

This document contains the draft RAS products for

## Level 1 Science.

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# Science Rationale

## Purpose of this rationale

The purpose of this document is to explain the structure and content of the Learning Matrix and the Assessment Matrix for Level 1 Science. This rationale explains how these two matrices were developed and how they connect to the curriculum. It also explains how these matrices can be used to construct a teaching and learning programme.

## Matrix descriptions

The purpose of the **Learning Matrix** is to identify the Significant Learning in a subject which will generally be grouped under a number of Big Ideas for that subject. The Learning Matrix is a new tool teachers can use to construct a coherent programme that covers all the 'not to be missed' learning in a subject.

There is no prescribed order to the Learning Matrix. A coherent programme of learning might begin with a context that is relevant to the local area of the school, or an idea that students are particularly interested in. This topic or context may relate strongly to one Big Idea but may link to other Big Ideas. The matrices are designed so that educators have the freedom to create courses that are both flexible and coherent.

When the Teaching, Learning, and Assessment Guide is produced, it will include more example of contexts that encapsulate the Big Ideas, but it is not a prescriptive or definitive list. Contexts suggested for teaching one Big Idea might also be used successfully to teach other Big Ideas but should always be level appropriate.

The **Assessment Matrix** identifies the learning that is most important to credential and gives the titles of the four standards that will be used to do this, along with their mode of assessment and credit value. It is important to remember that an external assessment does not necessarily mean an exam; there are a number of different modes of external assessment that may be applied. As with the Learning Matrix, there is no prescribed order to the Assessment Matrix to allow flexibility in accordance with the local curriculum.

## How these matrices were developed

The matrices were developed by Subject Expert Groups (SEGs). The suggestions for Big Ideas at the Learning Area level were initially developed by panels of curriculum experts. The Big Ideas were used by the SEG to explore and identify the Significant Learning important for learners to engage in at curriculum level 6 and to be assessed by Level 1 NCEA. The matrices are designed to be flexible enough so that educators can construct courses that cater to a wide range of students, taking into account diverse learners.

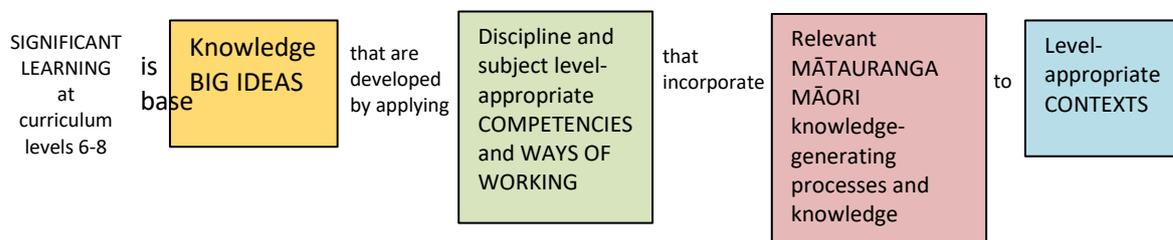
## Curriculum connections

### What are Big Ideas and Significant Learning?

Significant learning is the most important learning associated with each of the Learning Areas of New Zealand Curriculum (NZC). All students are entitled to opportunities to engage with that Significant Learning which is too important to be left to chance. Significant Learning differs across each Learning Area due to the differing disciplines and bodies of practice they are derived from but it will include aspects of learning drawn from:

- Declarative knowledge – typically involving memorisation and recall of facts
- Conceptual knowledge – understanding ideas and how they can be applied in a range of situations
- Epistemic knowledge – the processes used to construct and test new knowledge within a discipline, including procedural knowledge and skills. Epistemic knowledge enables a learner to operate as an 'amateur expert' in an area and is vital for engaging with complex contemporary problems using critical inquiry.

### A model for Significant Learning:



### What are Knowledge BIG IDEAS?

Big ideas are those that relevant during and beyond school, and are enduring. They are of lasting value and are remembered long after the details have been forgotten. They are central to a learning area, discipline or subject and can be developed with increasing complexity over time. A focus on big ideas supports connected learning as a big idea can be applied to multiple contexts that are increasingly complex, and discourages a 'coverage' of facts approach. Big ideas are **the knowledge** developed within a learning area, discipline or subject and may relate to knowledge generated within that discipline. (Here we've called these the Big Idea *of* Science – what we think of as the "content" of Science).

### What are COMPETENCIES and WAYS of WORKING?

Each Learning Area draws from one of more disciplines and each discipline has its own knowledges, languages, and practices that contribute to the community's particular

**ways of working.** These ways of working can be described using the **key competencies.** Schools are required to support students' development of key competencies across the whole school span, from years 1-13 and across Learning Areas. From curriculum level 6 the key competencies look different from earlier levels:

Students' competencies and ways of working have become more intuitive and disciplined-focused. They use discipline-specific ways of **thinking** such as critical and creative thinking, cause and effect thinking, abstract thinking, evidence-based thinking, embodied thinking, lateral thinking, systems thinking, values clarification, epistemic thinking, and evaluative thinking. They begin to evaluate the quality of their thinking. They interpret and produce **language, symbols and texts** using the conventions of the discipline and understand the disciplinary-specific ways of being and processes they need to follow. They can **manage themselves** accordingly. For example they can identify as a scientist, social scientist, artist, mathematician etc. Students understand and use the discipline/s set way of doing things that help progress understanding in the subject. They develop strategies to synthesise information; take risks; be resilient, patient and resourceful; suspend judgement; persevere; and be reflective.

Students use and reflect on the disciplinary-specific ways of **relating to others** and to others' perspectives. They can see from different perspectives; notice power relationships and positioning; interact with theoretical models and frameworks that frame perspectives; and negotiate and resolve different perspectives and theoretical positions. Students **participate and contribute** to their community by following discipline-specific practices and conventions. They understand the rules of engagement. For example, they provide evidence to support viewpoints, and they communicate both methodology and results.

Explicitly describing the key competencies with a discipline focus shows how knowledge and competencies weave together and each **Learning Area** contributes the following to the competencies and ways of working:

- specific **processes** of meaning-making
- understandings about the **nature** of the learning area e.g. a Big Idea about science is that the application of science can have social, ethical, political and economic implications.

In the matrices, we've expanded and identified these as Big Ideas **about** Science.

### **What are MĀTAURANGA MĀORI knowledge and knowledge-generating processes?**

Mātauranga Māori is a distinctive body of knowledge **and** a means of knowledge generation from a Māori perspective. Mātauranga Māori is best expressed in te reo Māori me ona tikanga. Mātauranga Māori provides powerful learning tools and is represented in a number of ways including waiata, haka, karakia, whakairo, tukutuku, pūrākau, texts, video, film, theatre. Mātauranga Māori provides opportunities to affirm and validate Māori students' identity, knowledge and experience, and opportunities to enrich learning for all students.

### **What are CONTEXTS for making meaning?**

Big ideas can be understood at multiple levels from junior primary to senior secondary. What distinguishes the levels of understanding is the degree of abstraction, complexity and scope of the context. By curriculum level 6 we expect students to engage with contexts that are typically broad, deep and large in scale, and extend beyond personal experience. The contexts are likely to involve multiple interacting elements; contested ideas; provocative or nuanced interpretations; and may require sustained engagement to understand. Theoretical models and frameworks are needed to make sense of contexts beyond curriculum level 6.

### **So what IS Science?**

The New Zealand Curriculum tells us the Science learning area is about exploring how both the natural, physical world and science itself work so people can participate as critical, informed, and responsible citizens in a society in which science plays a significant role.

Science is able to inform problem solving and decision making in many areas of life. Many of the major challenges and opportunities that confront our world need to be approached from a scientific perspective, taking into account social and ethical considerations.

By studying science, students:

- develop an understanding of the world, built on current scientific theories
- learn that science involves particular processes and ways of developing and organising knowledge and that these continue to evolve
- use their current scientific knowledge and skills for problem solving and developing further knowledge
- use scientific knowledge and skills to make informed decisions about the communication, application, and implications of science as these relate to their own lives and cultures and to the sustainability of the environment.

### **What are those Big Ideas *about* Science?**

In developing the Level 1 Science Learning Matrix the SEG has identified four overarching Big Ideas derived from the NZC. They are aspects of science and mātauranga Pūtaiao that will provide young New Zealanders with the skills, attitudes and capabilities to engage fully with life. They are an amalgam of:

- [Nature of Science](#) achievement aims from NZC
- [Key competencies](#) from NZC
- [Values and vision](#) from NZC
- [Science capabilities](#)
- [Mātauranga Pūtaiao](#)

## **Big Idea: Investigating in Science**

Investigations are used to generate and evaluate knowledge both in Science and in mātauranga Pūtaiao, to answer questions. A variety of investigation methods exist that involve making observations, gathering evidence, and collecting and interpreting data. Different investigation approaches are appropriate for answering different questions. Approaches may include pattern-seeking, exploring and observing, investigating models, classifying and identifying, making things, developing systems, and fair testing. Key aspects of investigating in Science include formulating questions, using an appropriate investigation approach to generate evidence, and evaluating both the suitability of the approach and the rigour of the evidence generated. All steps are important to ensure the findings of an investigation are robust and fit for purpose.

### **Rationale for why this is a Big Idea**

Investigations enable scientists to create, test and clarify knowledge and understanding which builds the body of science knowledge. Investigations allow learners to not only test current science understanding, but also to question and challenge the status quo, with the potential to create new knowledge and understandings. Learners have questions they want answers to, and these range in nature and complexity requiring various investigation approaches. Learners who are curious about the natural world will collect data to seek patterns or to gain a greater understanding of the phenomenon in question. Everyone has the capacity to produce and use primary data from a variety of contexts and sources, including the ability to consider narratives and human experiences as authentic and valid inputs. By engaging in investigations themselves, learners are more likely to think critically about information, data and claims from the investigations of others. A life-long learner is able to investigate, evaluate and collect data to enhance their participation in society.

### **What does it look like at curriculum level 6?**

Students understand that science knowledge is developed through investigation and can select, plan and carry out appropriate investigations. When planning science investigations at this level students can identify and refine testable questions and apply investigation approaches that are appropriate to specific questions and contexts. They understand there is no single “scientific method” but that there are common ways of working that apply across all approaches. They begin to evaluate their own and others’ methods and data and use appropriate ways to communicate their own understanding of evidence and draw conclusions.

## **Big Idea: Using science to engage with real world issues**

Science and mātauranga Pūtaiao offer ways for students to engage with real world issues (including problems, needs and opportunities) at a personal, community, and/or global level. Students will bring their own world view, experiences, and knowledge while building new capabilities such as disciplinary meaning making, perspective taking

and critical inquiry to develop evidence-based opinions, and respond to real world issues at a local level.

### **Rationale for why this is a Big Idea**

Students are empowered when they learn to explore different perspectives, develop and express their own reasoned opinions, and make decisions to take action. Students will use the practices and knowledge drawn from multiple knowledge systems including mātauranga Māori and western science to inform their perspectives, opinions and actions. As they explore real world issues, as well as considering science perspectives, they will also need to consider relevant cultural, social, environmental, ethical, economic and political implications. Using science to engage with real world issues provides a tangible purpose for learning, builds student agency, and enables science-informed actions that contribute to communities.

### **What does this look like at curriculum level 6?**

In exploring real world issues students establish what knowledge they already bring and what new knowledge they may need to gain, determining the different perspectives relevant to the problem (these could be cultural, social, environmental, ethical, economic, political). They recognise how western science and mātauranga Māori knowledge can help them address issues and problems at the global and local level. Students analyse information in its various forms and know how to check the sources of information. Science-based conclusions are used to undertake action and they begin to reflect on the suitability and impact of their own actions.

### **Big Idea: Science as a human endeavour**

Science and mātauranga Pūtaiao involve particular processes and ways of developing and organising knowledge, and these continue to evolve. Both recognise the importance of creativity and curiosity, and neither deals with absolutes. Developments in culture, history, technology, and philosophical viewpoints have changed what science can explain. People currently working in these fields learn from and build on knowledge that has been generated by those who came before them. By understanding how science knowledge has developed, extended, and changed over time, learners can appreciate how Science and mātauranga Pūtaiao operate and can use appropriate tools in their own science practice.

### **Rationale for why this is a Big Idea**

Understanding how science and mātauranga Pūtaiao have developed over time, and familiarity with the tools used to generate scientific knowledge allows students to contextualise content knowledge gained across the strands of the science discipline.

By exploring the stories, the models used to generate and test ideas, the experiments carried out to explore concepts (including classic failures), and the development of theories and laws, students gain some understanding of the philosophy of Science and of mātauranga Pūtaiao. Through their explorations, they come to appreciate the tentative and robust nature of science.

## **What does this look like at curriculum level 6?**

At curriculum level 6 students begin to understand the nature of mātauranga Pūtaiao and the nature of western science. They understand how models and theories have developed through time (and are influenced by culture, politics etc), and how evidence continues to inform future projections of the application.

## **Big Idea: Communicating in Science**

Science offers a way for students to interpret representations, critique evidence, and communicate knowledge, thus enabling their active participation in society. While mātauranga Pūtaiao and Science represent their ideas in different ways, both help our understanding of the natural world, giving us two rich perspectives. The rigour of the conventions used in both mātauranga Pūtaiao and Science means science ideas remain testable which justifies their inclusion in the growing body of science knowledge. Science ideas are presented in different ways depending on whether they are communicated to other scientists or to the public.

### **Rationale for why this is a Big Idea**

There are conventions in the way science knowledge is generated. When science-related information is communicated to the public, it may be presented in various forms, including primary research findings (scientific reports and scholarly articles), pūrākau (narratives containing scientific wisdom), and popular media such as TED Talks, infographics, and illustrated narratives – among others. The way science information is conveyed to the public may not use all the formal science conventions but knowing what these conventions are and how they work can help us interpret and evaluate scientific claims and ideas in the public space.

Young people are bombarded with a huge volume of information from the internet and other sources. Those who are able to critique information and arguments involving evidence, and assess the validity of that evidence will make informed decisions. The tools to discern valid evidence and to distinguish science from pseudo-science are vital in this information-rich world. Students are also communicators of science. Different audiences will require them to communicate their own findings and understandings in different styles.

## **What does this look like at curriculum level 6?**

Students understand the need to think critically about science claims made in various contexts and media. They engage in scientific conversations about the quality of evidence by being open-minded and being able to critically analyse data and evidence-based conclusions.

## **Why is Context so important?**

The Big Ideas *of* and *about* science apply to learning in this subject across all curriculum levels and years. What distinguishes learning at each curriculum level is the degree of complexity and sophistication of the concepts and epistemic aspects

involved, and the level-appropriate contexts chosen. From curriculum level 6 upwards students engage with contexts that are typically broad, deep and large in scale, and extend beyond their personal experience. The contexts are likely to involve multiple interacting elements; contested ideas; provocative or nuanced interpretations; and may require sustained engagement to understand. Theoretical models and frameworks may be needed to make sense of these contexts at curriculum levels beyond level 6.

## The relationship with te ao Māori

### What's the relationship between mātauranga Pūtaiao and Science?

Deep indigenous understandings of the natural world are found in many nations around the world. In Aotearoa New Zealand the broad indigenous body of knowledge and way of engaging with the world is called mātauranga Māori. An integral part of mātauranga Māori is what has become known as mātauranga Pūtaiao - those aspects of mātauranga Māori concerned with understanding and interacting with the natural world around us.

Mātauranga Pūtaiao expresses the existence of and the relationships between organisms and systems in the natural world through specific concepts such as whakapapa, mauri, kaitiakitanga and derived conceptual frameworks.

The term 'natural world' encompasses all four strands of the NZC – living world, chemical world, physical world, and planet Earth and beyond. For Māori, it expresses the existence of and the relationships between all organisms as well as the interconnectedness of all realms and aspects of their environment.

For Māori, the natural world is whatever their local environment provides. Māori have a place-based understanding of their environment. Even in an urban environment displaced from their ancestral whenua, Māori apply the concepts of mātauranga Pūtaiao to interpret and interact with their local environment within the wider world.

The key to accessing mātauranga Pūtaiao is through concepts such as whakapapa, whanaungatanga, mauri, tapu, noa, and kaitiakitanga. These concepts do not sit within any one curriculum strand and cannot be separated because in te ao Māori they are fully integrated. A te ao Māori view is holistic. For this reason, in the Learning Matrix, some focus questions have been provided that span the strands of Significant Learning we associate with 'subjects' in order to provide opportunities to work with the interconnectedness of the Māori world view. This is a rich opportunity to move away from the compartmentalising of teaching and learning.

One key aspect of mātauranga Pūtaiao, for example, is the way Māori view themselves (humans) as an integral part of all systems in the natural world, rather than being outside of the system. This relates to the concept of whanaungatanga, and contrasts with the more detached perspective that has historically been a feature of western science understandings and activity. If teachers miss this point then ākongā in their classes are less likely to see themselves in the learning of Science.

The knowledge that we call mātauranga Pūtaiao informs the world view of Māori – so mātauranga Pūtaiao is less about the knowledge itself and more about how engaging with it provides a Māori perspective on the world.

When we incorporate mātauranga Pūtaiao into our programmes of learning it's important to avoid inserting it in, or comparing it to western science. The two world views and bodies of knowledge are separate and need to be considered separately. One should not be given greater status than the other - both have authority.

### **Why should we consider alternative world views in our teaching of Science?**

An appreciation of the existence and nature of mātauranga Pūtaiao and its relationship with Science is a key aspect to being a New Zealander.

It is imperative in order to provide educationally powerful connections for ākonga Māori who have the right to engage in learning that recognises their language, culture and identity.

Other learners, including Pacific, are also entitled to have their language, culture and identity recognised in their learning.

All learners can and should learn from indigenous knowledge systems at a time when new approaches are needed to deal with the challenges faced by all.

### **Questions for teachers to consider in planning a teaching and learning programme:**

- What different perspectives can be gained by exploring a mātauranga Pūtaiao view on this topic or question?
- How can we explore this concept or issue using multiple knowledge systems, including mātauranga Pūtaiao?
- Who is available to provide a te ao Māori perspective?
- What do the learners in my class/school hold in the way of prior knowledge that I need to be aware of? How can this be used to empower them as learners and to benefit other learners?
- What other world views do young people in my class bring to their learning and how can I recognise this in the contexts and activities we use, particularly for Pacific learners?

## Learning Matrix

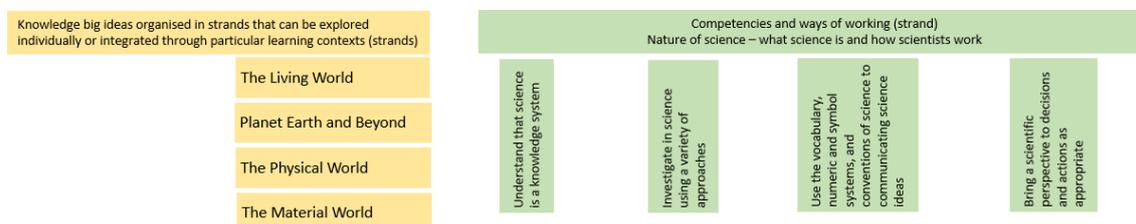
### What is the Level 1 Science Learning Matrix? What is its purpose and what does it reflect?

The Learning Matrix is an opportunity to revisit the way the most Significant Learning in Science can be woven together to achieve a coherent learning experience for young people. It is intended to serve as a model or planning tool for teachers in developing their programmes of Science learning (and assessment) at curriculum level 6. The Learning Matrix recognises the importance of Science content knowledge (both knowledge derived through western science and the knowledge contained within mātauranga Pūtaiao) as well as the overarching ideas, knowledge, attitudes and competencies associated with operating as an ‘amateur scientist’.

The SEG has suggested ways to weave ideas *about* the Science learning area (the epistemic aspects – including Nature of Science (NOS) and key competencies as they apply in the Science discipline) with ideas *of* Science (drawn from across the contextual strands of the NZC - Living world, Material world and so on).

Each of the ‘boxes’ in the body of the matrix suggests questions or themes for inquiry to exemplify ways learning might be framed, including examples of activities that might fit the learning and ensure that significant science knowledge is built up. Teachers will have many other ideas about how to do this weaving.

#### Simplified model of Level 1 Science matrix:



### Why use the overarching Competencies/Nature of Science Big Ideas to structure the Learning Matrix?

The overarching Big Ideas *about* Science act as threads to weave the matrix. A teacher might begin anywhere and build a coherent learning programme by drawing from both the content column and from one of the overarching Big Ideas columns to develop unique and meaningful learning activities that build the competencies/capabilities and knowledge identified as important at curriculum level 6. It has always been the intention of the national curriculum that schools develop their own local curriculum to reflect their community, tapping into local needs and opportunities, as well as local expertise and knowledge, including the mātauranga Māori held by local hapu/iwi or from a local hapu/iwi perspective.

### **Where do I start teaching? Do I have to teach it all?**

The Learning Matrix is **not** a prescription. It does identify the Significant Learning we expect learners to have the opportunity to engage with at curriculum level 6 and it reflects the vision of a Level 1 NCEA Science course that involves broad curriculum exploration.

The short answer is 'start anywhere'. A coherent programme of learning might begin with an area of local significance or student interest. It might start with a fertile context, or local or global issue.

Learning should not be linear. To allow learners to transfer the capabilities developed in one context to new contexts they need exposure and practice in developing and applying those capabilities across multiple contexts using a range of content.

Using an iterative/spiral approach involves covering the Significant Learning in the left hand column while engaging with the overarching Big Ideas in the other four columns multiple times across the year.

Some 'content' ideas sit comfortably within one curriculum strand but others, like the concept of energy, run across strands and provide linking threads between strands and contexts. (Energy captured and used to do biological work in living systems and as heat driving atmosphere and ocean currents, energy in thermodynamics of chemical reactions and in motion and electricity etc.) Other ideas, like the way systems operate and interact with one another, recur in multiple strands. Ecosystems as interconnected webs of relationships and Earth systems of interacting ocean/atmosphere/geosphere all have ideas in common.

## Science Learning Matrix at curriculum level 6

<b>Big Ideas of Science</b> from the contextual strands are woven with the <b>Big Ideas about science</b> to exemplify the significant learning at curriculum level 6				
<p>These four Big Ideas reflect the nature of science and of mātauranga Pūtaiao and the key competencies from the NZC, and they sit across all strands of Science and mātauranga Pūtaiao:</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><i>Mā te whakaaro nui e hanga te whare; mā te mātauranga e whakaū.</i></p> <p><i>Big ideas create the house; knowledge maintains it.</i></p> </div>	<p><b>Investigating in Science</b></p> <p>Investigations are used to generate and evaluate knowledge both in science and in mātauranga Pūtaiao (to answer questions). There is no one scientific method. Different investigation approaches are appropriate for answering different questions. Key aspects of investigating in science include formulating questions, using an appropriate investigation approach to generate evidence, and evaluating both the suitability of the approach and the rigour of the evidence generated. All steps are important to ensure the findings of an investigation are robust and fit for purpose.</p>	<p><b>Using science to engage with real world issues</b></p> <p>Science and mātauranga Pūtaiao offer ways for students to engage with real world issues (including problems, needs and opportunities) at a personal, community, and/or global level. Students will bring their own world view, experiences, and knowledge while building new capabilities such as disciplinary meaning making, perspective taking and critical inquiry to develop evidence-based opinions, and respond to real world issues.</p>	<p><b>Science as a Human Endeavour</b></p> <p>Science and mātauranga Pūtaiao involve particular processes and ways of developing and organising knowledge, and these continue to evolve. Both recognise the importance of creativity and curiosity, and neither deals with absolutes. Developments in culture, history, technology, and philosophical viewpoints have changed what science can explain. People currently working in these fields learn from and build on knowledge that has been generated by those who came before them. By understanding how scientific knowledge has developed, extended, and changed over time, learners can appreciate how science and mātauranga Pūtaiao operate and can use appropriate tools in their own science practice.</p>	<p><b>Communicating in Science</b></p> <p>Science offers a way for students to interpret representations, critique evidence, and communicate knowledge, thus enabling their active participation in society. While mātauranga Pūtaiao and science represent their ideas in different ways, both help our understanding of the natural world, giving us two rich perspectives. The rigour of the conventions used in both mātauranga Pūtaiao and science means scientific ideas remain testable which justifies their inclusion in the growing body of scientific knowledge. Science ideas are presented in different ways depending on whether they are communicated to other scientists or to the public.</p>
<p><b>Mātauranga Pūtaiao brings particular perspectives for working with the four Big Ideas about Science:</b></p>	<p>Mātauranga Pūtaiao involves long term observations, recognition of patterns, and rigorous testing of ideas. Existing or old knowledge is continually refined and new knowledge is developed through ongoing observation and experiences. Knowledge and values are used to guide behaviours and to inform decisions, and are often transmitted via narratives including pūrakau, metaphors and analogies.</p>			
<p><b>All living things are interrelated. Genetic information provides for continuity of life and is passed from parent to offspring via DNA.</b></p> <p>Mātauranga Pūtaiao recognises the interconnectedness of all life.</p> <p>DNA is the unit of inheritance and it carries information in a chemical code.</p>	<p>Use a range of approaches to investigate genetics, inheritance and evolution.</p> <p>Explore ways to show the relationships between groups of organisms based on their structure using leaves or flowers.</p> <p>Investigate the impact of human actions and natural events on NZ ecosystems. eg by collecting data to compare diversity in managed and natural communities.</p>	<p>What are the local socio-scientific issues related to genes and inheritance?</p> <p>What is the impact of genetic knowledge on human decisions about generational relationships? Is there a place for genetic testing, genetic counselling for inherited disorders or other familial conditions?</p> <p>What are the implications of (a lack of) genetic variation in the conservation of species?</p>	<p>How have scientists and mātauranga practitioners developed our understanding of genetics and inheritance, and how have technologies helped them with this?</p> <p>How has our science-informed understanding of genes and inheritance changed over time, and who were some of the people involved??</p> <p>What is the mātauranga Pūtaiao view of inheritance, and how this has changed over time? What can local</p>	<p>Examine science claims made about genetics and evolution, and explain your findings.</p> <p>Are mutations always 'bad'?</p> <p>How do scientists use representations to communicate the relationship between chromosomes, genes and DNA?</p> <p>What are some of the claims made about genetic manipulation, and what is the credibility of these claims?</p>

<p>Genetic variation arises by: 1: mutation 2: shuffling of genes in sexual reproduction</p> <p>Human choices and activities can affect the flow of genetic information between generations.</p> <p><i>At the population level, process of evolution drives the diversity of life.</i></p> <p>Natural selection can result in changes in the genetic makeup of populations over generations.</p> <p>Genetic variation is essential for evolutionary change.</p> <p>Environmental changes (random or human-induced) can apply selective pressure on populations.</p> <p><i>Where populations cannot adapt to the rate of environmental change, extinction occurs.</i></p> <p><i>Biodiversity is important for ecosystem resilience.</i></p> <p>Systems with more biological diversity are more likely to survive environmental changes which can be human induced.</p>	<p>Using keys to identify and classify organisms in a local community.</p> <p>Interpret tracking tunnel prints to identify organisms present in the local area. Collect data over time to investigate the impact of an action.</p>	<p>What are some of the local socio-scientific issues related to selection and evolutionary change? What might be the impact of climate change/global change on local ngahere?</p> <p>Examine the difference between selective breeding techniques and GE in the context of conserving a locally- endangered plant or animal species. How do these impact on indigenous IP?</p> <p>Do action-based community projects such as species monitoring and pest control actually make a difference? How can we measure their success?</p> <p>What can we do locally in terms of restoration ecology? Who should be involved in decisions - landowners, local hapu or hapori?</p>	<p>hapū, iwi and place-based understandings tell us about the importance of genealogy for Māori?</p> <p>What cutting edge research is happening in New Zealand around selective breeding for new animals, crops and foods? How have Māori used Pūtaiao knowledge to selectively breed plant crops? eg taewa, kumara. What new approaches make this possible?</p> <p>What evidence is there for evolutionary change, and who has helped to discover it? Explore examples such as Darwin’s finches; NZ weta and land snails on offshore islands; moa, kiwi, kākā in NZ; diversity of NZ Veronica species linked to their habitats.</p> <p>What contributions have NZ scientists made to our understanding of the importance of biodiversity? How have local conservation strategies such as predator-proof fences added to our understanding of ecosystems and their resilience?</p> <p>What can modern DNA technology tell us about Pacific migrations?</p>	<p>How can genealogical information be represented and used to investigate questions about things like human health or production in farmed species?</p> <p>Evolution vs creationism - what is used to support the respective arguments? What constitutes evidence?</p> <p>Explore how ideas are communicated by groups with differing perspectives and opinions on an issue such as predator control (eg trapping vs 1080).</p>
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<p><b><i>The total amount of energy in the universe is always the same but the energy can be transformed and/or transferred when things change or happen.</i></b></p> <p>Energy is required to do work.</p> <p>Heat energy transfers from regions of relative warmth to colder regions.</p> <p>Wave motion transfers energy without transferring matter.</p> <p>A force is required to change motion</p> <p>Forces acting at a distance are explained in terms of fields.</p> <p>Newton's three laws of motion describe the relationship between force and motion.</p>	<p><b>Use a range of approaches to investigate the nature of energy.</b> Where does the energy go when I .....? (turn on the light, start the car, put a log on the fire etc)</p> <p>How does the strength of fields change over distance? (eg light, magnetic, wifi signals, bluetooth)</p> <p>How do we know what representation or convention to use (diagram, graph, mathematical formula, all of the above)? Investigate the effectiveness are different types of insulation.</p>	<p><b>Identify socio-scientific issues relating to human uses of energy, at a local level.</b></p> <p>What are the local impacts of increasing human demands for energy (production, &amp;/or use)?</p> <p>Is climate change affecting the local sea levels and currents, and what actions might be taken?</p> <p>Would it be possible for my kāinga to use only renewable energy, and what would we need to do to get there?</p> <p>What kind of heating system should we use for my house? Is there an argument for the government subsidising housing insulation and heating?</p>	<p><b>How has our understanding of the nature of energy changed over time, and which people and what technologies have enabled this?</b></p> <p>What can science tell us about our electrical energy future?</p> <p>How important was the discovery of X-rays?</p> <p>What's the relationship between magnetism and electricity and how did/does this affect electricity generation?</p> <p>How is Earth's magnetic field used in navigation (by humans and animals)? How do we know it has changed over time?</p> <p>Can we link what is happening to 'Newton's apple' to what is happening in the 'stars'?</p>	<p><b>Examine science claims made about energy, and explain your findings.</b></p> <p>Do the benefits of 5G outweigh the potential risks?</p> <p>What is the relationship between carbon dioxide and a warming world - how does the carbon dioxide trap heat?</p> <p>Is it possible that the radiation from cell phones can cause cancer?</p>
<p><b>All matter in the universe is made of very small particles.</b> Properties of substances observable at the macroscopic level can be explained by, but are different from, the structures of atoms and molecules and the interactions between them. Rearrangements of matter (chemical reactions) can be observed at the macroscopic level and involve changes at the atomic and sub-atomic level. The total amount of matter remains the same in chemical reactions.</p>	<p><b>Use a range of approaches to investigate the particle nature of matter.</b> Investigate what happens when ice melts in salt water vs fresh water and explain using ideas about particles, states and density. How does the concentration of a substance change its perceived smell – eg ethyl mercaptan? How much acid does it take to dissolve a shell? (Involves exploring concentration and strength of acids). Varying the relative amounts of reactants – what happens to the products produced? What happens when we vary the amount of oxygen available when burning fuels?</p>	<p><b>Identify a socio-scientific issue related to chemistry that has local significance.</b></p> <p>Is 1080 used in our ngahere? What is the chemistry of 1080? Does it break down in the environment?</p> <p>Explore the chemistry of 1080. How does it breakdown in the environment?</p> <p>How might changes in ocean chemistry affect kai moana, and are there any actions my community could take to mitigate this?</p>	<p><b>How has science and mātauranga Māori understanding of the structure of matter changed over time? Which people, and what technologies, have driven our changes in understanding?</b> Explore how a particular model has been developed from scientific investigations. How did the experimental evidence at the time impact on the development of the periodic table? Explore the science ideas involved in the development of Māori dyeing and weaving. How have new pigments and processes been integrated into traditional practices?</p> <p>How were and are new elements discovered?</p> <p>How have different scientists contributed to the understanding of matter and the interactions between substances?</p>	<p><b>Examine some of the scientific and pseudoscientific claims made about chemistry, and explain your findings.</b></p> <p>Examine the scientific claims made about consumer products such as cosmetics, sunscreens, medicines (eg vaccines), and foods (eg nutritional supplements).</p> <p>How do we distinguish science from pseudoscience communicated in the media (e.g. homeopathy, crystals)?</p> <p>What is meant by organic food? Are 'natural' foods better than 'artificial' foods?</p>

<p><b>Interacting processes within and between the hydrosphere, biosphere, atmosphere, and geosphere shape and affect the surface, the climate, and life on Earth.</b></p> <p><b>Mātauranga Pūtaiao expresses the existence of and the relationships between organisms and systems in the natural world through concepts such as whakapapa, mauri, tapu, noa, kaitiakitanga and derived conceptual frameworks.</b></p> <p><b>The distribution of heat energy within the Earth system is dynamic, and this is affected by human activity.</b></p> <p><b>The universe changes over time. The Earth and space systems within the universe interact with each other. Earth is affected by interactions between solar, lunar and Earth cycles</b></p>	<p><b>Use a range of approaches to investigate questions about earth and space science.</b></p> <p>Investigate a specific human impact on the Earth System. (Possibility of looking at a pattern seeking investigations and correlations)</p> <p>Collect data to investigate energy budgets, on an individual/local/global level</p> <p>How might climate change be affecting the maramataka, now and in the future?</p> <p>Explore, using models, the impact of various strategies for reducing the impact of sea surge or flooding for coastal areas.</p>	<p><b>Identify a local socio-scientific issue related to earth &amp; space science/environment</b></p> <p>Are there local actions that can be taken to mitigate the effect humans are having on rising atmospheric carbon dioxide levels (eg the impacts of changing sea levels and more frequent storms on coastal communities)?</p> <p>What can be done to address the inundation of low-lying Pacific Islands?</p> <p>Is food security an issue for my local community? Should we be concerned, and are there actions we could take to address this?</p> <p>The local awa seems to be flooding more and more often. What are some of the likely causes, and are there things my whānau, hāpori or iwi could do to address it?</p>	<p><b>How has science and mātauranga Māori understanding of both the Earth and space changed over time? Which people, and what technologies, have driven our changes in understanding?</b></p> <p>Tupāia's navigational map and its significance in understanding Pacific exploration. What natural phenomena did Polynesian navigators use to cue their navigation?</p> <p>When did scientists first start noticing the impact of humans energy use on Earth Systems?</p> <p>Explore the work of Rangi Mātāmua. How are wave patterns used in Māori navigation?</p> <p>How has our understanding of climate change been enhanced by new methodologies and tools? What new evidence can we collect now and how?</p> <p>How is knowledge held within mātauranga Māori developed and used in deciding where to base settlements? eg Matatā taniwha.</p> <p>Explore, in your local context, how the interactions between the Earth and Space systems are understood from a mātauranga Pūtaiao perspective, and how they apply/utilise these views.</p>	<p><b>Examine some of the scientific and pseudoscientific claims made about Earth and space science.</b></p> <p>Critique information provided about energy usage and efficiencies, eg cars, appliances.</p> <p>How can people argue the case for a flat earth? Where's the evidence? What about the moon landings?</p> <p>Look at the claims made by a range of sources around climate change and sea level rise/disappearing islands.</p> <p>What is the moon's influence on geological and weather events on the Earth?</p> <p>Explore the mātauranga Pūtaiao view of the relationships between organisms and the Earth system (whenua, moana, kōhauhau) for a local or global issue.</p>
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## The Assessment Matrix

### Science Assessment Matrix

A.S. 1.1 Use a range of scientific investigative approaches.  6 credits, Internal	A.S. 1.2 Explore a real-world issue and devise a local, science-informed action.  4 credits, Internal	A.S. 1.3 Describe attributes of Science that contribute to the development of scientific ideas and processes.  6 credits, External	A.S. 1.4 Interpret scientific claims in publicly communicated information.  6 credits, External
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#### Rationale for Assessment Matrix:

The aim of the Assessment Matrix is to provide opportunities for graduates of NCEA Level 1 Science to take away an understanding of how Science works as a process and a discipline as well as a basic grasp of the most significant concepts and ideas from across the contextual strands.

For some students, NCEA Level 1 will be the last time they engage in formal Science learning. These students are entitled to take away from their NCEA Level 1 Science course skills and knowledge that will allow them to engage with the science (and pseudoscience) they will encounter in life beyond school.

For learners continuing in any of the specialist Science subjects, their learning at Level 1 NCEA will build the disciplinary capabilities that enable them to take deep dives into their chosen strands, understanding how that disciplinary knowledge has developed, and is communicated and applied.

Ākonga Māori in both English medium and kura settings are entitled to see themselves in learning and assessment contexts and approaches, so they are able to engage as Māori in their learning of Science. This applies also to learners of other cultures.

The Level 1 Science Learning Matrix illustrates the Significant Learning envisaged when the content from our contextual strands is woven with the overarching (epistemic/Nature of Science) Big Ideas. Those overarching Big Ideas were used to frame the Assessment Matrix of four Achievement Standards. The Subject Expert Group (SEG) identified key learning outcomes related to each Big Idea at curriculum level 6 and drafted standards that allow for mastery to be demonstrated across any or all of the contextual strands.

Big Idea about Science	Achievement Standards
Investigating in Science	Use a range of scientific investigative approaches. (I)
Using Science to Engage with Real-world Issues	Explore a real-world issue and devise a local, science-informed action. (I)
Science as a Human Endeavour	Describe attributes of Science that contribute to the development of scientific ideas and processes. (E)
Communicating in Science	Interpret scientific claims in publicly communicated information. (E)

A key focus in developing both the Learning and Assessment matrices has been the integration of the Nature of Science aims, the Science Capabilities and the Key Competencies. The draft achievement standards provide rich opportunities for developing all of these key aspects with some more strongly reflected in certain standards. **The following is just one possible mapping of the four Big Ideas/Achievement Standards against NOS, Science Capabilities and the KCs.**

	Big Ideas about Science:	Investigating	Engaging with real world issues	Science as Human Endeavour	Communicating
	Achievement Standards:	AS 1.1	AS 1.2	AS 1.3	AS 1.4
Nature of Science	Understanding about Science				
	Investigating in Science				
	Communicating in Science				
	Participating & contributing				
Science capabilities	Gather and interpret data				
	Use evidence				
	Critique evidence				
	Interpret representations				
	Engage with science				
Key Competencies	Thinking				
	Using language, symbols & texts				
	Managing self				
	Relating to others				
	Participating & contributing				

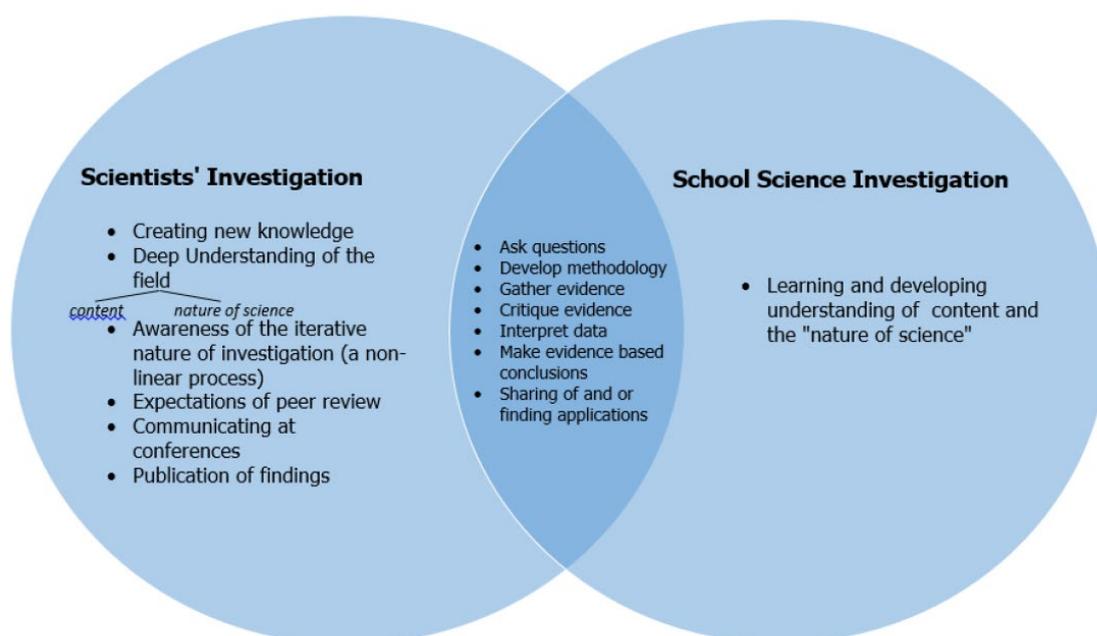
## Draft achievement standards

**Science 1.1** Use a range of scientific investigative approaches.

The focus of this standard is strongly on students' own activities (whereas the focus of AS 1.3 is on the activities of others). It recognises that scientists' investigations and school science investigations involve several of the same features, but while students might gain new knowledge through their investigations, the emphasis in a school setting is on learning *how* to investigate.

See below: Features of Investigations

### Features of Investigations



The requirement for students to demonstrate their understanding and skills across a range of investigative approaches signals a shift away from the current state for many schools and aims to encourage teachers to explore a wider range of ways to investigate. Evidence of three different approaches is required by the standard, and students will be asked to discuss the suitability of each approach for the purpose.

This standard is assessed internally to allow maximum flexibility in the range of approaches and contexts used for investigating. Students will demonstrate capabilities around selecting and refining suitable questions and investigative methods including, where appropriate, the use of a mātauranga Pūtaiao investigative framework.

At NCEA Level 1, teachers would provide some direction by providing a purpose and general instructions for the investigative method, as well as resources for students to select from.

**Science 1.2** Explore a real-world issue and devise a local, science-informed action.

This standard brings together the key competencies, NOS, and Science capabilities with relevant Science content knowledge to build students' action competence in a Science-related context. It is distinct from a Social Science inquiry and action in that the issue, position and action must be explained in terms of scientific evidence, including that from mātauranga Pūtaiao. The standard recognises the importance of considering different perspectives, including a te ao Māori world view, when formulating a position/action, and the appropriateness of students using a collaborative approach in the planning and action-taking stages.

The context for learning assessed by this standard needs to be carefully chosen. The focus is on an issue with local significance, even if the issue itself is a global one. At NCEA Level 1, a community context is important so local expertise and perspective can be used and action can be evaluated in terms of its local impact. Local iwi and hapu could have an interest in issues and activities involving local moana or whenua. Schools/communities might have long term projects under way that lend themselves to learning and assessment using this standard, with students negotiating particular angles and actions in response to the same issue.

**Science 1.3** Describe attributes of Science that contribute to the development of scientific ideas and processes.

This standard focuses on the activities of others (whereas Science 1.1 focuses on students' own activities) and explores the development of science ideas and of the science process itself. It relates to the Science as a Human Endeavour Big Idea which is about the history, philosophy and processes underpinning Science as a discipline. Learning about the development of Science helps students to understand where the science ideas, models, and theories they learn about in school came from. It lets them engage effectively with science in their lives and build the insights they need to critique science claims.

Western Science and mātauranga Pūtaiao are both rich in accounts of the people and events that contributed to the development of science ideas in their respective bodies of knowledge. For both, technological advances and cultural shifts have impacted the pace and direction of the development of ideas. Ideas in both Science and mātauranga Pūtaiao continue to develop as new methods and evidence emerge so this standard does not only look back into history, it includes a current and future focus.

The attributes of both Science and mātauranga Pūtaiao can be used to explore the development of science ideas. By recognising those attributes in the activities of those who contributed to the development of science ideas, students build an appreciation for what makes Science robust and trustworthy. An appreciation of the tentative

nature and continuing development of science ideas allows students to apply their understanding of the Nature of Science (NOS) to new contexts.

It is expected that students will explore the development of science ideas as they encounter them in their learning throughout the year. The stories of science are often used to engage learners but the challenge is to be far more explicit about how the nature of science is reflected in those stories so students build their understanding of Science as a Human Endeavour across many strands, contexts and where appropriate, through a mātauranga Pūtaiao lens.

For several reasons, an external assessment mode is appropriate for assessing this standard. Being an entirely new way of assessing the Nature of Science curriculum strand, a structured approach will provide support for teachers and students preparing for assessment. Providing a range of case studies ahead of the final submission date provides choice and flexibility, making the assessment more accessible for a range of learners. Teachers will have the chance to appropriately support learning around the chosen case study, and students will not be restricted to extended written text to provide evidence. They might use annotated diagrams, timelines, cartoons etc to contribute evidence. A list of attributes will be used along with focusing questions to guide students in what they need to provide.

**Science 1.4** Interpret scientific claims in publicly communicated information.

In a world where young people encounter increasing volumes of information and claims about science via multiple media, a critical filter is an important life skill.

Understanding of the language, conventions and processes of science provides students with tools to interrogate scientific claims, to evaluate the robustness of science, and to recognise pseudo-science. Scientific claims include those based on mātauranga Pūtaiao, which has its own science language and conventions.

Recognising when science claims are trustworthy allows students to form soundly reasoned opinions which are defensible using evidence.

It is envisaged that throughout the year students will build their critical skills by critiquing a wide range of communication forms that involve real science concepts drawn from the Significant Learning *of* Science (the 'content' column on the Learning Matrix). Evidence will be collected in an externally marked portfolio comprising three critiques across a range of forms of communicated information. A template/rubric will be applied to guide students to address key credibility criteria in each case while allowing for a variety of formats/methods of recording their critique (eg tracking comments, annotating an advertising poster). Students would be expected to select examples that demonstrate both Science/mātauranga Pūtaiao and pseudoscience.

## Rationale for Science Level 1 Credit Allocation

<b>DRAFT Standard:</b>	A.S. 1.1 Use a range of scientific investigative approaches.	A.S. 1.2 Explore a real-world issue and devise a local, science-informed action.	A.S. 1.3 Describe attributes of Science that contribute to the development of scientific ideas and processes.	A.S. 1.4 Interpret scientific claims in publicly communicated information.
<b>Scope of assessment:</b>	A range of investigative approaches – multiple reports with comparison across all (three?) approaches – focus is on breadth	One report that takes a deep dive into an issue with supporting science information to explain and justify an action – focus is on depth	One report that takes a deep dive into development of a significant science idea – focus is on depth	Portfolio of evidence from across several forms of communication – focus is on breadth
<b>Assessment mode:</b>	Internal	Internal	External	External
<b>Proposed credits:</b>	6 credits	4 credits	4 credits	6 credits

- The 50/50 split in both number of standards and number of credits between internal and external assessment means this matrix meets the expectations of NCEA Change 4.
- Credits values are provisional and will be confirmed once SEG writers and NZQA have developed tasks for each. Not until then will the full scope and likely proportion of time for teaching, learning and assessment be really clear.
- SEG rationale for credit value by standard:
  - AS 1.1 – Investigation – (internal) – Current Level 1 Science investigations are worth 4 credits and use a single context and investigative approach. The focus has been shifted to consider the breadth of approaches used to investigate in Science and this would mean each investigation may involve a somewhat

“lighter touch” with evidence of key aspects of investigation (management of variables/sampling technique, collection and processing of data, etc) coming from across three investigations.

- AS 1.2 – Engaging – (internal) – There is no current standard involving taking action but one Level 1 Biology standard requires students to Report on a biological issue for 3 credits. The added requirement of a science-informed action and reflection on that action justifies the higher credits value in the new standard.
- AS 1.3 – Development of science ideas – (external) – This is another example of a deep dive into a single context. Currently Level 1 Physics and Chemistry have standards that explores an application of science, worth 2 credits each. The new standard requires students to apply a broad set of NOS criteria in their response and invites a focus back in time and into the future. A value of 4 credits recognises the greater demands of applying a philosophical approach, rather than simply an application of science ideas.
- AS 1.4 – Communication – (external) – Again, the breadth intended by this standard justifies the six credits allocated. A range of three pieces of communicated information will be analysed within a structured report, with the structure specified by NZQA but allowing for flexibility in the way students present their evidence (not just written text).

## AS 1.1 Use a range of scientific investigative approaches.

### Level

1

### Credits

6

### Assessment mode

Internal

### -- Achievement Criteria --

#### Statement linked to key learning outcomes

Investigating in Science Level 6 of NZC.

Plan and carry out a range of scientific investigations.

Students will consider the validity in their method design.

Students will evaluate the suitability of the investigative approaches chosen.

#### Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
Use a range of scientific investigative approaches.	Explain a range of scientific investigative approaches.	Evaluate a range of scientific investigative approaches.

## Explanatory Notes

### Explanatory Note 1

Use a range of scientific investigative approaches involves:

- developing methods for each investigative approach

- applying methods to gather and interpret data
- drawing conclusions based on their findings

Explain a range of scientific investigative approaches involves:

- developing methods for each investigative approach to improve the validity of findings
- processing data appropriately

Evaluating a range of investigative approaches, involves:

- applying scientific conventions when presenting findings
- discussing the suitability of the investigative approaches used.

### Explanatory Note 2

Investigative approaches include:

- applying a mātauranga Pūtaiao framework
- pattern seeking
- exploring and observing
- using models to generate data
- classifying and identifying
- fair testing.

## Possible activities for working with AS 1.1 Use a range of scientific investigative approaches.

These possible teaching and assessment activities have been created to provide teachers with examples of how a standard might be used in the classroom, including possible contexts and learning activities that might be used either to build investigative skills and knowledge or to collect evidence toward this Achievement Standard. These are not assessment tasks. Full assessment resources to support the internally assessed standards will be developed in Phase 2 of the Trial and will incorporate sector feedback on these draft ideas.

### Achievement Standard 1.1 Use a range of investigative approaches in science.

#### NCEA level 1

#### Credits 6

#### Assessment Mode and Approach

Internal (Evidence will be collected into a structured report/portfolio across multiple investigations)

#### Rubric

Achievement Criteria	Indicators	Comments on quality of student evidence collected from across the range of investigative approaches used.
<p><b>Achieved:</b> Use a range of scientific investigative approaches.</p>	<ul style="list-style-type: none"> <li>developing methods for each investigative approach</li> <li>applying methods to gather and interpret data</li> <li>drawing conclusions based on data</li> </ul>	Developing and applying methods
<p><b>Merit:</b> Explain a range of scientific investigative approaches.</p>	<ul style="list-style-type: none"> <li>developing methods for each investigative approach to improve the validity of findings</li> <li>Processing data appropriately.</li> </ul>	Improving validity of findings
<p><b>Excellence:</b></p>		

Evaluate a range of scientific investigative approaches.	<ul style="list-style-type: none"> <li>• applying scientific conventions when presenting findings</li> <li>• discussing the suitability of the investigative approaches used.</li> </ul>	Discussing suitability of each approach		
<b>Basis for final decision:</b>				
<b>Final Decision:</b>	<b>Not Achieved</b>	<b>Achieved</b>	<b>Merit</b>	<b>Excellence</b>

-- Possible Learning and Assessment Activity 1 --

Possible Context

**Sea level on the rise**

This is an appropriate context because New Zealand is an island nation, meaning it is surrounded by sea, and will be greatly impacted as a result of any rise in sea level. Climate change is causing temperatures to rise, causing ocean temperatures to change, and ice to melt. There are multiple, possible investigative approaches that could be applied in this topic.

*Curriculum Key Concepts and Content*

The context of sea level rise offers numerous links to curriculum concepts. Learners could study a range of key processes such as:

- global warming
- greenhouse effect
- dwindling ice coverage in the Arctic and Antarctic
- disappearing islands in the Pacific
- effects of reduced ice on: organisms/ecosystems/biodiversity
- coastal erosion and effects on town planning/building
- chemistry and physics of sea level rise

- changes in ocean chemistry as a result of ice melt
- effects of warming on ocean circulation

Concepts such as kaitiakitanga, whakawhanaungatanga and other culturally relevant perspectives and investigative frameworks may be incorporated into investigations to ensure the scientific approach taken is relevant to the learners involved.

Investigating any of the above aspects of the broader context provides students with opportunities to learn about and apply a range of different investigative approaches chosen from:

- pattern seeking
- exploring and observing
- using models to generate data
- classifying and identifying
- fair testing
- application of a mātauranga Māori investigation framework

Students will develop strategies and techniques to increase the validity of data collected for the different investigative approaches. They will also have explored the advantages and disadvantages of the investigative approaches learnt, so they can evaluate the suitability of an approach for a specific investigative purpose.

#### *Possible Learning and Assessment Activities*

Groups/classes/individuals might explore different aspects of the impact of sea level rise or whole classes might undertake the same general investigations, working collaboratively where appropriate, but reporting individually.

Some specific examples of learning and/or assessment include:

Using simple models to demonstrate the differing impacts of melting land ice and sea ice on sea level rise. (ref: <https://www.sciencelearn.org.nz/resources/2278-investigating-sea-level-rise> )

Investigate, using models, the impact of melting polar ice on sea levels (ref: <https://www.scientificamerican.com/article/bring-science-home-sealevel-rise/> )

What makes ice melt the fastest? (ref: <https://www.scientificamerican.com/article/what-makes-ice-melt-fastest/> )

Investigate the effect that contact with water has on melting ice. (Ref: <https://www.sciencelearn.org.nz/resources/2279-melting-glacial-ice> )

Investigate the relationship between temperature and the volume of water. (ref: <https://archive.epa.gov/climatechange/kids/documents/sea-level-rise.pdf> )

Explore and observe the effects of sea level rise on coastal communities. (Could use data from <https://climate.nasa.gov/vital-signs/sea-level/> , or photos of the same area over time)

Investigate sea-level data to create models and compare short-term trends to long-term trends. (Uses secondary data - ref: <https://www.jpl.nasa.gov/edu/teach/activity/graphing-sea-level-trends/> )

Use a model to investigate the effect of sea level rise on small islands (Ref: [http://arcticclimatemodeling.org/lessons/acmp/acmp\\_912\\_ClimateChange\\_MappingSeaLevelRise.pdf](http://arcticclimatemodeling.org/lessons/acmp/acmp_912_ClimateChange_MappingSeaLevelRise.pdf) )

#### *Collecting Evidence for Assessment*

Assessment evidence could be collected as a portfolio from a range of investigations then collated into a structured report.

Learners may be given an appropriate template, a suitable aim, and a skeletal method.

It may be appropriate for learners to gather data in groups, but each learner should be actively involved.

Assessors should be able to verify that the evidence submitted for assessment is authentic and has been produced by the learner.

Assessment will involve a minimum of three different investigative approaches. The grade for the Achievement Standard will be decided using professional judgement based on the holistic examination of the evidence from all investigations, against the criteria of the Achievement Standard.

#### *How student work will be assessed*

Students will have:

- developed methods relevant to the purpose stated
- made decisions to improve the validity of the method
- collected data
- processed and interpreted data
- made a conclusion based on data
- evaluated the suitability of different investigative approaches

For all levels of achievement, students need to develop valid methods relevant to the purposes stated, and carry out investigations which allow them to collect, process and interpret data in order to make a conclusion.

Excellence also requires an evaluation of the suitability of the investigation to the purpose.

## -- Possible Learning and Assessment Activity 2 --

### *Possible Context*

#### **Energy on the move**

Everything depends on energy transfer. Therefore there are numerous possible investigation approaches that can be applied within this broad context.

Groups/classes/individuals might explore different aspects of the energy transfer, for example:

- Home insulation
- Milk cooling
- Car cooling systems
- Heat regulation in organisms

### *Curriculum Key Concepts and Content*

Some or all of these investigations could form part of a unit of work studying the overall context of energy transfer. There is broad scope for incorporating the learning of concepts and content such as:

- the particle nature of matter
- phase changes
- home insulation
- temperature regulation in animals
- cooling systems in agricultural or domestic settings
- the Earth's temperature regulation/energy budget
- heat transfer in the Earth and atmospheric circulation.

Concepts such as kaitiakitanga, whakawhanaungatanga and other culturally relevant perspectives and investigative frameworks may be incorporated into investigations to ensure the scientific approach taken is relevant to the learners involves.

Students should be given the opportunity during the teaching of this context to learn about a range of different investigative approaches chosen from:

- pattern seeking
- exploring and observing
- using models to generate data
- classifying and identifying
- fair testing

- application of a mātauranga Māori framework

Students will have used techniques to increase the validity of data collected for the different investigative approaches.

Students will have learned about the advantages and disadvantages of the investigative approaches learnt, so they can evaluate the suitability of an approach for a specific investigative purpose.

Students will have learned accuracy improving techniques that can be used to increase the validity of data collected for the different investigative approaches.

#### *Possible Learning and Assessment Activities*

Groups/classes/individuals might explore different aspects of the impact of Energy transfer or whole classes might undertake the same general investigations, working collaboratively where appropriate but reporting individually.

Some specific examples of learning and/or assessment include:

Investigate the effect of colour on heat absorption. (Ref: <https://www.sciencelearn.org.nz/resources/1590-investigating-heat-absorption>)

Investigate the effectiveness of different home insulation products

Investigate ways to reduce the amount of heat lost from a hot water cylinder.

Investigate the best fluid to use in a car radiator (ref: [https://www.teachengineering.org/activities/view/uoh\\_magic\\_lesson01\\_activity1](https://www.teachengineering.org/activities/view/uoh_magic_lesson01_activity1) )

Investigate patterns in the temperature of soil at different times of the day/month/year.

Identify patterns in the rate at which coffee cools in a variety of different mugs.

Investigate the albedo effect, by modeling different surfaces/colours and their absorbency of heat.

#### *Collecting Evidence for Assessment*

Assessment evidence could be collected as a portfolio from a range of investigations then collated into a structured report.

Learners may be given an appropriate template, a suitable aim, and a skeletal method.

It may be appropriate for learners to gather data in groups, but each learner should be actively involved.

Assessors should be able to verify that the evidence submitted for assessment is authentic and has been produced by the learner.

Assessment will involve a minimum of three different investigative approaches. The grade for the Achievement Standard will be decided using professional judgement based on the holistic examination of the evidence from all investigations, against the criteria of the Achievement Standard.

*How student work will be assessed*

Students will have:

- developed methods relevant to the purpose stated
- made decisions to improve the validity of the method
- collected data
- processed and interpreted data
- made a conclusion based on data
- evaluated the suitability of different investigative approaches

For all levels of achievement, students need to develop valid methods relevant to the purposes stated, and carry out investigations which allow them to collect, process and interpret data in order to make a conclusion.

Excellence also requires an evaluation of the suitability of the investigation to the purpose.

## A.S. 1.2 Explore a real-world issue and devise a local, science-informed action.

Level 1

Credits 4

Assessment mode Internal

### Statement linked to key learning outcomes

Learners will explore a real-world issue with local significance. They may use the practices and knowledge drawn from multiple knowledge systems including mātauranga Pūtaiao and western science to inform their action. They will consider a range of perspectives and make decisions to take science-informed action.

### Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
Explore a real-world issue and devise a local, science-informed action.	Analyse a real-world issue and devise a local, science-informed action.	Evaluate a real-world issue and devise a local, science-informed action.

### Explanatory Note 1

Explore a real-world issue and devise a local, science-informed action, involves:

- describing the science concepts involved in the issue
- identifying perspectives relevant to the issue
- undertaking an action based on scientific evidence.

Analyse the science-informed action involves:

- explaining the science concepts involved in the issue
- examining different perspectives relevant to the issue
- explaining the action taken linked to the scientific evidence

Evaluating the science-informed action involves justifying the local action taken.

## Explanatory Note 2

*Real world issue means an issue that affects the lives of learners. An issue is something on which people hold varying opinions and perspectives.*

*Local significance* means an issue with direct relevance to the learner. Examples include: an issue affecting a place a learner links to through whakapapa; an issue which has personal relevance to the learner; or in geographical proximity to the school or individual.

*Scientific evidence* may include evidence generated through mātauranga Pūtaiao, science or other indigenous knowledge systems.

*Perspectives* may include alternative viewpoints and may be personal, community, iwi, national, global, cultural, social, ethical, environmental, economic or political.

*Action* may involve an article in a newsletter; a creative product; an online petition; surveying changes in whanau opinion; a science-based website; participating in a community-based action, a citizen-science project, or other organised event.

*Evaluating* an action might involve considering how attitudes and behaviour has changed, how appropriate the action was in relation to the community and the issue, discussing a future focus or recommendations for further action, expanding on the relevance of the chosen issue, reflecting on effectiveness (or its lack) in effecting change.

## Possible activities for working with AS 1.2 Explore a real-world issued and devise a local, science-informed action.

### Purpose

These possible teaching and assessment activities have been created to provide teachers with examples of how a standard might be used in the classroom, including possible contexts and learning activities that might be used either to build investigative skills and knowledge or to collect evidence toward this Achievement Standard. These are not assessment tasks. Full assessment resources to support the internally assessed standards will be developed in Phase 2 of the Trial and will incorporate sector feedback on these draft ideas.

*NCEA level 1*

*Credits 4*

*Assessment Mode and Approach*

Internal - Report or presentation

### Rubric

Achievement Criteria	Indicators	Comments on quality of student evidence
<p><b>Achieved:</b> Explore a real-world issue and devise a local, science-informed action.</p>	<ul style="list-style-type: none"> <li>describing the science concepts involved in the issue</li> <li>identifying perspectives relevant to the issue</li> <li>undertaking an action based on scientific evidence.</li> </ul>	<p><u>Use of science concepts:</u></p> <p><u>Consideration of other perspectives:</u></p>
<p><b>Merit:</b> Analyse a real-world issue and devise a local, science-informed action.</p>	<ul style="list-style-type: none"> <li>explaining the science concepts involved in the issue</li> <li>examining different perspectives relevant to the issue</li> <li>explaining the action taken linked to the scientific evidence.</li> </ul>	<p><u>Action taken:</u></p>
<p><b>Excellence:</b> Evaluate a real-world issue and devise a local, science-informed action.</p>	<ul style="list-style-type: none"> <li>justifying the local action taken.</li> </ul>	

<b>Basis for final decision:</b>				
<b>Final Decision:</b>	<b>Not Achieved</b>	<b>Achieved</b>	<b>Merit</b>	<b>Excellence</b>

-- Possible Learning and Assessment Activity 1 --

*Possible Context*

**Water Quality**

Students report on the science behind the issue of water quality as it relates to some aspect of their local community or area. They identify some of the differing perspectives held by groups or people on the issue and make links in their report between those perspectives, the science underpinning the issue and their chosen action.

**This context is appropriate because:**

It involves understanding of a broad range of Big Ideas of science (particles, biodiversity, energy, Earth's systems). The science information related to the issue is readily available and diverse in nature and data is available in a variety of forms. The issue is highly topical and multiple perspectives are likely to be available within any community. There is potential for exploring mātauranga Pūtaiao perspectives and for applying concepts such as kaitiakitanga.

*Curriculum Key Concepts and Content*

The content will depend on the aspect(s) of water quality that is/are being focused on but are likely to include aspects from across the contextual strands including understanding about particles (ions, solutions, concentration), biodiversity, energy flow through ecosystems, Earth's systems.

For example:

- Aspects of water health/quality - eg: oxygen content, phosphates, nitrates, turbidity, temperature, flow rate
- Ecosystems existing in the water system
- Uses of water (why this is an issue)
- Identifying the range of stake-holders and their respective perspectives.

### *Possible Learning and Assessment Activities*

Students spend learning time as a group or class exploring a local body of water. This could involve a field trip, virtual field trip and/or kōrero from local iwi.

Potential activities include:

- brainstorming to identify/establish activities that are influencing the water quality
- assessing water health by collecting and testing water samples (this could be done by the learners if feasible or done independently of the learners)
- gathering of different perspectives - could include popular media or interviews with people.
- contact with local iwi to explore tikanga and local kawa in relation to the body of water. Exploring mātauranga Pūtaiao about water health and local narratives specific to the body of water
- connecting science ideas to the local body of water - what is relevant?
- synthesising knowledge, evidence and perspectives to inform a proposed action
- taking action - which may be a collaborative activity in the doing but individually reported and evaluated.
- critiquing the appropriateness of the action taken in relation to the science evidence that has been collected.

### *Collecting Evidence for Assessment*

Evidence collected throughout the activity/unit - data may be collected collaboratively and pooled, and action taken may be as a group. The report is compiled individually but likely to include some joint material (data tables etc).

Teachers need to manage safety aspects around any water - based visits or sample collection. Cultural considerations are very important when undertaking activity in any waterway - check local kaitiaki for a stream etc and engage to ensure permissions and local kawa are respected.

Teachers need to manage collaborative aspects of the activity. How might collaboration/group work be managed? How can authenticity be assured?

### *How student work will be assessed*

While the evidence/data may have been collected collaboratively and action taken as a group, the report will be compiled individually and will be likely to include some joint material (data tables etc).

See AS 1.2 Assessment Rubric for collecting evidence toward an holistic judgement against the criteria.

## -- Possible Activity 2 --

### *Possible Context*

#### **Diabetes in our community**

Students will report on the science behind the issue of Diabetes as it relates to their local community. They will identify some of the differing perspectives held by groups or people on the issue and will make links in their report between those perspectives, the science underpinning the issue and their chosen action.

#### **This context is appropriate because**

It involves understanding of some key ideas of science and builds on prior learning from curriculum level 5 (eg. human body systems and links between genetics and the environment in terms of health outcomes). The science information related to the issue is readily available and diverse in nature and data is available in a variety of forms. The issue is highly topical and multiple perspectives are likely to be available within any community.

### *Curriculum Key Concepts and Content*

Inheritance as a factor in human disease - what is the role of genetics in a condition like diabetes?

Possible aspects to consider:

- the distinction between inherited diseases, non-infectious diseases and lifestyle-influenced diseases.
- body systems – diet, obesity, physical activity (this could build on knowledge from level 4/5)
- treatment approaches, options, and outcomes
- kidney damage and transplant as a possible long-term implication
- identifying the range of stake-holders and their respective perspectives – including about treatment and organ transplant (kidney).

Will have to ensure this is pitched at curriculum level 6 and not higher, as it would be easy to make the concepts too difficult.

### *Possible Learning and Assessment Activities*

Potential activities include:

- exploring diabetes, blood glucose, diet, exercise, and the treatment of diabetes, including complications

- potentially assessing their own health by collecting data about family history, diet, exercise
- gathering of different perspectives - could include popular media or interviews with people
- contact with local iwi to explore tikanga and local kawa in relation to organ transplant
- exploring mātauranga Pūtaiao about hauora
- collating/brainstorming to identify initiatives that are currently helping to develop awareness, reducing the risk, treatment - and actions that could be taken
- synthesising of knowledge, evidence and perspectives to inform a proposed action
- taking action (some examples might include presenting information to whanau, preparing a pamphlet discussing the issues relevant to their community, making a podcast from interviewing different people/perspectives in the community)
- critiquing the appropriateness of the action taken in relation to the science evidence that has been collected.

#### *Collecting Evidence for Assessment*

Evidence collected throughout the activity/unit that documents learning, action and critique - this could be an ongoing document or folder of evidence that students add to over time. This way both group work and individual work can be part of the assessment. This could be photos/videos/written evidence. Report is a compiled individually but likely to include some joint material.

Teachers need to manage collaborative aspects of the activity. How might collaboration/group work be managed? Aspects of group work - there could be a daily/weekly activity for students to reflect on participation/collaboration.

Ethical issues around interviewing or discussing the issue with whanau need to be carefully managed.

#### *How student work will be assessed*

Evidence collected throughout the activity/unit that documents learning, action and critique - this could be an ongoing document or folder of evidence that students add to over time. Report is a compiled individually but likely to include some joint material (data tables etc).

See AS 1.2 Assessment Rubric for collecting evidence toward a holistic judgement against the criteria.

## 1.3 Describe attributes of Science that contribute to the development of scientific ideas and processes

*Level 1*

*Credits 4*

*Assessment mode External*

### -- Achievement Criteria --

*Statement linked to key learning outcomes*

**Students demonstrate their understanding of how the attributes of Science contribute to the development of scientific ideas and processes.**

*Achievement Criteria*

<b>Achievement</b>	<b>Achievement with Merit</b>	<b>Achievement with Excellence</b>
Describe attributes of Science that contribute to the development of scientific ideas and processes.	Explain attributes of Science that contribute to the development of scientific ideas and processes.	Discuss attributes of Science that contribute to the development of science ideas and processes.

### Explanatory Notes

- The Ministry has adopted a standard approach to the wording in all achievement standards: <achievement criterion/quality descriptor> involves <outlining the critical requirements for each grade>
- Clarify what is being assessed in the standard and the requirements for each grade level
- The notes are not guides to teaching and learning programmes (this is what the curriculum and the TLAG are for). Ensure any support for understanding this standard is placed in the TLAG in the assessment section
- The notes do not define words - this should be placed in the appropriate section of the TLAG unless absolutely essential
- Only terms or phrases taken verbatim from the achievement criteria should be italicized

- Use of “typically” is not permitted in the stem of the statements. This is because it means there is no minimum requirement for that grade, ie if it is “typically” present, it doesn’t have to be present and is therefore not a requirement.

*Explanatory Note 1*

*Describing* attributes of Science involves identifying within a context where a range of attributes contributed to the development of science ideas and processes.

*Explaining* attributes of Science involves giving reasons how and why, within a context, a range of attributes contributed to the development of science ideas and processes.

*Discussing* attributes of Science involves evaluating the significance of, and the interaction between, attributes which have contributed to the development of science ideas and processes in a context.

*Explanatory Note 2*

Attributes of **people** engaged in science include:

- Curiosity
- Creativity
- Critical thinking
- Collaboration

Attributes of **Science** include:

- Making direct and indirect observations
- Interpreting patterns and interactions with the natural world
- Linking new evidence to existing models, theories and ideas
- Showing awareness of different knowledge systems and their contributions to scientific knowledge and development
- Influenced by social and cultural factors
- Development and use of technology
- Responding to needs and opportunities
- Rigorously reviewing claims
- Use of specific language, symbols, and conventions
- The only certainty in science is when a claim is disproved.

Attributes of mātauranga Pūtaiao may include many of the above, as well as emphasising:

- a Māori world view
- a place-based focus
- the importance of values
- connections to the land, environment and all living things.

# Science 1.3 Ext Development of Science Assessment Brief

## Purpose

The purpose of the external assessment specification is for the SEGs to document the preferred mode and context of external assessment of external achievement standards. SEGs will choose from a pre-approved list of assessment modes and provide details of possible contexts in order to guide NZQA in their development of external assessment specifications and tasks.

### *Learning and Subject area*

Science

### *Achievement standards to be externally assessed*

Describe attributes of Science that contribute to the development of scientific ideas and processes.

## Level 1

## 4 Credits

### *Preferred Assessment method*

**Structured Report**

**Common Assessment Task (working title)**

### *Preferred response volume*

A structured report of about 600 words based on resource material provided three weeks ahead of the due date.

A structured report is compiled individually and would allow for evidence to be provided in a variety of ways including annotated timelines, cartoons etc to support written text.

Responses would be based on collaborative engagement (over the three week period) with the stimulus material/case study as well as group and individual research into the science/Pūtaiao idea and its development.

Ideally a range of modes for collecting evidence would be available - written report/oral presentation/video/etc.

Time span of 3 weeks in-class time.

### *Justification/rationale for this*

- This standard is a new way of assessing Nature of Science (which is the focus of our learning area) and being externally assessed signals to the sector that this is important and not a 'soft' aspect of science learning and assessment.
- Students will be expected to apply their knowledge of the Nature of Science built from exploring the development of multiple science ideas. They will select one case study from a range and use it to apply their understanding.
- This is an opportunity to model the Science as a Human Endeavour Big Idea for teachers and students. Over time NZQA will build up a bank of case study resources that will be available for rich teaching of this Big Idea.
- This approach addresses equity of opportunity; the flexible format and time to engage with resource material allows teachers to appropriately scaffold learning and assessment for different levels of literacy and does not privilege recall skills or written literacy.

#### *Alternate assessment mode*

#### *Task overview*

- Learners will be presented with several case studies.
- Learners will receive the case studies three weeks before the common due date. Suggested timing - late term 3.
- Teachers/learners will select one case study to focus on that meets the needs and interests of the learner(s).
- Case studies will include a range of contexts such as mātauranga Pūtaiao contexts, western science contexts, ones involving significant contribution by New Zealanders, or a Pacific context.
- Learners will be provided with questions and prompts to guide their engagement with the resources and to ensure they cover all Achievement Standard criteria, for example:
  - What are some observations that led to this science idea?
  - Using this case study, explain how the use of data or observation or evidence has helped the development of the science idea?
  - Explain the influence of a social or cultural event on the development of the science idea.
  - Explain how the attributes of the nature of science have affected the development of a science idea?
  - How has technology contributed to the development of the scientific idea?
  - Integrate science language, symbols, conventions into your evidence.
  - Analyse the use of data, observation or evidence in the development of a science idea in a case study.
- Student responses may be presented in a range of ways including timelines, bullet points, audio, cartoons, etc.
- Templates are appropriate for managing the collection of the student response into a structured report.

## Science 1.4 Interpret scientific claims in publicly communicated information.

*Title*

Interpret scientific claims in publicly communicated information.

*Level*

1

*Credits*

6

*Assessment mode*

External

*Version*

1

*Status*

Draft

### -- Achievement Criteria --

*Statement linked to key learning outcomes*

Students are able to interpret and critique information in order to examine scientific claims.

*Achievement Criteria*

<b>Achievement</b>	<b>Achievement with Merit</b>	<b>Achievement with Excellence</b>
Interpret scientific claims in publicly communicated information.	Analyse scientific claims in publicly communicated information.	Evaluate scientific claims in publicly communicated information

## Explanatory Notes

### *Explanatory Note 1*

Interpret scientific claims in publicly communicated information involves:

- identifying the science information relevant to the claims
- drawing a conclusion about the claims based on scientific ideas.

Analyse scientific claims in publicly communicated information involves:

- explaining the science information relevant to the claims
- commenting on the credibility of the sources
- identifying the use of science language and conventions
- making a judgement about the claims based on scientific ideas.

Evaluating scientific claims in publicly communicated information involves:

- critiquing the use of science language and conventions
- justifying their conclusion about the claim based on scientific ideas.

### *Explanatory Note 2*

*Scientific claims* may be based on:

- Western Science ideas
- mātauranga Pūtaiao ideas
- scientific world views relevant to other cultures.

*Credibility* is defined as trustworthiness and is strengthened by scientific consensus.

### *Explanatory Note 3*

Example modes of information communicated to the public include:

- recognised scientific sources
- social and mainstream media
- narratives, waiata, mōteatea, pūrākau, and whakatauki.

# Science 1.4 Communication A.S External Assessment Brief

## Purpose

The purpose of the external assessment specification is for the SEGs to document the preferred mode and context of external assessment of external achievement standards. SEGs will choose from a pre-approved list of assessment modes and provide details of possible contexts in order to guide NZQA in their development of external assessment specifications and tasks.

### *Learning and Subject area*

Science

### *Achievement standards to be externally assessed*

Interpret scientific claims in publicly communicated information.

Level 1

6 Credits

### *Preferred Assessment method*

**[X] Structured Report**

### *Preferred response volume*

An 800 word structured report will comprise responses to a range of sources of information.

Evidence may be collected throughout the year and submitted on a common day.

A rubric/template would be appropriate to provide guidance related to each achievement criteria. It would need to allow for evidence to be submitted in different formats (may include annotated diagrams or text, for example).

Evidence should be evaluated from across all responses within the structured report to give a holistic grade.

### *Justification/rationale for this*

- This is a new way of assessing the Nature of Science at NCEA Level 1 and making this an external assessment recognises that this is important and not a 'soft' aspect of science learning and assessment.
- Both Science and mātauranga Pūtaiao are communicated in a variety of modes and learners are expected to engage across a range. A structured report means students' evidence across a range is collated into one report. It also allows for a variety of communication modes to be used in students' response to the claims.

- The standard and the mode of assessment address equity of access and inclusivity by:
  - providing the opportunity for students to demonstrate their learning within one broad context or across several contexts drawn from different strands of the learning area
  - allowing for relevant contexts to be explored using a range of approaches
  - ensuring ample time to engage with information
  - not privileging recall skills or written literacy.

*Alternate assessment mode*

*Task overview*

We expect students, during their learning programme, to have examined multiple examples of science communication across different modes and contexts. These modes could be drawn from science sources, social or mainstream media, narratives, waiata, pūrākau, or whakatauki.

Students will submit a structured report based on a given template/rubric that demonstrates their ability to interpret and critique science claims involving both science and pseudoscience contexts, and including sources that use a range of modes of communication.

## Glossary of Terms:

*Real world issue* means an issue that affects the lives of learners. An issue is something on which people hold varying opinions and perspectives.

*Local significance* means an issue with direct relevance to the learner. Examples include: an issue affecting a place a learner links to through whakapapa; an issue which has personal relevance to the learner; or in geographical proximity to the school or individual.

*Scientific evidence* may include evidence generated through mātauranga Pūtaiao, science or other indigenous knowledge systems.

*Perspectives* may include alternative viewpoints and may be personal, community, iwi, national, global, cultural, social, ethical, environmental, economic or political.

*Action* may involve an article in a newsletter; a creative product; an online petition; surveying changes in whanau opinion; a science-based website; participating in a community-based action, a citizen-science project, or other organised event.

*Evaluating* an action might involve considering how attitudes and behaviour has changed, how appropriate the action was in relation to the community and the issue, discussing a future focus or recommendations for further action, expanding on the relevance of the chosen issue, reflecting on effectiveness (or its lack) in effecting change.