult given differences in the questions[24].

Relative to comparable countries, a relatively high proportion of New Zealand adults have a secondary or tertiary qualification[25]. There are 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 are limited data on the level and effectiveness of the engagement of the science sector and science and technology communicators with the public

There is increasing recognition of the broader social responsibility of scientists to engage with the wider public in meaningful ways[26]. It is difficult to track and measure this engagement, in part because it can take place in a great variety of venues and with various goals. Two main ways that scientists engage with the public is by conveying knowledge to governments to ensure science-informed public policy and decision making, and through more direct engagement with the public.

It is difficult to measure the impact of these types of engagement[27]. It is also difficult to estimate the proportion of government expenditure on public engagement by science organisations. However, a proportion of the $1.4 billion[28] invested by Government in supporting science and innovation in New Zealand was spent by universities and science organisations on making research more accessible to end-users through communication, public outreach and public education activities. Other government investment in these organisations may also be spent on communication, public engagement and education.

Many local government and private sector organisations, such as industry training providers, zoos, museums, science centres, charities and businesses engage with the public about science and technology for education, cultural and marketing reasons. The Government also invests $167 million in public broadcasting services and funding museums[29].

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[22] *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.*

[23] *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.

[24] *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*

[25] *35% of New Zealand adults have a secondary qualification and a further 21% have a tertiary qualification New Zealand Census 2013.*

[26] *THe National Academy Press, On Being a Scientist 2009.*

[27] *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.*

[28] This includes: $967m from Vote Science and Innovation, $335 m from Vote Tertiary Education, $90m from Vote Primary Industries and $18m from other government areas.

[29] *The appropriations in Vote: Culture and Heritage for 2013/14 are $134,417m (for public broadcasting services) and $33.094m (for museum services). The $33.094m (for museum services) funds the Museum of New Zealand Te Papa Tongarewa.*

Since the Science Media Centre was established in 2008, 'science' in the media has increased by 75 percent[30].

As scientific engagement with the public has increased and changed in character, potential ethical issues have emerged and it is timely for the science sector to reconsider standards of scientific conduct.

Use of evidence in policy development

In part as a response to a report by the PMCSA, the State Services Commission recently reviewed government agencies to identify where departmental science advisors could lift internal capabilities to take up research and new knowledge. A network of advisors across government departments chaired by the PMCSA will grow in responsibility as additional science advisors are appointed. These changes are expected to help strengthen the channels of communication with the science sector and progress will be monitored as departmental science advisor positions are filled. The network is to report on progress to the State Services Commissioner in 12 months.

3. Action Areas and Priority Actions

This section sets out three Action Areas designed to deliver on the objective and outcome of the plan. Each action area includes a set of priority actions for the next three years that are divided into innovative actions developed specifically for the plan (described as 'new actions") and work already underway, that will be aligned with the objective of the plan (described as 'supporting actions'). These actions maintain a view on the 10-year horizon, commensurate with the National Science Challenges.

In addition to these Action Areas, at the heart of this plan is an Integrating Action that spans all three AAs: the Participatory Science Platform. This platform (described in section 3.4) is designed to simultaneously:

- Work with the education sector to make it easier to bring "real-world" science into the classroom by connecting teachers with practising scientists
- Enable and foster the public's understanding of and engagement in real-world science through research that is relevant to local communities
- Create opportunities for science professionals to become better engaged with the public by contributing both to science education and to filling knowledge gaps that are locally relevant and scientifically valuable.

3.1 Action Area 1: Enhancing the role of education

The principle goal of 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. This goal will contribute to building creativity, innovation and increased critical science literacy. Action Area 1 will include 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 / kura, families, whānau, iwi and the business and science communities.

[30] *Meltwater Statistics http:/www.sciencemediacentre.co.nz/five-years-of-science-in-the-media.*

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

These activities will explicitly focus on enabling a future-oriented science and technology education system. Integrative thinking for improving science and technology teaching and learning, skills and dispositions for innovation, and changes to pedagogical practice as e-learning and ICT evolves will be central. This will include how the focus of science education should differ at the different levels of schooling.

1. ***Improve initial teacher education with increased science teaching competencies leading to increased confidence***

New action

- **Lifting the science and technology content in initial teacher education**

  We will work with initial teacher education providers, qualification accreditation bodies and relevant professional bodies in considering the nature and scope of science and technology content in initial teacher education. This could form a component of under-graduate qualifications for early childhood and 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).

  Early childhood and primary education is important 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.

Curious minds case study

How can a community lift students' engagement with science?

The Hutt Valley Primary Science Education Network hosted by Hutt City Council and the Open Polytechnic, brings together key stakeholders, including school principals, to address challenges in science education in primary schools.

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

The Government spends more than $80 million every year on PLD to support the development of a highly capable profession, and a PLD system that builds the skills of teachers and education leaders. This investment is intended to deliver measurable gains for students across the curriculum, including science/pūtaiao, technology/hangarau and mathematics/pāngarau.

In 2014 about $5.7 million was appropriated by government to science and technology PLD. This figure does not include the science and technology PLD included in other contracts, and that schools can apply for on the basis of need.

The Minister of Education has appointed an Advisory Group with representatives from across the education sector to provide advice on the design of future PLD across the compulsory schooling sector. The group will provide advice on what improvements

should be made to the targeting of centrally funded PLD to achieve a system-wide lift in student achievement; and provide advice on how changes could be implemented to achieve the maximum impact.

New actions

- **Science Skills in Education Initiative**

  We will establish an initiative to support schools and teachers to build confidence and access resources to develop rich, contextualised science programmes that are exciting for students. It will include assisting teachers to continue their science education, focusing on skills that reflect science/pūtaiao in the national curriculum, and expanding the availability of the Sir Paul Callaghan Academy initiative. This initiative focuses on professional learning and will explore links to the Teachers in Industry Project as appropriate.

Sir Paul Callaghan Science Academy

The Sir Paul Callaghan Science Academy runs intensive professional development programmes that aim to build excellence in the teaching of science. The Academy aims to create primary and intermediate teachers who celebrate science and inspire their students to explore and engage with the world through science.

- **Teachers in Industry Project**

  We will establish a project for teachers to connect schools with science-intensive businesses to enable teachers to spend a period of time in a business to bring business-relevant content into their science lesson plans.

Supporting actions

- Providing teachers of science in years 1 to 10 opportunities to work with research organisations to develop leadership skills and enhance the teaching of science within schools and communities.
- Supporting the Science/Biotechnology Learning Hubs to provide a high-quality online repository of New Zealand science and resources to support science education for teachers, students and communities.

3. *Build and maintain meaningful linkages between science and technology educators and learners, and science professionals and technologists, both in the classroom and through opportunities that engage the wider community*

Partnerships with Tertiary Education Organisations, 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.

New action

- **Develop and implement a Participatory Science Platform**

  This Platform (described below at 3.4) will engage schools / kura, community-based groups and organisations and science professionals 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.

4. Reviewing the position and content of digital technology within the New Zealand Curriculum and Te Marautanga o Aotearoa

New action

- **Review the position and content of digital technology**

  We will work alongside sector partners to review the positioning and content of digital technology within the framework of the New Zealand Curriculum and Te Marautanga o Aotearoa.

3.2 Action Area 2: Public engaging with science and technology

The goal of this Action Area is to build a nationally supportive environment for public engagement in science and technology. In addition, the Action Area is also designed to increase the number of learners with an interest in STEM-related career pathways. This action area recognises the changing demographic of New Zealand including the increasing iwi and hapū asset base and the partnership model of service delivery. It operates with 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 publicly engaged science sector'.

The immediate objective is to 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, support youth into science and technology-based careers and build greater connectivity across sectors. In the longer term, Action Area 2 recognises that the culture change that is necessary to encourage and enable public engagement in science must start with young learners, their teachers, families, whanāu and their communities.

Finally, improved evidence on public attitudes to, and engagement with science and technology, will assist in targeting future actions and form part of the monitoring and evaluation for the plan.

Curious minds case study
How can communities use science?

The community of Uawa/Tolaga Bay are working with the Allan Wilson Centre on a management plan for the Uawa River and surrounding coastline.

1. Support quality initiatives on science and technology for harder-to-reach audiences

New action

- **A contestable fund for science and technology outreach and education initiatives for engaging harder-to-reach groups**

We will establish a contestable fund that will fund education and community outreach initiatives that focus on science and technology for harder to reach groups. This could fund initiatives using innovative approaches for reaching groups such as youth, Māori and Pasifika, and rural New Zealanders. . Internationally, similar funds have supported initiatives including robotic workshops across rural areas for future young engineers, the development of a free Apple/Android app that will help people identify native creatures and a two-day camp for 30 young refugee migrants to inspire them to pursue science at school.

There is a growing international recognition that efforts to engage the public in science and technology find their greatest success with people who already have some level of engagement science. The challenge is to reach and inspire a broader base of New Zealanders through initiatives that bring science and technology to groups that are generally considered harder to reach. This action will support initiatives with a broad reach.

2. ***Support youth into science and technology-based careers***

Actions in this area will develop more responsive educational pathways, including the impacts of student study choices, and to develop entrepreneurial thinking in the science and innovation sector. The relevance of science and technology learning to future career options needs to be made clearer at an earlier stage for learners, and the education and training pathways leading to these potential careers should be clarified.

New action

- **Increasing girls' participation in science and ICT**

  We will identify effective actions to influence girls' subject choices and increase their participation in science and ICT areas of study, especially from year 12, and encourage them to pursue science and technology careers.

- **Increasing participation in science and ICT for all students**

  We will identify the assessment standards on the National Qualifications Framework (levels 2 and 3) that will improve the visibility of STEM capabilities.

Supporting actions for all youth

- Working with Careers NZ to raise awareness of science and technology careers on the Careers NZ website
- Working to develop and promote the uptake of information for learners about science careers
- Supporting talented school students through young achievers and travel awards
- Exploring more strategic targeting of the FutureinTech programme, and other potential changes to increase its impact
- Exploring more equitable ways to fund students to attend Learning Experiences Outside the Classroom
- Reviewing and evaluating the pilot of the Science Education Leadership and Coordination role for merit to expand

- Using the Vocational Pathways to design programmes that use real world contexts to deliver science and technology education in ways that engage learners' needs and interests
- Considering how to strengthen science literacy in senior secondary schooling particularly at Year 11
- Considering the future of the STEM feature in the Occupational Outlook publication.

3. ***Support parents and whānau to increase their engagement with science***

New action

- **Develop a Participatory Science Platform**

  The platform (described below at 3.4). will offer Early Childhood Education Services, schools / kura and their communities opportunities to participate in scientific research in projects with broad appeal, scientific value and pedagogical rigour that resonate with the community.

  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 science professionals with schools and other community organisations on real-world questions.

Curious minds case study

How do you excite tamariki about science?

A Rotorua iwi trust have established a science and technology wananga based on matauranga Maori for ages 7-15.

4. ***Build and maintain meaningful linkages between businesses, science and technology educators and learners, and science professionals and technologists***

New action

- **Connecting business, local government, educators with the science sector**

  We will explore opportunities to connect businesses with learners, educators, local government and the wider science sector.

  Improving connections between science and technology-led businesses and learners at a regional, industry or sector level will give more learners real world understanding of potential STEM career pathways. It will enable more science and technology-led businesses to promote STEM careers and build early connections with future employees.

5. ***Support quality science journalism and coverage 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.

Supporting action

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

6. ***Build greater connectivity between the science and education sectors and museums, zoos and science centres***

Supporting action

- We will work with organisations such as museums, zoos and science centres to build greater connectivity with the science and education sectors and agree their role in delivering on the plan.

  Non-traditional learning environments, such as those provided by museums, zoos and science centres, can play an important part in encouraging STEM competencies and innovations. Reaching millions of New Zealanders each year, museums and other science organisations facilitate engagement and lifelong learning, and are ideally placed as community spaces or forums.

7. ***Build the evidence base on public attitudes to, and engagement with, science and technology.***

Supporting action

- We will regularly survey public attitudes to, and engagement with, science and technology.

3.3 Action Area 3: Science sector engaging with the public

Action Area 3 complements Action Area 2 because there cannot be a scientifically engaged public without a publicly engaged science sector. This 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 science organisations and scientists have a social responsibility to share some level of knowledge where it's applicable. As New Zealanders, we look to science for useful new technologies and evidence-based guidance on the most pressing issues facing our society today.

1. ***Support scientists to contribute meaningfully to schools and communities, while advancing their scientific output, by enabling their involvement in participatory research***

New action

- **Develop and implement a Participatory Science Platform**

  The platform (described below at 3.4) will match scientists with members of schools or community organisations seeking to take part in community-initiated or scientist-initiated research.

2. ***Support scientists and science organisations to continue to employ leading edge practices and standards to engage the relevant public in identifying priority research questions and usefully disseminating results for publicly funded research.***

New actions

- **Engaging the public in implementing the National Science Challenges**

  As the National Science Challenges are implemented, we will consider an approach and opportunities to engage the public in their implementation. This project builds on the success of the public engagement process used to identify the National Science Challenges.

- **The Royal Society of New Zealand will lead the development of a Code of Practice on public engagement for scientists**

  The Royal Society of New Zealand will work with the scientific community and consult widely including with universities, CRIs, 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[31].

Supporting actions

- Public research funding bodies will review and update the knowledge translation expectations for research contracts, and assess the current state of publicly-relevant knowledge transfer and end-user engagement practice among funding recipients, including with Iwi and Māori organisations. Results of this exercise can be used to inform future expectations
- We will continue to implement recommendations of the PMCSA on the use of science-based evidence in policy formation by creating opportunities, through new Departmental Science Advisors, for the science sector to engage with government and share relevant results with policy makers.

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

New action

- **Public engagement training for science and technology researchers**

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

Supporting action

- We will continue to ensure that scientists' excellence is acknowledged and showcased through the Prime Minister's Science Awards.

4. Increase the profile of the work of researchers who are Māori in science/ pūtaiao and of all researchers engaged in mātauranga Māori.

New action

- **Increasing the profile of researchers in science/pūtaiao and mātauranga Māori**

[31] 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.

We will work with researchers who are Māori, iwi and Māori organisations about their mātauranga Māori and science/ pūtaiao knowledge to increase their profile.

3.4 Integrating Action: The participatory science platform

1. Develop and implement a Participatory Science Platform

While Action Areas 1, 2 and 3 target specific sectoral goals, they are nonetheless interconnected. A unique feature at the heart of this strategic plan is an integrating activity that simultaneously addresses important objectives in all three Action Areas.

The Participatory Science platform builds on traditional concepts in citizen science and enhances these through collaborative approaches more common to community-based participatory research. Participatory Science is a method of undertaking scientific research where volunteers can be meaningfully involved in research in collaboration with science professionals (including post-graduate students or researchers and private sector scientists) and builds on international models of engagement.

The goal is to involve schools / kura and/or community-based organisations such as museums and associations in projects with broad appeal, having both scientific value, pedagogical rigour, and that resonate with the community. In addition, several ideas are being tested for projects of national significance that would integrate with the National Science Challenges and be national in reach.

The Participatory Science Platform has the potential to:

- offer inspiring and relevant learning opportunities for students and teachers
- engage learners and participants beyond the school / kura community to reach parents, whanau and wider communities
  We will offer researchers opportunities to become involved in locally relevant lines of enquiry, where data can be enriched by the local knowledge and contribution of citizens.

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

1. A process that seeks ideas for participatory science projects from both the community (including Early Childhood Education Service and kōhanga, schools / kura, museums and other organisations, iwi authorities or community associations) and from science professionals (from post-graduate students to principal investigators in both the public and private sectors);
2. A managed process for evaluating these ideas for both pedagogical potential (in the case of schools / kura) and scientific quality, and for ensuring their practicality and relevance to the participating partners (science sector and community-based);
3. A web-based match-making process between interested community-based partners and science professionals; and
4. A resource for teachers and other community or learning leaders to assist in developing their projects to robust standards.

The Platform's website will serve as a match-making tool between scientists and potential community-based partners 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 will have an institutional home which will provide a coordination role. This could be a school, museum, zoo, science centre, iwi office or research institute, university or other tertiary organisation.

The projects will be offered as opportunities for community based partners to participate in scientific research as a way to enhance their local input, their science knowledge and their interest, and (in the case of schools) to strengthen learning programmes through stronger links to relevant learning environments and expertise.

Once matches are made between community based partners and scientists, these partners would self-direct their involvement in carrying out the research according to an agreed plan and approach.

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.

To enable more sophisticated projects, a limited number of seed grants will be made available to help foster a meaningful level of community involvement. The seed-grants will part-fund science professionals and community/school groups to plan together the research question, data collection, analysis and knowledge translation strategy for the project. In addition, eligible costs could include research tools or consumables that would not otherwise be accessible to community partners.

Curious minds case study

What if we could fish more sustainably?

Three fishing companies—Aotearoa Fisheries, Sealords and Sanford—worked with Plant and Food Research to develop a net that minimises trawling's impact on non-target species.

3.5 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 Authority review of qualifications – Mandatory reviews of levels 1-6 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, including in areas of new and emerging shortage such as science and technology; and Priority 5, strengthening research-based institutions. The TES emphasises the importance of tertiary institutions being more outwardly focussed and in particular, connecting learning to employment outcomes and encouraging providers to be more connected to industries and communities.
- The State Service's Commission's efforts to include action for better use of evidence in public policy formation. This is being operationalised through the creation of a number of Departmental Science Advisor (DSA) roles and the creation of a network of these

advisors chaired by the PMCSA. This plan recognises the role of scientists to better connect with the public service through the DSA network and other opportunities to bring evidence into policy formation.

- The Office of the PMCSA was established, in part, to address the role of science in society. Positioned at the nexus of the science sector, government, and the public, a central focus of the Office is to help establish better communication of concepts in science and research to the public and to government. This plan recognises the uniqueness of the PMCSA model internationally and can leverage the channel of public communication that the Office provides.

- MBIE's Vision Mātauranga policy aims to unlock the science and innovation potential of Māori knowledge, people and resources for the benefit of New Zealand. The four themes of the Vision Mātauranga policy are:
    - Indigenous innovation: contributing to economic growth through distinctive science and innovation
    - Taiao/environment: achieving environmental sustainability through iwi and hapū relationships with land and sea
    - Hauora/health: improving health and social wellbeing
    - Mātauranga: exploring indigenous knowledge and science and innovation.

For this reason the Vision Mātauranga policy is embedded across all science investments, and as such forms a core component for the implementation of MBIE's approach to supporting outcomes for Māori and New Zealand.

Curious minds case study

What if we could earn extra from our pine forests?

A central North Island incorporation is working with CRI Scion to cultivate ginseng as an under-crop in pine plantations.

4. Implementing and monitoring the plan

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, modify as we go and continue engaging with stakeholders.

4.1 Implementation approach

As this is the first Science in Society plan, the government has asked the Science in Society Reference Group to reconvene in 2015 to review progress and advise about any modifications to the actions to better deliver on the outcomes. MBIE and MoE together with the PMCSA will oversee implementation of the plan by government agencies, iwi and other sectors including the education, science, business and museum sectors. The two agencies will also lead a process of engagement with the public on the plan and the actions in it.

Central to the terms of reference of the PMCSA is to support an improved and productive relationship between science and society. As such, the PMCSA and the DSA network will continue to be active in implementation of the plan.

4.2 Timeframe

While the challenges are long term, the plan sets out a direction for the next ten years and actions for the next three years from 2014 to 2017. The actions may be modified and enhanced as we learn more over the life of the plan.

Some actions are already underway as they continue or enhance effective existing actions. Enhancing the role of the Science Media Centre and MoE'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 initiatives focused on science outreach and engaging harder-to-reach groups will 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 (over school years 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 sector. These actions will help inspire and provide authentic learning opportunities of relevance and interest to students.

4.3 Monitoring and evaluation

Monitoring will comprise:

- A survey of public attitudes toward science, complemented by in-depth qualitative research with the general public
- Analysis and synthesis of education and skills data, for example student achievement in science and maths
- Analysis and synthesis of administrative data, for example monitoring of relevant contracts and science communications measures and indicators
- Formal and informal stakeholder consultation.

MBIE has developed an intervention logic to inform the monitoring activities (Annex 1). The intervention logic details the links between the challenges that Science in Society seeks to address, the activities being undertaken within the action areas and their intended impacts and outcomes. These impacts and outcomes include short-term changes in awareness, medium-term changes in behaviour, and long-term changes in terms of a skilled workforce, informed New Zealanders and responsive science and technology sectors. The intervention logic model will inform the selection of indicators and measures for monitoring purposes.

Work to date has included MBIE commissioning (in June 2014) a survey of public attitudes towards science and technology and the ways in which the public conceptualises science. This survey retains some questions asked in previous studies for comparability, and thus will identify changes in public attitudes from those previous studies. Responses to questions in the survey will form part of the baseline measures for monitoring the initial plan.

The Ministry of Education is able to utilise existing data collection and analysis to monitor the impact of the plan. The Ministry regularly publishes data about student achievement in science and mathematics through Public Achievement Information (PAI) which is available on www.educationcounts.govt.nz.

The performance framework for the National Science Challenges will include some assessment of public engagement in science.

Monitoring and evaluation will establish a baseline and track progress against the initial plan's outcomes. It will also assess the performance of specific action areas. In response, initiatives that are making a measurable contribution to the expected outcomes will be continually adapted and extended.

The monitoring and evaluation activities for this plan are founded on the plan's three expected outcomes as follows.

Outcome 1: more science and technology competent learners and more 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 2: a more scientifically and technologically engaged public and a more publicly engaged science sector

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

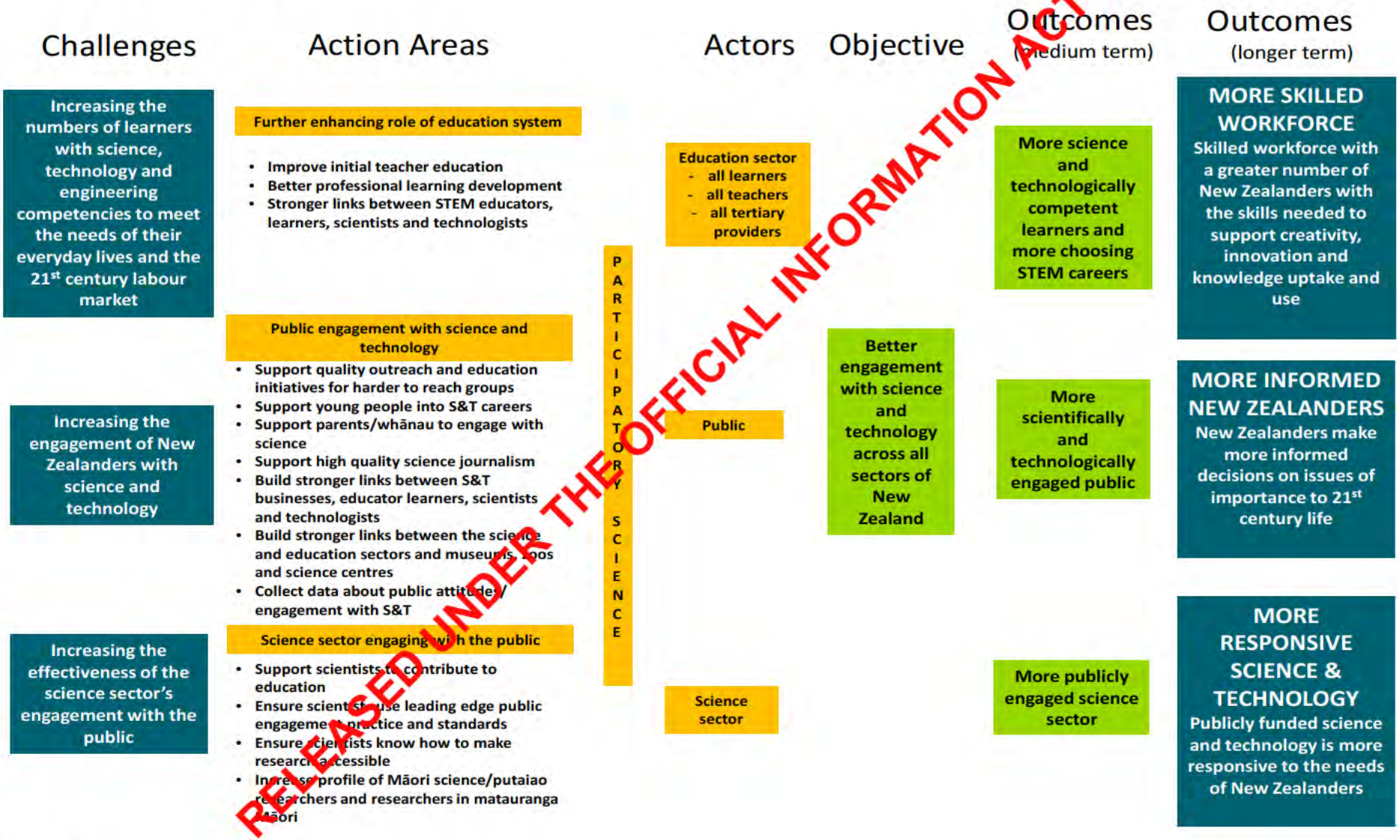
- a greater proportion of New Zealanders across all sectors of society are engaged with, and value, science and technology
- there is more in-depth media reporting on science and technology based on robust scientific evidence
- there are increased opportunities for the public to learn about, and be involved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

Outcome 3: a more skilled workforce, more informed New Zealanders and more responsive science and technology

In the longer term, we expect that progress towards outcomes 1 and 2 will contribute to New Zealand's economic growth and improved social and environmental outcomes through:

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

Annex 1: Intervention logic



Annex 2: Process for developing this plan

This plan was developed by the MBIE, MoE and the office of PMCSA 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 PMCSA. 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 MBIE. 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. 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 and 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 was formerly 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 is Managing Partner of connections and communications agency, The Family. Lee attended the

	Transit of Venus forum and was consulted in the development of the 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 the 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 (IPENZ). 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 membership of the Science in Society Reference Group will be reviewed before it is reconvened in 2015.

We would like to thank the following stakeholders for their contribution to the plan through providing feedback on an earlier draft or drafts of the plan: the Reference Group, the National Science Challenges Panel, Business New Zealand; the Chief Executive of Science New Zealand; the New Zealand Association of Scientists; municipal museums; the Royal Society of New Zealand; the Chambers of Commerce; Callaghan Innovation; the Secondary School Principals Association; New Zealand Principals Federation; the Post-Primary Teachers Association; the New Zealand Education Institute; the leadership of Universities, Polytechnics and Wānanga; the Tertiary Education Union; the New Zealand Union of Students Association; the National Science-Technology Roadshow Trust; and stakeholders from the Society of Māori Astronomy and Research Traditions and Ngā Pae o te Māramatanga.

Annex 3: Key definitions

What do we mean by 'science', technology and STEM?

Science is a set of formal processes that interrogates the "real things" or phenomena of the natural and social world in order to construct explanations of them.[32] It describes a way of thinking about the world, a creative process which generates knowledge and the ability to think critically about that knowledge. *The New Zealand Curriculum* describes ***science*** as "*a way of investigating, understanding and explaining our natural, physical world and the wider universe*."[33] 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.

Science knowledge means both knowledge of the processes, methods, and facts of science on one hand, and knowledge about science's applications and limitations on the other. Certain audiences will specialise in knowledge 'of' science, but basic knowledge 'about' science is broader and is an important tool of 21st century citizenship and public discussion on today's most pressing societal concerns. This has been referred to as 'critical science literacy'[34]. We also acknowledge that 'knowledge' may also mean the science sector's own knowledge of various public audiences and how to connect with these to make their science relevant.

Technology intervenes in the world to solve problems or meet needs or desires; that is, to create part of the made world[35]. *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*".[36]

STEM is the internationally recognised term that refers to subjects or areas of learning, namely science, technology, engineering and mathematics, which are used broadly and are inclusive of all levels of learning. Often, the acronym is used as shorthand to denote the family of numerate subjects, even when one or more are not considered. In the plan, we distinguish deliberately between **STEM** and **STM**, which refers to compulsory level subjects (science, technology and mathematics) because engineering is taught only at tertiary level. **STE** refers to science, technology and engineering subjects.

What do we mean by 'engagement'?

Engagement' can and should be a range of things for different people and different times, and is dependent upon purpose.

The goal of 'engagement' in the plan is to recognise and enable the role that we all have in understanding, becoming informed and questioning what we need science to address and what we do with the new knowledge that science produces.

In some instances, this is through the opportunity to learn in a more hands-on and relevant way that can help shape our attitudes and decisions. In other situations, it is a participatory tool for a more open approach to research and for making decisions about how to use the information it

[32] France and Compton *Bringing Communities Together*.
[33] The New Zealand Curriculum, p28.
[34] Susanna Priest, *Critical Science Literacy: What Citizens and Journalists Need to Know to Make Sense of Science*, Bulletin of Science Technology & Society 2013 33: 138
[35] See footnote 33.
[36] The New Zealand Curriculum, p32.

produces. This is one way that a stronger relationship between science and society can be developed.

For the public (including government) 'engagement' means the acquisition and application of multiple types of STEM-knowledge by multiple kinds of audiences for various purposes.

For the science sector it involves communicating new knowledge clearly for different users, as well as undertaking research and responding to the knowledge needs of society.

Taken together these characteristics of 'engagement' imply an improved and productive social relationship between the science sector and wider society that will lead to the responsible application of knowledge for the social, environmental and economic wellbeing of New Zealanders.

Thus, in the plan, the focus is on public engagement in:

- *acquiring knowledge*, which is about the public, including and especially compulsory level learners acquiring the STE skills and knowledge needed to develop a career in science and/or to engage in much needed and ongoing public conversations about the application of scientific knowledge and technology.

- *generating knowledge*, which 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 opportunities in Participatory Science.

- *applying knowledge*, is about being enabled to make the best use of what we know, including the responsible and evolving use of or limiting of new technologies or novel applications of existing technology.

This definition of engagement reflects a fresh approach through a necessary mix of what has in the past been called 'public understanding of science' or 'science literacy' and of 'public engagement in science'[37].

Annex 4: Description of initiatives

KEY: Existing action continuing | Changed existing action | New project

Action Area	Goal	Action	Status	Lead agency	Other agencies	Comment
Education Sector	Improve initial teacher education with increased science and technology teaching competencies and confidence	Work with initial teacher education providers, qualification accreditation bodies and relevant professional bodies to consider the nature and scope of science and technology content in initial teacher education		MoE		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 and technology (teachers currently report limited confidence, particularly at years 7-8).
	Improve the quality and relevance of continuing professional learning and development opportunities for teachers in science and technology	MoE 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		MoE		
		Provide primary and secondary school teachers with opportunities to work with research organisations and develop leadership skills to enhance the teaching of science within school communities		MBIE		In 2014/15, reframe the teacher fellowship programme to further imbed the leadership responsibilities within the school community, enhance leadership competencies and align with Ministry of Education initiatives.
		Support the Science/Biotechnology Learning Hubs to provide an online repository of New Zealand science for use by teachers, students and communities		MBIE		In 2014/15, support the Science/Biotechnology Learning Hubs as a high-quality online repository of New Zealand science and resources to support science education.
		Create a Science Skills in Education Initiative to support schools and teachers to build confidence and access resources to develop rich, contextualised science programmes that are exciting for students		MoE		The initiative will be developed with education and industry stakeholders to create a network between local industry, local and national government and schools to assist teachers to continue their science education with providers who have a proven record of excellence in science teaching. Examples include access to courses for primary teachers with a focus on developing science skills and knowledge that reflect science/pūtaiao in the national curriculum, and expanding the availability of the Sir Paul Callaghan Academy initiative. This initiative focuses on teacher learning, and will explore links to the Science in Industry Programme as appropriate.
		Create a Teachers in Industry Project for teachers, to connect schools with science intensive businesses to enable teachers to spend a period of time in the businesses to bring business relevant content into their science lesson plans		MoE		This initiative focuses on building the currency of programmes, and will explore links to the Science Skills in Education initiative as appropriate. 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.
	Develop science and technology curriculum materials and support teachers to use them	The New Zealand Curriculum (NZC) and Te Marautanga o Aotearoa address STM skills development and building a scientifically and technologically engaged population more generally Te Whāriki – Strand 5: Exploration Children experience an environment where they develop working theories for making sense of the natural, social, physical and material worlds		MoE		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.
		The Matakōkiri Project supports students to engage with science by linking science/pūtaiao to Māori language, culture and identity through students' local tikanga, whakapapa and stories [MoE – do we retain this?]		Te Taumata o Ngāti Whakaue Iko Ake Trust		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.
		Establish Learning and Change Networks with a dedicated focus on student achievement in science		MoE		These 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.
		A range of online and print publications to support quality teaching, learning and assessment		MoE		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.
	Review the positioning and content of digital technology within the framework of the New Zealand Curriculum and Te Marautanga o Aotearoa	The Ministry of Education will work alongside sector partners to review the positioning and content of digital technology within the framework of the New Zealand Curriculum and Te Marautanga o Aotearoa		MOE		It is intended this will result in additional guidance and support materials exemplifying ICT provision across primary and secondary years and will complement the National Certificate of Educational Achievement (NCEA) review and maintenance programme.
Public engaging with the science sector	Support quality science journalism and coverage in the multi-platform media	The Science Media Centre – a centre that provides an interface for the media with the science and technology sectors and educates scientists on engaging with the media to improve the quality and professionalism of science and technology reporting		MBIE		In 2014/15, enhance the role and reach of the Science Media Centre to support more training and outreach to science journalists to encourage respons ble and insightful science news reporting and long-form analysis that is relevant to the New Zealand public.
	Support quality targeted initiatives on science and technology	Establish a contestable fund for targeted initiatives focused on science outreach and on engaging harder-to-reach groups		MBIE		To be designed and piloted in 2014/15 and, subject to the results of the pilot, implemented in 2015/16.

	Support youth into science and technology-based careers	The STEM feature in the 2014 Occupation Outlook identified the current and future demand for STEM-related careers		MBIE		To consider its future in 2014/15.
		Youth Transitions Framework that focuses on more young people participating in learning areas of high growth and demand (eg STEM subjects)		TEC		
		Identification of STEM-related credits within the Vocational Pathways that support students to progress to higher level STEM-related education and training		MoE, TEC		
		Māori Future Makers website which profiles Māori and whānau in non-traditional, knowledge intensive sectors		TPK		
		Work with Careers NZ to explore and develop ways to raise awareness of science and technology careers on the Careers NZ website		Careers NZ		
		Supporting Young Achievers Awards		MBIE		Awards to continue.
		Talented School Students Travel Awards		MBIE		In 2014/15, extend the programme to intermediate students and provide additional flexibility to reach more low decile students.
		Continue work to develop and promote the uptake of information provision for learners about science careers		MoE		
		Use Vocational Pathways to support schools and tertiary providers to contextualise STEM-related learning in ways that are relevant to further study and career options		MoE		
		Explore equitable funding models to enable schools / kura to meet the costs of students attending Learning Experiences Outside The Classroom		MOE		
		Identify the assessment standards on the National Qualifications Framework (levels 2 and 3) that will improve the vis bility of STEM capabilities within assessment standards		MoE		
		School, science sector partnerships that support school students' science learning. 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		MoE		A pilot will run through to July 2014 to build school, science sector 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.
		Consider how to strengthen science literacy in senior secondary schooling particularly at year 11		MoE		
		Promoting STEM careers to students through the FutureinTech programme		Callaghan Innovation		In 2014/15 explore more strategic targeting of the programme, and other potential changes to increase

						its impact
		Consider how to increase girls' participation in science and ICT		MBIE and MoE		
	Build and maintain meaningful links between science and technology-led businesses, educators and learners and science professionals and technologists	Explore opportunities to better connect business, local government, educators, learners and the science sector at a regional, industry or sector level		MBIE		To be considered in 2014/15 and, subject to the results, implemented in 2015/16.
	Build greater connectivity between the science and education sectors and museums, zoos and science centres	Work with organisations such as museums, zoos and science centres and the science and education sectors to build greater connectivity and agree the role of museums, science centres and zoos in delivering on the plan		MBIE, MCH		To begin in 2014/15.
	Build the evidence base on public attitudes to, and engagement with, science and technology	Regularly survey public attitudes to, and engagement with, science and technology		MBIE		Survey to be carried out in 2014 and a regular programme agreed.
Science sector engaging with the public	Ensure publicly funded scientists employ leading edge knowledge and international best practices to engage relevant public(s) in identifying priority research questions and usefully disseminating results	Government expectations on researchers receiving public funds to make research public and provide public engagement and outreach		MBIE, TEC		From 2015/16 to review and update the knowledge translation expectations for research contracts, and assess the current state of publicly-relevant knowledge transfer practice among funding recipients. Results will be considered to inform future expectations.
		The Crown Research Institute's (CRIs) Statement of Core Purpose in the Crown Research Institutes Act 1992 includes expectations on engagement with key stakeholders and to transfer technology and knowledge to key stakeholders		MBIE, CRIs		No changes proposed.
		Request for proposals for the first ten National Science Challenges sets a key objective for engagement by the science sector with the public		MBIE		In 2014/15 build on the success of the public engagement process used to identify the National Science Challenges by considering an approach and opportunities to engage the public in the implementation phase of the National Science Challenges.
		Work with the scientific community to develop a Code of Practice for Scientists on public engagement that enshrines their public responsibilities		RSNZ		To begin in 2014/15.
	Ensure emerging scientists and technology researchers have the basic communication skills to make their research accessible to relevant audiences beyond their peer group	Work with the tertiary sector to identify ways to ensure that all emerging and established science and technology researchers have access to training that supports engagement and the dissemination of their knowledge to non-academic audiences		MBIE, MoE, TEC		To begin in 2014/15.
		The Prime Minister's Science Prizes and the Rutherford Medal – prizes for scientific research or technological practice that raise		MBIE		Prizes to continue.

		the profile and prestige of science				
	Increase the profile of the work of Māori researchers in science/pūtaiao and of all researchers engaged in mātauranga Māori	Increase the profile of the work of researchers who are Māori in science/ pūtaiao and of all researchers engaged in mātauranga Māori by engaging with researchers who are Māori, iwi and Māori organisations about their mātauranga Māori and science knowledge and science projects to increase their profile		MBIE, PMCSA		To begin in 2014/15.
Across all action areas		Develop and implement a Participatory Science Platform		MBIE, MoE		To be designed and piloted in 2014/15 and, subject to the results of the pilot, implemented in 2015/16.

A Nation of Curious Minds
He Whenua Hihiri i te Mahara

- **A national strategic plan for science in society**

Contents

Ministers' foreword

New Zealand has always been proud of its "do-it" attitude. From the very first humans to land here, generations of us have seen a problem and come up with an ingenious way to deal with it – from how to grow warm temperature kumara in a much colder climate to a novel piece of farm equipment put together in the barn. We can thank curious Kiwi minds for these examples of science and innovation, and the need for them is set to increase in the years ahead.

All New Zealanders should feel encouraged and equipped to deal with the challenges and opportunities presented by science and technology, and capable of participating in the debates involving science. We also need an environment that helps New Zealanders to use our natural curiosity to interrogate, decide on and make the most of new developments and technologies.

New Zealand is a small, geographically isolated and well educated country. To overcome the disadvantages of modest size, we must maximise opportunities to harness our curiosity and cultivate our ability to be competitive and improve social and environmental outcomes. Our workforce must be skilled in science and technology to develop new high value products, meet the demands of business, and mitigate and adapt to the challenges of a quickly changing world.

This Science in Society strategic plan is one of a number of Government initiatives that recognises the importance of science to New Zealand's future. The project emerged from the National Science Challenges and sits alongside other initiatives such as the establishment of the Office of the Prime Minister's Chief Science Advisor, the formation of Callaghan Innovation, and the recently-released draft National Statement of Science Investment.

Developing stronger connections between science and society is a long-term project.

This plan puts special emphasis on our young people and science education. Science literacy is fundamentally important to the future of young New Zealanders. It gives our students a platform to meet challenges and compete here at home and internationally. This plan accepts the challenge of building innovation, creativity and increased science literacy across the education sector. Lifting engagement and achievement in science education is absolutely vital. The education profession must prepare all New Zealanders to be participants, and leaders, in a 21st century economy, and society.

Business, community, iwi, and whānau engagement in science and technology education is critical to the success of our learners. The plan engages schools/kura, the community and scientists in partnerships that acknowledge the place of science/pūtaiao and technology/ hangarau within and beyond the New Zealand Curriculum and Te Marautanga o Aotearoa.

The plan also identifies ways to increase engagement between the science sector and New Zealanders as publicly funded science is for the benefit of us all.

Government has a key role to play in facilitating better engagement in science across all sectors. This plan draws together the key issues around growing engagement in science in New Zealand, summarises available evidence and outlines a number of innovative actions to be developed, and presents them as the start of a conversation about the role of science in this country.

Developing a more publicly engaged science sector and a more scientifically engaged public is a collaborative and long term process. It will require action from a wide range of stakeholders

including government, research organisations, schools, non-government organisations, families/whānau, communities and businesses. We believe the ideas in this plan will get us a considerable way down that track. We also know that New Zealand is a nation of curious and creative people with great ideas. As the new actions in the plan are tested, reviewed and adjusted, we encourage you to get involved while also thinking about what could be done better. Your feedback will be most welcome when progress on the initial plan is reviewed in 2015.

Steven Joyce
Minister of Science and Innovation

Hekia Parata
Minister of Education

Executive summary

Science and the knowledge and innovation that flow from scientific progress have a critical role in creating and defining our future.

Many of today's most complex decisions (e.g. on public health, natural resources stewardship and communications technology) require us all to weigh scientific evidence and our values. This will be even more so in future years as the world becomes increasingly connected and technology and knowledge advance. As New Zealanders we should all feel encouraged and equipped to engage in the key questions facing our society now and in the future. Improving New Zealand's economic, social and environmental outcomes through growing an innovative society drives the need for an increasingly science, technology, engineering and mathematics (STEM) competent workforce.

This plan responds to the science and society challenge for government considered by the National Science Challenges Panel to be central to the success of all the Challenges.

The Government's objective in addressing this challenge is to 'encourage and enable better engagement with science and technology across all sectors of New Zealand' society in order to deliver the outcomes of:

- more science and technology competent learners, and more choosing STEM-related career pathways
- a more scientifically and technologically engaged public and a more publicly engaged science sector
- a more skilled workforce~~, more informed New Zealanders~~ and more responsive science and technology.

These are long-standing challenges that will take time to address. While some actions are underway to encourage and enable better engagement with science and technology, more are needed if we are to make the objective and outcomes of this plan a reality. This plan sets out a strategic direction for the next 10 years and actions for the next three years.

This plan focuses on three Action Areas and one Integrating Action, each of which incorporates specific actions:

- ***Action Area one*** enhancing the role of education
  - Improve initial teacher education through increased science and technology teaching competencies, leading to increased confidence
  - Better in-service professional learning and development for science and technology teachers
  - Building stronger links between science and technology educators, learners, technologists and scientists, in the classroom and in the community
- ***Action Area two:*** public engaging with science and technology
  - Establishing a contestable fund for education and outreach initiatives on science and technology for harder to reach sectors of the community
  - Supporting young people into careers in science and technology
  - Supporting parents and whānau to engage with science
  - Supporting high quality science journalism and media coverage

- Building stronger links between businesses, educators and learners, and between scientists and technologists to better connect business with science and interest more young people in studying science
- Build stronger links between the science and education sectors and science centres, museums and zoos
- Monitor data about public attitudes to and engagement with science and technology

- ***Action Area three:*** science sector engaging with the public
  - Support scientists to contribute to broader science education while advancing their work
  - Support scientists and science organisations to continue to use leading edge practices and standards to engage the public in identifying research questions and sharing the results
  - Ensure that scientists know how to make their research accessible to wider audiences
  - Increase the profile of Māori science/ pūtaiao researchers and of researchers engaged in mātauranga Māori
- ***Integrating Action:*** participatory science platform:
  - Integrating all three Action Areas through a platform to engage students, communities and scientists in participatory science.

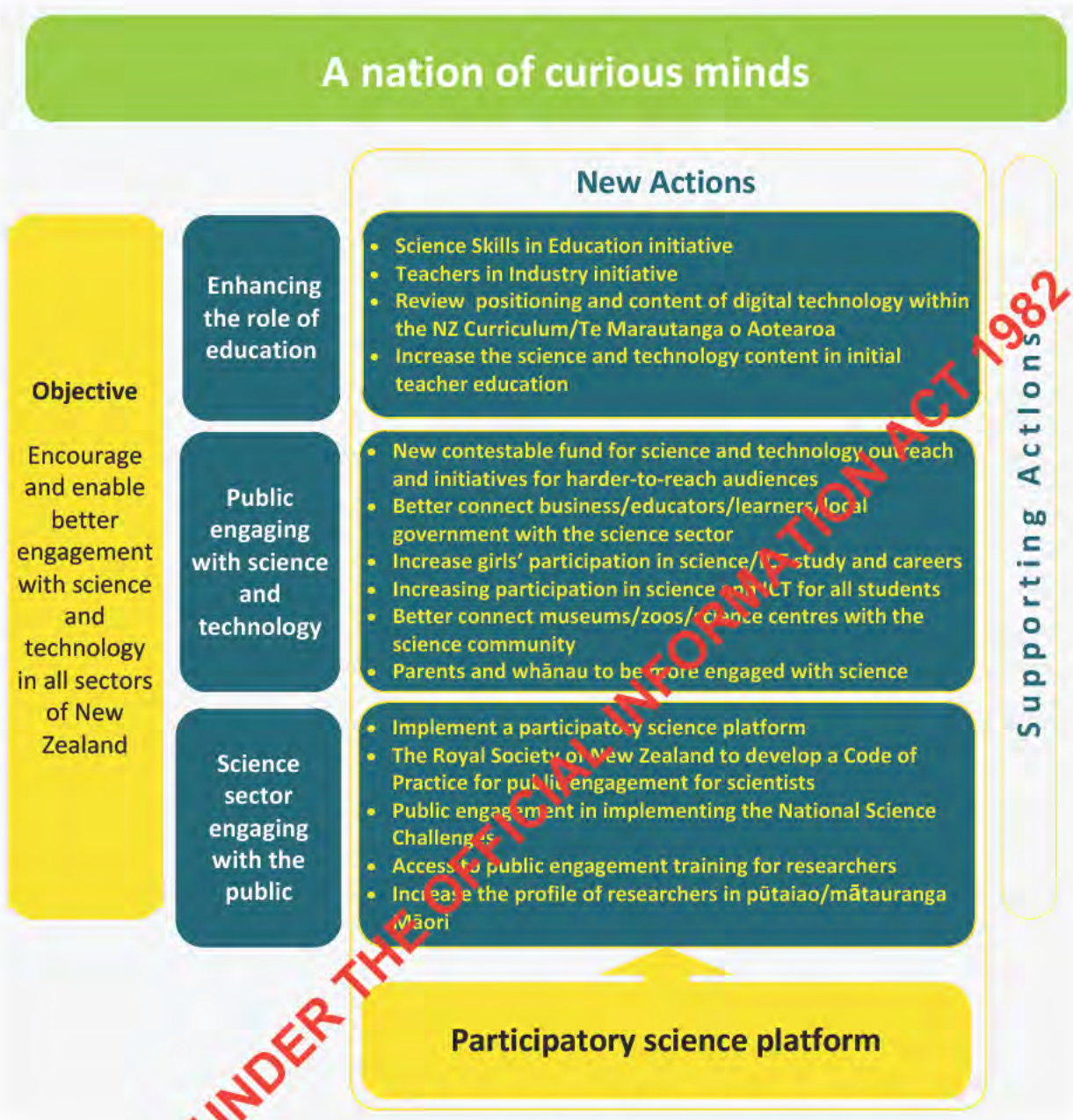
This plan recognises and acknowledges the importance of mātauranga Māori to build cultural confidence and identity, and how, through this, New Zealand can grow its skills and generate innovation and creativity. Mātauranga Māori is Māori knowledge that is dynamic, building from earliest traditions to future knowledge. Each of the three Action Areas and the Integrating Action will be developed in ways that respect whānau, hapū and iwi as the key conduits of mātauranga Māori, and focus on realising the potential gain for New Zealand through building capability in science and technology to support Māori economic development and management of natural resources.

The Ministry of Business, Innovation and Employment and the Ministry of Education, together with the Office of the Prime Minister's Chief Science Advisor (PMCSA), will oversee implementation of the plan by government agencies, iwi and other sectors including the education, science, business and museum sectors.

This Initial Science in Society strategic plan will be subject to ongoing monitoring and evaluation. It will respond to changing needs and contexts by adapting and extending initiatives that are making a measurable contribution to the expected outcomes.

The Science in Society Reference Group will reconvene in 2015 to consider progress in delivering on the objective and outcomes and to incorporate wider stakeholder views into its ongoing development and implementation.

The following diagram summarises the initial plan's approach in responding to the challenges of better engagement with science and technology.



1. Setting the Scene

Science and technology are critical for enhancing living standards through economic growth and improving social and environmental outcomes. Today, science is embedded in the many decisions policy makers, business, individuals and societies must make. Societies with strong "science capital[1]" sustain more innovative economies and have a greater awareness of both the opportunities and limits of science in development and wellbeing. Science is central to the many global challenges we face (from environmental challenges to an aging and increasingly urban population, for instance).

Following significant public engagement led by Government 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' as central to the success of the National Science Challenges and the most important challenge if New Zealand is to responsibly apply science and innovation and benefit optimally from its investment in scientific research.

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. Annex 1 sets out the process for developing this plan.

The plan sets out the objective and outcomes the Government wishes to achieve to strengthen the place of science in society over the next 10 years. It sets out the available evidence on where New Zealand is now. It concludes by setting out a three-year plan of action to make progress towards the objective and outcomes.

The plan does not cover the supply of mathematics skills and demand for STEM skills as these are being addressed through the Business Growth Agenda and the literacy and numeracy taskforce.

The plan is addressed to all New Zealanders. To be effective, it is important to be specific about target audiences where actions can make the most difference. In particular, the plan recognises that there are certain stakeholders in our social relationship with science who are important 'agents of change.' These are:

- Students, teachers and the compulsory learning sector
- Parents, whānau and communities
- Science sector including technology
- Business, especially science and technology-led businesses
- The public sector and government
- Communicators of science and technology, including traditional and online media, museums, zoos, science centres and industry organisations

[1] Science capital refers to science-related qualifications, understanding, knowledge (about science and 'how it works'), interest and social contacts (e.g. knowing someone who works in a science-related job). This definition is from *Aspires Young people's science and career aspirations, age 10-14,* Department of Education and Professional Studies and King's College London: 13

The plan presents a coherent approach to addressing the challenge of strengthening the role of science in our society. The actions in the plan support wide engagement to deliver on the plan's objective and outcomes.

Curious minds case study
How could surgery be improved?

In her job as clinical leader of orthopaedics at New Plymouth's Southern Cross hospital, nurse Lorraine Parthemore felt the hopsital's method of traction for patients undergoing surgery to correct a damaged disc in the neck left a lot to be desired. It was cumbersome and obstructive, adding to the time needed to undertake the operation. "I thought there had to be a more streamlined way to set it up," she says, but couldn't find anything better on the market. With encouragement from colleagues, she designed a pulley device with a counterweight that could be attached directly to the operating table to keep the neck in traction. A prototype was produced and cleared for use. "It really shortened the time needed for the procedure," Lorraine says. The Parthemore Pulley has subsequently gone in to production with Nelson medical equipment manufacturer Opritech, and Taranaki Base Hospital bought the first one off the assembly line. It is now being marketed elsewhere in New Zealand. Lorraine puts her inventive streak down to her childhood growing up on a Taranaki farm. "In the 60s everybody was frugal and we made do with what we had, adapting things to suit – like making calf covers out of sacking and baling twine."

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. These encompass environmental, societal, health and economic goals. 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[2]. New Zealanders should feel encouraged and equipped to engage in the key questions facing our society now and in the future.

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

The production and application of scientific knowledge and new technologies often imply trade-offs that we need to weigh carefully such as how to prioritise research investment and the potential for unintended consequences. Addressing these trade-offs requires 'social licence' because these are complex issues which no single group, such as scientists, government or businesses, should make on behalf of New Zealanders without their input. 'Social licence' exists where there is an environment of mutual understanding and transparent and deliberate communication between the public and science sector. This plan includes actions to create the environment needed for 'social licence' to exist.

We need an increasingly STEM-competent workforce for a more ~~n 'innovation-focused society'~~

New Zealand's economic and social wellbeing depends on the productivity and competitiveness of the economy and the knowledge we have to help make informed decisions as a society. Innovation that leads to increased productivity and promising solutions to society's most pressing concerns is increasingly being seen around the world as an important way to generate economic growth and improved living standards[3].

Improving policies and practices will enable ~~-~~New Zealand to be more focused on innovation~~the development of an 'innovation society'~~. To do this, New Zealand needs a high performing and responsive science and innovation system and skilled people who can solve problems and create and deliver high-value products and services for sustainable economic, social and environmental wellbeing. We need businesses, policy makers and citizens who are able to create, 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, technologists and innovators 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 and domestic investment in our research is also critical for economic growth.

A creative culture and a wide range of skills are needed for innovation, societal advancement and sound environmental stewardship. Internationally, it is recognised that STEM skills underpin the development of new practices and technologies, the application of existing technologies and the development of new, high-value products and services[4]. STEM skills and competencies also underlie growth in many industries[5], and are highly transferable across industries[6].

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 higher levels of competency has a much lower likelihood of experiencing both economic and social disadvantage than an individual with lower competency levels[8].

Students' career choices are influenced beyond school / kura by family, whānau, iwi, business and the wider community, with parents providing the most important influences[9]. Greater

[3] *Madsen, JB. 2010. The Anatomy of Growth in the OECD since 1870. Journal of Monetary Economics, v57(6) pp 753-67*
[4] *Ministry of Business, Innovation and Employment Occupation Outlook 2014, p7*
[5] *Ministry of Business, Innovation and Employment Occupation Outlook 2014, p8*
[6] *Ministry of Business, Innovation and Employment Occupation Outlook 2014, p7*
[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,*

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 (MoE) 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. Its ultimate goal is to equip young people with the skills to live a fulfilling life and contribute to New Zealand's economic prosperity.

The Ministry of Business, Innovation and Employment (MBIE) aims to grow New Zealand for all. It is focused on improving the productivity and competitiveness of our economy and the knowledge we have to help make informed decisions as a society. The science system contributes know-how for economic growth, helps to identify and manage risks in the natural world, and provides skilled researchers and workers to support an innovation economy. MBIE aims to increase the economic contribution of the skills, science and innovation systems.

Curious minds case study

Could you invent a robot capable of climbing walls?

A team of engineers from the University of Canterbury have devised technology for robots that can walk up walls and across ceilings. Associate Professor XiaoQi Chen, who led the research, says climbing robots have been developed elsewhere, but they can only operate on certain materials and in certain circumstances. "Our robot ...can work on all kinds of surfaces — concrete, glass, wood, and on surfaces with cracks or gaps." The team saw potential for their robots in checking industrial infrastructure and a start-up company—Invert Robotics Ltd—was formed to commercialise the idea. The company now produces remote-operated robots to check for cracks in the stainless steel milk and milk powder storage tanks used in the dairy industry. Traditionally, the companies have used abseilers to check the tanks for any flaws that could cause bacterial contamination, but working in such a confined space can be hazardous. The robot, on the other hand, uses a single operator who remains outside the tank. As it travels around the tank, the robot sends back high-definition video pictures. Invert Robotics CEO, James Robertson says the dairy industry is just the start. "Our company has potential to spread into a wide range of markets."

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

2.2 Objective and outcomes

The objective of this strategic plan is to:

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

We expect progress towards the objective will contribute to three expected outcomes:

- more science and technology competent learners, and more choosing STEM-related career pathways
- a more scientifically and technologically engaged public and a more publicly engaged science sector
- a more skilled workforce~~, more informed New Zealanders~~ and more responsive science and technology.

Curious minds case study

What if there was a safer way to cut kindling?

When Ayla Hutchinson's mother had a close shave with the axe as she was cutting firewood, the Inglewood teenager—then aged 13—decided to design a safer way to do the job. "My mum nicked the top of her finger when she was cutting kindling and I was doing a science board at the time so I ended up doing something to help fix the problem." Ayla's product is called the Kindling Cracker and has the axe head, cutting edge up, welded within a metal frame. The log is placed on the axe and struck with a mallet or hammer to split it. Ayla's invention has been a great hit: after winning the 2013 Fieldays' Young Investor Award, she put Kindling Cracker into production. The 200 devices she displayed at the 2014 Fieldays sold out in two days as did her website outlet. Ayla says people have told her they wished her Kindling Cracker had been around 20 years ago, showing her where their finger used to be. Meanwhile, the accolades keep coming. In 2014, Ayla was named Most Inspiring Individual at the New Zealand Innovators Awards and was named a regional finalist for the 2014 Google Science Fair – just one of 30 young people in her age group chosen worldwide. She's also among 15 people from around the world nominated for a Scientific American Science in Action award.

2.3 The state of play

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

There are STEM skills shortages

There are skills shortages for many kinds of scientists, engineers, technologists, health and ICT professionals[10]. A number of factors are expected to lead to increasing demand for workers in many STEM-related occupations[11]. In addition, many jobs not directly STEM-related require STEM competencies. Internationally it is estimated that up to 75 percent of high-growth jobs require STEM skills and competencies[12].

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

There is global demand for those with STEM qualifications. Those who gain the STEM qualifications required to resolve shortages are often either lost from New Zealand to the global job market or pursue alternative careers. MBIE estimates that fewer than half of New Zealand graduates work in the field in which they studied and highly skilled immigrants are often required to fill the gaps. However, it is expected to become increasingly difficult to attract these immigrants as wages rise in increasingly knowledge-intensive Asian economies.

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. For example, 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 has recently increased. The industry training providers are facing difficulties in growing engineering at technician and technology qualification levels[13]. In 2012, 15,560 domestic students, or 37% of domestic students, completed qualifications at bachelor's level and above in health; natural and physical sciences; engineering and related technologies, IT, and architecture and building[14]. Girls and women are under-represented in studying and working in STEM, apart from in the health and biological sciences[15].

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[16] 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 over years 11 to 13 in the proportion of students enrolled in science-related subjects[17]. New Zealand is not unique in this, as declines have been seen in many other developed countries.

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[11] *Immigration NZ: www.immigration.govt.nz/essential skills.htm*
[1] *Ministry of Business, Innovation and Employment Occupation Outlook 2014, p8*
[12] *Inspiring Australia: A national strategy for engagement with the sciences, http://www.innovation.gov.au/*

[13] *www.ipenz.org.nz/ipenz/forms/pdfs/NEEP_Project_Report.pdf*
[14] Ministry of Education 2012 SDR data*: New Zealand's Tertiary Education Sector, http://www.educationcounts.govt.nz/publications/series/2531/profile-and-trends-2012*
[15] *Association for Women in Science Snapshot: Encouraging women to use and develop their scientific abilities to achieve their full potential, 2011*
[16] *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*
[17] *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*

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[18] 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[19].

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[20]

The National Monitoring Study of Student Achievement (NMSSA) and the Programme for International Student Assessment (PISA) results show growing inequity in student performance in science in New Zealand.

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 the Trends in International Mathematics and Science Study (TIMMS), and NMSSA is yet to assess it.

What is causing the decline in student performance?

Research suggests that student achievement in science is declining in part because science teachers are not always confident in teaching science, particularly to diverse groups. Teachers do not always have access to the appropriate resources. Furthermore, some students lack confidence in their ability to succeed in STE subjects and lack support for deciding on senior secondary school subjects[21].

[18] *Trends in International Mathematics and Science Study*
[19] *OECD, Programme for International Student Assessment 2012*
[20] *Prepared by the Ministry of Education from data from the Programme for International Student Assessment*
[21] *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*

How scientifically and technologically engaged is 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 in 2010 of public attitudes to science[22]. 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[23] (44 percent) or were disengaged from science (9%). Similar surveys have been done in other countries although comparisons are difficult given differences in the questions[24].

Relative to comparable countries, a relatively high proportion of New Zealand adults have a secondary or tertiary qualification[25]. There are 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 are limited data on the level and effectiveness of the engagement of the science sector and science and technology communicators with the public

There is increasing recognition of the broader social responsibility of scientists to engage with the wider public in meaningful ways[26]. It is difficult to track and measure this engagement, in part because it can take place in a great variety of venues and with various goals. Two main ways that scientists engage with the public is by conveying knowledge to governments to ensure science-informed public policy and decision making, and through more direct engagement with the public.

It is difficult to measure the impact of these types of engagement[27]. It is also difficult to estimate the proportion of government expenditure on public engagement by science organisations. However, a proportion of the $1.4 billion[28] invested by Government in supporting science and innovation in New Zealand was spent by universities and science organisations on making research more accessible to end-users through communication, public outreach and public education activities. Other government investment in these organisations may also be spent on communication, public engagement and education.

Many local government and private sector organisations, such as industry training providers, zoos, museums, science centres, charities and businesses engage with the public about

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[22] *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*

[23] *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

[24] *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*

[25] *35% of New Zealand adults have a secondary qualification and a further 21% have a tertiary qualification New Zealand Census 2013*

[26] *The National Academy Press, On Being a Scientist, 2009*

[27] *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.*

[28] This includes: $967m from Vote Science and Innovation, $335 m from Vote Tertiary Education, $90m from Vote Primary Industries and $18m from other government areas

science and technology for education, cultural and marketing reasons. The Government also invests $167 million in public broadcasting services and funding museums[29].

Since the Science Media Centre was established in 2008, 'science' in the media has increased by 75 percent[30].

As scientific engagement with the public has increased and changed in character, potential ethical issues have emerged and it is timely for the science sector to reconsider standards of scientific conduct.

Use of evidence in policy development

In part as a response to a report by the PMCSA, the State Services Commission recently reviewed government agencies to identify where departmental science advisors could lift internal capabilities to take up research and new knowledge. A network of advisors across government departments chaired by the PMCSA will grow in responsibility as additional science advisors are appointed. These changes are expected to help strengthen the channels of communication with the science sector and progress will be monitored as departmental science advisor positions are filled. The network is to report on progress to the State Services Commissioner in 12 months.

3. Action Areas and Priority Actions

This section sets out three Action Areas designed to deliver on the objective and outcomes of the plan. Each action area includes a set of priority actions for the next three years that are divided into innovative actions developed specifically for the plan (described as 'new actions") and work already underway, that will be aligned with the objective of the plan (described as 'supporting actions'). These actions maintain a view on the 10-year horizon, commensurate with the National Science Challenges.

In addition to these Action Areas, at the heart of this plan is an Integrating Action that spans all three Action Areas: the participatory science platform. This platform (described in section 3.4) is designed to simultaneously:

- Work with the education sector to make it easier to bring "real-world" science into the classroom by connecting teachers with science professionals
- Enable and foster the public's understanding of and engagement in real-world science through research that is relevant to local communities
- Create opportunities for science professionals to become better engaged with the public by contributing both to science education and to filling knowledge gaps that are locally relevant and scientifically valuable.

3.1 Action Area 1: Enhancing the role of education

The principle goal of 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. This goal will contribute to building creativity, innovation and increased critical science literacy. Action Area 1 will include a focus on quality

[29] *The appropriations in Vote: Culture and Heritage for 2013/14 are $134,417m (for public broadcasting services) and $33.094m (for museum services). The $33.094m (for museum services) funds the Museum of New Zealand Te Papa Tongarewa*

[30] *Meltwater Statistics http:/www.sciencemediacentre.co.nz/five-years-of-science-in-the-media.*

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 / kura, families, whānau, iwi and the business and science communities.

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

These activities will explicitly focus on enabling a future-oriented science and technology education system. Integrative thinking for improving science and technology teaching and learning, skills and dispositions for innovation, and changes to pedagogical practice as e-learning and ICT evolves will be central. This will include how the focus of science education should differ at the different levels of schooling.

1. ***Improve initial teacher education with increased science and technology teaching competencies, leading to increased confidence***

New action

- **Lifting the science and technology content in initial teacher education**

We will work with initial teacher education providers, qualification accreditation bodies and relevant professional bodies in considering the nature and scope of science and technology content in initial teacher education. This could form a component of under-graduate qualifications for early childhood and 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).

Early childhood and primary education is important 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.

Curious minds case study

How can a community improve students' engagement with science?

A collaborative network—the Hutt Valley Primary Science Education Network—has been set up to help build the confidence among local primary school teachers in science teaching. The network, administered by the Hutt-based Open Polytechnic, brings together school principals, teachers and other key individuals to provide an opportunity to learn from each other how best to advance science education at the primary level. The network builds on an Open Polytechnic initiative for 2014 offering all teachers, free of charge, its distance-learning Graduate Certificate in Primary Science Teaching (Curriculum) programme. The network also has the support of the Hutt City Council, which has earmarked $120,000 for Mayoral scholarships worth $2,500 each. These will be available to each Lower Hutt primary school with a teacher studying for the graduate certificate and is to be put towards additional science resources for that teacher to use in their classroom. The initiative builds on research that shows that the best time to build an interest in science is when children are at primary school. Hutt Mayor Ray Wallace points out the importance of science literacy for the future of the region. "Giving primary teachers support to inspire our youth in the sciences will help transform the Hutt Valley into one of New Zealand's leading export and economic growth centres, based on science, engineering and technology."

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

The Government spends more than $80 million every year on PLD to support the development of a highly capable profession, and a PLD system that builds the skills of teachers and education leaders. This investment is intended to deliver measurable gains for students across the curriculum, including science/pūtaiao, technology/hangarau and mathematics/pāngarau.

In 2014 about $5.7 million was appropriated by government to science and technology PLD. This figure does not include the science and technology PLD included in other contracts, and that schools can apply for on the basis of need.

The Minister of Education has appointed an Advisory Group with representatives from across the education sector to provide advice on the design of future PLD across the compulsory schooling sector. The group will provide advice on what improvements should be made to the targeting of centrally funded PLD to achieve a system-wide lift in student achievement; and provide advice on how changes could be implemented to achieve the maximum impact.

New actions

- **Science Skills in Education Initiative**

  We will establish an initiative to support schools and teachers to build confidence and access resources to develop rich, contextualised science programmes that are exciting for students. It will include assisting teachers to continue their science education, focusing on skills that reflect science/pūtaiao in the national curriculum, and expanding the availability of the Sir Paul Callaghan Academy initiative. This initiative focuses on professional learning and will explore links to the Teachers in Industry Project as appropriate.

Sir Paul Callaghan Science Academy

Primary school science teachers play a key role in cultivating students' curiosity about the world around them. Since 2012, the Sir Paul Callaghan Science Academy has been developing "champions of science" for New Zealand primary and intermediate schools. The Academy sessions consist of intensive four-day, professional development programmes for teachers of year 1 to 8 students. Participants are nominated by their schools for their potential to develop new science teaching initiatives and inspire and mentor their colleagues, and in turn their students. The participants hear from a host of skilled presenters and guest speakers on a range of science teaching themes such as the nature of science, investigative skills, hands-on skills, science for citizenship and the interconnected nature of science. The programme doesn't end with the course. A website allows alumni to continue to share ideas and experiences and Academy staff remain in contact to support graduates. As one participant, Janine Fryer of Pukekohe Intermediate, said "It…re-sparked my love of teaching and also provided me with an on-going resource bank to share with my colleagues and students." The Academy is organised by the National Science-Technology Roadshow Trust and is named for the late Sir Paul Callaghan who strongly believed in the importance of effective science education for children.

- **Teachers in Industry Project**

  We will establish a project for teachers to connect schools with science-intensive businesses to enable teachers to spend a period of time in a business to bring business-relevant content into their science lesson plans.

Supporting actions

- Providing teachers of science in years 1 to 10 opportunities to work with research organisations to develop leadership skills and enhance the teaching of science within schools and communities.
- Supporting the Science/Biotechnology Learning Hubs to provide a high-quality online repository of New Zealand science and resources to support science education for teachers, students and communities.

3. ***Build and maintain meaningful linkages between science and technology educators and learners, and science professionals and technologists, both in the classroom and through opportunities that engage the wider community***

Partnerships with Tertiary Education Organisations, 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.

New action

- **Develop and implement a participatory science platform**

  This Platform (described below at 3.4) will engage schools / kura, community-based groups and organisations and science professionals 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.

4. ***Reviewing the positioning and content of digital technology within the New Zealand Curriculum and Te Marautanga o Aotearoa***

New action

- **Review the positioning and content of digital technology**

  We will work alongside sector partners to review the positioning and content of digital technology within the framework of the New Zealand Curriculum and Te Marautanga o Aotearoa.

3.2 Action Area 2: Public engaging with science and technology

The goal of this Action Area is to build a nationally supportive environment for public engagement in science and technology. In addition, the Action Area is also designed to

increase the number of learners with an interest in STEM-related career pathways. This action area recognises the changing demographic of New Zealand including the increasing iwi and hapū asset base and the partnership model of service delivery. It operates with 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 publicly engaged science sector'.

The immediate objective is to enhance the quality, breadth and depth of science communication to the public by the media and education and community outreach providers, support youth into science and technology-based careers and build greater connectivity across sectors. In the longer term, Action Area 2 recognises that the culture change that is necessary to encourage and enable public engagement in science must start with young learners, their teachers, families, whanāu and their communities.

Finally, improved evidence on public attitudes to, and engagement with science and technology, will assist in targeting future actions and form part of the monitoring and evaluation for the plan.

Curious minds case study

How can a community use science to address a local issue?

In 2004, Tolaga Bay school won a Royal Society of New Zealand prize with a science and filmmaking project. The topic was the Transit of Venus, reflecting the fact that Captain Cook had called at the Bay in 1769 during his voyage of discovery that included observing the passage of the planet across the face of the sun. The prize was a trip to the UK and the school also established a relationship with the Allan Wilson Centre for Molecular Ecology and Evolution (AWC). Now the school has moved on to a much larger project involved the local community. The goal is the ecological restoration of Tolaga Bay/Uawanui to restore the bay and its catchment to a state that more closely resembles the landscape that Captain Cook would have seen when he visited. School prinicipal Nori Parata realised the project needed serious scientific help if it was to succeed and the relationship with AWC was the obvious source. The project is gathering wide community support too. The school students brought their parents on board and farmers and foresters have also got involved. Nori Parata says the aim is to extend the community co-operation still further to include everyone in the region. The project will see, among other things, river banks restored, water quality improved and kai moana (seafood) sources rejuvenated. Native birds and vegetation are also being re-established and school students have already propagated some lost species with seeds gifted by Kew Gardens during the school visit to the United Kingdom.

2. Support quality initiatives on science and technology for harder-to-reach audiences

New action

- **A contestable fund for science and technology outreach and education initiatives for engaging harder-to-reach groups**

  We will establish a contestable fund that will fund education and community outreach initiatives that focus on science and technology for harder to reach groups. This could fund initiatives using innovative approaches for reaching

groups such as youth, Māori and Pasifika, and rural New Zealanders. . Internationally, similar funds have supported initiatives including robotic workshops across rural areas for future young engineers, the development of a free Apple/Android app that will help people identify native creatures and a two-day camp for 30 young refugee migrants to inspire them to pursue science at school.

There is a growing international recognition that efforts to engage the public in science and technology find their greatest success with people who already have some level of engagement in science. The challenge is to reach and inspire a broader base of New Zealanders through initiatives that bring science and technology to groups that are generally considered harder to reach. This action will support initiatives with a broad reach.

2. *Support youth into science and technology-based careers*

Actions in this area will develop more responsive educational pathways, including the impacts of student study choices, and to develop entrepreneurial thinking in the science and innovation sector. The relevance of science and technology learning to future career options needs to be made clearer at an earlier stage for learners, and the education and training pathways leading to these potential careers should be clarified.

New action

- **Increasing girls' participation in science and ICT**

  We will identify effective actions to influence girls' subject choices and increase their participation in science and ICT areas of study, especially from year 12, and encourage them to pursue science and technology careers.

- **Increasing participation in science and ICT for all students**

  We will identify the assessment standards on the National Qualifications Framework (levels 2 and 3) that will improve the visibility of STEM capabilities.

Supporting actions for all youth

- Working with Careers NZ to raise awareness of science and technology careers on the Careers NZ website
- Working to develop and promote the uptake of information for learners about science careers
- Supporting talented school students through young achievers and travel awards
- Exploring more strategic targeting of the FutureinTech programme, and other potential changes to increase its impact
- Exploring more equitable ways to fund students to attend Learning Experiences Outside the Classroom
- Reviewing and evaluating the pilot of the Science Education Leadership and Coordination role for merit to expand
- Using the Vocational Pathways to design programmes that use real world contexts to deliver science and technology education in ways that engage learners' needs and interests
- Youth Transitions Framework that focuses on more young people participating in learning areas of high growth and demand (eg STEM subjects)

- Considering how to strengthen science literacy in senior secondary schooling particularly at Year 11
- Considering the future of the STEM feature in the Occupational Outlook publication.

3. *Support parents and whānau to increase their engagement with science*

New action

- **Develop a participatory science platform**

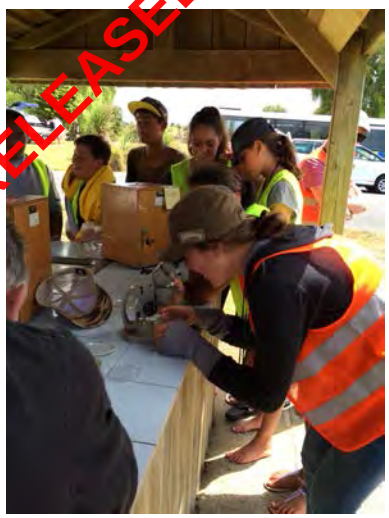
  The platform (described below at 3.4). will offer Early Childhood Education Services, schools / kura and their communities opportunities to participate in scientific research in projects with broad appeal, scientific value and pedagogical rigour that resonate with the community.

  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 science professionals with schools and other community organisations on real-world questions.

Curious minds case study

Why does science matter to me?

Ngāti Whakaue, a Rotorua iwi trust, are providing the opportunity for their young people to explore the wonders of science and to see themselves as scientists. The Matakōkiri – *light up the sky* – project provides science and technology wānanga/excursions for tamariki, rangatahi and whānau. The trust wants to inspire a love of enquiry and learning in their young people and frequent references are made to the discoveries, inventions, knowledge and practices of the learners' forebears. They're also keen to equip their young people with the science and technology skills needed for the modern workforce. Trust general manager Roana Bennett says Ngāti Whakaue identity, language and culture become the reference point and the scientific knowledge and understanding is built from there. "Rangatahi are engaged and pursue self-directed learning on topics featured during the week-long workshop. And whānau are actively supporting their children by participating alongside them in the wānanga." The approach combines Ngāti Whakaue (Māori) worldviews of scientific and technological knowledge with the expertise and resources of science and technology organisations that support the kaupapa. Themes for wānanga have included Geothermal – Te Ara Ahi, Fresh Water – He awa he taniwha He awa he tipua, and Our Storehouse – Te Pātaka. These wānanga have infused local whakapapa and legends to enhance kaitiakitanga and scientific knowledge, which creates authentic learning opportunities for curious young minds.



4. ***Build and maintain meaningful linkages between businesses, science and technology educators and learners, and science professionals and technologists***

New action

- **Connecting business, local government, educators with the science sector**

  We will explore opportunities to connect businesses with learners, educators, local government and the wider science sector.

  Improving connections between science and technology-led businesses and learners at a regional, industry or sector level will give more learners real world understanding of potential STEM career pathways. It will enable more science and technology-led businesses to promote STEM careers and build early connections with future employees.

5. ***Support quality science journalism and coverage 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.

Supporting action

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

6. ***Build greater connectivity between the science and education sectors and museums, zoos and science centres***

Supporting action

- We will work with organisations such as museums, zoos and science centres to build greater connectivity with the science and education sectors and agree their role in delivering on the plan.

  Non-traditional learning environments, such as those provided by museums, zoos and science centres, can play an important part in encouraging STEM competencies and innovations. Reaching millions of New Zealanders each year, museums and other science organisations facilitate engagement and lifelong learning, and are ideally placed as community spaces or forums.

7. ***Build the evidence base on public attitudes to, and engagement with, science and technology***

Supporting action

- We will regularly survey public attitudes to, and engagement with, science and technology.

3.3 Action Area 3: Science sector engaging with the public

Action Area 3 complements Action Area 2 because there cannot be a scientifically engaged public without a publicly engaged science sector. This 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 science organisations and

scientists have a social responsibility to share some level of knowledge where it's applicable. As New Zealanders, we look to science for useful new technologies and evidence-based guidance on the most pressing issues facing our society today.

1. ***Support scientists to contribute meaningfully to schools and communities, while advancing their scientific output, by enabling their involvement in participatory research***

   New action

   - **Develop and implement a participatory science platform**

     The platform (described below at 3.4) will match scientists with members of schools or community organisations seeking to take part in community-initiated or scientist-initiated research.

2. ***Support scientists and science organisations to continue to employ leading edge practices and standards to engage the public in identifying priority research questions and usefully disseminating results for publicly funded research***

   New actions

   - **Engaging the public in implementing the National Science Challenges**

     As the National Science Challenges are implemented, we will consider an approach and opportunities to engage the public in their implementation. This project builds on the success of the public engagement process used to identify the National Science Challenges.

   - **The Royal Society of New Zealand (RSNZ) will lead the development of a Code of Practice on public engagement for scientists**

     The RSNZ will work with the scientific community and consult widely including with universities, CRIs, the network of departmental science advisors and the PMCSA to develop a Code of Practice for scientists on public engagement[31].

   Supporting actions

   - Public research funding bodies will review and update the knowledge translation expectations for research contracts, and assess the current state of publicly-relevant knowledge transfer and end-user engagement practice among funding recipients, including with Iwi and Māori organisations. Results of this exercise can be used to inform future expectations.
   - We will continue to implement recommendations of the PMCSA on the use of science-based evidence in policy formation, by creating opportunities, through new Departmental Science Advisors, for the science sector to engage with government and share relevant results with policy makers.

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

[31] 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.

New action

- **Public engagement training for science and technology researchers**

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

Supporting action

- We will continue to ensure that scientists' excellence is acknowledged and showcased through the Prime Minister's Science Awards.

4. Increase the profile of the work of researchers who are Māori in science/ pūtaiao and of all researchers engaged in mātauranga Māori

New action

- **Increasing the profile of researchers in science/pūtaiao and mātauranga Māori**

  We will work with researchers who are Māori, iwi and Māori organisations about their mātauranga Māori and science/ pūtaiao knowledge to increase their profile.

3.4 Integrating Action: The participatory science platform

1. Develop and implement a participatory science platform

While Action Areas 1, 2 and 3 target specific sectoral goals, they are nonetheless interconnected. A unique feature at the heart of this strategic plan is an integrating activity that simultaneously addresses important objectives in all three Action Areas.

The participatory science platform builds on traditional concepts in citizen science and enhances these through collaborative approaches more common to community-based participatory research. Participatory Science is a method of undertaking scientific research where volunteers can be meaningfully involved in research in collaboration with science professionals (including post-graduate students or researchers and private sector scientists) and builds on international models of engagement.

The goal is to involve schools / kura and/or community-based organisations such as museums and associations in projects with broad appeal, having both scientific value, pedagogical rigour, and that resonate with the community. In addition, several ideas are being tested for projects of national significance that would integrate with the National Science Challenges and be national in reach.

The participatory science platform has the potential to:

- offer inspiring and relevant learning opportunities for students and teachers
- engage learners and participants beyond the school / kura community to reach parents, whanau and wider communities
- offer researchers opportunities to become involved in locally relevant lines of enquiry, where data can be enriched by the local knowledge and contribution of citizens.

The participatory science platform is built on four core components and incorporates Matauranga Māori:

1. A process that seeks ideas for participatory science projects from both the community (including Early Childhood Education Service and kōhanga, schools / kura, museums and other organisations, iwi authorities or community associations) and from science professionals (from post-graduate students to principal investigators in both the public and private sectors)
2. A managed process for evaluating these ideas for both pedagogical potential (in the case of schools / kura) and scientific quality, and for ensuring their practicality and relevance to the participating partners (science sector and community-based)
3. A web-based match-making process between interested community-based partners and science professionals
4. A resource for teachers and other community or learning leaders to assist in developing their projects to robust standards.

The Platform's website will serve as a match-making tool between scientists and potential community-based partners 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 will have an institutional home which will provide a coordination role. This could be a school, museum, zoo, science centre, iwi office or research institute, university or other tertiary organisation.

The projects will be offered as opportunities for community based partners to participate in scientific research as a way to enhance their local input, their science knowledge and their interest, and (in the case of schools) to strengthen learning programmes through stronger links to relevant learning environments and expertise.

Once matches are made between community based partners and scientists, these partners would self-direct their involvement in carrying out the research according to an agreed plan and approach.

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.

To enable more sophisticated projects, a limited number of seed grants will be made available to help foster a meaningful level of community involvement. The seed-grants will part-fund science professionals and community/school groups to plan together the research question, data collection, analysis and knowledge translation strategy for the project. In addition, eligible costs could include research tools or consumables that would not otherwise be accessible to community partners.

Curious minds case study

How can New Zealanders gain access to scientific research?

All New Zealanders have an interest in the quality of their lakes and rivers. There's a vast array of research around about freshwater quality but how do you make this information accessible to the general public and to the very people who might be able to do something about it? The country's 16 regional authorities and unitary councils, the Ministry for the Environment, Cawthron Institute and Massey University teamed up to set up a website that provides freshwater science to the public in an easy-to-understand format. Land and Water Aotearoa – or LAWA – as it's known, provides data from 1100 freshwater monitoring sites around the country based on readings of the levels of bacteria, nitrogen and phosphorous as well as water clarity and acidity. By visiting the LAWA site, people can check out the current state of their local waterway, how it compares with other sites, and whether the water quality is improving, getting worse, or staying the same. The project was developed with funding from the Tindall Foundation. Co-founder Sir Stephen Tindall wanted to see the LAWA vision become reality after experiencing difficulty accessing clear information about New Zealand rivers. "To me the fact that the quality of our waterways is on the decline is a horrifying thought," he says. "By collecting data we can identify problems early and see if water quality is improving or not."

LAND AIR WATER AOTEAROA

3.5 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 Authority review of qualifications – Mandatory reviews of levels 1-6 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, including in areas of new and emerging shortage such as science and technology; and Priority 5, strengthening research-based institutions. The TES emphasises the importance of tertiary institutions being more outwardly focussed and in particular, connecting learning to employment outcomes and encouraging providers to be more connected to industries and communities.
- The State Service's Commission's efforts to include action for better use of evidence in public policy formation. This is being operationalised through the creation of a number of Departmental Science Advisor (DSA) roles and the creation of a network of these advisors chaired by the PMCSA. This plan recognises the role of scientists to better connect with the public service through the DSA network and other opportunities to bring evidence into policy formation.

- The Office of the PMCSA was established, in part, to address the role of science in society. Positioned at the nexus of the science sector, government, and the public, a central focus of the Office is to help establish better communication of concepts in science and research to the public and to government. This plan recognises the

uniqueness of the PMCSA model internationally and can leverage the channel of public communication that the Office provides.

- MBIE's Vision Mātauranga policy aims to unlock the science and innovation potential of Māori knowledge, people and resources for the benefit of New Zealand. The four themes of the Vision Mātauranga policy are:
    - Indigenous innovation: contributing to economic growth through distinctive science and innovation
    - Taiao/environment: achieving environmental sustainability through iwi and hapū relationships with land and sea
    - Hauora/health: improving health and social wellbeing
    - Mātauranga: exploring indigenous knowledge and science and innovation

For this reason the Vision Mātauranga policy is embedded across all science investments, and as such forms a core component for the implementation of MBIE's approach to supporting outcomes for Māori and New Zealand.

Curious minds case study

What if we could earn extra from our forests?

That's the question that faced the 1100 beneficiaries of the vast central North Island forest block known as Maraeroa C Incorporation. They are the direct descendants of Rereahu – whose ancestor was Hoturoa, the captain of the Tainui waka. Their ancestral land covers a huge area of South Waikato and King Country. The shade-loving ginseng plant –highly valued in Chinese medicine— seemed a good candidate as an under-crop to the pine plantations. Wild-grown ginseng –the most sought after – is in decline after years of over-harvest. As a result, chief executive Glen Katu says they saw a gap in the Chinese market for ginseng grown in wild natural conditions with no fertilisers or pesticides. "It takes longer to grow and the roots are much smaller but are more highly valued." Scientists from Crown research institute Scion have been working with the team that manages Maraeroa C, to identify suitable climate, soil and typography conditions in the central North Island to grow ginseng as an understory crop to radiata pine plantations. The research suggests over half the 450,000 hectares of planted radiata forests in the central North are suitable for producing top-quality ginseng roots and the benefits economically could be significant, with premium dried ginseng fetching around $2,000 per kilo.

4. Implementing and monitoring the plan

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, modify as we go and continue engaging with stakeholders.

4.1 Implementation approach

As this is the first Science in Society plan, the government has asked the Science in Society Reference Group to reconvene in 2015 to review progress and advise about any modifications to the actions to better deliver on the outcomes. MBIE and MoE together with the PMCSA will oversee implementation of the plan by government agencies, iwi and other sectors including the education, science, business and museum sectors. The two agencies will also lead a process of engagement with the public on the plan and the actions in it.

Central to the terms of reference of the PMCSA is to support an improved and productive relationship between science and society. As such, the PMCSA and the DSA network will continue to be active in implementation of the plan.

4.2 Timeframe

While the challenges are long term, the plan sets out a direction for the next ten years and actions for the next three years from 2014 to 2017. The actions may be modified and enhanced as we learn more over the life of the plan.

Some actions are already underway as they continue or enhance effective existing actions. Enhancing the role of the Science Media Centre and MoE'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 initiatives focused on science outreach and engaging harder-to-reach groups will 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 (over school years 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 sector. These actions will help inspire and provide authentic learning opportunities of relevance and interest to students.

4.3 Monitoring and evaluation

Monitoring will comprise:

- A survey of public attitudes toward science, complemented by in-depth qualitative research with the general public
- Analysis and synthesis of education and skills data, for example student achievement in science and maths
- Analysis and synthesis of administrative data, for example monitoring of relevant contracts and science communications measures and indicators
- Formal and informal stakeholder consultation.

MBIE has developed an intervention logic to inform the monitoring activities (Annex 1). The intervention logic details the links between the challenges that Science in Society seeks to address, the activities being undertaken within the action areas and their intended impacts and outcomes. These impacts and outcomes include short-term changes in awareness, medium-term changes in behaviour, and long-term changes in terms of a skilled workforce, informed New Zealanders and responsive science and technology. The intervention logic model will inform the selection of indicators and measures for monitoring purposes.

Work to date has included MBIE commissioning (in June 2014) a survey of public attitudes towards science and technology and the ways in which the public conceptualises science. This survey retains some questions asked in previous studies for comparability, and thus will identify changes in public attitudes from those previous studies. Responses to questions in the survey will form part of the baseline measures for monitoring the initial plan.

The Ministry of Education is able to utilise existing data collection and analysis to monitor the impact of the plan. The Ministry regularly publishes data about student achievement in science and mathematics through Public Achievement Information (PAI) which is available ~~on **Error! Hyperlink reference not valid.**~~at www.educationcounts.govt.nz.

The performance framework for the National Science Challenges will include some assessment of public engagement in science.

Monitoring and evaluation will establish a baseline and track progress against the initial plan's outcomes. It will also assess the performance of specific action areas. In response, initiatives that are making a measurable contribution to the expected outcomes will be continually adapted and extended.

The monitoring and evaluation activities for this plan are founded on the plan's three expected outcomes as follows.

Outcome 1: more science and technology competent learners and more 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 2: a more scientifically and technologically engaged public and a more publicly engaged science sector

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

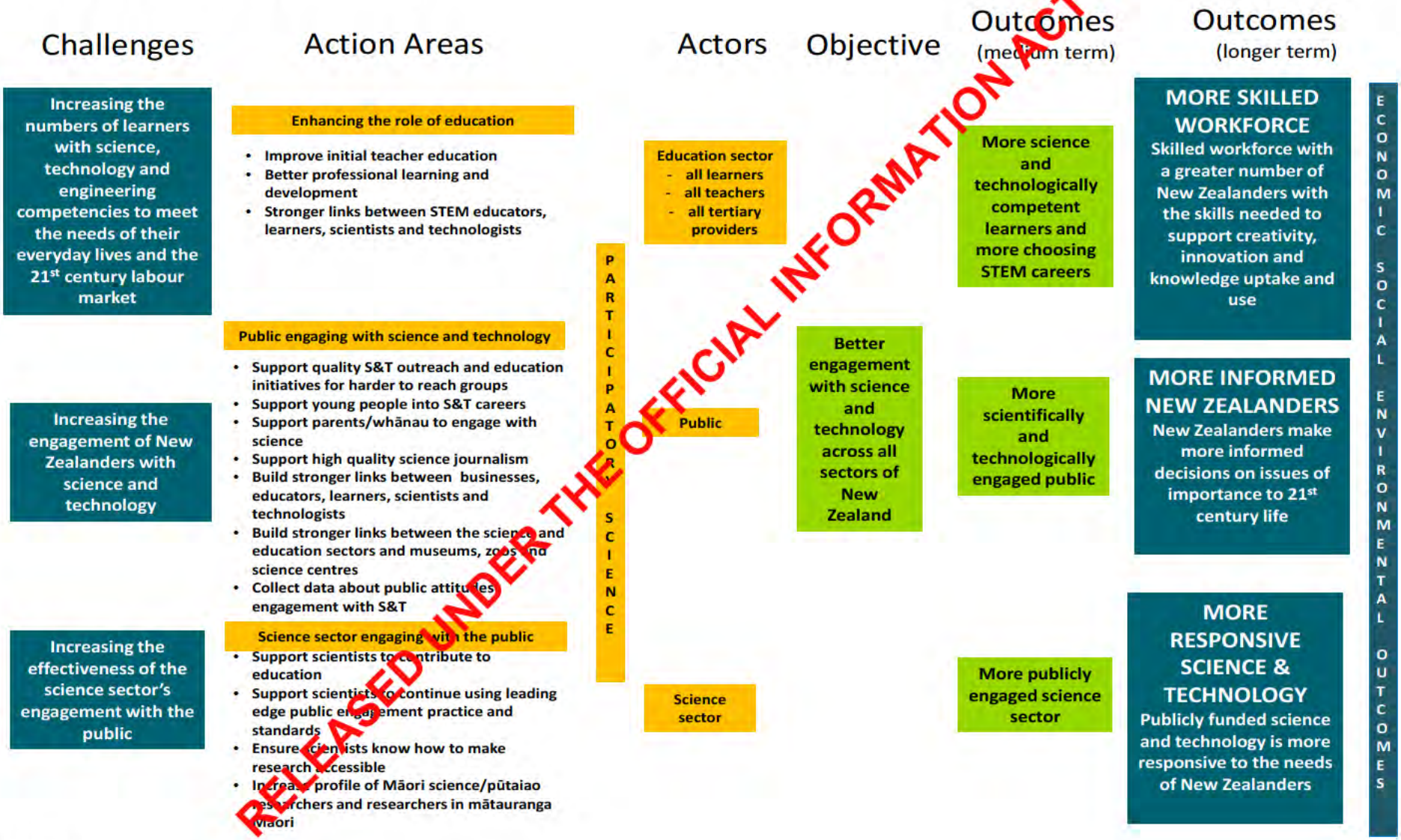
- a greater proportion of New Zealanders across all sectors of society are engaged with, and value, science and technology
- there is more in-depth media reporting on science and technology based on robust scientific evidence
- there are increased opportunities for the public to learn about, and be involved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

Outcome 3: a more skilled workforce ~~, more informed New Zealanders~~ and more responsive science and technology

In the longer term, we expect that progress towards outcomes 1 and 2 will contribute to New Zealand's economic growth and improved social and environmental outcomes through:

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

Annex 1: Intervention logic



Annex 2: Process for developing this plan

This plan was developed by MBIE, MoE and the office of PMCSA 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 PMCSA. 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 MBIE. 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. 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 and 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 was formerly 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 is Managing Partner of connections and communications agency, The Family. Lee attended the Transit of Venus forum and was consulted in the development of the

	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 the 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 (IPENZ). 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 membership of the Science in Society Reference Group will be reviewed before it is reconvened in 2015.

We would like to thank the following stakeholders for their contribution to the plan through providing feedback on an earlier draft or drafts of the plan: the Reference Group, the National Science Challenges Panel, Business New Zealand; the Chief Executive of Science New Zealand; the New Zealand Association of Scientists; municipal museums; the Royal Society of New Zealand; the Chambers of Commerce; Callaghan Innovation; the Secondary School Principals Association; New Zealand Principals Federation; the Post-Primary Teachers Association; the New Zealand Education Institute; the leadership of Universities, Polytechnics and Wānanga; the Tertiary Education Union; the New Zealand Union of Students Association; the National Science-Technology Roadshow Trust; and stakeholders from the Society of Māori Astronomy and Research Traditions and Ngā Pae o te Māramatanga.

Annex 3: Key definitions

What do we mean by science, technology and STEM?

Science is a set of formal processes that interrogates the "real things" or phenomena of the natural and social world in order to construct explanations of them.[32] It describes a way of thinking about the world, a creative process which generates knowledge and the ability to think critically about that knowledge. *The New Zealand Curriculum* describes ***science*** as "*a way of investigating, understanding and explaining our natural, physical world and the wider universe*."[33] 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.

Science knowledge means both knowledge of the processes, methods, and facts of science on one hand, and knowledge about science's applications and limitations on the other. Certain audiences will specialise in knowledge 'of' science, but basic knowledge 'about' science is broader and is an important tool of 21st century citizenship and public discussion on today's most pressing societal concerns. This has been referred to as 'critical science literacy'[34]. We also acknowledge that 'knowledge' may also mean the science sector's own knowledge of various public audiences and how to connect with these to make their science relevant.

Technology intervenes in the world to solve problems or meet needs or desires; that is, to create part of the made world[35]. *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*".[36]

STEM is the internationally recognised term that refers to subjects or areas of learning, namely science, technology, engineering and mathematics, which are used broadly and are inclusive of all levels of learning. Often, the acronym is used as shorthand to denote the family of numerate subjects, even when one or more are not considered. In the plan, we distinguish deliberately between **STEM** and **STM**, which refers to compulsory level subjects (science, technology and mathematics) because engineering is taught only at tertiary level. **STE** refers to science, technology and engineering subjects.

What do we mean by engagement?

Engagement can and should be a range of things for different people and different times, and is dependent upon purpose.

The goal of 'engagement' in the plan is to recognise and enable the role that we all have in understanding, becoming informed and questioning what we need science to address and what we do with the new knowledge that science produces.

In some instances, this is through the opportunity to learn in a more hands-on and relevant way that can help shape our attitudes and decisions. In other situations, it is a participatory tool for a more open approach to research and for making decisions about how to use the information it

[32] France and Compton *Bringing Communities Together*
[33] The New Zealand Curriculum, p28
[34] Susanna Priest, *Critical Science Literacy: What Citizens and Journalists Need to Know to Make Sense of Science*, Bulletin of Science Technology & Society 2013 33: 138
[35] See footnote 33
[36] The New Zealand Curriculum, p32

produces. This is one way that a stronger relationship between science and society can be developed.

For the public (including government) 'engagement' means the acquisition and application of multiple types of STEM-knowledge by multiple kinds of audiences for various purposes.

For the science sector it involves communicating new knowledge clearly for different users, as well as undertaking research and responding to the knowledge needs of society.

Taken together these characteristics of 'engagement' imply an improved and productive social relationship between the science sector and wider society that will lead to the responsible application of knowledge for the social, environmental and economic wellbeing of New Zealanders.

Thus, in the plan, the focus is on public engagement in:

- *acquiring knowledge*, which is about the public, including and especially compulsory level learners acquiring the STE skills and knowledge needed to develop a career in science and/or to engage in much needed and ongoing public conversations about the application of scientific knowledge and technology.

- *generating knowledge*, which 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 opportunities in participatory science.

- *applying knowledge*, is about being enabled to make the best use of what we know, including the responsible and evolving use of or limiting of new technologies or novel applications of existing technology.

This definition of engagement reflects a fresh approach through a necessary mix of what has in the past been called 'public understanding of science' or 'science literacy' and of 'public engagement in science'[37].

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

Annex 4: Description of initiatives

KEY: Existing action continuing | Changed existing action | New project

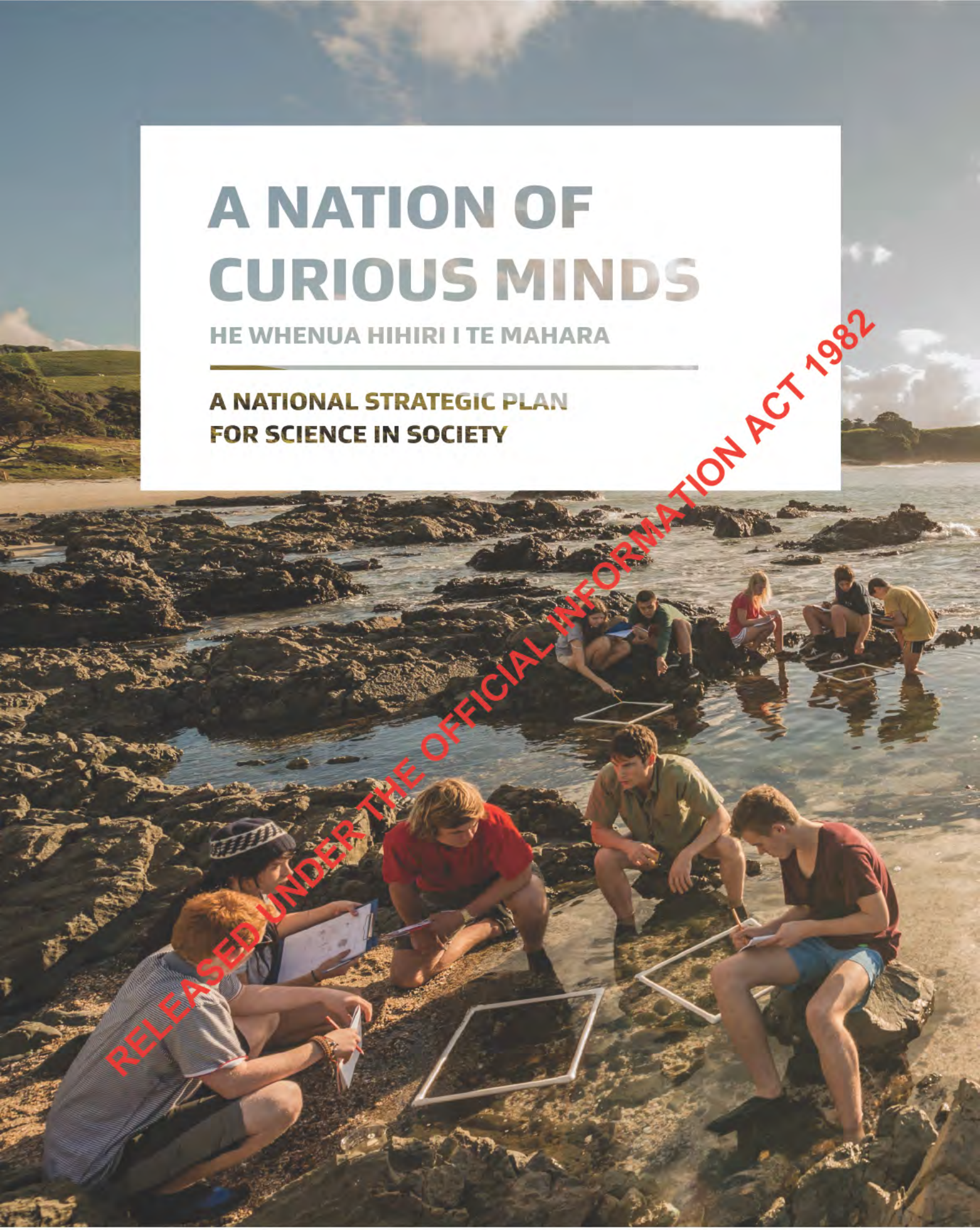
Action Area	Goal	Action	Status	Lead agency	Other agencies	Comment
Enhancing the role of education	Lifting the science and technology content in initial teacher education	Work with initial teacher education providers, qualification accreditation bodies and relevant professional bodies to consider the nature and scope of science and technology content in initial teacher education		MoE		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 and technology (teachers currently report limited confidence, particularly at years 7-8).
	Improve the quality and relevance of continuing professional learning and development opportunities for teachers in science and technology	MoE 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		MoE		
		Provide primary and secondary school teachers with opportunities to work with research organisations and develop leadership skills to enhance the teaching of science within school communities		MBIE		In 2014/15, reframe the teacher fellowship programme to further imbed the leadership responsibilities within the school community, enhance leadership competencies and align with Ministry of Education initiatives.
		Support the Science/Biotechnology Learning Hubs to provide an online repository of New Zealand science for use by teachers, students and communities		MBIE		In 2014/15, support the Science/Biotechnology Learning Hubs as a high-quality online repository of New Zealand science and resources to support science education.
		Create a Science Skills in Education Initiative to support schools and teachers to build confidence and access resources to develop rich, contextualised science programmes that are exciting for students		MoE		The initiative will be developed with education and industry stakeholders to create a network between local industry, local and national government and schools to assist teachers to continue their science education with providers who have a proven record of excellence in science teaching. Examples include access to courses for primary teachers with a focus on developing science skills and knowledge that reflect science/pūtaiao in the national curriculum, and expanding the availability of the Sir Paul Callaghan Academy initiative. This initiative focuses on teacher learning, and will explore links to the Science in Industry Programme as appropriate.
		Create a Teachers in Industry Project for teachers, to connect schools with science intensive businesses to enable teachers to spend a period of time in the businesses to bring business relevant content into their science lesson plans		MoE		This initiative focuses on building the currency of programmes, and will explore links to the Science Skills in Education initiative as appropriate. 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.
	Develop science and technology curriculum materials and support teachers to use them	The New Zealand Curriculum (NZC) and Te Marautanga o Aotearoa address STM skills development and building a scientifically and technologically engaged population more generally Te Whāriki – Strand 5: Exploration Children experience an environment where they develop working theories for making sense of the natural, social, physical and material worlds		MoE		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.
		The Matakōkiri Project supports students to engage with science by linking science/pūtaiao to Māori language, culture and identity through students' local tikanga, whakapapa and stories		Te Taumata o Ngāti Whakaue Iko Ake Trust		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.
		Establish Learning and Change Networks with a dedicated focus on student achievement in science		MoE		These 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.
		A range of online and print publications to support quality teaching, learning and assessment		MoE		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.
	Review the positioning and content of digital technology within the framework of the New Zealand Curriculum and Te Marautanga o Aotearoa	The Ministry of Education will work alongside sector partners to review the positioning and content of digital technology within the framework of the New Zealand Curriculum and Te Marautanga o Aotearoa		MOE		~~It is intended this will result in additional guidance and support materials exemplifying ICT provision across primary and secondary years and will complement the National Certificate of Educational Achievement (NCEA) review and maintenance programme.~~
Public engaging with the science sector	Support quality science journalism and coverage in the multi-platform media	The Science Media Centre – a centre that provides an interface for the media with the science and technology sectors and educates scientists on engaging with the media to improve the quality and professionalism of science and technology reporting		MBIE		In 2014/15, enhance the reach of the Science Media Centre to support more training and outreach to science journalists and encourage respons ble and insightful science news reporting and analysis that is relevant to the New Zealand public.
	Support quality initiatives on science and technology for harder to reach audiences	Establish a contestable fund for initiatives focused on science outreach and on engaging harder-to-reach groups		MBIE		To be designed and piloted in 2014/15 and, subject to the results of the pilot, implemented in 2015/16.

	Support youth into science and technology-based careers	The STEM feature in the 2014 Occupation Outlook identified the current and future demand for STEM-related careers		MBIE		To consider its future in 2014/15.
		Māori Future Makers website which profiles Māori and whānau in non-traditional, knowledge intensive sectors		TPK		
		Work with Careers NZ to raise awareness of science and technology careers on the Careers NZ website		Careers NZ		
		Supporting Young Achievers Awards		MBIE		Awards to continue
		Talented School Students Travel Awards		MBIE		In 2014/15 extend the programme to intermediate students and provide additional flexibility to reach more low decile students.
		Working to develop and promote the uptake of information for learners about science careers		MoE		
		Use Vocational Pathways to design programmes that use real world contexts to deliver science and technology education in ways that engage learners' needs and interests		MoE		
		Youth Transitions Framework that focuses on more young people participating in learning areas of high growth and demand (eg STEM subjects)		TEC		
		Explore more equitable ways to fund students attending Learning Experiences Outside The Classroom		MOE		
		Increase participation in science and ICT for all students		MoE		Identify the assessment standards on the National Qualifications Framework (levels 2 and 3) that will improve the visibility of STEM capabilities within assessment standards
		School science sector partnerships that support school students' science learning. 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		MoE		A pilot will run through to July 2014 to build school, science sector 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.
		Consider how to strengthen science literacy in senior secondary schooling particularly at year 11		MoE		
		Promoting STEM careers to students through the FutureinTech programme		Callaghan Innovation		In 2014/15 explore more strategic targeting of the programme, and other potential changes to increase its impact
		Increase girls' participation in science and ICT		MBIE and MoE		Identify effective actions to influence girls' subject choices and increase their participation in science and ICT areas of study, especially from year 12, and encourage them to pursue science and technology careers

	Build and maintain meaningful linkages between business, science and technology educators and learners and science professionals and technologists	Explore opportunities to better connect business, local government, educators, learners and the science sector at a regional, industry or sector level		MBIE		To be considered in 2014/15 and, subject to the results, implemented in 2015/16.
	Build greater connectivity between the science and education sectors and museums, zoos and science centres	Work with organisations such as museums, zoos and science centres to build greater connectivity with the science and education sectors and agree the role of museums, science centres and zoos in delivering on the plan		MBIE, MCH		To begin in 2014/15
	Build the evidence base on public attitudes to, and engagement with, science and technology	Regularly survey public attitudes to, and engagement with, science and technology		MBIE		Survey to be carried out in 2014 and a regular programme agreed.
Science sector engaging with the public	Support scientists and science organisations to continue to employ leading edge practices and standards to engage relevant public(s) in identifying priority research questions and usefully disseminating results for publicly funded research	Government expectations on researchers receiving public funds to make research public and provide public engagement and outreach		MBIE, TEC		From 2015/16 to review and update the knowledge translation expectations for research contracts, and assess the current state of publicly-relevant knowledge transfer and end-user engagement practice among funding recipients. Results can be used to inform future expectations.
		The Crown Research Institute's (CRIs) Statement of Core Purpose in the Crown Research Institutes Act 1992 includes expectations on engagement with key stakeholders and to transfer technology and knowledge to key stakeholders		MBIE, CRIs		No changes proposed.
		Request for proposals for the first ten National Science Challenges sets a key objective for engagement by the science sector with the public		MBIE		In 2014/15 build on the success of the public engagement process used to identify the National Science Challenges by considering an approach and opportunities to engage the public in the implementation phase of the National Science Challenges.
		The RSNZ will lead development of a Code of Practice on public engagement for scientists		RSNZ		To begin in 2014/15.
		Continue to implement recommendations of the PMCSA on the use of science-based evidence in policy formation, by creating opportunities, through new Departmental Science Advisors, for the science sector to engage with government and share relevant results with policy makers		SSC, PMCSA		
	Ensure emerging and established scientists and technology researchers have the basic communication skills to make their research accessible to relevant audiences beyond their peer	Work with the tertiary sector to identify ways to ensure that all emerging and established science and technology researchers have access to training that supports engagement and the dissemination of their knowledge to non-academic audiences		MBIE, MoE, TEC		To begin in 2014/15.

	community	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		MBIE		Prizes to continue to showcase scientists' excellence.
	Increase the profile of the work of Māori researchers in science/pūtaiao and of all researchers engaged in mātauranga Māori	Increase the profile of the work of researchers who are Māori in science/ pūtaiao and of all researchers engaged in mātauranga Māori by engaging with researchers who are Māori, iwi and Māori organisations about their mātauranga Māori and science knowledge and science projects		MBIE, PMCSA		To begin in 2014/15.
Across all action areas		Develop and implement a participatory science platform		MBIE, MoE		To be designed and piloted in 2014/15 and, subject to the results of the pilot, implemented in 2015/16.



A NATION OF CURIOUS MINDS

HE WHENUA HIHIRI I TE MAHARA

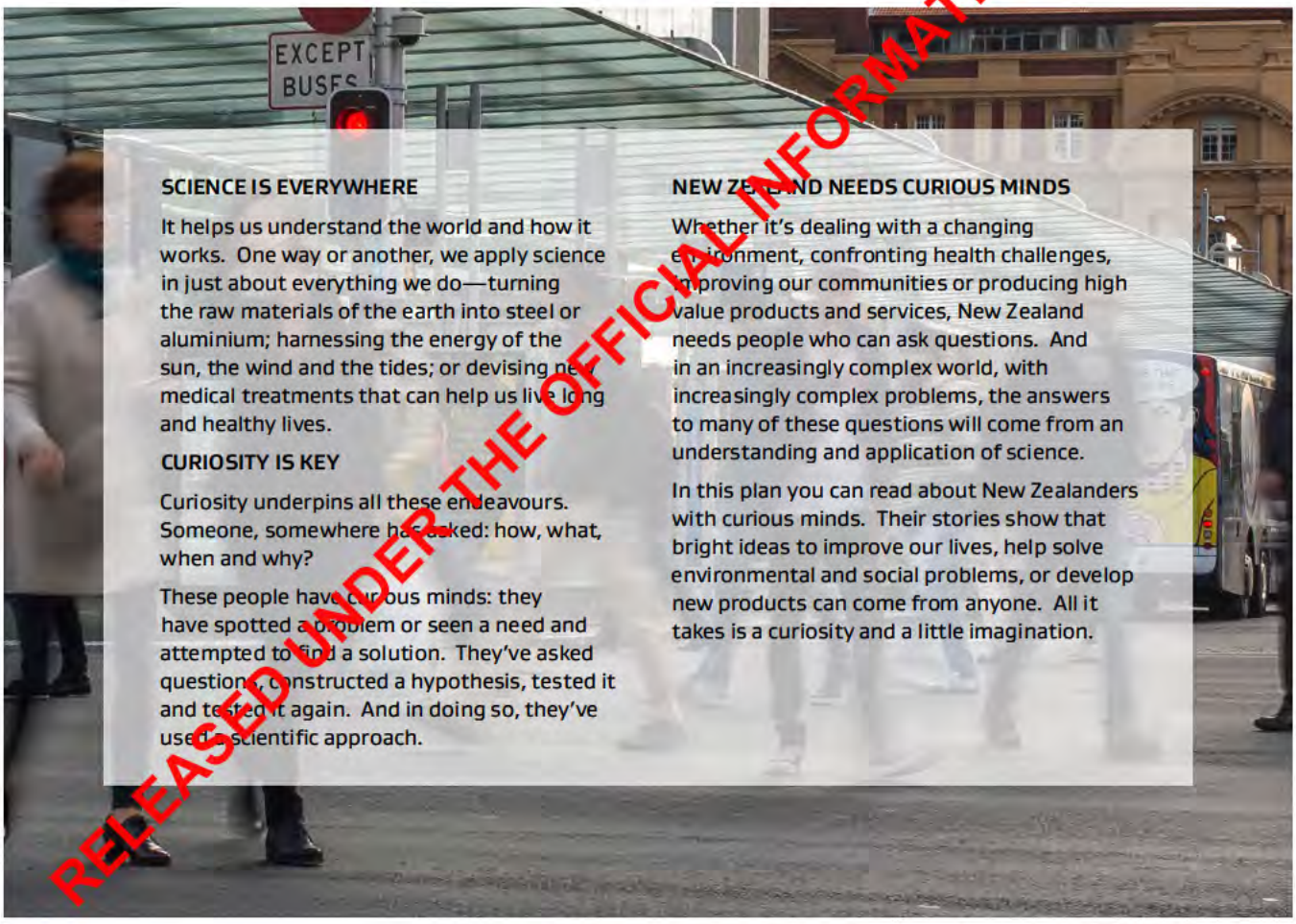
A NATIONAL STRATEGIC PLAN FOR SCIENCE IN SOCIETY

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

Office of the Prime Minister's Chief Science Advisor

"YOU DON'T NEED TO TEACH A CHILD CURIOSITY. CURIOSITY IS INNATE. YOU JUST HAVE TO BE CAREFUL NOT TO QUASH IT. THIS IS THE CHALLENGE FOR THE TEACHER – TO FOSTER AND GUIDE THAT CURIOSITY."
– SIR PAUL CALLAGHAN



SCIENCE IS EVERYWHERE

It helps us understand the world and how it works. One way or another, we apply science in just about everything we do—turning the raw materials of the earth into steel or aluminium; harnessing the energy of the sun, the wind and the tides; or devising new medical treatments that can help us live long and healthy lives.

CURIOSITY IS KEY

Curiosity underpins all these endeavours. Someone, somewhere has asked: how, what, when and why?

These people have curious minds: they have spotted a problem or seen a need and attempted to find a solution. They've asked questions, constructed a hypothesis, tested it and tested it again. And in doing so, they've used a scientific approach.

NEW ZEALAND NEEDS CURIOUS MINDS

Whether it's dealing with a changing environment, confronting health challenges, improving our communities or producing high value products and services, New Zealand needs people who can ask questions. And in an increasingly complex world, with increasingly complex problems, the answers to many of these questions will come from an understanding and application of science.

In this plan you can read about New Zealanders with curious minds. Their stories show that bright ideas to improve our lives, help solve environmental and social problems, or develop new products can come from anyone. All it takes is a curiosity and a little imagination.

New Zealand Government

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