



IT'S A BUG'S LIFE

HOW TO HELP YOUNG CHILDREN DO SCIENCE

For kaiako (educators) of children aged 2–8 years
Early childhood (ECE) and junior primary levels

See how easy it is to learn and teach scientific skills, knowledge, dispositions, and practices. This practical resource, based on real-life experiences, implements the Ministry of Education's five science capabilities.

CO-CREATED BY REBECCA BROWNE, MUSEUM OF NEW ZEALAND TE PAPA TONGAREWA, WITH THE CHILDREN, TEACHERS, AND WHĀNAU OF RAUMATI SOUTH KINDERGARTEN, KIWI KIDS CHILDCARE CENTRE, AND IMAGINE CHILDCARE





Equipped with his five senses, man explores the universe around him and calls the adventure Science.

– Edwin Powell Hubble





A resource based on real-life experience

Te Papa co-created this resource with three Wellington region early childhood centres in 2015: Raumati South Kindergarten, Kiwi Kids Childcare Centre, and Imagine Childcare. We combined their tried-and-tested recommendations and activity ideas with our own expertise to form this practical resource.

We hope you have as much fun on your scientific adventures as we did on ours!

→ Read more about our ECE partners and research process on pages 104–107.



From top left, kaiako and tamariki from Raumati South Kindergarten, Kiwi Kids Childcare Centre, and Imagine Childcare.



How to use this resource

DESIGN YOUR OWN SCIENTIFIC ADVENTURE

In this resource, you'll find inspiration, support, and guidance. Use our recommendations and activity ideas to inform your teaching, and let our young scientists' learning stories spark your own ideas. Find helpful tools and resources at the back.

Feel free to dip in and out of different chapters. To help you find your way, we have created a colour and symbol key.

Before you start teaching and learning, we recommend reading 'Approaching science' on page 9.

FOCUS ON CAPABILITIES

Capabilities are combinations of skills, knowledge, and dispositions. With these in place, young children are made ready and able to discover and engage with our world.

Use this resource to better understand the Ministry of Education's five science capabilities as we unpack meaning and application.

GO BEYOND BUGS

Bugs (or land invertebrates) are a great topic for early science, but we know how important it is to follow children's interests. So, you can apply the recommendations in this resource to any living world topic – just as Kiwi Kids Childcare did when they took a child-led opportunity to investigate tadpoles.

→ Find out why we chose bugs as our science topic on page 108.

Orientate yourself

SYMBOL KEY

Find these symbols on top right corner of the page. They relate to a part of the scientific process.



COLOUR KEY

Follow these coloured icons to find each chapter.



Introductions
Background
Appendix



Capability 1
Gather and
interpret data



Capabilities 2 & 3
Use and critique
evidence



Capability 4
Interpret
representations



Capability 5
Engage
with science

Contents

07

What is science anyway?

Discover what science and scientists are as we debunk some common misconceptions.



25

Capability 1 Gather and interpret data

The main focus of this resource. Get exploring, ask questions, make hypotheses, observations, and meaning, and share findings.

102

Curriculum links

How this resource relates to *Te Whāriki* and the *New Zealand Curriculum*.

09

Approaching science

Jam-packed with useful tips to help you approach science in a positive and effective way.



65

Capabilities 2 & 3 Use and critique evidence

Supporting your claims, and working to make your science better.

104

How we made this resource

Meet our ECE partners. Find out how we went about doing our research, and why we picked bugs as our broad focus.

22

The five science capabilities

A brief outline of the framework.



76

Capability 4 Interpret representations

Using science communication and making your own.

109

Appendix

Graphics, templates, techniques, terminology, and reading recommendations.

24

Introducing the scientific process

A helpful diagram. How do the capabilities relate to the way you do science?



90

Capability 5 Engage with science

Examples of how our young scientists applied their science to real-life situations.



What is science anyway?

Scientific literacy is essential in today's society. By enabling young children to investigate the living world, you'll help them build confidence, broaden their interests, develop scientific thinking skills, and build knowledge. But what is science?

SCIENCE IS:

- a way of thinking and doing
- a way to discover and understand the world around us
- a way to build and communicate knowledge
- a commitment to using evidence – things that can be observed or measured.



The whole of science is nothing more than a refinement of everyday thinking.

– Albert Einstein





Science needn't be scary

Educators need to feel comfortable with science to explore it with children, but there are some popular misconceptions that can make it seem daunting. Here, we debunk some of those myths.

Misconception	Reality
It's difficult.	→ Science can be easy and fun! We'll show you how to get started.
I'd have to change my programme.	→ You can find (or make) excellent opportunities to do science in everyday life, and within your current activities. It just means thinking about the things you do in a slightly different way.
I'd have to learn lots about set topics.	→ You can follow the natural interests of children and learn together. Scientific facts are great, and an important part of science - but science is bigger than the facts.
I'd need special equipment and a laboratory.	→ All you need are your senses and an enquiring mind – you can do science anywhere.

WHO CAN BE A SCIENTIST?

We can all do science – tamariki, kaiako, and whānau.
We just need to be up for the learning journey!

A scientist is someone who:

- is curious about the world (pātaitai/kaitoro)
- has developed their scientific capabilities – combinations of skills, knowledge, and dispositions needed to do science.
- uses their scientific capabilities in real-life contexts.

As competent and capable learners, young children needn't have a set list or ceiling to their learning in science. Anything is possible in the early years! We can and should take our interests, topics, and activities even further.



Approaching science

The way science is taught makes all the difference. Your approach will impact hugely on your children's thinking and learning. Consider our recommendations before you start doing science.



OUR RECOMMENDATIONS

Reflect on your own attitude	Page 10
Take a child-led approach	Page 10
Don't dumb it down	Page 10
Build confidence	Page 11
Be kaitiaki	Page 17
Show everyday relevance	Page 21



REFLECT ON YOUR OWN ATTITUDE

If you react to bugs as if they were monstrous or talk about science as if it were dull or hard, that's what these things will become in the eyes of the young children around you.

Reflect on your behaviour and beliefs, and consider modifying them to create an enthusiastic and encouraging learning environment.

Be relaxed, facilitate rather than direct, give lots of scope, join in, and, most of all, stay present.

DON'T DUMB IT DOWN

- Avoid talking about animals as if they have human emotional traits (anthropomorphism). Some cartoon-like animals in children's books and media can be misleading when doing science. Prioritise those representations that stay more true to life.
- Learn and use scientific terms, such as 'specimen', 'habitat', and 'ecosystem', and proper names such as 'abdomen' instead of 'tummy'. You'll find some bug body terminology in English and te reo Māori on [page 116–121](#).

We feel it is very important to use proper names and scientific terminology, not to use baby language or to dumb it down, because [the children] can add these words to their vocabularies and can use them appropriately.

For example, we talk about cicada exoskeletons, not cicada skins. The children have picked this up, and we are noticing that they are becoming tuakana to their parents' teina – 'It's not a skin, it's an exoskeleton.'

I guess it is starting as you wish to go on. Learn it correctly the first time.

- Nichola (kaiako) from Imagine Childcare

- Use the scientific process – learn about this, and see how it relates to the five science capabilities, on [page 22](#).

TAKE A CHILD-LED APPROACH

Our experience suggests that young children engage and learn best in science when you:

- provide opportunities for them to discover their interests
- give priority to exploring and extending their interests
- personalise (differentiate) their learning experiences based on their interests.

In short – if they are into cicadas, go with cicadas. Not everyone will be into cicadas – and that's OK. Find out what lights their fire.

Caterpillars and worms are great – but don't go with an inquiry about these bugs just because they are more comfortable or manageable for you.



BUILD CONFIDENCE

Tamariki need to feel confident (arahina/māiatanga), capable, and empowered to think, act, and participate as scientists. Use these tips to build confidence in your group.

Start in a familiar setting

When you can relate new learning to familiar places and prior experiences, it can help to make the whole experience less scary, and the learning more concrete.



Work in small groups

Activities in small groups allow more opportunities for young children to talk, exchange perspectives, and receive feedback. This also encourages the development of social skills and creates a more supportive learning environment. Science is a highly collaborative field, so forming and maintaining relationships (whanaungatanga) and working cooperatively (kotahitanga) are essential.



Use scaffolding techniques

Scaffolding refers to a range of supportive teaching strategies:

- **‘What’ questioning**
Prompting children to share what they’re doing and thinking. This starts a kōrero based on observation and communication. In contrast, ‘why’ questioning can imply there are right and wrong answers.
- **Think-alouds**
For example, ‘Hmm, I wonder why the fly landed on the biscuit and not the carrot. I think I’ll watch longer to find out.’
- **Say-mores**
For example, ‘What happened next?’ or ‘Why do you think that?’
- **Re-voicing**
For example, ‘So you’re saying that ...’
- **Fish-bowling**
Gathering a group round those with expertise undertaking an activity to learn by watching.
- **Connection making**
Finding ways to tie the situation or concept to prior knowledge and experience. For example, ‘Look, there’s a ladybird, just like in our story *The bad-tempered ladybird*.’
- **Extension and provocations**
Introducing a question, prop, or demonstration to extend thinking.
For example, ‘But I’m wondering if bees do get honey from flowers. I haven’t seen any honey in flowers. Have you? What do you think – is there honey in the flowers for the bees to get, or are they using something from the flowers to make honey?’
- **Think, pair, share**
Support children to ‘learn to learn’ with others. They first choose who they want to learn with in the group, and how they want to do their thinking – drawing, talking, role play, etc). They pair up and go through the process. Then they share their ideas with an adult.



Science is fun, science is curiosity ... It's delving in.

– Sally Ride 



Encourage, extend, acknowledge, and involve

→ Encourage

Nurture curiosity and exploration (tinihanga), and build confidence through encouraging children to make comments and ask questions about what they see and do.

Help tamariki establish a growth mind-set too. When things don't go to plan, that is an opportunity to grow and learn. It is not a sign that we should give up altogether. Keep trying! 'FAIL' stands for First Attempt In Learning.

→ Extend

Promote the use of good scientific practices like researching, observing, documenting, and collaborating.

Have tamariki consider scientific ideas such as similarity and difference, cause and effect, and the relationships between bugs, or between bugs and their environment.

→ Acknowledge

Document prior knowledge (perhaps through a brain dump), as well as learning as it unfolds. Make contributions from tamariki, whānau, and kaiako visible. For example, create a project wall and position it in a public space.

→ Involve

Actively include children in planning processes, enabling them to have a role in managing their own learning (rangatiratanga).

Observing the caterpillars

Learning story excerpt from
Raumati South Kindergarten

DEMONSTRATES: ENCOURAGEMENT; EXTENSION

'Look at all the holes in the leaves!
They have been busy caterpillars!' said kaiako Tash.

'Is that what makes them grow?'
- Oscar wondered.

Together they had a group kōrero about the evidence, and agreed the caterpillars must have been munching and crunching on those leaves to get bigger. When they had watched the caterpillars before, the holes hadn't been there, and the caterpillars had looked much smaller.

Oscar went to get a book so he and Tash could learn more.





Stick insects at Grayson's place!

Learning story excerpt from Imagine Childcare

DEMONSTRATES: ACKNOWLEDGING THE ROLE OF WHĀNAU



Grayson, recently you were very excited (and your mum was too) about sharing news of two stick insects in the strawberry patch at your place. Apparently you had thought about bringing them in, but it was decided that they would probably be happiest in the home that they had chosen for themselves.



What you *could* do, though, was take a couple of photos of them, and, as it happens, because Alex was coming round to play, you could combine the two!

This is what your mum had to say about your sticky friends:

Grayson loves to go outside morning and night to check on the two stick insects. Only the green one could be found yesterday. The brown one has gone walkabout. He is really gentle with them and has given them names.

I like that your mum said that the brown one had gone 'walkabout' as some people call stick insects 'walking sticks'.

Grayson, thank you for sharing these photos of one of your stick insects with us – he's pretty camouflaged, isn't he? By your care of your tiny friends, you are showing that you know all about being a kaitiaki (guardian) of the living things in your garden as well as those here at Imagine.



Enable tuakana-teina (senior-junior) relationships

Pair a more skilled learner (tuakana) with a less experienced learner (teina).

The tuakana shares their expertise and acts as a guide for the teina. Through this reciprocal system of ako (learning and teaching), the tuakana is able to solidify their knowledge, and the teina to add to theirs.

This is empowering as it means that the children are recognised as being sources of expertise, not just the adults.

Make resources readily available

Ensure that books, tools, props, and other science resources are there for everyone to access, and gender-neutral.

This will reduce barriers to learning.

Support creative thinking

In science, thinking creatively is just as important as thinking logically. Give children room to explore their ideas, even if they seem somewhat impractical.



Maia's butterfly song

Learning story excerpt from
Raumati South Kindergarten

DEMONSTRATES: SUPPORTING CREATIVE THINKING



This afternoon, kaiako Tash saw something in the kitchen and called people over to have a look.

'Whoa! It's a beautiful butterfly,' said Olive.

We could see it was fluttering around the window, and looking like it needed some help. Tash wondered aloud if anyone had some ideas about how we could help it out.

'I've got a butterfly song that could help it!' said Maia, and he started his waiata:

*'Butterfly
You can fly, bye-bye
You can fly with your wings
Everything belongs outside
Bye-bye butterfly.'*

Maia sang the song several times, and Olive and Arianwyn joined in. Another butterfly song was composed:

*'Bye-bye butterfly
You can fly in the sky
You can fly in the sky
Bye-bye butterfly.'*

Maia suggested that now that the butterfly knew what it needed to do, we could use some paper to help guide it out of the window. Our kaiako helped with this, and the butterfly flew away unharmed.

Tash asked if Maia remembered the caterpillar they had seen together previously. 'Yeah, that – yeah, it might be it turned into a butterfly,' Maia responded.

What awesome manaakitanga you showed, Maia!





BE KAITIAKI

Before you start looking for bugs, ensure young children are familiar with the values of kaitiakitanga (guardianship), manaakitanga (kindness), and mauri (respect for all living things).

Write a tikanga matatika (code of conduct)

The children from Raumati South Kindergarten created their own tikanga matatika (code of conduct):

- 'You need to look after your bugs. You shouldn't shake them, or squeeze them, or squish them, or stomp on them, or pull them apart – 'cause they are real [meaning alive]!'
- 'When you touch worms, you use gentle hands, and you need wet hands or the worms will die.'
- 'Don't touch butterfly wings – it will hurt them.'
- 'No jars on windowsills – they get too hot.'
- 'Only keep [your bugs] in jars for a little while, then put them back where you found them. More than two days is too long.'
- 'Make sure you put holes in the lid of the jar. Bugs can only last a day or two without air!'
- 'Make homes [temporary habitats] for them when you are keeping them for a while so they feel safe. They need something like a stick or leaf to hold on to.'
- 'Stay safe when you are collecting bugs. You could use a jar and some cardboard. You could look at them on the spade.'*

*Poisonous invertebrates are rare in New Zealand, but some can cause discomfort, such as the white-tailed spider.

Consider alternatives to touching

The children suggested these alternatives to handling bugs:

- 'Look with your eyes, not your fingers.'
- 'Use a magnifying glass.'
- 'Look in a book, or on the computer.'
- 'Take a photo.'
- 'Make pictures, like paintings and drawings, and make models using paper, or the play dough, or the clay.'
- 'Touch the plastic bugs that look just like real ones, rather than the real ones.'
- 'Ask your friends or other scientists, like the ones at Te Papa.'
- 'Look at dead ones or at bits they have left behind.'

EXPLORE ATUATANGA (THE MĀORI VIEW OF CREATION)

Learn about ngā atua Māori (Māori gods), and their roles and realms in te ao Māori (the Māori world). This knowledge can help us to see the interrelatedness of the natural and human worlds. Doing this through Māori myths and legends proved especially effective at our partner centres.

Highlights from our young scientists and their kaiako:

- 'We need to care for Papatūānuku and Tānemahuta, and the bugs are Tāne's children so we need to look after them too.'
– Child from Raumati South Kindergarten to Rebecca during a centre visit
- 'Last week, Jo was telling me how helpful you were at explaining to a friend that we don't hit trees with sticks. "Tāne won't like that," you explained. How wonderful that you are able to share your knowledge of the atua with us at kindergarten.'
– Lara, kaiako at Raumati South Kindergarten, to Nathan
- 'A shadow puppet display has been planned to retell the story of Rata and the Tree (<https://www.careers.govt.nz/practitioners/tools-and-activities/the-magic-of-myths/rata-and-the-treerata-me-te-rakau/>) to illustrate the important relationship between the small creatures of the forest and Tāne.' – Adela, kaiako at Imagine Childcare
- 'We need to show butterflies manaaki.' – Maia to kaiako Tash, Raumati South Kindergarten



Lucy – a kaitiaki with manaakitanga

Learning story excerpt from
Raumati South Kindergarten

DEMONSTRATES: USING A CODE OF CONDUCT

One morning, you and Rose found some snails and a long worm. 'Our hands are very cold,' you told me, showing that you were considering the worm's comfort, as their skins cannot handle hot hands.

You had made a home for the snails you had collected on the deck, with leaves and bark. I could tell you were showing them respect.

'We wanted to put them back soon,' you explained, demonstrating your knowledge of our tikanga – that our invertebrates must be put back in their natural habitats.



Assign responsibilities

Teachers at Kiwi Kids Childcare and Imagine Childcare found that kaitiakitanga was enhanced through assigning responsibilities.



Caring for our tadpoles

Learning story excerpt from
Kiwi Kids Childcare

DEMONSTRATES: ASSIGNING RESPONSIBILITIES

Three of our children at Kiwi Kids became our 'tadpole teachers'. Their role was to oversee the well-being of the tadpoles in our classroom. They made key decisions, such as when to change the water in the tank.

Other children at Kiwi Kids took responsibility for sourcing rainwater for their tadpoles outside. We had determined through our background research that the chemicals in the tap water would be harmful to our tadpoles.

Hari went as far as to bring in the peg bucket from home that had been filled with water over the weekend – such was his dedication and enthusiasm for his entrusted role!



Thomas teaches younger children how to be good kaitiaki

Learning story excerpt from Imagine Childcare

DEMONSTRATES: ASSIGNING RESPONSIBILITIES

Thomas, you have shown great responsibility where it comes to looking after our caterpillars and butterflies. I noticed that there were a few toddlers around the swan plants yesterday, and you went over to make sure they didn't disrupt the process the butterfly was going through. You asked them to use their eyes to watch instead of touching.

'Caterpillars need to be safe,' you said. After being in a chrysalis for two weeks or so, the last thing you wanted was for the butterfly to be upset!



SHOW EVERYDAY RELEVANCE

It's important to show the relevance (māramatanga) that science has to our lives and the world around us. This makes learning more meaningful. We recommend you explicitly point out examples of relevance for young children, and recap often.

Examples

- When we know more about bees and how essential they are, we can look after them better. We can also avoid getting stung by mistake.
- When we can identify different bugs, we're likely to find species that live only in Aotearoa New Zealand, and nowhere else in the world. They're as unique as kiwi and kākāpō!
- When we apply our new knowledge, skills, and dispositions, we can build a great habitat for bugs.
- You'll find examples of practical projects initiated by our young scientists in 'Engage with science', page 87.



The five science capabilities

This resource introduces the science capabilities published by the Ministry of Education in 2014. These aim to refocus science teaching and learning towards the 'nature of science'. They refer to what science is and how scientists work.



Capability 1: Gather and interpret data

Page 25



Capability 2: Use evidence

Page 65



Capability 3: Critique evidence

Page 65



Capability 4: Interpret representations

Page 76



Capability 5: Engage with science

Page 90

Capabilities 2 and 3 are closely aligned, so we combined them into one chapter.

- Capabilities 1–3 are linked to understanding science, and to the skills needed to undertake scientific investigations.
- Capability 4 links to communicating in science.
- Capability 5 links to participating in, and contributing to, society through science.

You can read more about the framework on Te Kete Ipurangi online:



scienceonline.tki.org.nz/Introducing-five-science-capabilities



Blurry boundaries

Note this advice from the MoE:

The boundaries between the capabilities are blurry. Any learning activity could provide opportunities to strengthen more than one of them, but for planning, teaching, and assessment purposes, it is useful to foreground one specific capability.

Take a holistic approach more generally

The capabilities do not need to be developed sequentially or in isolation. Engaging in rich, authentic scientific inquiries will provide opportunities to grow all five simultaneously.

Don't shy away from Capabilities 2 and 3

Young children are more than able to use and critique evidence. They might just need a little more support initially.

Introducing the scientific process

Scientists use a process to help them discover and understand more about our world. It's made up of specific practices that require the scientific capabilities you'll explore in this resource.

The flow chart on the following page shows just one way to use the scientific process. Move back and forth between elements, or even jump around to create your own process if this better suits your tamariki, inquiry, or setting. For example, you might start by asking a scientific question, then make a hypothesis before exploring.

Remember there is no one 'right' step-by-step way to do science. Making sure young children can engage with the different parts of the process is most significant.

Colours indicate links to the five science capabilities.



Capability 1
Gather and
interpret data



Capabilities 2 & 3
Use and critique
evidence



Capability 4
Interpret
representations



Capability 5
Engage with
science

THE SCIENTIFIC PROCESS



CAPABILITY 1
Gather and interpret data



CAPABILITY 2
Use evidence



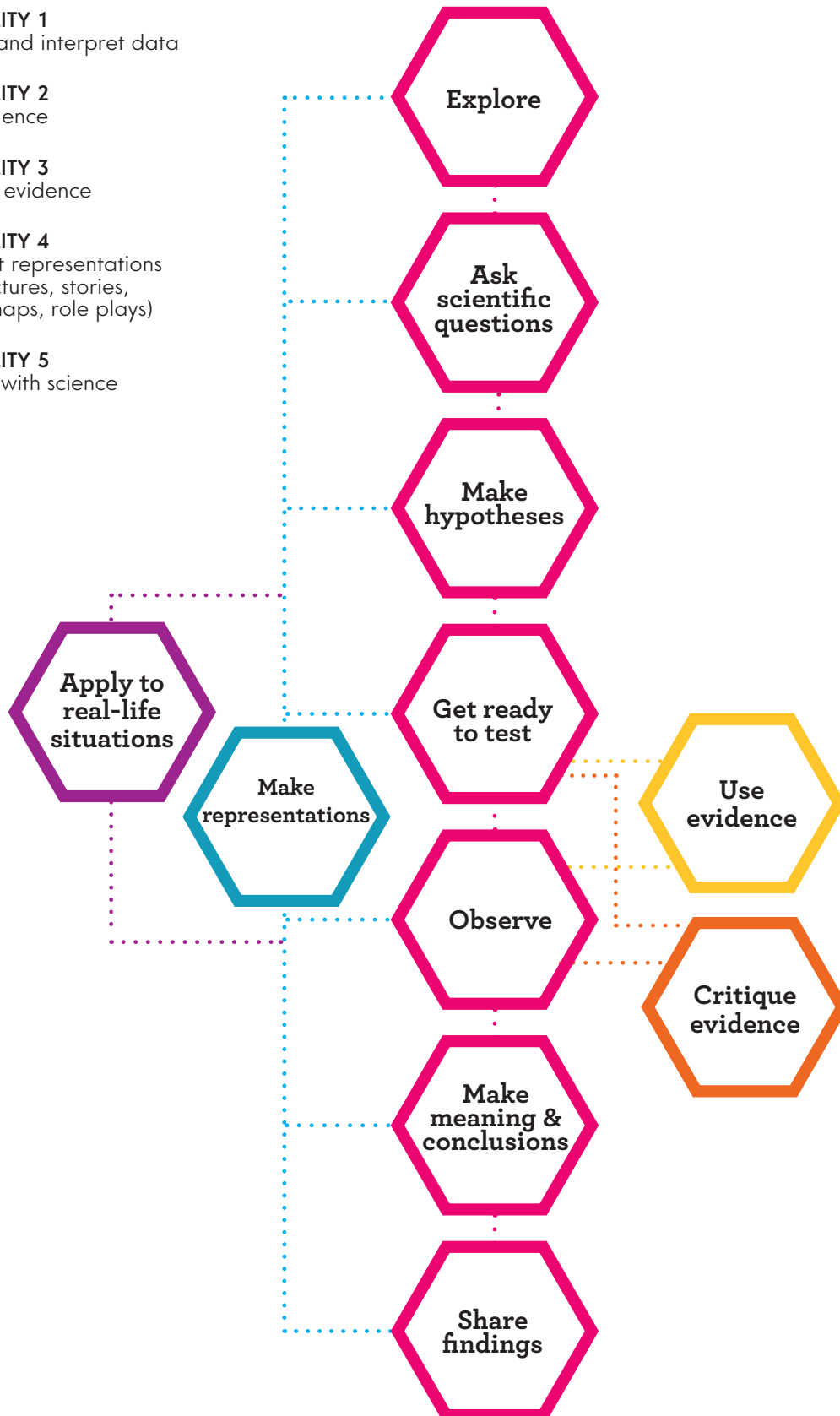
CAPABILITY 3
Critique evidence



CAPABILITY 4
Interpret representations
(e.g. pictures, stories,
plans, maps, role plays)



CAPABILITY 5
Engage with science





CAPABILITY 1.

Gather & Interpret Data

Scientific knowledge is special in that it comes from the information, or data, that we collect about the world as we explore, question, make theories, test, and observe.

As we make meaning from what we (or others) have seen, smelled, tasted, heard, or touched, we draw conclusions or inferences. These findings either prove or disprove our initial thinking, and cause new questions to arise.



IN THIS CHAPTER

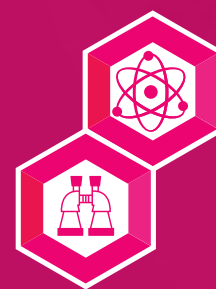
Explore	page 27
Ask scientific questions	page 38
Make hypotheses	page 43
Get ready to test	page 49
Observe (Print as A3 landscape)	page 53
Make meaning and conclusions	page 55
Share your findings	page 59



It is a capital mistake
to theorise before
one has data.

– Arthur Conan Doyle

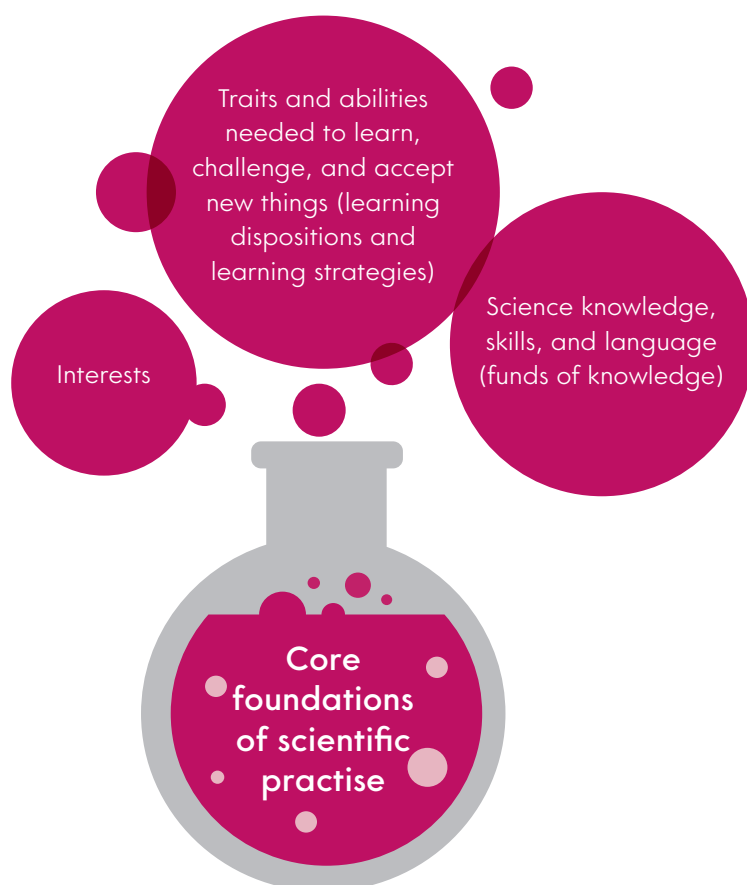




Explore

Exploration fosters young children’s innate sense of wonder and curiosity about the natural world. In turn, this helps build their funds of knowledge, their learning dispositions and strategies, and their interests – the foundations from which all scientists work.

It’s essential to provide many varied, engaging, and active experiences when introducing young children to science. This should be a major focus of any science education programme at this level.



OUR RECOMMENDATIONS

Get outside	Page 28
Bring the outdoors in	Page 29
Use free and focused approaches	Page 31
Practise with tools and techniques	Page 35
Engage with scientific and local communities	Page 35



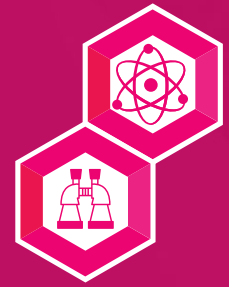
Kiwi Kids went out on excursions to their community park, as well as exploring their own garden and playground.

GET OUTSIDE

Participating in science outdoors is important (and fun) no matter how much time children spend outside in their day-to-day lives.

Benefits of getting outside

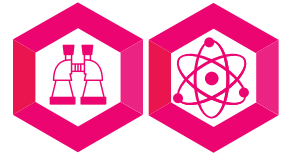
- **Authenticity**
Time spent in the field allows children to observe a diverse range of authentic bugs, behaviours, and habitats – things that can't be reproduced in a classroom. It may be a species found only in outside habitats that sparks the interest of a child.
- **Variety**
By exploring varied environments, young children can better understand the impact different conditions have on bug life – what lives in a particular habitat, what cannot, and why.
- **Relevancy**
There's no better way to make the natural world relevant than to be out there in it.
- **Connection**
By exploring easily accessible local spaces, you increase the chance of children making meaningful and long-lasting connections with them over time. A sense of belonging fosters deeper engagement.



BRING THE OUTDOORS IN

Explore the living world with meaningful indoor and deck experiences too. Think cross-curricular – you can weave science and environment themes into all kinds of activities and topics.

It is best if your indoor and deck experiences have ‘boundary crossing’ qualities – ie, relate directly to the exploration outside, or involve things or representations of things (photographs, drawings, objects) that can physically cross the boundary between outside and the classroom/house.



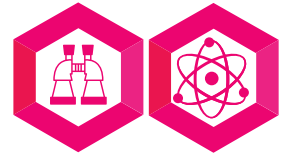
ACTIVITY IDEAS FOR BRINGING THE OUTDOORS IN

- **Use nature as an art material**

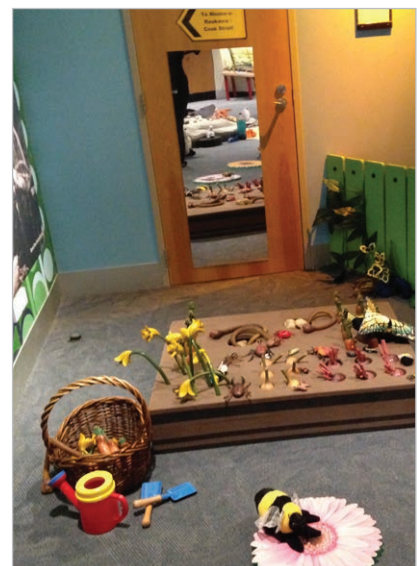
Collect habitat materials and bring them into your art area for children to use. Our groups used bark, sticks, leaves, seeds, flowers, grasses, stones, empty shells, and sand.
- **Read and watch**

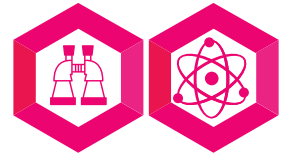
Use relevant books and videos (fiction and non-fiction) to help children explore their experiences, questions, and ideas from outside further.
- **Role play**
 - Create dress-ups and props for play relating to the lives of the bugs the children have encountered and their activities as scientists.
 - Ask children to re-enact bug behaviour, such as the wiggle dance that bees use to communicate the location of flowers.
 - Turn the classroom into a giant beehive or ant nest, and get children to play the different colony roles, such as cleaner, builder, nurse, forager, chef, and guard.
- **Explore bug sounds**
 - Ask children to use available instruments to mimic the sounds of different bugs, or to make music inspired by bugs.
 - Listen together to bug-inspired music, such as ‘Flight of the Bumblebee’ by Nikolai Rimsky-Korsakov, and ask children what bug traits are represented in the music and how.
 - Learn and sing nature-themed waiata together, such as:
 - ‘Head, Thorax, Abdomen’ (<https://www.youtube.com/watch?v=PhG2mybDzp4>) – video naming the main body parts of insects
 - ‘Pūngāwerewere’ (www.tessarose.co.nz/index.php?/Lyrics/pungawerewere.html) – bilingual lyrics about the building of a spider web and nest. Watch a video of part of the song (<https://www.youtube.com/watch?v=nC5n1glrFNs>)
 - ‘Pūrerehua’ (folksong.org.nz/purerehua/index.html) – bilingual lyrics and recording about the life cycle of the butterfly.





- **Touch, smell, and taste**
Explore bug-like and bug-related sensory textures. For instance, you could make soap flake 'snail slime', or try honey.
- **Use your photographs**
Print off your field photographs and use them for magnetic whiteboard activities, like story sequencing or bug classification. Invite parent and community participation.
- **Sort food scraps**
Involve children in sorting out food scraps after mealtimes, discussing what can and can't be used as worm food and why. This also promotes sustainability.
- **Provide inspiration for play**
Position containers of model bugs in popular spaces, such as the block area or home corner, as provocations. See where the children take this new element in their play. Alternatively, set up open-ended play scenarios involving bugs and their environments.
- **Distribute documenting materials**
Provide clipboards, with paper and pencils, for use in your classroom and outside. Encourage children to record the interesting things they explore while playing, as well as their observations of bugs.
- **Set up a discovery area**
Create a special indoor space to keep specimens in, and to display and revisit other collected items and resources.





USE FREE AND FOCUSED APPROACHES

Free observation plays an important part in children being inspired and discovering the world around them. Adults can help to focus children on a more scientific investigation, using specific topics and tasks.

When our young scientists first started the project, they learned to:

- classify invertebrates into groups – mostly by noticing similarities and differences, such as numbers of legs
- use reference books to identify bugs
- recognise different types of habitat around their school or home
- use techniques and tools to sample the habitats, and capture invertebrates for closer observation
- document their observations scientifically, often with tally sheets and observational drawings. See pages 127–128



Te Papa blog > It's a Bug's Life Education Resource Project
MUSEUM OF NEW ZEALAND
TE PAPA TONGAREWA

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It's a Bug's Life Education Resource Project

Posted 11 March 2015 by Rebecca Bromme & filed under Bugs, insects and spiders, DeCLASSIFIED!, Early Childhood Education, Education, Field trips, Kids, Science.



Discovering Nature. Photographer: Imagine Childcare, © Te Papa

"Equipped with his five senses, man explores the universe around him and calls the adventure Science..." – Edwin Powell Hubble.

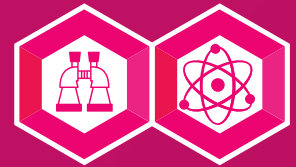
The natural world is full of amazing opportunities for exploration and creativity, and therefore an excellent platform on which to build and grow the scientific thinking, knowledge and confidence of young children!

In 2015, Te Papa is creating a teacher resource to support you to 'do science' in your own backyard/outdoor environments – with a focus on the invertebrates who make these places home. We are working with three Wellington region Early Childhood Centres to do this: Raumati South Kindergarten, Kiwi Kids Childcare Centre and Imagine Childcare.

You can read more about our early It's a Bug's Life experiences in our introductory blog post:



blog.tepapa.govt.nz/2015/03/11/its-a-bugs-life-education-resource-project/



Insect silhouettes: Identification tool and fun game

Learning story excerpt from
Raumati South Kindergarten

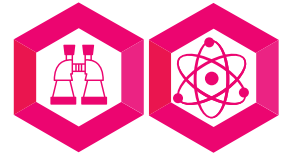
DEMONSTRATES: INTRODUCING TECHNOLOGY, AND CREATING PUZZLES AND GAMES

Our exploration began by looking at copies of photographs (printed on acetate sheets) that we had taken of some insects. Using an overhead projector (OHP), we were able to zoom in and take a closer look at things like wings, body parts, and the composition of the insect. Ngā kaiako Tash and Jo had been to an exhibition at one of the city galleries on bees, and images from these were brought in to study too.

As we got to understand the OHP more, we transitioned into using this technology in different ways. We sought to identify insects by looking at the silhouettes of them on the white wall. As we hadn't seen just their shadows before, this took a bit of problem solving. We worked through each one, distinguishing the facts that we knew about insects.

'Find the insect' games were created by some of the children. One child took charge of giving a slight description of the insect, and the other children had to find it on the wall.

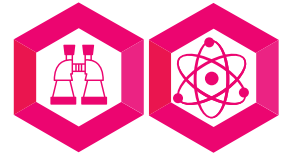




- **Have a sensory adventure**
Examine bugs from a sensory point of view. Ask questions such as, 'What do you hear?', 'What do you smell?', and 'What do you see?' Make links to previous learning wherever possible.
- **Draw**
Enable children to make detailed observational drawings of the environment and the things living in it, for example, features of an ant's body, the behaviour of a spider, or a feature of a plant from a bug's environment.
- **Have group discussions**
At your mat-time hui, encourage children to share ideas and information about what they've learned, and to listen to each other's opinions and alternative ideas. Decide together on new lines of inquiry.
- **Start a collection**
Collect invertebrates that interest the class, or encourage individuals to start their own collections. Talk about how, years ago, some people built huge collections of insects, such as George Hudson's collection at Te Papa ([youtube.com/watch?v=y9HelWFCISY](https://www.youtube.com/watch?v=y9HelWFCISY)). You could collect photographs of the invertebrates – a large photo album is much kinder, and easier to look after!

Kaiako Tash brought in another bee product – beeswax – for Nerys to observe as part of her investigation into how honey is made. 'It smells like honey!' exclaimed Nerys. 'I think the bees have made this too.'





PRACTISE WITH TOOLS AND TECHNIQUES

You can do great science without special equipment, but tools such as pencils and paper, clipboards, magnifying glasses, microscopes, and drop sheets or drop trays enable richer exploration, and can be great fun to use.

You'll need to learn some simple techniques – see from page 111 of this resource for more details on the ones we found most useful.



ENGAGE WITH SCIENTIFIC AND LOCAL COMMUNITIES

Enrich your explorations by connecting with experts and other willing individuals.

Use online resources

Our centres found that NatureWatch.org.nz (naturewatch.org.nz/) is an excellent way to communicate with professional and amateur scientists around the country. They also shared their journeys with the public through *It's a Bug's Life* posts (blog.tepapa.govt.nz/tag/its-a-bugs-life) and wrote to each other as fellow project participants through email and the post.

Correspondence on NatureWatch NZ site: Raumatī South

[Spiders, mites, and relatives](#) (Class Arachnida)

Description

The spider was found in Lucy's home, and she brought it to kindergarten for us to examine. She said, 'it has white spots on it and looks like a daddy-long-legs, but I don't think it is.' We couldn't find it in any of our reference books. Are you able to tell us what kind of spider it is?

Added: Mar. 13, 2015 13:55:11 +1300
[Add/edit more fields](#)

Comments: [P. M. Williams](#)

Your ID: [Arachnids](#) (Class Arachnida) [Remove](#)

Posted by [you](#) about 2 months ago

 I have invited this observation to the "Spiders with Te Papa" project (click on the button over on the right to accept), and that will bring it to the attention of their experts. But it may be a bit hard for them to tell from the photo, but we'll see :-)

Posted by [tony_wills](#) about 2 months ago

 Hi raumatīsouth, Welcome to NatureWatch! If you accept the invitation to the "Spiders with Te Papa" project, your photo will get seen by Te Papa's Phil Sirvid, and he'll then have a go at identifying it for you. Leon (from Te Papa)

Posted by [leonerperie](#) about 2 months ago

 [phil_sirvid's ID: Cellar Spiders](#) (Family Pholcidae) [Agree?](#)

Hi Raumatī South. My apologies for taking so long to get back to you on this as I've been so busy this past week that I've been neglecting my NatureWatch duties. The photo is a little bit blurry and I am by no means certain, but I wonder if this might be another species called *Psilochorus simon*. This is a cousin of the daddy longlegs (*Pholcus phanglossoides*) that you know so well. These are much smaller than the regular daddy longlegs and seem to like making their webs down near the floor. They are another foreign species that has become established in New Zealand.

Posted by [phil_sirvid](#) about 1 month ago

 I think it might be *Cryptachaea giganteipes* (white porch spider), but it is difficult to be sure from the photograph.

Posted by [corvink](#) about 1 month ago

 I thought about theridiids too Cor, but as you say it's tough to be sure based on the photo. RaumatīSouth, can you tell us how big the spider was? That may help us get a better idea of what it is.

Posted by [phil_sirvid](#) about 1 month ago

 Hi there the spider would have approximately 5cm in length. We are trying to track down a lens for one of our cameras so we can take better close up shots. Thanks for feedback the children have been very excited about all of this.

Posted by [you](#) about 1 month ago




Explore the societal roles of scientists

Demonstrate that science is a job that people do, and examine the roles scientists play in our society. If you can meet a working scientist, do so.

For example, our centres met working scientists on a special behind-the-scenes visit to Te Papa (see the photos above). The children learned about our scientists' roles and day-to-day activities.

Read more in our blog post:

 [Blog.tepapa.govt.nz/tag/scientistmeetscientist/](https://blog.tepapa.govt.nz/tag/scientistmeetscientist/)

Seek advice from supportive institutions

Each of our centres sought teaching resources and advice from:

Te Papa
www.tepapa.govt.nz/

Enviroschools
www.enviroschools.org.nz/

Kiwi Conservation Club
kcc.org.nz/

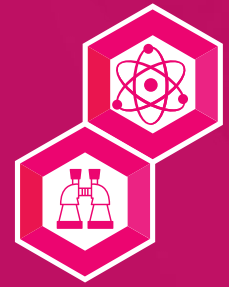
Zealandia
www.visitzealandia.com/

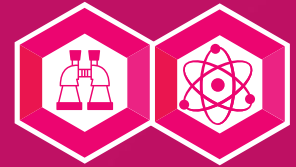
Royal Society of New Zealand
www.royalsociety.org.nz/

Landcare Research
www.landcareresearch.co.nz/home

Department of Conservation
www.doc.govt.nz/

Sustainability Trust
www.sustaintrust.org.nz/





Involve your local community

Engage with knowledgeable, invested people from your local community.

Our groups worked with:

- parents and extended whānau
- neighbours
- other ECE centres and schools
- the Scouts and Girl Guides.

Working with Robin

Learning story excerpt Kiwi Kids Childcare Centre

DEMONSTRATES: INVOLVING YOUR LOCAL COMMUNITY

During one of our regular excursions down Hazelwood Ave, we met Robin. She is part of our local Karori community.

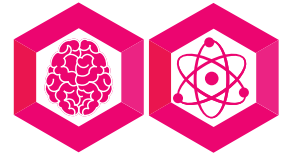
Robin had some caterpillars and butterflies in her garden, and she invited us to come and observe them.

We took Robin up on this kind offer, and Robin offered up her time and knowledge to help us discover more about butterflies.

This meeting has sparked an interest, and we have now visited Robin and her butterflies many times.

The children and teachers have developed a great relationship with Robin – one we hope to continue well into the future.





Ask scientific questions

I wonder ...

Once children's curiosity has been sparked, they begin to form questions, and can be motivated to think more deeply about what they've experienced.

Asking questions, and deciding which to follow through to an answer, is at the core of science. But not just any question is a scientific question.

A scientific question:

- can have a real answer (even if it is just yes or no)
- can be tested, usually by doing an experiment (a test) where you observe or measure something.

A good scientific question also:

- builds on what is already known
- fosters scientific thinking (see page 110 for more information on productive questioning)
- when answered, leads to other good questions.

NON-SCIENTIFIC QUESTIONS

Do cicadas like making noise? (We can't ask the cicada to find out.)

Are earthworms better than tiger worms? (Better at what? How would you test 'better'?)

Ladybirds eat aphids. (This is a statement, not a question.)

GOOD SCIENTIFIC QUESTIONS

Do cicadas make more noise during the day or night?

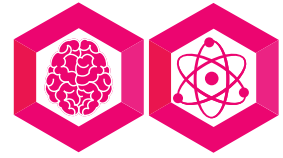
Are earthworms faster at breaking down the compost than tiger worms?

Do ladybirds just eat aphids?



OUR RECOMMENDATIONS

Explore what makes a question	Page 39
Identify interests	Page 39
Strike a wondering pose	Page 39
Encourage critical and creative thinking	Page 40
Use a wondering wall	Page 40
Ask questions to improve questions	Page 40
Be specific	Page 41
Do no harm	Page 41
Research	Page 41
Showcase big questions	Page 42



EXPLORE WHAT MAKES A QUESTION

It's not uncommon for young children to confuse questioning with storytelling. Demonstrate using the basic question words (who, what, where, why, when, and how), and ask children to form their own questions using these words. You could use the 'Question Song', or prompt cards to support learning.



IDENTIFY INTERESTS

Ask children to share (orally or visually) what they've seen and what they've learned so far – perhaps by using a picture display to facilitate recollection. Retelling can help children organise their thoughts and highlight their interests and funds of knowledge.

Thinking and talking more deeply about the invertebrates you have encountered as a group, and what the children would like to find out more about, will make for more sophisticated, stimulating levels of inquiry questioning too.

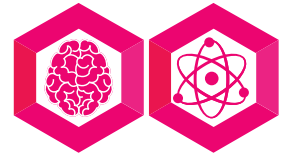


STRIKE A WONDERING POSE

Use the wondering pose – where you hold your chin and say, 'Hmm ...'

This can help prompt children to move into a thinking or reflective mode.





ENCOURAGE CRITICAL AND CREATIVE THINKING

Encourage children to use both their critical and creative thinking skills to form questions – both are useful in science!

- **Critical thinking** is a logical and investigative approach. Imagine Childcare used critical thinking to come up with the question ‘How do spiders make their webs?’
- **Creative thinking** generates new and imaginative questions. Kiwi Kids provided an example of this when they wondered, ‘Do spiders dance to music like kids do?’

USE A WONDERING WALL

Capture children’s scientific questions on a wall or chart as soon as they come up.

Take this further by making the questions moveable for easy grouping.

For example:

- move all the questions about bees into a group
- pull together all the questions relating to your bark area
- include pictures of each tamariki and create ‘communities of inquiry’ – groups of children with similar inquisitive interests.

ASK QUESTIONS TO IMPROVE QUESTIONS

Challenge children, with support, to consider the scientific quality of their questions.

In particular, try asking these questions:

- **Can we find that out?**
For example, we can’t find out the emotions of a fly when it’s caught in a web (unless you speak fly, of course), but we can find out how it physically feels and what it does when it’s in this situation.
- **How could we find that out?**
For example, we can measure how long it takes for a snail to travel 10 centimetres by using a clock, but we wouldn’t have the equipment to measure a fly’s speed over the same distance – it would be too fast!
- **Why would you like to know this?**
Good scientific questions are also interesting and have a purpose – you want to know the answer, and there is a clear reason for finding out the answer. By asking young children to think about what their motives are, it can help them (and you) identify if the question they are asking is really the best fit.

For example:

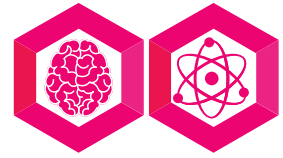
Child: Are grasshoppers green?

Educator: Why would you like to know?

Child: Because the praying mantis is green!

Educator: It sounds more like you want to know which bugs are green coloured. Shall we find this out instead?





BE SPECIFIC

Our Te Papa bug expert, Phil Sirvid, shared this wisdom about questioning:

I think children might be led astray if they try to apply specific behaviours or features across all groups. For instance, if we asked, 'Do spiders look after their young after they hatch?', the answer will usually, but not always, be no. If they look at a spider like a wolf spider that might be carrying her young around on her back, they might wrongly infer that all spiders look after their young. The diversity of bugs is so huge that if children start trying to apply general questions across large groups of invertebrates, they may draw a false conclusion.

In short, 'Does this spider ...' is a better start to a question than 'Do spiders ...' if you are not planning to look across a wide range of specimens.

Adults could let children know that their questions are a little too general by saying something like, 'Good question, but there are lots of different kinds of spiders. Do you think they will all be the same?'

DO NO HARM

Make ethical considerations, and be good kaitiaki (guardians), when selecting questions.

Raumati South Kindergarten decided not to follow through with the question 'Do monarch caterpillars eat just swan plants?' While they could have experimented with other foods (jellybeans were suggested as an option) and found out the answer, the kaiako knew that doing so would have harmed the caterpillars.

RESEARCH

Do some research with children to get a feel for what answering their questions might entail and to find out if they have already been answered.

For example, you could do research by:

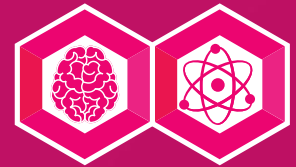
- looking in scientific books
- searching the internet
- asking your friends, whānau, or community for advice.

Research can also give us good background information that can help to further spark an interest, and bring forth new lines of questioning as we see gaps in the 'scientific record'.



SHOWCASE BIG QUESTIONS

Create a physical space to display together any big questions you want your group to follow through the inquiry process. The action of going to revisit this space can be incorporated into your daily or weekly programme, and can serve as a prompt – helping children to remain focused



Researching & questioning to find out more

Learning story excerpt from
Raumati South Kindergarten

DEMONSTRATES: RESEARCH

‘Where did the caterpillars come from?’ you asked kaiako Tash. What a great question! Let’s do some research first.

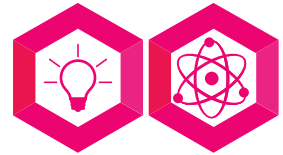
We had a look at a butterfly book and saw that the caterpillars had hatched from eggs, like some other creatures we know – birds, snakes, and turtles, to name a few.

This led you to another question: ‘But where do their eggs come from?’ Reading the book some more, we found out that there was a cycle of life – the monarch butterfly lays the eggs, the eggs have inside them a caterpillar who pops out, then the caterpillar eats lots and makes a home called a chrysalis. ‘It looks like a pod,’ you said, looking at the picture. ‘And then there’s the butterfly!’ you said, pointing to the picture.

Running over to our swan plant, you looked carefully on the leaves and had another question: ‘How come we can’t see the eggs here?’

You decided to go on a search for eggs. ‘Hey,’ you called me over excitedly by the worm farm, ‘This might be an egg!’ You had discovered an egg – it was a big egg. It looked like an egg a chicken would lay. Having a look again at the picture in the book to check, you decided it was different. ‘Maybe all the eggs have already turned into caterpillars,’ I wondered.

Do you know what I found out later that day? The other teachers showed me some eggs on the underside of the leaves! That was the one place we didn’t look. I wonder why the butterfly at our kindy laid them there. Could this be a question for us to investigate and find an answer to?



Make hypotheses

I think ...

'Hypothesis' is a big word with a simple meaning. Children often make hypotheses naturally when they come up with an answer to their scientific question by making an educated guess.

Making and testing hypotheses is a big part of what scientists do – it's the starting point for scientific investigation.

A hypothesis has to be:

- plausible
- able to be proven right or wrong (falsifiable)
- able to be tested.

We try to relate our hypothesis to what we already know.

Example

Question: What do our ants choose to eat?

Exploration experience: Some ants were observed near the sugar bowl in the cupboard.

Hypothesis: I think that the ants in the cupboard prefer sweet foods.

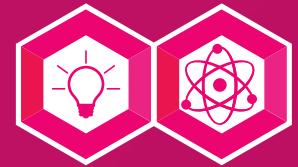
Failure is (very much) an option – and that is OK!

Did you know that a hypothesis doesn't need to be true to be useful? Some of the most meaningful investigations can follow from disproving your first idea. Remember that 'FAIL' stands for First Attempt at Learning.



OUR RECOMMENDATIONS

Follow a question with a hypothesis	Page 44
Use a variety of resources	Page 44
Have a brainstorm	Page 44
Ask why	Page 45
Be responsive to new information	Page 45
Activity ideas for making hypotheses	Page 47



FOLLOW A QUESTION WITH A HYPOTHESIS

Children engage more readily when an idea is fresh and interesting to them. Each of our partner centres found it effective to encourage hypothesis-making as tamariki first wondered and formed a scientific question.

USE A VARIETY OF RESOURCES

Not sure what you think yet? Revisit exploration experiences with children, or do more research using photos, audio, or video to promote the development of a hypothesis.

HAVE A BRAINSTORM

Work in a group to encourage idea sharing. This provides opportunities for tamariki to make connections and fuel each other's critical and creative thinking.

Making hypotheses on an insect hunt

Learning story excerpt from
Imagine Childcare

DEMONSTRATES: FOLLOWING A QUESTION WITH A HYPOTHESIS

Rimutaka Forest Park was the location for a family fundraising day.

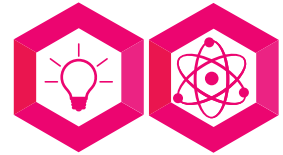
This new environment presented us with the opportunity to do an insect hunt within a different ecosystem.

Tally charts were made, pencils and clipboards supplied, and out we went in search of the area's mini-beasts. Mums and dads joined their children in finding centipedes, sandflies, worms, spiders, and hoppers. Discussions were encouraged around questioning ('I wonder ...') and the making of hypotheses ('I think ...') during the activities. These discussions were recorded by whānau.

Alma wondered, 'How many legs does the slater have?' She asked the question 'Why were slugs under rocks?' and then proposed an answer: 'Because that's where they sleep. That's where they live. The bugs like hiding under rocks.'

Olivia J hypothesised when seeing a spider: 'He's making his web. Spiders don't like to see people when they are making their webs – that's why it's hiding.'





<p>Why do bumble flies have 2 wings at front & two smaller at the back? Ava</p>	<p>"Why do insects have six legs?" Emmaline. 11.3.15</p>	<p>Are spiders born with 8 legs? or do they grow later?</p>	<p>"Why do they stay in their webs so long?"</p>
<p>→ "They need to fly" - Emmaline. → "They have four wings to fly because with no wings they won't be able to fly" - Ava → "Spiders can't fly, to fly they don't have wings" - Sammy.</p>	<p>→ "so they can walk" ^{12.5.15} - Olivia L. → "they need to crawl" - Alex → "because insects fly" - Ava → "They will fall down if they don't have six legs" - Emmaline. → "They need to help them walk (spiders with 8 legs) & insects don't have a heavy body" - Emmaline.</p>	<p>^{12.5.15} → "They grow their legs" - Alex → "They grow their legs in the egg" - Emmaline How could we find this out? → "we could look at them ^{12.5.15} really long or the computer" - Emmaline.</p>	<p>→ "They are eating the insects" - Olivia L. → "to catch some flies" - Alex.</p>

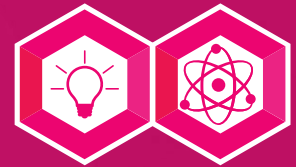
ASK WHY

Challenge children, when they are ready, to demonstrate their reasoning by asking a more complex question: 'Why do you think that?' This will help them to work through the plausibility of their hypothesis, and emphasise the need to use evidence to back up their thinking (more on this under Capability 2 on page 63).

BE RESPONSIVE TO NEW INFORMATION

Generally, more experienced scientists stick with a hypothesis right through the scientific process (through to a resolution), even if it becomes clear early on that it's wrong. A lot of background experience, thinking, and work is behind their statements.

However, at this level, we suggest that young scientists focus on being responsive to new information when it's presented, even if this means 'parking' a hypothesis for now, and shifting their focus earlier and more often. A good demonstration of this came from Raumati South Kindergarten.



Nerys revises her hypothesis

Learning story excerpt from
Raumati South Kindergarten

DEMONSTRATES: BEING RESPONSIVE TO NEW INFORMATION

You told me about your theory that bumblebees mix honey in their bottoms, while we were looking at a book on insects. 'The bees land on a flower and pick up the nectar, and take it back to the hive and mix it in their bums.'

'They must have spoons in their bums, and that's where they mix it!' you said while showing me the diagram.

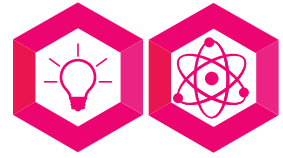
I thought that was a bit funny, and so did you! You were pretty sure they mixed it in their bums, though. I wondered how we could plan to test your idea and find out.

Since we weren't too far through the book, you decided to keep reading about bees for a while. We noticed a picture of the bees doing something with their mouths and I pointed that out .

'They're making honey with their mouths!' you told me.

I like how you built a new theory and based it on something you had seen. Let's leave our work on the last question for now, and make another hypothesis based on this question: How do bees use their mouths to make honey?





ACTIVITY IDEAS FOR MAKING HYPOTHESES

- **Examine popular stories**

Use shared storytelling based on the books in your library corner to practise the skills behind hypothesis creation with young children. Ask children questions about the events of the story, and the explanations given (explicitly or implicitly) for their occurrence.

For instance, if you were reading *The Gruffalo* by Julia Donaldson, you might ask why the little brown mouse seems so wary of the owl.

In the process of co-narrating (giving their own perspectives), children will stimulate and grow their critical, social, cognitive, and linguistic skills – all needed for making good hypotheses.

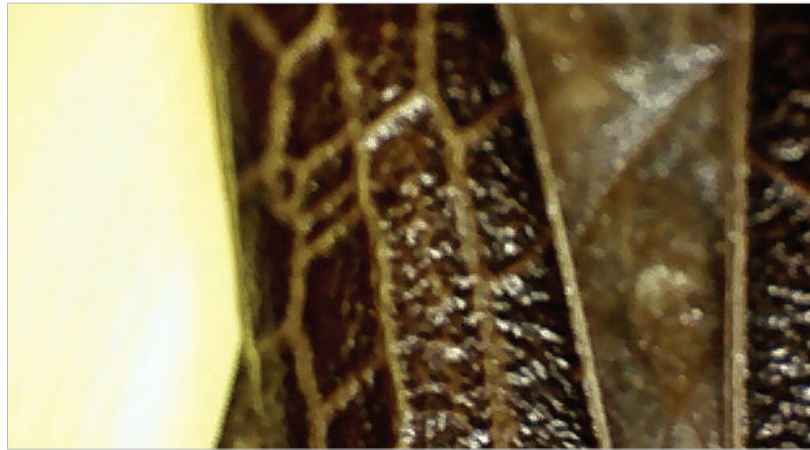
Responses might include 'I think those owls must eat mice,' or 'I think the mouse is scared because he is small and the owl is big.'

Challenge their responses with the question 'How would you find out if that is true or not?' This reinforces the importance of making sure your theories are potentially testable and falsifiable when you are doing science.

For more background on this activity, see the paper *Storytelling as a Theory-Building Activity*.

- **Rebuild a badly formed hypothesis**

Use a deconstruction and reconstruction approach to demonstrate why hypotheses need to be plausible. As tamariki become more confident, encourage them to lead this activity too.



The wings of a huhu beetle under a digital microscope, by Imagine Childcare.

Example

Kaiako suggests a hypothesis:

'I think huhu beetles are brown on Wednesdays and pink on Fridays, so they can go to parties.'

Kaiako encourages deconstruction:

'Is this possible?'

'Why not?'

Tamariki:

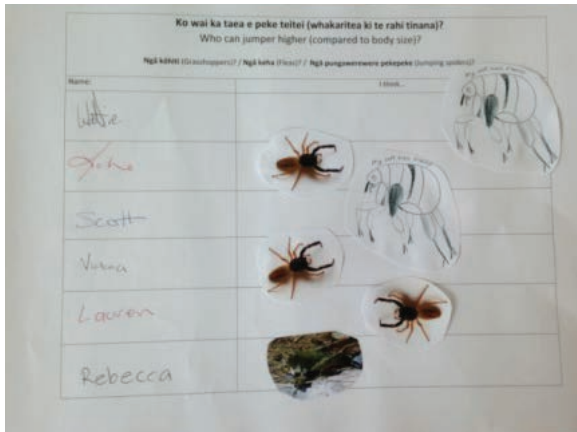
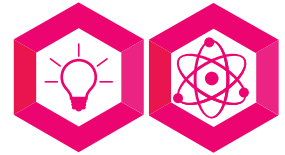
'No – because we haven't seen a pink huhu beetle.'

'No – because we haven't seen any bug change colour just because it's Friday.'

'No – because huhu beetles don't go to parties – only people do.'

Reconstruction with tamariki:

'I think huhu beetles are always brown.'



- **Create a visual hypothesis**

Use varied approaches to help children construct hypotheses, such as arrangements of objects, photographs, or drawings.

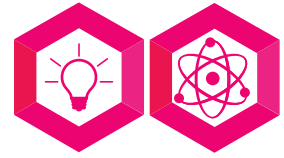
Example

Scientific question:

'Who can jump higher, compared to body size: ngā kōhiti (grasshoppers), ngā keha (fleas), or ngā pūngāwerewere pekepeke (jumping spiders)?'*

In the chart pictured, different hypotheses are illustrated by using photographs and drawings. Afterwards, we thought that plastic figurines could also have been used.

*The answer is ngā keha (fleas), which can jump up to 100 times as high as their body length!



Get ready to test

I predict ... I will ... I need ...

Scientists use various methods to find out if their hypotheses are correct. We call this step testing.

- **Experiments** test scenarios that the scientist has some control over.
Example: Setting up a worm farm to observe the way worms eat.
- **Observational studies** test uncontrolled scenarios that are already occurring.
Example: Observing snails eat in the garden.
- **Research** involves investigations into what other scientists have recorded from their observations. Example: Reading books on snails to find out how they eat.

Scientists must test their ideas more than once to make sure their findings are accurate. They take steps to help them get ready for testing too.

Predicting: What will happen if I'm right?

Scientists describe what test results they expect to observe to prove their hypotheses. This prediction informs their planning and preparations, and vice versa. It will usually be able to be confirmed or disproved.

Example:

Hypothesis: I think slaters (woodlice) prefer dark places.

Prediction: *If I put the slaters on the concrete, then they'll run under the pot.*

Planning

Scientists ask themselves two questions when starting to plan tests:

- What will I do?
- What will I need?

Example:

- I *will* collect some slaters, put them on the concrete by the pot plant, and draw what I see them do.
- I *need* slaters, a container to keep them in beforehand, the concrete in the playground, paper, and a pencil.

Scientists plan to keep everything the same in all their tests.

Example:

- If I have five slaters in my first test, I should also have five in future tests too.

Preparing

Scientists get ready to put their plans into action.

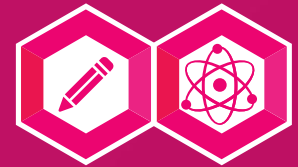
Example:

- The scientist sets aside time to collect some slaters, and gets a container, paper, and pencil.

Troubleshooting: Is my procedure working?

Scientists have to identify and solve problems. If when they start their test, they find that something is not working, they will go back to their planning and preparation stages to get them right.

For example, if you found that your slaters were escaping from your container, you might need to rethink your plan, or maybe replace the container for one more fit for purpose.



What does this look like in practice?

A great example of prediction, planning, and preparation comes from Kiwi Kids Childcare Centre.



Testing with tadpoles

Learning story excerpt from Kiwi Kids Childcare Centre

DEMONSTRATES: PREDICTING, PLANNING, AND PREPARING

We wondered, 'What do our tadpoles eat?'

To help us answer this question, we asked some people who've kept tadpoles before for their advice.

Curdin (Cillian's dad) told us that tadpoles can eat boiled lettuce leaves, and Alice (Donna's mum) told us that tadpoles can eat cold-water fish food – but that it needs to be ground up lots because tadpoles have very small mouths.

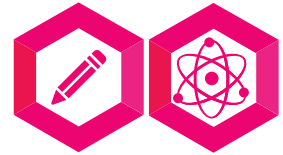
We decided that the best way to find out which of these our tadpoles like best was to do an experiment. We planned to give them both a bit of lettuce and a bit of fish food over the week, and watch (or observe) them eating. We thought we could then record what we saw at morning and afternoon feedings on our feeding chart.

We asked ourselves, 'What will happen to tell us which food they like or dislike?' We predicted that if tadpoles ate the food, then they liked it. If they didn't want it, then they would leave it behind (just like we do).

We talked about the need to prepare the food first, or we wouldn't be able to do our investigation. We decided the food had to be very, very small as the tadpoles were so little. We thought using our hands to grind up the fish food and rip up the lettuce would work. The lettuce would need to be boiled, so we asked our lovely cook if she would help us do this.

After a few days, we decided that the tadpoles definitely liked some of the food, because we observed that they'd done lots of poos in the water. The boiled lettuce became smelly very quickly, so we changed our preparation of it – making little boiled lettuce ice cubes instead. The tadpoles (and all of us) liked this much better.

We gave the tadpoles just one portion of fish flakes and one ice cube of lettuce at a time, to keep it fair. We found out that our tadpoles liked the fish food much better because there was lettuce floating around the top of the tank still uneaten, but no fish food flakes left.



How will I find out?

Step 1

Child's voice:
Get ants from the footpath
(Find a place where the ants are found on the footpath).

Step 2

Child's voice:
Get fruit scraps

Step 3

Child's voice:
Put bits of fruit under the pot (on the concrete) but make sure ants can get ant's from the pot

Step 4

Child's voice:
See what pot the ants go to & eat.
Watch them lots!

Tessa

What equipment will I need?

Child's voice:
We should put the flat on the footpath with the flower pot on top.

ACTIVITY IDEAS FOR PREDICTING, PLANNING, AND PREPARING

- **Use our planning template**

Help children plan the steps they'll take, and identify the equipment they'll need, by using the planning template found in this resource (page 126). It makes room for four steps, but it's good to use more if you can draw out more detail.

By recording your method, you are also making sure that someone else could repeat or follow on from your test themselves – this is good scientific practice!

- **Read or listen to a story that encourages prediction**

For example, in *The Magic Hat* by Mem Fox, a wizard's hat blows into town and lands on the townsfolk's heads, turning them into different animals.

- o Before reading the story, state your hypothesis that this magical hat turns people into the animals they most resemble.

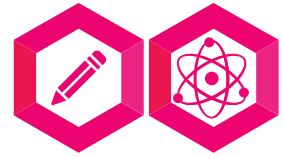
- o Pause throughout the story to ask the children to make predictions that could prove your hypothesis.

For example:

'Hmm ... What do you predict? If the hat lands on this man with the bananas, then he will turn into ...'

As you carry on reading, the story gives immediate feedback, which is fun and helpful for younger children.

- o At the end of the story, evaluate your hypothesis together – has it been proven?



- **Put on a prediction performance**

Design and make your own 'science wizard' or 'future-teller' hats to wear when using your own magical prediction abilities. What can you foresee?

- **Explore the idea of inference**

An inference is a conclusion we come to by identifying reasonable meaning in a particular occurrence.

In our earlier examples, when an animal eats food, that means the food is appealing; and when a slater goes under a pot, that means it doesn't like the brightness of the sun.

Practise making inferences using everyday occurrences in the classroom or at home.

- o The steam coming out of the pot means _____.
- o The scissors cutting the paper means _____.

You could also link observations and inferences by making paper chains. Use coloured pens to differentiate between them. As there can be than one reasonable meaning for an occurrence, your chain could get very long!

- **Go on a preparation excursion or involve your community**

For instance, you might all go to a local garden centre to buy flowering plants for an experiment with bees, or you could ask families to donate their containers to use for your experiments.

Observe

I see/smell/hear/taste/feel ...

are deliberate or purposeful
(not just spur of the moment)

are done closely and carefully, looking for the big and little details

build on, or are influenced by, what we already know

must demonstrate the identity of each species being observed

Examples from Raumati South Kindergarten:

'Sam ... What a love you have for *The Life-Size Guide to Insects and Other Land Invertebrates of New Zealand* book. We have looked at this book many times and learned lots from it. Now we get out the magnifying glass to see some of the smaller insects closer when we are observing them. We spend time counting legs and antennae, and looking for mouths, tails, eyes, and wings.'

'Careful observational drawings of the butterflies (and other insects) have been done in the classroom. Lieza was one child who showed a great eye for detail, ensuring that she had the shape, colours, and anatomical features (number of legs, antennae, wings, eyes, spots) down pat.'

Scientists do this by:



USING REFERENCE BOOKS

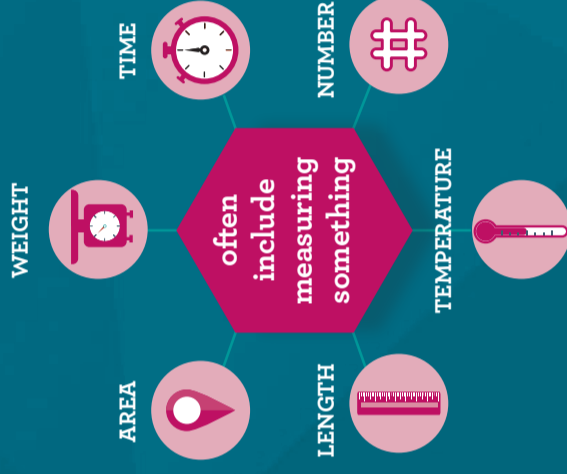


TAKING PHOTOGRAPHS



KEEPING A SPECIMEN

Observation that are scientific ...



With young children, measure by making comparisons and ordering, as well as using standard measurements such as above.

take the context into account

The actions and reactions of bugs are not separate from the features of their environment. Because of this, scientists make note of this background information too.

Example: 'It's very windy here, so that could be why there are few webs.'

are objective
(focus on the facts)

Scientists put their personal feelings and opinions aside because these are subjective and could bias their observations.

✓ Ngā pūngāwerewere (spiders) don't always care for their young after they've hatched.

✗ Ngā pūngāwerewere are bad mothers.

can be direct or indirect

Both types are useful, but direct observations should be a priority with young children.

- o A direct observation is one where we use our own senses to notice and record what's happening.

Example: Watching a bee collect pollen from a flower in the garden.

- o An indirect observation is one where we rely on reports of others' observations.

Example: Using a non-fiction book, seeing a diagram, or watching a documentary on bees.

must be described
(recorded and communicated)

See 'Interpret representations', page 76, for more information.

are repeatable

They can be done in the same way again and again.

are peer-reviewed

Scientists check with others that they agree with their information.

Example: 'I see that the caterpillar has yellow and black stripes – is that what you see too?'

can be extended or enhanced by tools and techniques

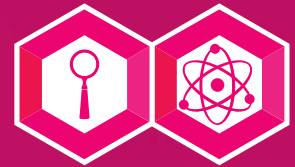
Tools like magnifying glasses enhance our sight, allowing us to see details we couldn't see otherwise. Collection techniques like the use of pooters allow us to collect bugs for closer observation without hurting their small bodies. Find out more from page 112.

Observing is the most important part of gathering data with young children. This is where our evidence comes from.

Scientists collect evidence during their tests that is empirical – meaning based on sensory experience. To know about something, it must be able to be seen, heard, tasted, touched, or smelled.

What makes an observation reliable?

See 'Use and critique evidence', page 65, for more on making your observations reliable.



Insect-observing enthusiasts

Learning story excerpt from
Imagine Childcare

DEMONSTRATES: OBSERVATIONS EXTENDED AND ENHANCED BY TOOLS AND TECHNIQUES



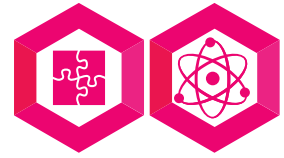
We have been some busy bees since Te Papa's visit to Imagine Childcare and have become real insect-observing enthusiasts. It is an everyday occurrence to hear about the invertebrate discoveries that our tamariki are making. If there is an insect, inside it is quickly brought to our attention. Outside, logs are overturned and nooks and crannies are checked in search of mini-beasts. Children are out with their magnifying glasses and invertebrate books, eager to learn more.

Sometimes, clipboards are at hand to draw observations. Observations have been made of a mosquito trying to get out of the playhouse, a centipede wrapped round a nail, and spiders in their webs. The worm farm has proven to be a good spot to observe.

Spiders are a current favourite due to their prevalence in the preschool – families have been encouraged to bring them in for us to observe. We have had many spiders through our door, ranging from daddy-long-legs to orb-web spiders and large brown vagrant spiders.

When we have come back inside, we have used our digital microscope to look closer still. The images we have taken have amazing detail.





Make meaning & conclusions

This means ...

Making meaning

Scientists think about (analyse) the results of their test (the evidence), and give them meaning (inference). They use this meaning to decide whether their results support their hypothesis.

If not, they might refine or expand their hypothesis and go back to planning. They may even discard it and form a new hypothesis in light of the findings. Even if they got the results they expected, they'll still use a critical eye. Find more on this in 'Use and critique evidence,' page 63.

Drawing conclusions

A conclusion is a reasonable answer to a scientific question, arrived at by interpreting observations. It's a significant step in science, but often skimmed over in schools. We record and then communicate our findings with others.

Example:

Question: Do worms eat with teeth?

Hypothesis: I think worms have teeth, because they eat hard carrots.

Prediction: If worms have teeth, then I'll see them in a scientific diagram.

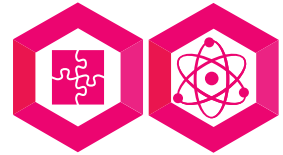
Interpretation: I saw in the diagram that worms have strong mouth muscles, but no teeth. They don't use teeth to eat. I think my idea about worms having teeth was wrong.

Conclusion: This means worms do not have teeth – they eat with their strong mouth muscles.



OUR RECOMMENDATIONS

Separate observations and inferences	Page 56
Work backwards from a conclusion	Page 56
Play inferential games	Page 56
Practise with picture books	Page 57
Represent your thinking	Page 57
Use visual comparisons	Page 57

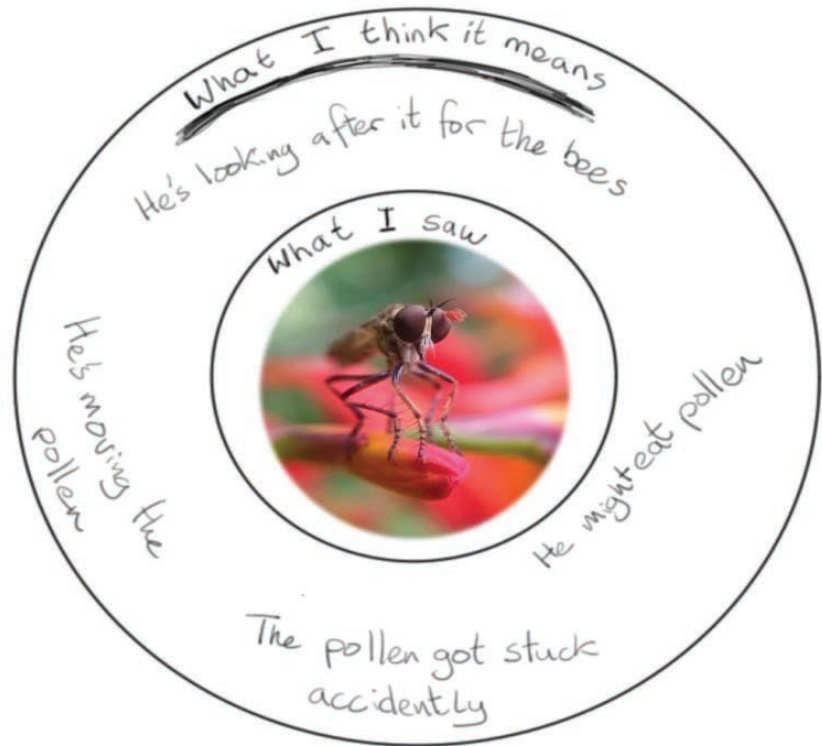


SEPARATE OBSERVATIONS AND INFERENCES

This can be tricky, even for older scientists. Try documenting children's observations and inferences visually. This example uses an observational photograph of a dragonfly with something looking like pollen stuck to its eye:

Question your observations, inferences, and conclusions – do they fit in with what you already know?

For instance, could that really be pollen? Pollen is usually yellow.



WORK BACKWARDS FROM A CONCLUSION

Children will often start with a conclusion. Help them work backwards to identify the inference they've already made.

Example:

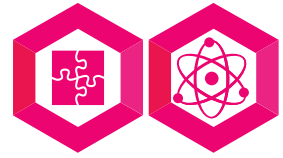
Child: The caterpillars were very hungry today.

Adult: How can you tell?

Child: There are lots more leaves eaten today than yesterday, and that's what they eat.

PLAY INFERENTIAL GAMES

Games such as Mystery Bags and Twenty Questions can build interest and skill in interpreting data.



PRACTISE WITH PICTURE BOOKS

There are no right or wrong interpretations of picture books (especially wordless ones) – it's all about what the child sees and puts together using their schema and the clues from the author. Use them to practice making inferences. Jon Klassen's books *I Want My Hat Back*, *This Is Not My Hat*, and *We Found a Hat* could be useful for this type of activity.

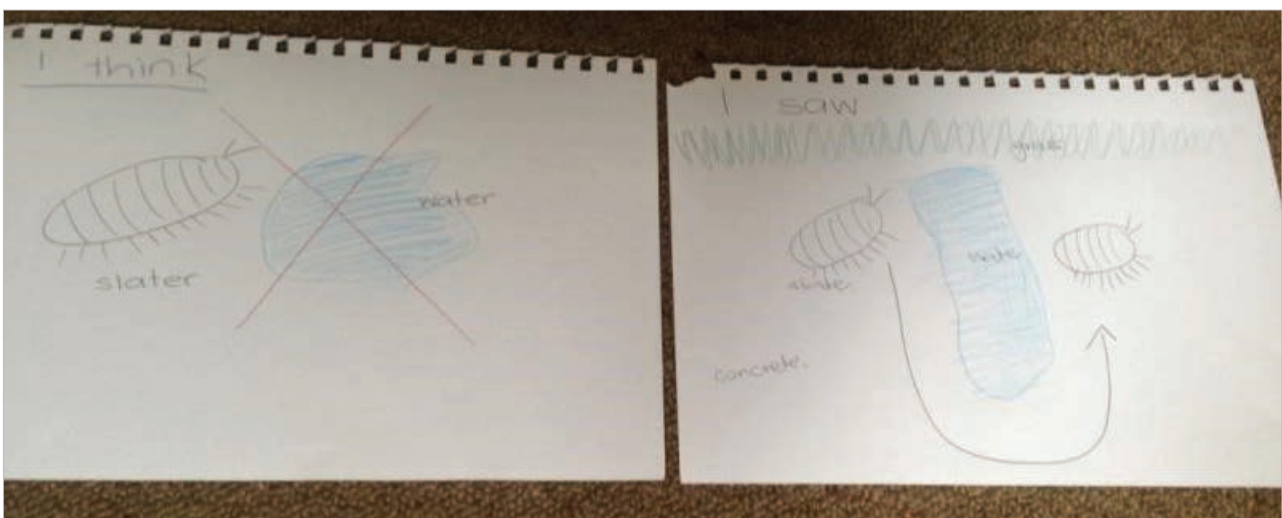
In *This is Not My Hat*, we are faced with questions – will the big fish ever find the little fish? Why has the little fish chosen to hide where he has? What might stop the big fish from finding the little one? Although the questions are answered indirectly, if the children are not making inferences, they'll miss it.

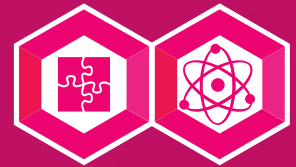
REPRESENT YOUR THINKING

Encourage children to work through their thinking around their observations by creating representations such as charts, graphs, drawings, models, brain dumps, movement, and role play. Find more on this in 'Interpret representations', page 76.

USE VISUAL COMPARISONS

Position a hypothesis next to an observation to help children make comparisons.





Thinking about locust

Learning story excerpt from
Raumati South Kindergarten

DEMONSTRATES: REPRESENTING THINKING



Nathan, this afternoon you found an insect reference book, and we found out from it that locusts hear from their abdomens (their stomachs) and talk to each other through their legs! While you were finding out more about the specifics of this using the details in the book, you told me about your plan to make a locust. You told me what you needed to do this. After we had organised some materials, you set to it.

'These are the antennae,' you shared with me. 'Now I'm making the legs ... They look like legs.' Looking at the book some more, you declared that, 'This one seems to have six legs.'

You pointed out something in the book that I hadn't noticed. It was a diagram showing how the locust moves. 'I can see from here it doesn't really use its wings. It's supposed to hop, not fly,' you inferred.

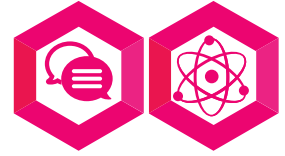
I asked you what else you had noticed and learned through looking at the locust book. You talked about the different layers of the locust in the book, and how you had also made layers in your model: 'There are green bits here, and the brown bits are inside.'

Checking out what you had created so far, you declared that 'I still have to do one leg. I forgot about that.'

'I better go get another pen, a black one for the eyes.' Yes, indeed, the insect had big black eyes in the book. I wonder if it sees really well with those?

Kaiako Jodi came over to have a look, and asked you about your wonderful work. 'I used the book to find out and help me,' you told her.

There was one last thing that you wanted to do. 'Ooh! I have to write my name on it,' you reminded yourself.



Share your findings

I found out ...

There are many ways to record and communicate your findings with others – check out ‘Interpret representations’, [page 76](#), for information on different approaches.

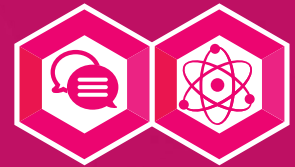
Nevertheless, the most important part is the sharing. When we share our findings, we help others to learn and build interests too. We also add to the scientific record – that big body of knowledge we all share about our world.

SHOWCASE YOUR CONCLUSIONS

- Have a consistent activity that signals a conclusion has been made, such as moving a question from a wondering wall to a conclusions wall.
- Apply your conclusions to your everyday practices. For example, if you found out that wētā don’t like loud noises, you might make it a rule to use only your quietest voices when near your bug hotel.
- Record and then share your conclusions with friends, whānau, and your community, both in informal and formal ways. For example, Imagine Childcare shared their conclusions with parents through Facebook, and in some of the dances, songs, and dramas in their special end-of-year production.



This group also shared their findings (and the method they took to get there) with the wider national and international community too through this learning story on Te Papa’s blog.



Learning story: How do spiders make their webs?

By Adela, kaiako from Imagine Childcare

Gathering and interpreting data is not a step-by-step process. As you will see, we go back and forth – incorporating the elements of the scientific process in the best and most natural ways for our tamariki, our programme, and the enquiry project at hand.

Question

How do spiders make their webs? This was the big question we decided to investigate at the end of our first visit from Rebecca and Scott (Te Papa Learning Innovation).

Hypothesis

Our initial hypothesis was that pūngāwerewere (spiders) make their webs from their legs. However, some of us wondered if perhaps they use their bottoms.

This discussion brought us to our next question – where do we start our investigation?

Identifying the spiders

We investigated the spiders' names using images from Andrew Crowe's book *Which New Zealand Spider?* On one occasion, we identified that we had two large brown vagrant spiders, and a green orb-web spider.

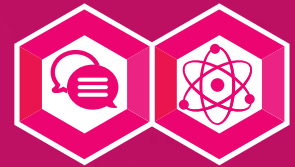
Planning and preparing

Our tamariki brainstormed what the spiders' enclosures would need and came up with this list:

- Leaves
- Water
- Flower petals
- Sticks
- Bark
- Plants

Finding spiders to observe

We felt it would be ideal if we could observe real spiders spinning their webs, so we asked the learning community for support. Some chose to bring spiders into the centre. Spiders came from far and wide – some as close as Korokoro and others as far as Wainuiomata and Pimmerton! We returned them home after observing them for a time. Thank you to all the families and teachers that participated.



A few of us were pretty sure that the spiders needed leaves (Catie and Olivia L) and plants (Emily) to eat, whereas others thought they would prefer ants (Emmaline) and flies (Alex). We retrieved these items from our garden.

Asking the scientific community

We took photos of our new spider friends and posted them on the Spiders with Te Papa page (naturewatch.org.nz/projects/spiders-with-te-papa) on the NatureWatch NZ website – a citizen science initiative that was part of Te Papa’s DeCLASSIFIED! Nature’s secrets exposed exhibition. Phil Sirvid, an entomologist (insect scientist) from Te Papa, commented on our posts, telling us the genus and species (scientific name) of each spider.

Observing the spiders

Sammy’s mum, Kim, also brought in two spiders for us to observe. ‘My mum found us lots of spiders at her school and at home,’ Sammy said.

The daddy-long-legs was of particular interest. I read some facts from Crowe’s book about how they shake their bodies to scare off intruders. Soon after this, we noticed the spider shaking when we carefully lifted its container!

The orb-web spider, which we’d found in our maple tree, was an interesting specimen to watch.



We had a close look at the web it had made encapsulating an insect. After release, it built a new web in our deck’s eaves, right where we could see it! One day, a large leaf blew onto its web, and a number of us watched as the spider worked busily to break parts of its web to remove the leaf.

Indirect observations with books

Through our observations at Imagine during the day, we discovered that many of our spiders make their webs at night, which meant it would be hard for us to observe them in action. We needed to look at some resources to help us answer our big question. We borrowed books from the local library, and watched spiders making their webs on YouTube too.

Conclusion

Finally, by using the books, we came to an answer, or conclusion:

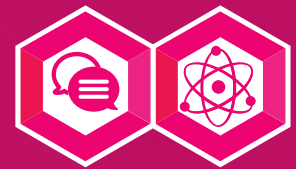
‘Spiders make webs out of their tails!’

Their liquid silk web comes from their tails, the bottom of their abdomen, from tubes within their spinnerets. Spiders use their legs to help them form their webs.

Through our research, we also found out that not all spiders make webs, and that some spiders catch their prey by hunting for them. Some jump on top of their victims and kill them with poisonous venom from their fangs! We decided to explore this too.

Acting it out

We acted out the spider behaviours we'd learned about. Some of us were jumping spiders leaping on our prey, and others imagined spinning webs and awaiting insects that would get stuck in them.



Drawing a tarantula

We got a close look at a spider's fangs thanks to Maggie's dad, who brought in his specimen of a Chilean rose tarantula. The dead spider was inside a glass frame, and its large size made it easy for us to see all of its structures. Some of us even had a go at drawing some observational pictures.

Making our own webs

Once we knew how webs were made, we got interested in the details of them. Webs have sticky parts for catching food and non-sticky parts to allow spiders to move about. Charlotte, Olivia L, and Emily created an interpretation of this by threading wool through cardboard, creating the spider web, and then covering parts with PVA glue to act as the sticky bits. They covered the glue with glitter to represent insects that had become caught, and made pompom spiders to reside on top of the web.

Nichola, one of our kaiako, made another web with the children utilising wool, glitter, and a large dead branch.

We also made spider webs in the garden using wool and rope. We'd learned a lot about the diverse types of webs that different spiders create.

'There are orb-web spiders and tunnel-web spiders too, and there are sheet-web spiders,' said Ava.

We had a go at constructing webs like orb-web, sheet-web, nursery-web, and tunnel-web spiders.

As I assisted the children in creating our orb-web spider web, I talked about how the spider forms the spoke-shaped frame first before creating the circular patterns round it. To reinforce this concept, some children also had a go at drawing similar webs on the concrete using chalk.

Many children wanted to help in erecting the web, and once it was up, it became a real talking point.

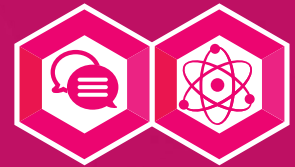
Some children questioned how it got there, and others announced that a huge spider had made it. Kayla pointed to the top corner of the web and said, 'Look! The big spider's up there!' Other children attempted to climb through the web like giant insects, some of them becoming entwined.

Once the web had become disfigured (there was a lot of prey, after all), Alex and Ava started to make another one in its place. The end result looked very much like a line web – a whole different type of web again. Lastly, we made a web similar to that of the nursery-web spider. It was decided that a mother and her baby spiders should be included inside.



'The babies are inside the web, and the mother dies,' said Emmaline.

Emmaline decided to create the spiders by scrunching up pieces of paper into balls, painting them black, and then sticking them together. She used pipe cleaners for the legs, and dotted on eyes with paint.



Another thing we learned is that spiders don't use their webs just to catch food – these are also safety trails. They make a line a bit like a bungy to climb up if they fall.

Learning the word 'abdomen'

From Te Papa's visit to Imagine, we knew that spiders have eight legs, but since then (and because of our enquiry), we've found out more about the body structures of our arachnid friends.

Unlike insects, which have three body parts, spiders only have two. Spiders have an abdomen (like an insect) and a cephalothorax – this means their head and thorax are fused together. This word proved to be quite tricky for us to say and remember, but from then on, we often pointed out a spider's abdomen.

Making spider body parts

To extend their understanding of spiders' body parts, some children endeavoured to make them out of clay. Some made two body parts with the eight legs coming off the cephalothorax, and an abdomen with a trail of web. Some included lots of eyes and hairs, which spiders use to feel vibrations. Spider structures were also painted using puff paint.



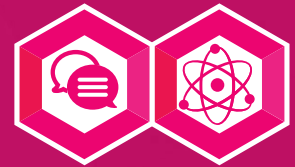
A web on our playhouse.

Continued exploration

Exploration continued outside on a daily basis. Very interesting discoveries were made.

One afternoon, a daddy-long-legs spider was found in the back shed carrying an egg sac on its back. Inside the playhouse, another daddy-long-legs was found on its web surrounded by many of its tiny babies. I'm frequently called upon to check out spider webs.

It's been noticed that spiders tend to wait on the outer reaches of their webs during the day. They sometimes enter the web if they feel it moving, indicating that something is present. The varying uses of webs by spiders could be a good subject for our next investigation.



What's happening here?

Our tamariki have been engaging with some of the five science capabilities (scienceonline.tki.org.nz/Science-capabilities-for-citizenship/Introducing-five-science-capabilities) by gathering information through observations (Capability 1), thinking about how they might use evidence to back up or dismiss a hypothesis (Capability 2), and using many different ways to represent their findings to others (Capability 4).

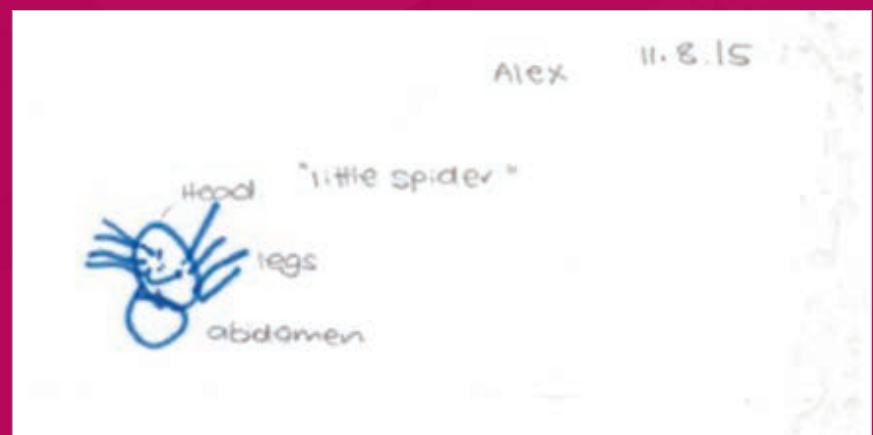
These experiences have presented opportunities for our tamariki to participate in active enquiry and develop their confidence in offering ideas and understanding (Contribution strand, Te Whāriki). They've learned strategies for active investigation, thinking, and reasoning (Exploration strand, Te Whāriki).

Where to next?

We plan on reading Patricia Grace's *The Kuia and the Spider*, which touches on a number of different uses for a spider web. Learning the pūngāwerewere waiata (spider song) from our *Four Seasons* CD is another must-do – it mentions the making of webs for catching flies and laying baby spiders inside. How much fun it would be to re-enact this with our own dance!

We also have other enquiry questions about spiders that we could investigate, including: 'I wonder if spiders live in flowers' (Charlotte), 'Why do they live in their webs so long?' (Augustine), 'How do spiders walk?' (Augustine), and 'Are spiders born with eight legs, or do they grow later?' (Alex).

I wonder what the answers to these questions might be. How we could go about finding out?





CAPABILITIES 2 & 3.

Use evidence & critique evidence

Just as a bridge needs strong supports to stand up, scientific conclusions must be supported by evidence.

Using evidence

Scientists use evidence to improve their understanding of how things work, but sometimes new evidence can disprove long-held beliefs. Young scientists must stay open-minded and be ready to evolve their thinking as new evidence comes to light.

Critiquing evidence

Not all evidence is created equal. It's essential that young children develop the ability to critique (weigh up) evidence. They need to judge the trustworthiness of their data and the quality of their methods and thinking.




IN THIS CHAPTER

Ask questions	page 67
Use the word 'because'	page 67
Create an evidence challenge	page 67
Explore scientific checks and measures	page 70
Select the best	page 72
Cast a critical eye	page 72
Discuss what you haven't found (as well as what you have)	page 75
Encourage reflection together	page 75



A wise man ... proportions his belief to the evidence.
– David Hume

Absence of evidence is not evidence of absence.
– Carl Sagan





ASK QUESTIONS

Encourage children to identify the evidence behind their thinking by asking them questions. With time, you can also encourage them to ask themselves and each other.

Examples:

- How do you know?
- What makes you think that?
- How did you come to that thinking?
- How could we find out?
- Can you tell me about a time you saw this?
- How could you show that?

Also, get children into the habit of judging the quality of their data with questions.

Examples:

- Is it good (accurate, trustworthy) evidence?
- Is it enough evidence, or do you need more?
- Is it related to what you're trying to find out?
- Is it typical, or could it just be a one-off?

USE THE WORD 'BECAUSE'

Signal the use of evidence as you speak, using 'because'.

Examples:

- I think that stick insects are long **because** then they look more like sticks. (Hypothesis)
- If the stick insect is in the grass, we will see it **because** the grass is a different colour and there are no sticks. (Prediction)
- I'm going to watch the snail all morning **because** it moves really slowly. (Planning)
- This means ants do prefer sugar, **because** I saw that they went to the fruit every time, but the vegetables only sometimes. (Conclusion)

CREATE AN EVIDENCE CHALLENGE

Complement natural opportunities to use evidence with purposeful exercises.

For instance, Te Papa Learning Innovation sent Imagine Childcare a set of high-quality images of spiders in our collection (see [What's that spider? website collections.tepapa.govt.nz/Topic/9420/](https://www.tepapa.govt.nz/Topic/9420/)) and challenged the children to help us identify them.



Mia makes a discovery

Learning story excerpt from Raumati South Kindergarten

DEMONSTRATES: ASKING QUESTIONS

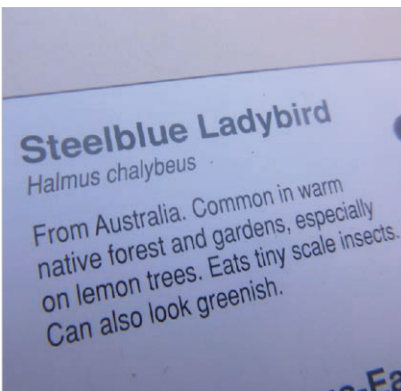
Today you came up with Arlo and Aria and showed me an amazing-looking metallic blue ladybug on your arm. We wondered where it might have come from, and decided to look in one of our books to find out more.

Before we did this, we shared some ideas about where we thought it might have come from. We hadn't seen a bug like this at kindergarten before, so this helped inform our thinking. Arlo thought it was from Auckland, and you thought maybe it was from the nearby beach.

As we looked in the book, we recognised a monarch butterfly, a moth, and a snail. Then, Aria spotted it. 'There it is, there it is!' she exclaimed. I wondered aloud how people knew it was the same one. 'Because it sparkles and it's blue,' you explained.

We read some more and found out our bug was called a steel blue ladybird, and that this species comes from Australia. 'What could this mean?' wondered kaiako Tash.

'Oh ... It flew all the way from Australia,' you said. We all listened as you shared a theory about how that could have happened. 'They fly for three or four weeks, then they crawl under a stone and have a rest.' I asked you why you thought it would be three or four weeks. 'Australia is far away, and they are small,' you explained.





An identification challenge

Learning story excerpt from Imagine Childcare

DEMONSTRATES: CREATING AN EVIDENCE CHALLENGE

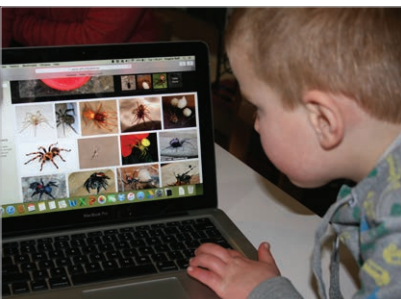
Rebecca set us a challenge to identify some spider species for her. Alex, Max, and Grayson gathered round as we looked over the photos. We talked about how we could find out the names of these creatures, and Alex mentioned that we could use the computer.

Alex described one image as a 'fluffy spider', declaring that he knows that they 'bite, sting, and pinch people – all they can do to look after themselves.' Searching on Google for 'fluffy spider' brought up a number of images, and one resembled our 'fluffy spider': the huntsman spider.

On hearing this, Alex shared some other knowledge he had about the species: they 'catch their food by hunting' and have 'no webs'. Alex also knew that one of the spider images was a white-tailed spider because he had seen one before.

Grayson wanted to identify a different spider. He used his prior knowledge about spider anatomy to pinpoint that the spider he was looking at would make spider webs 'because it would use these two things' (their long front legs). We soon learned that searching Google for 'spiders that make webs' wasn't specific enough, so instead the key feature of a 'see-through abdomen' was searched for. A spider similar to the image came up in the search, and it was called a small crab spider. Grayson agreed it was the same spider 'because it has two eyes'. The eyes at the front of its head did look very comparable.

Alex was keen to name another 'spider with a big bottom' (abdomen). He took charge of the computer, explaining to Max that 'When you see a spider like that, you say stop.'



EXPLORE SCIENTIFIC CHECKS AND MEASURES

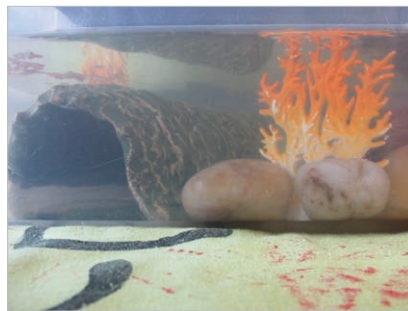
Together, find out more about how scientists carry out their investigations. Discuss how you think this makes their data more trustworthy, then use these checks and measures in your own investigations.

Examples:

- Raumati South Kindergarten thought carefully about their methodology, even during their exploration time. They decided that looking in just one area every time would not give them a very good knowledge of all the insects in their environment, and that visiting an area just once would probably not be enough to get a good survey either. They were rewarded when, upon revisiting their harakeke (New Zealand flax) bushes a third time, they discovered unexpected taonga – a stick insect!



- Kiwi Kids found out that scientists make observations from multiple perspectives – so that they don't miss any details. The children took pictures of their tadpoles from various angles to help identify their progress through the life cycle, then put this evidence into their observation study log.



- When we visited Imagine Childcare, we asked why they hadn't observed just one spider to come to their conclusion (about how spiders make their webs). Eva told us it was because 'the other spiders could do different things'.





Designing a better pitfall trap

Learning story excerpt from Imagine Childcare

DEMONSTRATES: CASTING A CRITICAL EYE

We have observed that a lot of the plastic cup pitfall traps we made with Rebecca and Scott from Te Papa have been blown away. We think this might be affecting our data gathering. While problem solving together, we came up with some new designs that would make our pitfall technique more efficient.

We concluded that the cups needed to be heavier.

'Put rocks in it,' suggested Emmaline and Emily. Another idea was to use a container made out of a heavier material, such as glass or wood. 'We could put something heavy on it ... a branch' or 'hang one on the tree,' said Eva O. Alex had the idea of putting 'Blu-Tack in the bottom. It will make it stick.'

Our next step was to test these new methods to see if they improved our results. We planned to test our new pitfall trap designs to see how they worked in comparison with the original plastic cups.

In the rethought pitfall designs, we ended up using glass jars instead of plastic cups. We kept the plastic-sheeted roofs to have a constant feature. Although the glass jars stayed in place, it seemed that the plastic roof is the real problem. It didn't prove to be strong enough to endure the Wellington wind and rain, and the containers ended up being filled with water.



- Imagine Childcare also went back and revisited their procedure – asking 'Is this the best way of working?' They set about making improvements to their pitfall traps in light of their findings.



SELECT THE BEST

Teach children to be selective without introducing bias, especially when communicating findings. If there is a lot of quality evidence, choose the best. Being selective is necessary for effective communication with others.

Example:

Imagine Childcare found out that flowers are structured to make it easy for bees to collect pollen and nectar. They took two pictures as evidence but decided to send us only the one image initially, taken with their digital microscope. This is because the teachers and children felt it showed the localised pollen most clearly.

To avoid adding bias, they made sure to tell us they had made this choice and why. They said we could see more pictures if we wanted to.



CAST A CRITICAL EYE

Encourage children not to accept evidence at face value – always cast a critical eye.

Approaches from our partner centres:

- If you use the internet, test the information you find.
- If something doesn't seem right, look for other explanations.



Lucy makes sure Google got it right

Learning story excerpt from Raumati South Kindergarten

DEMONSTRATES: CASTING A CRITICAL EYE

Today you came inside exclaiming, 'Look what I found – a slug!' What an interesting find!

You brought the slug over to me, and I asked you where you found it. 'Underneath a rock,' you said.

'Maybe he likes being in the dark, then?' I pondered out loud. Taking this suggestion on board, you went to find a dark place for the slug to hide, and returned shortly after with a piece of bark.

'I wonder what he likes to eat,' you said. I suggested we could find this out by using the computer or a book. You chose the computer for your research. 'What shall we ask?' I said. 'I want to know what he eats,' you told me. I typed into Google the question: 'What do slugs eat?'

The results came back quickly, and told us that slugs have been observed to eat apple, cucumber, and lettuce. 'I will feed it to check,' you decided. I really liked this decision because it shows you are thinking critically about evidence.

We had some apples in the kitchen, and so I cut one up for the slug and anyone else who wanted some. 'It should only need a little piece of apple 'cause it only has a little mouth', you commented.

After giving the apple to the slug, you observed that he was 'nearly eating it'. You seemed happier that you had seen this for yourself.





Why aren't our tadpoles growing?

Learning story excerpt from Kiwi Kids Childcare

DEMONSTRATES: CASTING A CRITICAL EYE

We had been waiting patiently for our tadpoles to develop their legs for some time. There just didn't seem to be anything happening. We thought that maybe our tadpoles were just slow growing, but we knew this was a wrong explanation when Cillian told us that his tadpoles (from the same pond, and of the same type) had already turned into frogs at his home.

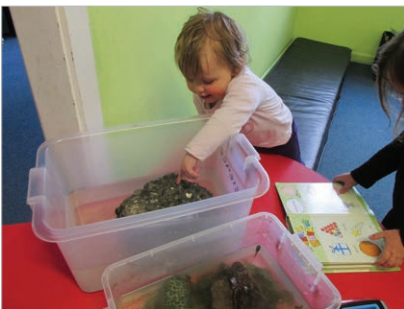
This got us to thinking more. Is it the food they are eating? Is the room not suitable – too sunny, too hot, too cold? Is it the water? The amount of water? Are they sick?

We did some research on the computer, and experimented. We tried having less water and tadpoles per container. We put the containers in a different place in our classroom to see if that helped.

It turned out that our container was too thick! This meant that the water temperature stayed far too cold, and the tadpoles' body clock was not turned on.

We got a new fish tank with thinner glass, and the tadpoles started to develop immediately – much to everyone's delight.

Lucky we thought to check our tadpoles against Cillian's, or else we might have been waiting for ever!





DISCUSS WHAT YOU HAVEN'T FOUND (AS WELL AS WHAT YOU HAVE)

Talk about what hasn't been revealed by the evidence as much as what has. Reflecting on what's yet to be found out, or even what cannot be found out, is a valuable part of the evaluation process.

For example:

We have noticed lots of brown house moths at our homes, but not any at kindy. Does that mean then that brown house moths don't live around kindy at all?

ENCOURAGE REFLECTION TOGETHER

Build an atmosphere in which children can helpfully critique each other's evidence and methods.

At mat time, you could invite children to share their proposed methods for finding an answer to a question. The differing methods could be analysed together, and a collective decision about the best way forward could arise.

For example:

Teacher: We want to know whether slugs prefer cabbage or lettuce more – how could we find out?

Child 1: I would give them lots of cabbage, and then lots of lettuce.

Teacher: What do we think, everyone?

Child 2: But if you give them lots of cabbage, they might get filled up.

Teacher: Good point! We want them to not to get too full on cabbage before they even try the lettuce. What should we do differently, then?

Child 2: Let them have both cabbage and lettuce.

Teacher: At the same time?

Child 2: Yeah, 'cause then they can choose.

Teacher: OK, sounds great. Should we give them lots and lots of cabbage and lettuce at once?

Child 3: No – they only have little mouths.



CAPABILITIES 4.

Interpret representations

Representation is a powerful tool that's used in all stages of the scientific process.

Scientists use a variety of approaches to communicate their observations, actions, and ideas to others. Each has different functions, advantages, and limitations.

Some of the most common modes of science representation made by young children are:

- textual – written and spoken (including stories)
- visual – diagrams, observational drawings, 2-D and 3-D models, animation, video clips, simulations, sculptures, paintings, dioramas, and photographs
- mathematical – graphs, tables, grids, scales, and keys
- gestural and embodied – dance, action songs, games, and socio-dramatic plays.

Scientists also need to be able to make meaning of other people's representations. To do this, they need to develop their knowledge of vocabulary, symbols, and systems, as well as the conventions (principles) of science communication.



IN THIS CHAPTER

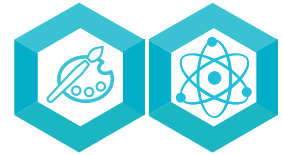
Try a variety of modes	page 76
Make materials and tools accessible	page 82
Take inspiration from others	page 82
Reinterpret	page 84
Use assessing questions	page 86
Co-construct	page 86
Enhance observational drawing	page 86
Involve families as peer reviewers	page 88



Nothing in science has any value to society if it is not communicated.

– Ann Roe





TRY A VARIETY OF MODES

We've already seen lots of great representations from our centres throughout this resource, but here are some more examples of different representation modes.

It can also be helpful to guide young scientists to expand their repertoire of representation modes. For example, if they always draw a picture, you could suggest they try something like box construction (using recycled cardboard and plastic packaging).

Textual

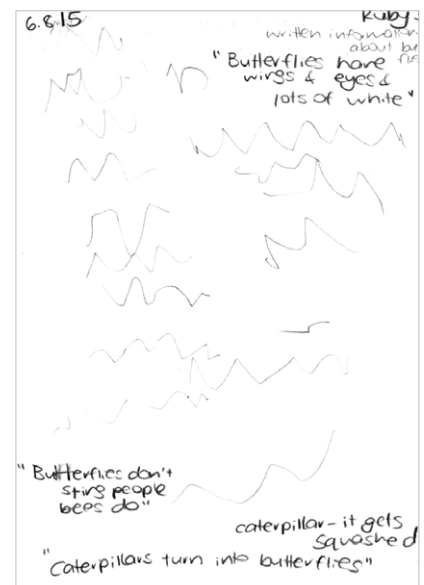
Ruby from Imagine Childcare wrote down this information about the butterflies that she had collected (represented by wiggly lines). Her teacher wrote what Ruby said about her writing next to it.

'Butterflies have wings and eyes and lots of white'

'Butterflies don't sting people - bees do.'

'Caterpillars turn into butterflies.'

'Caterpillar[s] [can] get squashed.'



This is a brain dump of ideas by children and teachers from Kiwi Kids Childcare recorded while they were forming their hypotheses around their questions:

- Do our spiders dance like kids do?
- Do our spiders make just one home web?
- Do our spiders like sunshine?



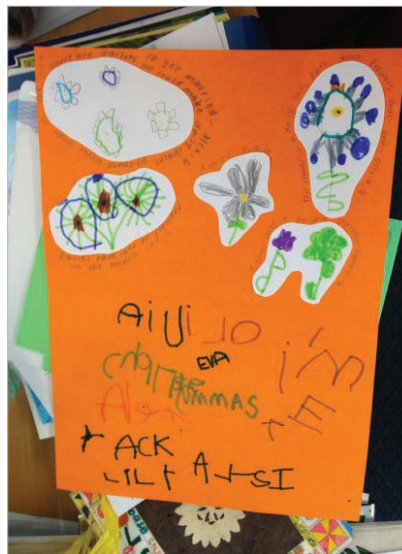
TEXTUAL-VISUAL



Briar from Raumatī South Kindergarten told this story about the life cycle of a butterfly to her friends and teachers:

'This is a caterpillar that is happy because it has eaten a swan plant, and then it rains. Then it turns into a cocoon, and then it comes out of the cocoon, and it flies around. And then there is another little caterpillar starting to grow, and it's hatched.'

Briar drew a life cycle (starting with the caterpillar at the bottom, and going clockwise) to support her story.

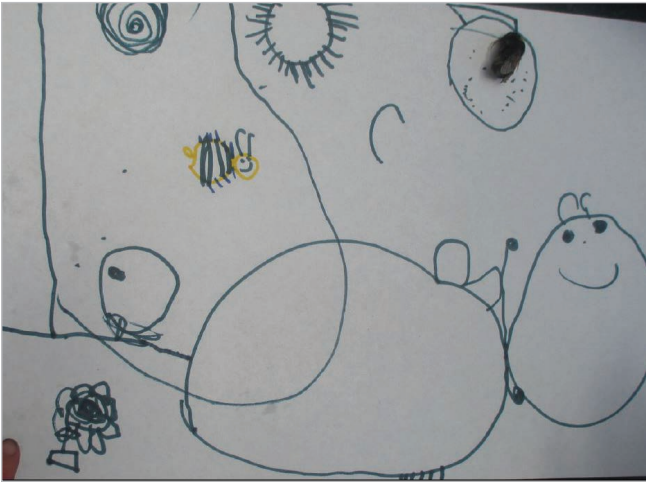


The children from Imagine Childcare made these cards for the botany scientists they met at Te Papa, sharing with felt tip drawings what they'd taken away from their time together. Their teachers wrote down each child's voice (their words) to support the visuals.



Kaiako Lara from Raumatī South Kindergarten created this great digital collage on the computer to showcase Nerys' hypothesis-making and use of evidence for her learning portfolio.

VISUAL



Briar (again from Raumati South) created this infographic to go on the wall and inform others about what bumblebees need to live, and what would make them die – she had recently needed to save one from being stomped on!



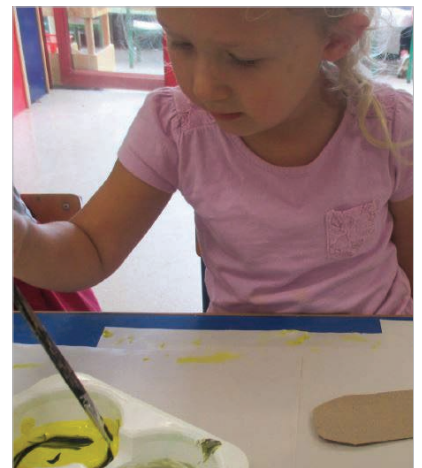
The children from Kiwi Kids created observational drawings of their tadpoles. They made sure to identify who was who so that comparisons could be made.

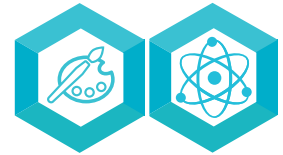


Children from Imagine Childcare created a model of honeycomb out of wooden blocks.



Isobel from Raumati South Kindergarten made a 2-D model of the life cycle of a butterfly by cutting, painting, and joining her own shapes out of cardboard and paper.











These diagrams were made by children at Raumati South Kindergarten to show the relative position of the jars (and what they contained) on their Discovery Table.

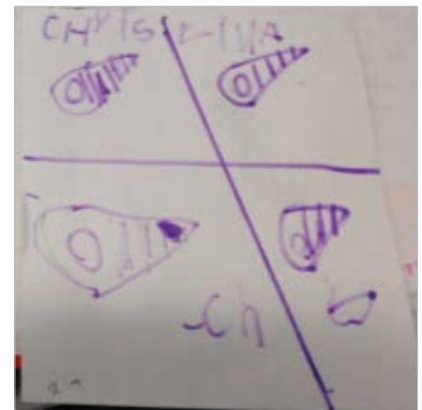


'The caterpillar has 14 legs,' announced Eli from Raumati South Kindergarten after he made his observational drawing. 'I counted them as I drew them.'

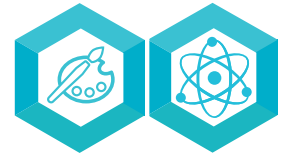
Tally Sheet

Invertebrate	Number found:	Invertebrate	Number found:
		 AISHA moth	
		 Butterfly	
 worm		 ladybird	

Aisha from Kiwi Kids identified the types of invertebrates she expected to see in the backyard, and then tallied those she found during her exploration.



Chyistina from Kiwi Kids divided up the whole group of tadpoles in this grid representation. She thought that this best helped to show that there were four distinct tadpoles in the tank.



Ruby from Imagine Childcare acted out how to gently hold a butterfly, using a lifelike plastic model.



The children from Imagine Childcare choreographed their own dance to the song 'Pūngāwerewere', based on their discoveries.



MAKE MATERIALS AND TOOLS ACCESSIBLE

Provide supplies of:

- writing, drawing, art, craft, and building materials
- digital resources such as laptops, tablets, cameras, apps, and microscopes
- magnifying glasses
- dress-up clothes and props.

Put them in places that are easy for children to access throughout the day. This will encourage representations to be made.

TAKE INSPIRATION FROM OTHERS

Together, find and explore a range of representations created by more experienced scientists. These could be cycle diagrams, graphs, flow charts, tables, posters, reference books, story books, songs, or documentaries – to name just a few.

Ask questions about each representation:

- How do we use it?
- What does it tell us?
- Are there any words or symbols we need to know more about so we can use it?
- Why do you think they chose to tell us in this way?

Encourage children to use these examples as inspiration for the communication of their own ideas, observations, and methods.



Looking at how other people do it

Learning story excerpt from Imagine Childcare

DEMONSTRATES: TAKING INSPIRATION FROM OTHERS

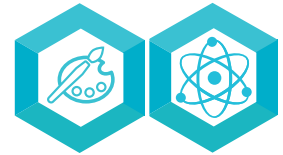
Diagrams of an insect's three-part body and a spider's two-part body have been displayed, as well as terminology used by scientists in their writing about invertebrates.

I've noticed a few children including the terms head, thorax, and abdomen in their drawings after we learned the 'Insect Song', which Emmaline shared with us.

A current favourite book is *Big Bug Surprise* by Julia Gran, which includes fun facts about insects, such as 'Bees follow their queen and are not able to see white.'

The main attraction is the dung beetle because it feeds on dung! More and more drawings of what invertebrates eat have been made as a consequence.





REINTERPRET

Offer young scientists multiple opportunities to engage with their records of thinking and understanding.

Revisit older representations with new eyes. If you provide photocopies of the original, children can add or subtract detail without causing damage.

By encouraging re-representation (using a different mode to share the same information), they will have another opportunity to learn first-hand about the advantages and limitations of different representations.

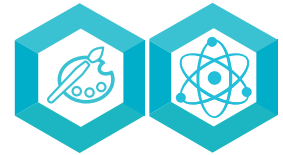


Examples:

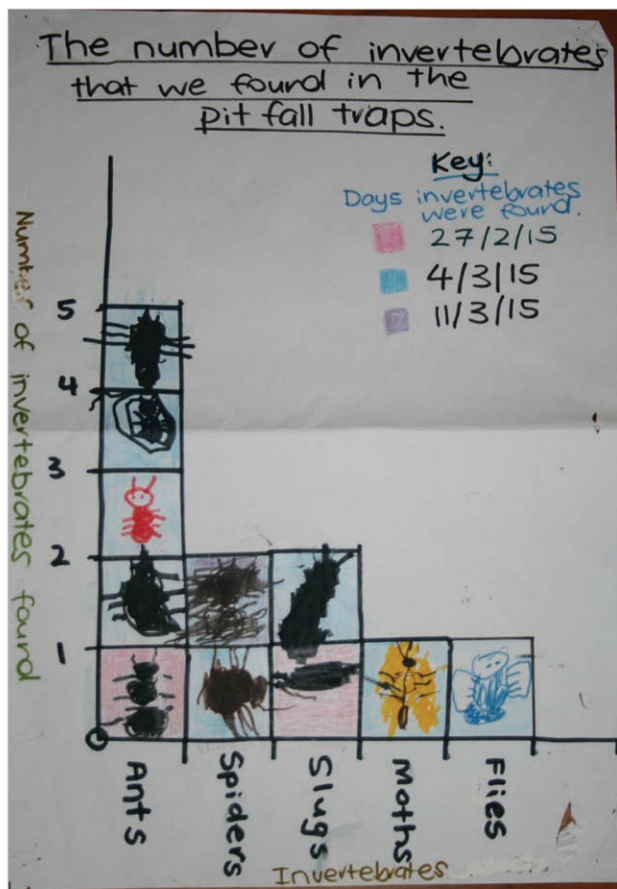
- Rose from Raumati South Kindergarten made a wonderful observational drawing of their caterpillars. She was encouraged to create a representation by her kaiako Tash, and given the opportunity to decide on what type of representation she would make.

Upon presenting her drawing to her teacher, she was asked if she could maybe elaborate further. Rose decided to do this verbally.

With her words, she gave more detail about all the different body parts and the diet of caterpillars. She also referred to the activity that had inspired her – her friend Briar had been holding the caterpillar while it was feeding on leaves. She explained the purpose of her representation: 'The picture's for Briar 'cause she is sad.' The picture was a reminder to Briar of her time with the caterpillar, because she could not hold it indefinitely.



- Using a tally chart, children from Imagine Childcare collected information about the number of different types of invertebrates living in their environment. They realised they had found more spiders living in their garden than any other type.



When the group came to communicate these findings with others, they decided to re-represent their information as a pictograph. They decided that this form would be easier for people to understand because it had pictures and colours. They put numbers alongside the line going up (y-axis), and the names of the different invertebrates under the line going across (x-axis) because they had seen this done in another graph in a book.

USE ASSESSING QUESTIONS

Help children assess their representations by asking questions such as:

- Does it tell others what you want them to know?
- Have you left anything out? Why?
- How do people use it?
- Why have you chosen to show this in this way?



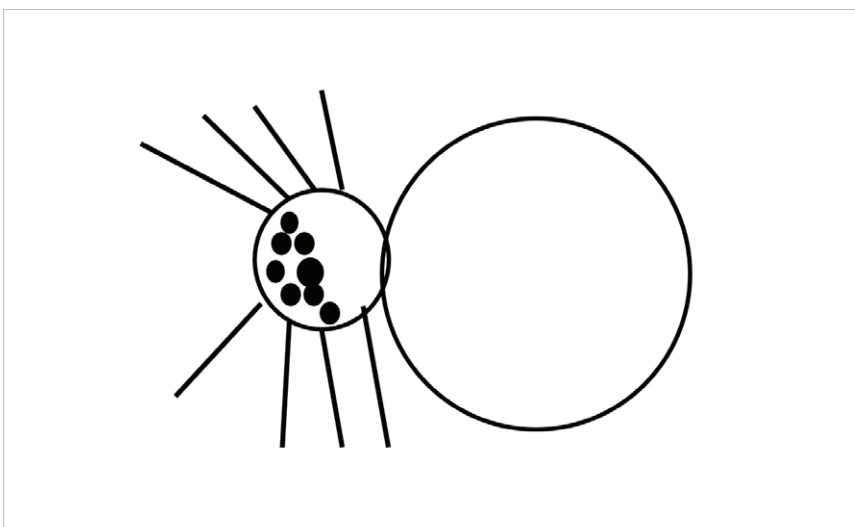
CO-CONSTRUCT

Work with children to identify the meaning in their representations, co-constructing rather than telling. With experience, children will be able to do this together without your help.

ENHANCE OBSERVATIONAL DRAWING

Develop children's skills with observational drawing – a significant part of scientific communication:

- Allow a whole A4 page (or bigger) for each scientific drawing. With more space, more detail can be recorded, including multiple perspectives. See a basic template on [page 127](#).
- Reinforce the need to count things, such as the number of legs and body parts.
- Demonstrate using geometric shapes to draw simplified body structures:
 - Te Papa's spider expert, Phil Sirvid, showed our visiting project centres how he uses circles to draw spiders.



'Spiders have two body parts. First, I draw a big circle for the abdomen, and then I draw a smaller one in front of it. This little circle is where both the head and the thorax of the spider are. The two circles together look a bit like a number 8.'

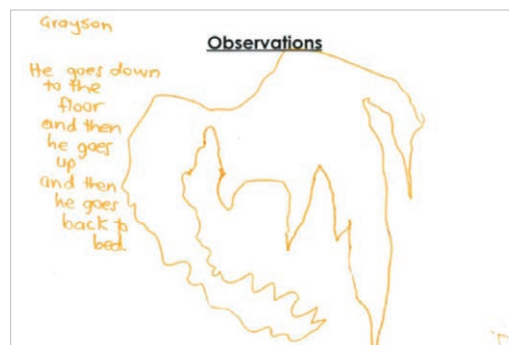
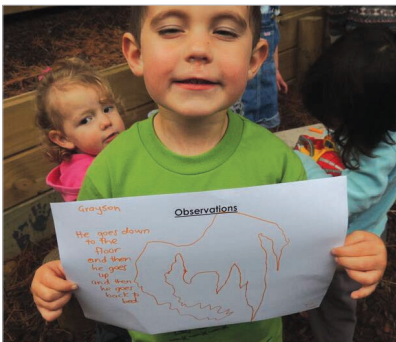
'I put eight lines for legs coming out of the little circle – four on each side. That's because spiders only have legs coming from their thorax. Then I put eight tiny circles on the small circle too, as most spiders have eight eyes.'



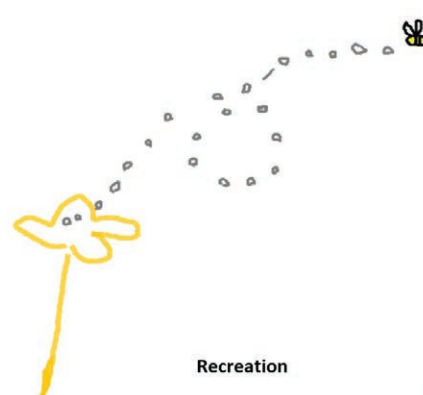
- Give children fine-point pencils to use rather than crayons or soft pencils. Scientists use pencils because the detail they can achieve with them is superior.
- Make annotations (written notes) on pictures to explain the information in the drawing. With pre-writers, educators might need to facilitate this. It is good for adults to model this practice in their own work too.
- Introduce the idea of scale, width, and length by using familiar items for comparison, for example:
 - o The stick insect is as big as this pencil.
 - o What would that insect look like if it was the size of this paper?
- Bugs are very rarely stationary. Demonstrate ways to show movement in drawings, and encourage children to record their observations of a moving bug:



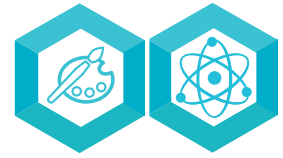
'This spider is as big as my hand!', says Phil.



Grayson from Kiwi Kids tracked the movement of a beetle on a bench using felt pen and paper.



Finlay from Raumati South Kindergarten tracked the movement of a bee using a curly line made of dots – showing the direction and gracefulness of the movement.



INVOLVE FAMILIES AS PEER REVIEWERS

Scientists always get their work peer reviewed before making it public, asking other experts to point out anything they could do better. Invite whānau and friends to play this role.

Example:

Send home a class-made book about your investigation, asking families to send back comments (in whatever mode they choose).

Together, come up with some key questions for your reviewers.

Questions could include:

'We wonder...was it easy to understand our method (i.e. the way we went about answering our big question)?

'We wonder...does our evidence (our findings) support our conclusions (our claims)?

'We wonder... what did you find out from looking at our book?

'We wonder... do we need more photographs in our book to help you to understand better?



CAPABILITY 5.

Engage with science

Once children have developed their scientific capabilities, they'll be equipped to engage with science in a variety of real-life contexts. Using science in everyday life is what takes someone from being a student of science to a fully fledged scientist!

REAL-LIFE SCIENCE IN THE IT'S A BUG'S LIFE PROJECT

Throughout the *It's a Bug's Life* project, our partner groups found plenty of everyday opportunities for young children to engage with science.

Everyday opportunities included:

- using science to enhance other activities
- using science to help make decisions
- engaging with relevant scientific issues and innovations (local and global)
- building the knowledge of the community
- having scientific discussions
- using science techniques to solve problems
- using science techniques to prove a point
- taking action for the environment.

We showcase examples of these opportunities in the following learning stories.



Science is
a way of life.
– Brian Greene



Digging the gardens & making a worm farm

Learning story excerpt from Kiwi Kids Childcare

DEMONSTRATES: USING SCIENCE TO ENHANCE OTHER ACTIVITIES

Early last week, a group of children asked if they could do some gardening in the playground, as they had noticed some weeds. The kaiako facilitated this by providing tools like spades, and the tamariki took great care in their task. Interest in gardening grew among the over-tuos group, and soon gardening was an everyday activity for many.

We decided we would move the scrub in the garden beds to another area of the playground so that the children could build their own gardens with vegetables, flowers, and herbs they had chosen themselves. So far, they have decided on sunflowers (because they are pretty), and celery and thyme (because we can use them for cooking).

The children have been very interested in the bugs they have found while digging. They observed that there were a lot of worms in the soil, and got a bit concerned about the environmental impact of their activities (were the worms being hurt?). We decided we needed to protect the worms by taking them away from the digging site for a while.

We had heard that worm farms were OK places for worms to live. Also, if we collected and concentrated the worm castings and wees, we could use these to make our plants grow better too! Aren't worms useful! Kaiako Mia did some research on the computer about how to make a worm farm, and found two suitable containers we could use to keep our worms in. The children went looking for worms: big ones, small ones, and worms that were in halves! They found eight worms to put in the farm to start with, along with soil from their natural environment.





Photo taken on Wednesday to show what the worms were given to eat.



Photo taken on Thursday to show what the worms had eaten overnight.

The children raised the subject of what the worms would eat (certainly, they wouldn't be making any worm wees for the garden if they were hungry!). We weren't sure, but the consensus was 'We could find out.' We shared some ideas to get us started. Initially, we listed food like chippies and chocolate, but we learned that worms were very healthy eaters. We subsequently started a new list with this in mind.

On Wednesday, we collected a range of food scraps to see if the worms would eat them, as we were still unsure exactly what to give them. We fed them the scraps, and came back on Thursday to observe. They had eaten everything apart from the carrots. We thought we should probably do some more observations because it might be that they just didn't feel like carrot.

Over three days, we fed them carrots, plus toast, apples, celery, and cheese, and made observations. We concluded that they were OK with carrots, but really liked toast and apples. They were not into celery and cheese. We stopped feeding them these in light of this evidence. We think there are probably other things they will eat, so we will keep experimenting.

We revolve the worm-feeding responsibilities to give all children the experience and the chance to build interest in worms and our investigation.



Making a bug-friendly garden

Learning story excerpt from Imagine Childcare

DEMONSTRATES: USING SCIENCE TO HELP MAKE DECISIONS

To increase the number of invertebrates in our backyards, we thought about ways we could change our garden to create a better ecosystem for them. We know that we would like to see more:

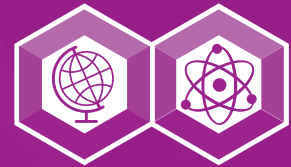
- ladybirds (Isla)
- grasshoppers (Eva)
- tree wētā (Augustine)
- stick insects (Olivia)
- ants (Ava).
- butterflies (Ava)
- spiders (Sammy and Max)
- bees (Ava)
- crickets (Alex)

But what do we need to encourage them to come?

Some ideas were shared. 'Flowers and swan plants,' said Ava, so we could attract more bees and butterflies. 'Trees and grass for wētā,' said Alex.

We have noticed that the insects in our garden have common places where they reside. It is known that monarch caterpillars live 'in the caterpillar garden,' or swan plant garden, as Charlotte said. Many are found in damp and dark places. 'They're hiding in shelter because they don't like the sun. It gets in their eyes and they don't like the hot. Worms don't like light,' Eva said. 'Snails like the dark and the rain because it's wet. They sleep at night,' Ava noted.

As it has been frequently noted that insects are found in these damp, cold, dark environments, it was suggested by Charlotte that we could find out more about it by looking 'on the computer' or by making observations of them by searching 'under a rock' or 'somewhere dark'. Discussions were had about the creatures we might find in these areas, including 'beetles, flies, and spiders'. Charlotte came up with the idea of insects 'hiding under a lid,' which kick-started our experimental exploration.



Using a container with a lid half covering the enclosure, bugs were tested to see whether they preferred the dark side (the lid-covered side) or the light side (without the lid). From the garden, a couple of worms and millipedes were found and taken inside. With all the lights turned off and half of the enclosure covered with a plastic lid, I asked the children what their predictions were. Alex predicted that they would die. A light was shone on the exposed area of the container, where the invertebrates were. We then watched as they all began to slowly move to the dark side. We concluded that they do prefer the dark.

To run the experiment in more natural conditions, a similar experiment was run outside the following day. However, this time, worms and slaters (wood lice) were tested. The children involved made observations:

- 'They don't like the sun,' Augustine said.
- 'They are hiding,' Ester said.
- 'It's warm under the leaves,' Max said.
- 'They don't like the sun. He does indeed like being under the leaf,' Sammy said.

The overall consensus was that slaters don't like light or heat. We decided we should make sure we have some colder and damper places in our ecosystem too.



Researching a weevil to set it free

Learning story excerpt from Raumati South Kindergarten

DEMONSTRATES: ENGAGING WITH RELEVANT SCIENTIFIC ISSUES

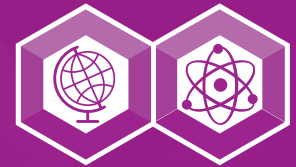
'I've found something inside,' you say, 'a bug'. You hold your finger up for me to inspect.

'I want to put it back in its home,' you say. I explain that we need to find out what sort of bug it is first so we can find out where it lives. We think it is an insect because it has six legs, so we track down the *Which New Zealand Insect?* book.

We look at the beetles first because that is what we think it could be. Kaiako Jo says that it might be a type of beetle called a weevil, so we turn to the weevil page, and there it is! The bug on your finger matches perfectly. I read the information out loud, and we find out together that weevils like to live in flax bushes. I show you where the flax bushes are at kindergarten, and you set it free.

Liam, you worked really hard comparing your insects to the others in the book until you found the perfect match, and for a noble purpose. We really do need to look after our insects, and especially those that are native and endangered.





Discovering new beehives

Learning story excerpt from Raumati South Kindergarten

DEMONSTRATES: ENGAGING WITH RELEVANT SCIENTIFIC INNOVATIONS

Nerys, you came for a little visit to the office today, looking for kaiako Lara. While you were there, you noticed I was on the computer.

'What is that for, Tash?' you asked me, pointing to an icon on the computer screen.

I explained that it was an icon, and that when you click on this particular icon (the PDF icon), it opens up pages with information on them.

'What information is in this one?' you asked, pointing to another icon on the desktop.

This icon just happened to lead to some information about a new design for honeybee hives. You asked if we could take a look at it together, as honey is something you are quite interested in.

I summarised the information written on the page. It told us that this new hive design is special because beekeepers do not have to go in and disturb the bees to collect honey. Instead, there is a tap that the honey comes out of.

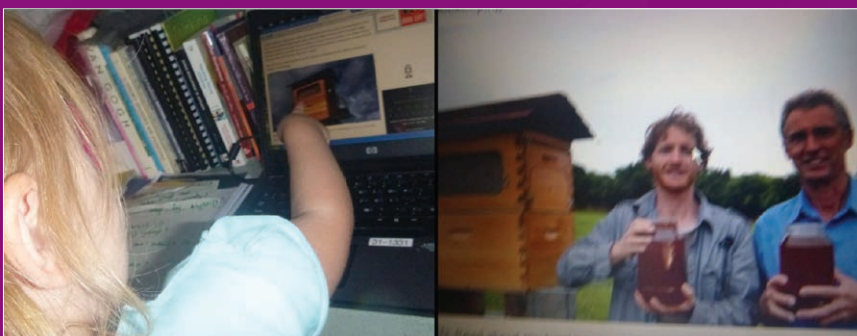
I clicked on a link within the PDF, and it brought up a video clip. An arrow came up next to it.

'Can you press that too?' you asked me. I pressed, and we watched the beekeepers collect honey in this new way.

Because the beehive had clear windows on the sides, we could see in. You noticed the bees buzzing all around.

'You're allowed to put your fingers in the bees, but you're not allow to squash them,' you advised.

Nerys, I could tell you were quite taken with this new hive design – just like your teachers were. You asked me to take a picture of the screen to document our discovery.





Passing on the science bug

Learning story excerpt from
Raumati South Kindergarten

DEMONSTRATES: BUILDING THE KNOWLEDGE OF THE COMMUNITY

Rebecca and Scott from Te Papa had shown us how to make pitfall traps to carefully collect insects in our environment to study before returning them to their homes.

Sam, you have been really excited about this, as you have a natural passion for caring for and investigating creatures, both living and extinct. Today when Dad came to pick you up from kindergarten, you wanted to show him the pitfall traps we were using, so he could know about them too. With a small group of equally keen friends, you took your dad to the garden to pinpoint the location of traps and talk to him about them.

When you had finished, your dad was as excited as you were about this fieldwork technique. There was a suggestion that it could be something that could be done at home together too. We really like to see the connections between home and kindergarten, and are so looking forward to seeing what you might find out together at home.

Sam, your wonderful enthusiasm and enquiring nature is a tool for your learning and that of the people closest to you. Keep sharing your passion for science, and your knowledge about gathering data, with your whānau and friends!



Debating bugs

Learning story excerpt from Imagine Childcare

DEMONSTRATES: HAVING SCIENTIFIC DISCUSSIONS

It is still a frequent thing for our children to explore the centre's gardens in an attempt to make mini-beast observations and discoveries. Alma is aware that one needs to be cautious while on such hunts: 'They die if you step on them.'

Eva, a keen entomologist, strives to learn more during her searches. 'Let's look in a book,' she says, and uses her prior knowledge to work out what she's looking at: 'It could be an insect. I see the antennae. I see the legs,' or 'I don't think it's an insect. It's a worm.' With clipboard, paper, and pencil, she then draws up her observations.

Children have used their funds of knowledge to engage in discussions and debates about invertebrate identification in the playground:

'It's a spider. It has eight legs. Ladybirds have got six, spiders have got eight,' said Max.

'It has more legs than an insect,' agreed Emily.

'That's an ant,' said Max.

'No, ants are black. They're white with a couple of legs and smaller than ants. They live under stuff,' challenged Alex.

Alma described a centipede as a 'spiky worm'.

Alex explained why he thought a stick insect looks like a stick:

'To stop them getting eaten, to look after themselves.'

Outside, a leaf was spotted with a white substance on it. I held it out for a small group of children to see, which prompted a discussion theorising what it was. Eva decided that it was a spider web and inside was an insect that it had caught. Alex believed it was a nursery-web spider web with baby spiders inside. He recalled that the mother nursery-web spider dies soon after making the web and 'then the babies come out.'



What's that bug?

Learning story excerpt from
Raumati South Kindergarten

DEMONSTRATES: USING SCIENCE TECHNIQUES TO SOLVE PROBLEMS

Tēnā koe Mia! Look at this picture of you taking a close-up view of the caterpillar you found. You were able to closely observe the caterpillar with the magnifying glass, noticing features that you couldn't see with your eyes. You discovered that this caterpillar had many hairs on its body, with black dots on its skin. You were even able to see its head and eyes.

We got out some research books to see if we could find out its official name and more information. We looked and looked at all the caterpillar pictures, but nothing matched the specimen you found. It was a mystery!

So you decided to draw a picture of your caterpillar, carefully ensuring that all the body parts and details were accounted for. We agreed that this record could prove useful in identifying it at a later date.

There are lots and lots of insects that are still to be found by scientists. Maybe your work here is the first documentation of a brand-new caterpillar! Wouldn't that be exciting!





Cillian makes a convincing case

Learning story excerpt from
Kiwi Kids Childcare

DEMONSTRATES: USING SCIENCE TECHNIQUES TO PROVE A POINT

Cillian has been very keen to share all of his knowledge about the tadpoles he has brought in to Kiwi Kids. He told us they are currently at the first stage of their development. To prove this, he invited his friends to look at the frog life-cycle book in the library with him.

Together, they looked at the pictures and found one matching the way Cillian's tadpoles looked. His friends agreed that he was right. They looked together at the subsequent pages, talking about what they would expect to see as the tadpoles continued on their journey to becoming frogs.



Making a safe house

Learning story extract from
Raumati South Kindergarten

DEMONSTRATES: TAKING ACTION

A lot of art work has been created around the theme of insects today. Kaitlyn, you joined some friends at the making table too.

You had chosen to create a 3-D residence for an insect – you called it an 'insect house' – and had thought all about how an insect needs to be kept safe and dry. Although you didn't classify your insect (the activity was more general), it was important to you that the house would be a safe refuge from 'the weather' for your insect.





Curriculum links

LEARNING DISPOSITIONS

As part of their role, early childhood educators must notice, recognise, and respond to children's emerging learning dispositions.

Dispositions are central to 21st-century learning, and are defined as 'relatively enduring habits of mind or characteristic ways of responding to experience across types of situations' (Katz, 1993).


Certain attitudes or dispositions are also central to scientific enquiry and discovery. These include curiosity, a drive to experiment, and a desire to share new ideas.

Use this resource to develop the following positive learning dispositions (and many more) in young children:



Tash, a kaiako at Raumati South, recommends these readings about dispositional learning →

Claxton, G, and Carr, M. 'A framework for teaching and learning: the dynamics of disposition'

 (qualitylearning.global2.vic.edu.au/files/2014/07/A-Framework-for-Teaching-Learning_The-Dynamics-of-Disposition-2-tef16z.pdf). *Early Years*, 24 (1), 2004

Hedges, H, and Jones, S. 'Children's working theories: The neglected sibling of Te Whāriki's learning outcomes'

 (www.nzcer.org.nz/nzcerpress/early-childhood-folio/articles/children-s-working-theories-neglected-sibling-te-whariki-s). *Early Childhood Folio*, 16 (1), 2012

Curious

Methodical

Persistent

Logical

Questioning

Attentive

Perceptive

Communicative/
Expressive

Collaborative/
Cooperative

Observant

Confident

Integrating
(makes links)

Playful

Evaluative

Responsible

Courageous

Imaginative
and creative

Focused

Empathetic

Experimental



LINKS TO TE WHĀRIKI AND THE NEW ZEALAND CURRICULUM

Te Whāriki	The New Zealand Curriculum
The Ministry of Education's early childhood curriculum framework	The Ministry of Education's primary and secondary curriculum framework
Capability 1: Gather and interpret data	
Exploration Mana Aotūroa → G1, G2, G3, and G4 Belonging Mana Whenua → G1, G2, and G4 Contribution Mana Tangata → G2 and G3 Communication Mana Reo → G2 and G3	Nature of Science → Understanding about science Nature of Science → Investigating in science Key Competencies → Managing self; Thinking; Using language, symbols and texts; Relating to others
Capability 2: Use evidence	
Communication Mana Reo → G2 Exploration Mana Aotūroa → G1, G3, and G4	Nature of Science → Understanding about science Nature of Science → Investigating in science Key Competencies → Using language symbols and texts; Thinking
Capability 3: Critique evidence	
Contribution Mana Tangata → G3 Communication Mana Reo → G2 Exploration Mana Aotūroa → G4	Nature of Science → Understanding about science Nature of Science → Investigating in science Key Competencies → Using language, symbols and texts; Thinking
Capability 4: Interpret representations	
Communication Mana Reo → G1, G2, and G3 Exploration Mana Aotūroa → G3 and G4	Nature of Science → Communicating in Science Key Competencies → Using language, symbols and texts; Relating to others
Capability 5: Engage with science	
Belonging Mana Whenua → G1 and G2 Contribution Mana Tangata → G2 Exploration Mana Aotūroa → G4	Nature of Science → Participating and contributing Key Competencies → Participating and contributing; Thinking



How we made this resource

IDENTIFYING A NEED

In late 2014, Te Papa's Learning Innovation Team surveyed early childhood education (ECE) and junior primary groups throughout the country. We asked:

- Which of our initiatives do you find most useful?
- What would you like from us in the future?

The feedback indicated an immense interest in science, and a desire for more professional development and outreach. Some educators wanted a little help to enhance their current science teaching, and many more reported feeling unconfident and ill prepared to approach it at all.

We knew that Te Papa's skills in science and learning innovation could make positive change, and introduce the world of science to more tamariki.

OUR KEY RESEARCH QUESTIONS

Before creating this resource, we carried out the *It's a Bug's Life* research project (we discuss our reason for choosing a bugs topic on page 108).

We wanted to find out what teachers and children needed. We asked ourselves:

- How might we do science with young children?
- Can early years groups use the Ministry of Education's five science capabilities, originally designed for primary and secondary levels?
- What implications will our findings have for educators of young children?

CO-CREATION APPROACH

A key principle at Te Papa is *mana taonga* – the idea that the community shares authority and should be empowered to cooperate, collaborate, and co-create. To make a helpful resource, we needed to work in partnership with our education sector.

We invited our survey participants to partner with us. Almost 20 ECE groups in the Wellington region registered their interest, a wonderful

response that left us with a difficult decision. To ensure close working relationships, we could select only three.

Partner selection criteria

We wanted our partners to represent the variety of ECE groups in New Zealand, so we selected groups with:

- different environmental settings (urban, coastal, rural, suburban)
- different levels of experience with science education.

It became important that our partners should vary in terms of their type, programme, philosophy, and pedagogy.

We also wanted our ECE partners to have the desire and drive to undertake their own journey with the five science capabilities.

Our groups took very different paths, and this variety contributed depth to our findings. You can read about our ECE partners on page 106–107.



KICK-OFF

In late January 2015, representative teachers from each ECE group came to Te Papa for a professional development session. They met our science specialists: curators, collection managers, and educators. The next month, we visited each ECE group to meet the other kaiako and our budding young scientists. We set them on their path...

RECORDING PROGRESS

Throughout the 2015 school year, the teachers kept in close contact with Te Papa, through email, Skype, phone calls, and kano ki te kano (face-to-face meetings).

Each group's journey acted as a case study. Their experiments, feedback, learning stories, photographs, and mahi (work) formed the raw material for this resource.

PULLING IT ALL TOGETHER

By talking with our ECE partners, analysing the material they recorded, and blending this with our own expertise, we created the recommendations presented in this resource.

We obtained consent to publish this material, as well as the photographs and first names of children, family members, and teachers.

Our ECE partners were involved in the whole research process, from first discussions to final review. We're incredibly proud of the tamariki, kaiako, and whānau of Raumatī South Kindergarten, Kiwi Kids Childcare, and Imagine Childcare – and we trust that you will be too.



OUR ECE PARTNERS

Raumati South Kindergarten

Raumati South Kindergarten is a community-based service located on the Kāpiti Coast. Their young scientists were primarily from their Tui Group – aged 4 to 5 years and attending kindergarten three days a week.

The natural environment is a core part of the curriculum at this kindergarten. Kaiako value the opportunity to work alongside tamariki to be kaitiaki (guardians). Much importance is placed on practices that promote conservation and sustainability.

The kindergarten sought involvement in the *It's a Bug's Life* project as an opportunity for their community to learn together. It was also seen as a way for children to build knowledge and skills that they could transfer to other environments as they grow to be citizens of the future.

Diana, Head Teacher, led the project, along with her 2015 teaching team: Jo, Natasha, Liz, and Lara.



Kiwi Kids Childcare

Kiwi Kids Childcare is a suburban centre located in semi-rural south Karori, Wellington. Their young scientists were primarily from their over-2s group. Tuakana-teina (senior-junior) relationships are encouraged, with interested under-2s included where possible. Children have their own schedule of attendance.

Teachers at Kiwi Kids Childcare had been exploring nature education. They were looking to enhance teaching and learning in their large outdoor area, and made excursions to other environments in and around their community.

The centre saw the *It's a Bug's Life* project as a great opportunity for tamariki and kaiako to link in further with Papatūānuku (the Earth). For the centre's teachers, professional development in science was another drawcard for their involvement.

Geraldine, Centre Owner and Manager, led the project, along with Ginalyn, Centre Supervisor. Teaching team members Donna and Mia were also heavily involved.



Imagine Childcare

Imagine Childcare is located in an urban environment – Petone, Lower Hutt. Their young scientists were primarily from their Preschool Room, aged 3 to 5 years. Children have their own schedule of attendance.

Imagine Childcare puts a focus on the natural world. Their large outdoor space supports exploration, and they aim for sustainability as a key part of their vision and philosophy.

The centre sought involvement in the It's a Bug's Life project as a way to meet a registration teaching goal to implement more science teaching and learning. Finding ways to use and share kaiako Adela's knowledge from tertiary study in environmental science and marine biology also drove involvement.

Adela led the project, with support from Nichola and Caroline.



WHY WE CHOSE BUGS

Research shows that environmental education is more effective and impactful if done in easily accessible outside environments. We wanted to focus on science that you could do in your own centre, school, or backyard.

Why bugs make such a good science topic

Bugs are easily found

There will be bugs in, or near, your centre or home. This enables your group to study bugs frequently and over a period of time – both are great opportunities for young scientists.

Bugs are a flexible topic

With so many weird and wonderful bugs, you'll find they're a varied and open-ended learning area.

Bugs are fascinating

Many young children have a natural interest in the living world. You can use this to encourage deeper exploration.

Other benefits

- **Broadens children's concepts of nature**
When they experience the diversity of the natural world, children's views of it won't be limited to popular mammals and birds.
- **Dispels fear**
When young children are familiar with bugs, they're less likely to develop an irrational fear or dislike of them.
- **Encourages conservation and sustainability**
An appreciation of bugs can lead to a more caring attitude towards New Zealand's many threatened and endangered invertebrate species. Did you know that 45% of the creatures either threatened or at risk in New Zealand are bugs?



What is a bug?

We could define a bug as any creep-crawly animal. In this resource, though, we focus on land invertebrates. Invertebrates are animals that have no backbone (they don't have, or develop, a vertebral column).

See the [page129](#) for a list of recommended books that can help children identify bugs.



APPENDIX

Scientific process symbols	Page 110
Productive questioning	Page 111
Fieldwork techniques and tools	Page 112
Bug body terminology: English and te reo Māori	Page 119
Templates	Page 125
Recommended reading	Page 129

Scientific process symbols



Use these cards to plan out and track your own scientific process.



Explore



Make representations



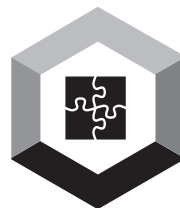
Ask questions



Apply to everyday life



Observe



Make meaning and conclusions



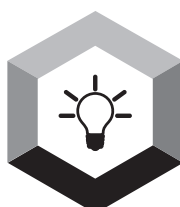
Get ready to test



Critique evidence



Use evidence



Make hypotheses



Share findings

OUR SCIENTIFIC PROCESS



Productive questioning

According to Professor Mary Lee Martens, there are six types of questions that foster scientific thinking. We suggest you model and scaffold these question types to engage tamariki and help them form deeper inquiries.

TYPE OF QUESTION	EXAMPLES	PURPOSE
Attention-focusing	How does a slug move? Why is the cicada on the tree trunk? What does the wētā's antennae do?	Focus on significant details such as behaviour, location, and anatomy.
Measuring and counting	How many legs do caterpillars have? How far could a snail move in a day?	Collect more precise information.
Comparison	How are snails and slugs the same? How are butterflies and moths different?	Foster analysis and classification.
Action	How do bees make honey? Why does honey go hard?	Explore the properties of things, and how events or processes take place.
Problem-posing	How could we get more butterflies to come to our garden? What if there were no bees?	Plan and implement solutions to problems.
Reasoning	Why do slaters avoid puddles, but not wet newspapers?	Consider the rationale or principles behind children's observations and experiences.

Read more in Lee Martens' paper *Productive Questions: Tools for supporting constructivist learning*  bit.ly/2eD7hpQ.



Fieldwork techniques and tools

Our ECE partners use the following techniques and tools to support their observation activities.

FOR COLLECTING BUGS

Drop sheeting

Put a tray (such as a kitty litter tray) underneath foliage. Shake the foliage and see what falls out! Brightly coloured containers make it easier to see bugs. This technique is recommend by Te Papa's bug expert, Phil Sirvid.



Soil sampling

Mark out a place to dig, perhaps making a quadrat with wooden stakes and string. Carefully dig up some of the soil and put it in a container, such as an ice-cream container. Gently search through this soil using your fingers.





Sweep netting

This is an effective and inexpensive technique if you're working in long grass or in a pond. Take a plastic bag and a wire coat hanger. Stretch out the coat hanger to make a loop and tape the bag to it. Then sweep...



Pitfall traps

Many land invertebrates prefer to come out at night, so setting a humane trap for them in the ground can be a convenient way to find them.

To make a basic trap, you'll need:

- a plastic cup
- a straw
- modelling clay (eg, plasticine)
- a square of laminated plastic
- sticky tape.





Cut the straw into four pieces and tape these to the outside of the cup at equal intervals, making sure they protrude above the rim. Then put a ball of modelling clay on top of each straw and attach the square of laminated plastic to make a roof. Dig a hole in the ground and place the cup in it. Make sure the rim is level with the soil's surface. If you can't dig deep enough, build the soil up round the sides of the cup.

You could check your traps at different times of the day to see if that has an effect on capture. You might like to experiment with differently sized and shaped containers – a bit of a science investigation in itself, as we saw from Imagine Childcare on [page 60](#)!

If you live in a windy place, like Wellington, try this more durable trap, advised by Te Papa's bug expert Phil Sirvid:

A grown-up might cut up an old wire coat hanger and make two straight-sided U shapes. These can be attached to the plastic cup with plasticine, or something stronger such as hot glue. Superglue might also work, but it depends on the plastic. The wire can be pushed into the ground to hold the cup secure.

Card and container

Place a plastic container over the top of a bug to trap it. Gently slide a thin piece of card underneath the container, making sure not to hurt the bug or let it out.

Slowly turn the container back over, keeping the card in place. Replace the card with a lid, or use a paper towel or cling film secured with a rubber band.



Pooters (aspirators)

Entomologists (insect scientists) use pooters to suck bugs up through a tube into a sealed container.



To make a pooter like ours, you'll need:

- a plastic bottle with a secure lid
- two straws, ideally one green and one red
- fine netting material
- modelling clay (eg, plasticine)
- sticky tape.

Tape the netting material to the bottom of the green straw. This will stop accidental bug inhalation. Make two opposing holes near the top of the bottle and put a straw in each one, with the netted end inside the bottle. The straws should be the only place air can flow, so seal the gaps round the holes with modelling clay, and make sure the lid is secure.

Test your pooter by sucking through the green straw (the one with netting at the end). Now hover the other straw over a small bug and suck again to collect it.

Bottle size doesn't matter, but smaller bottles might be easier for the children to handle.



'Green for GO and red for STOP!' says Finlay, a tamariki from Raumati South Kindergarten.



FOR VIEWING BUGS

Magnifying glasses and sheets

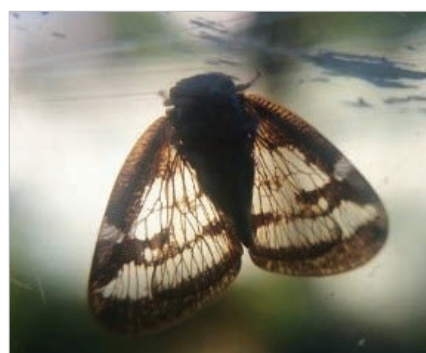
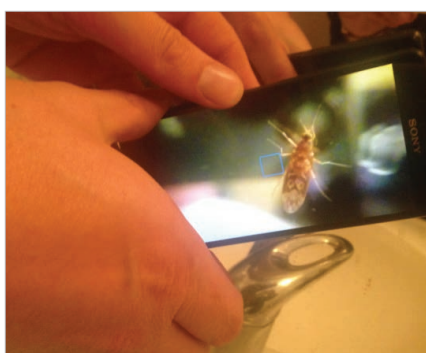
Magnifying glasses are wonderful tools. To get the best observations, hold the magnifying surface right up to your eye, and then move your head closer to the specimen until it comes into focus.

Our young scientists preferred magnifying glasses with at least 5x magnification.



Macro lens

Use a magnetic macro lens attachment to improve your smartphone's camera. We had great success experimenting with macro lens, which gave up to 15x magnification.

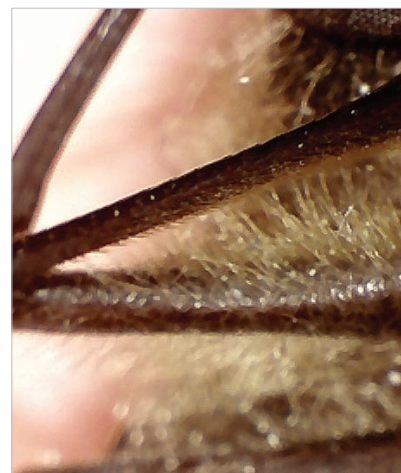




Handheld digital microscopes

Digital microscopes plug into computers via USBs, and make images immediately viewable. They can also take videos and photographs. Microscopes are best used in the classroom with collected specimens.

Imagine Childcare had great experiences using their Zoomy Handheld Digital Microscope. This gives up to 43x magnification and fits little hands well.



Imagine Childcare tamariki took these pictures of a monarch butterfly using their digital microscope.

FOR DOCUMENTING OBSERVATIONS

Observational drawing

Drawing what you see is an accessible, hands-on technique that requires only basic drawing materials.

Read our recommendations for enhancing observational drawings on pages 87–88.





Identification guides

Before documenting observations of a bug, we need to know what species, or at least what type of bug, it is. Graphic science books are useful identification tools.

Our ECE partners mostly used Andrew Crowe's series of NZ identification guides (penguin.co.nz/authors/44-andrew-crowe), and sometimes downloaded identification sheets from the internet. Some groups experimented with making their own identification materials too.

Digital camera

You can use a digital camera to create:

- photographs
- time-lapse photography
- short video clips.

For close-up photographs, it's good practice to include a recognisable object next to the bug. This makes it easier for others to understand the size of the bug. For example, you could use a 20-cent coin.

Voice recorder

Voice recorders are an excellent way to document child and teacher observations given orally. This is especially useful for children who don't like to draw.

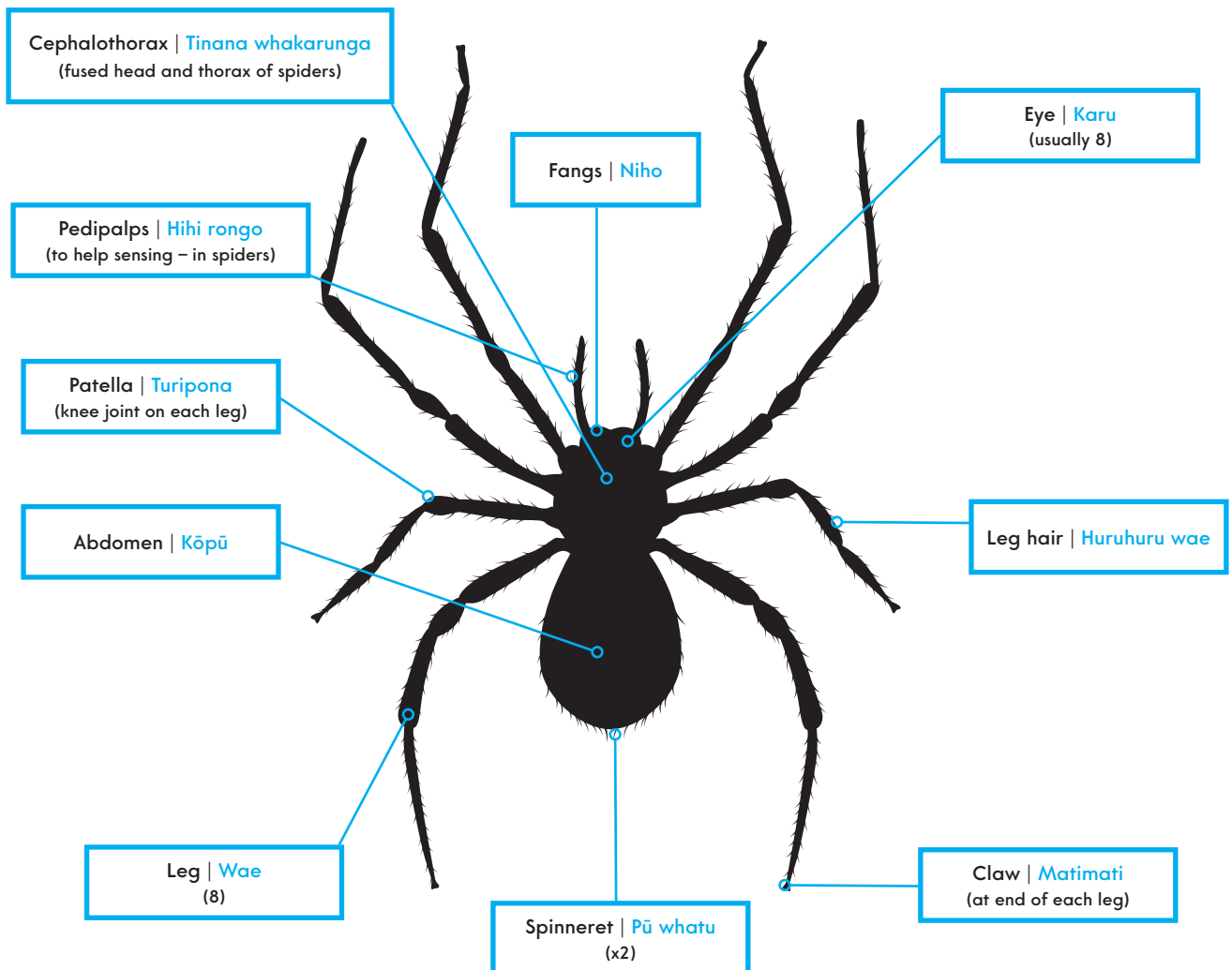


Bug Body Terminology: English And Te Reo Māori

Use these handy terminology sheets to learn the correct body part names for commonly-found bug types.

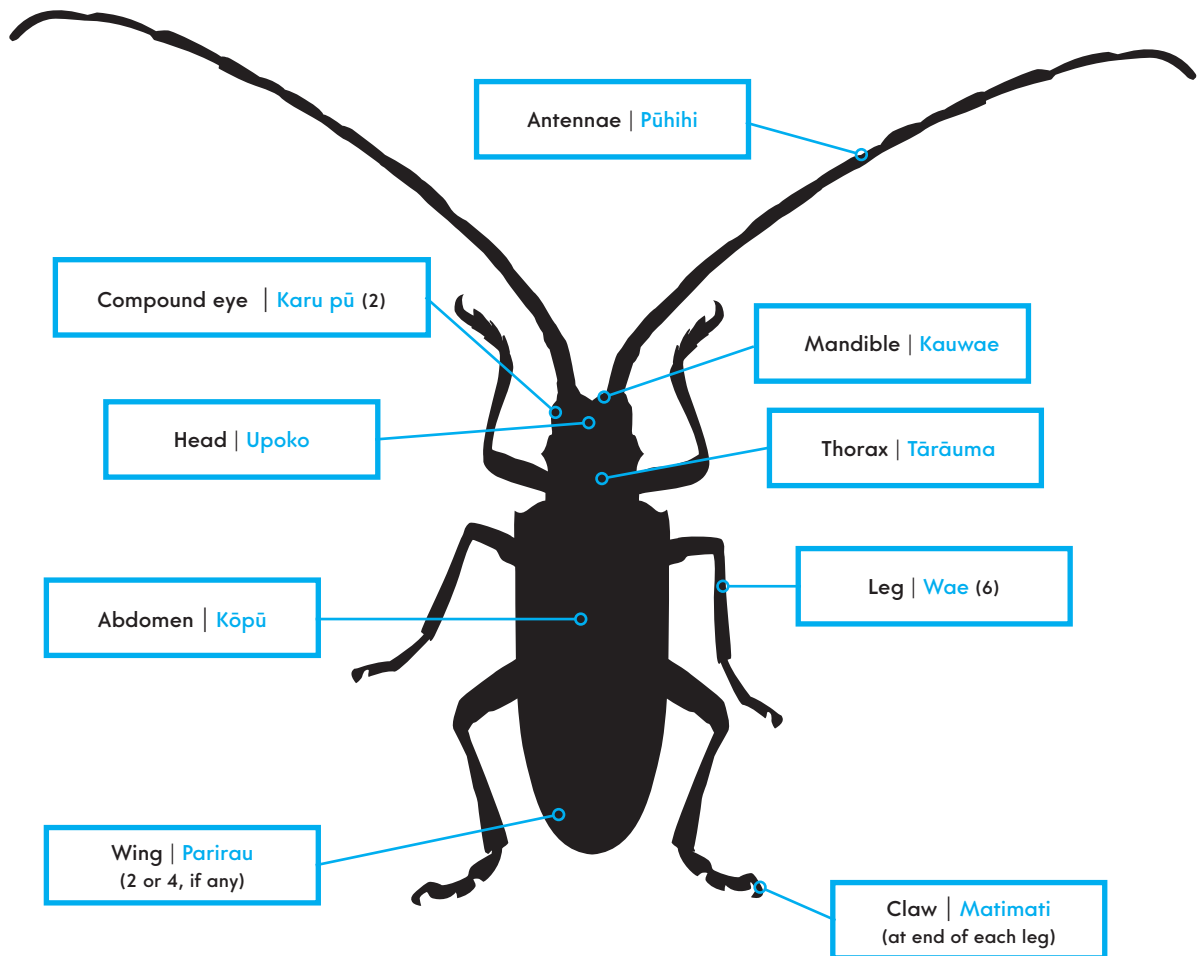
Arachnid

– Like a spider



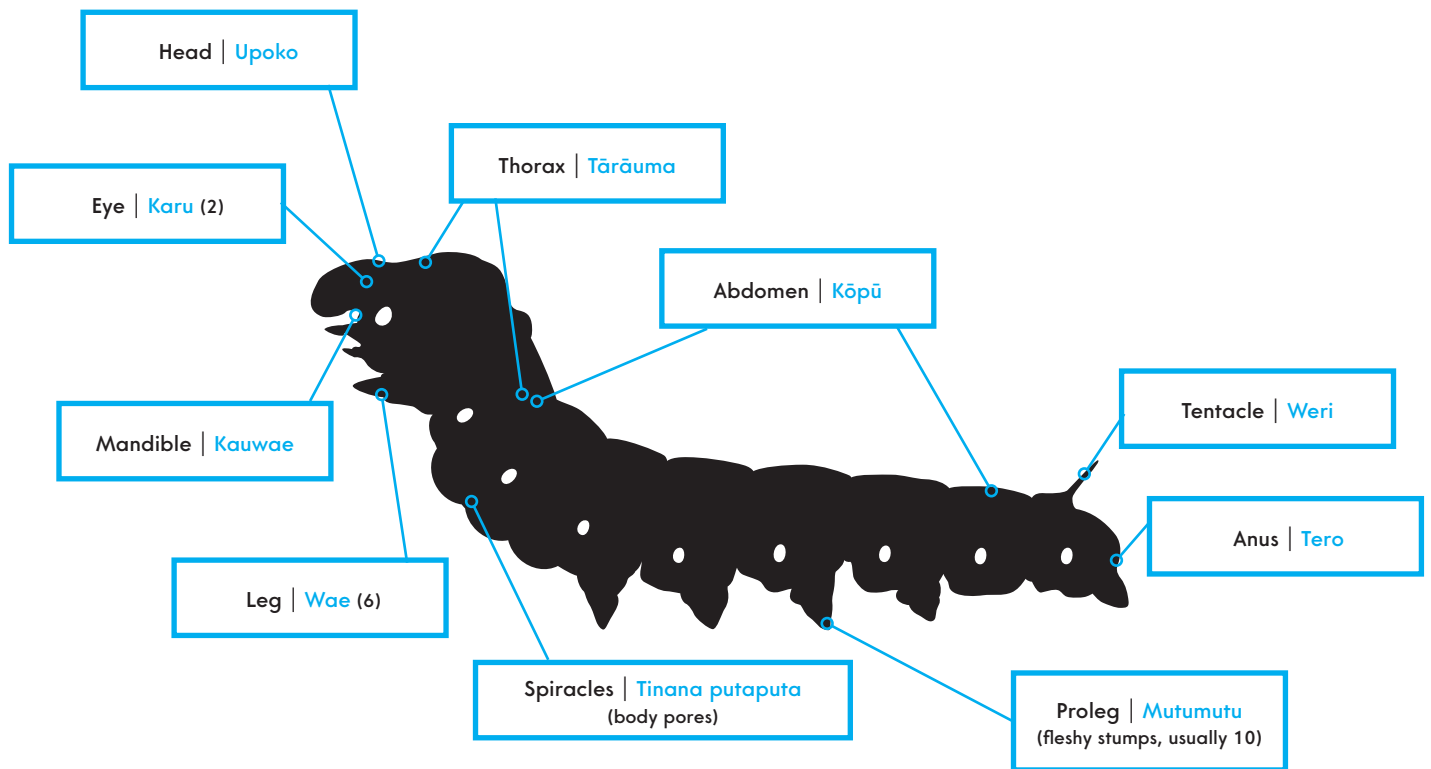
Insect (adults)

– Like a beetle



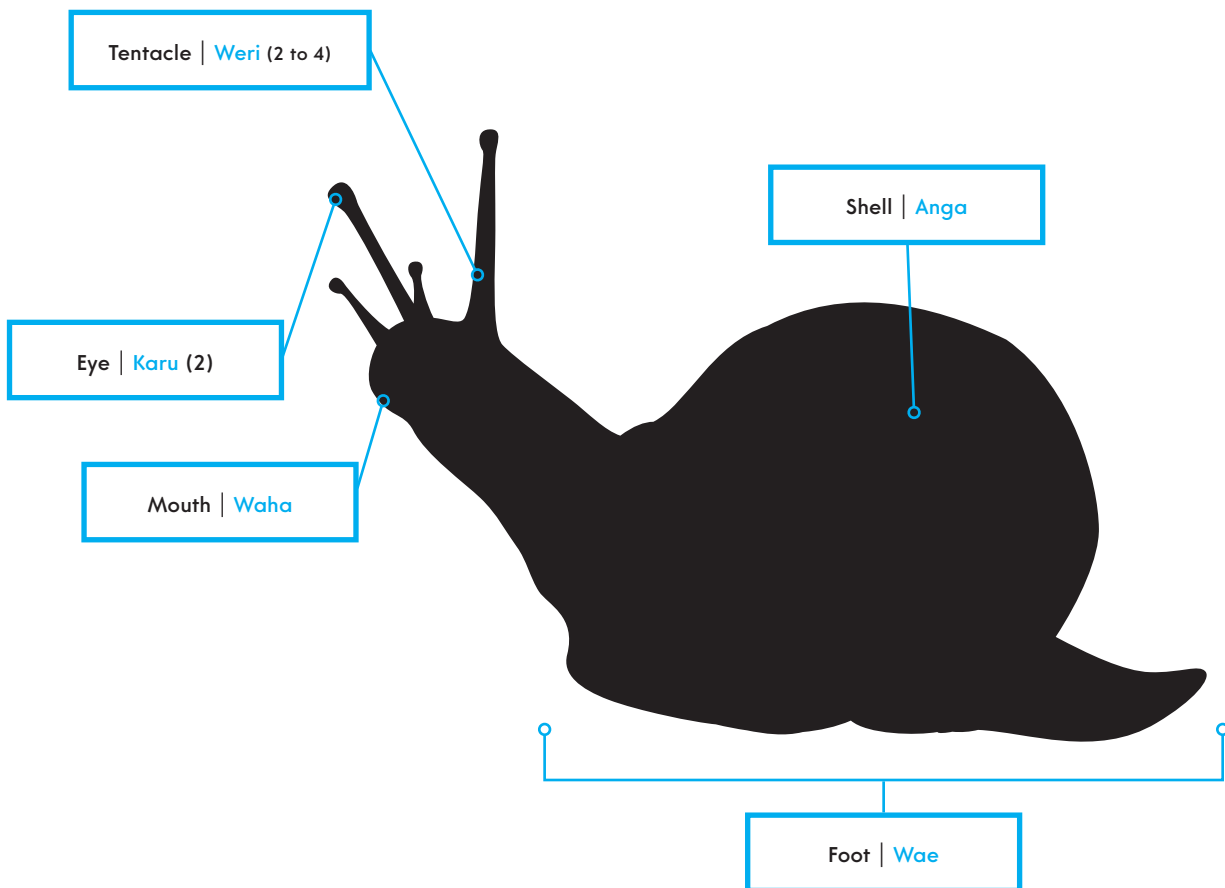
Insect (larvae)

– Like a caterpillar



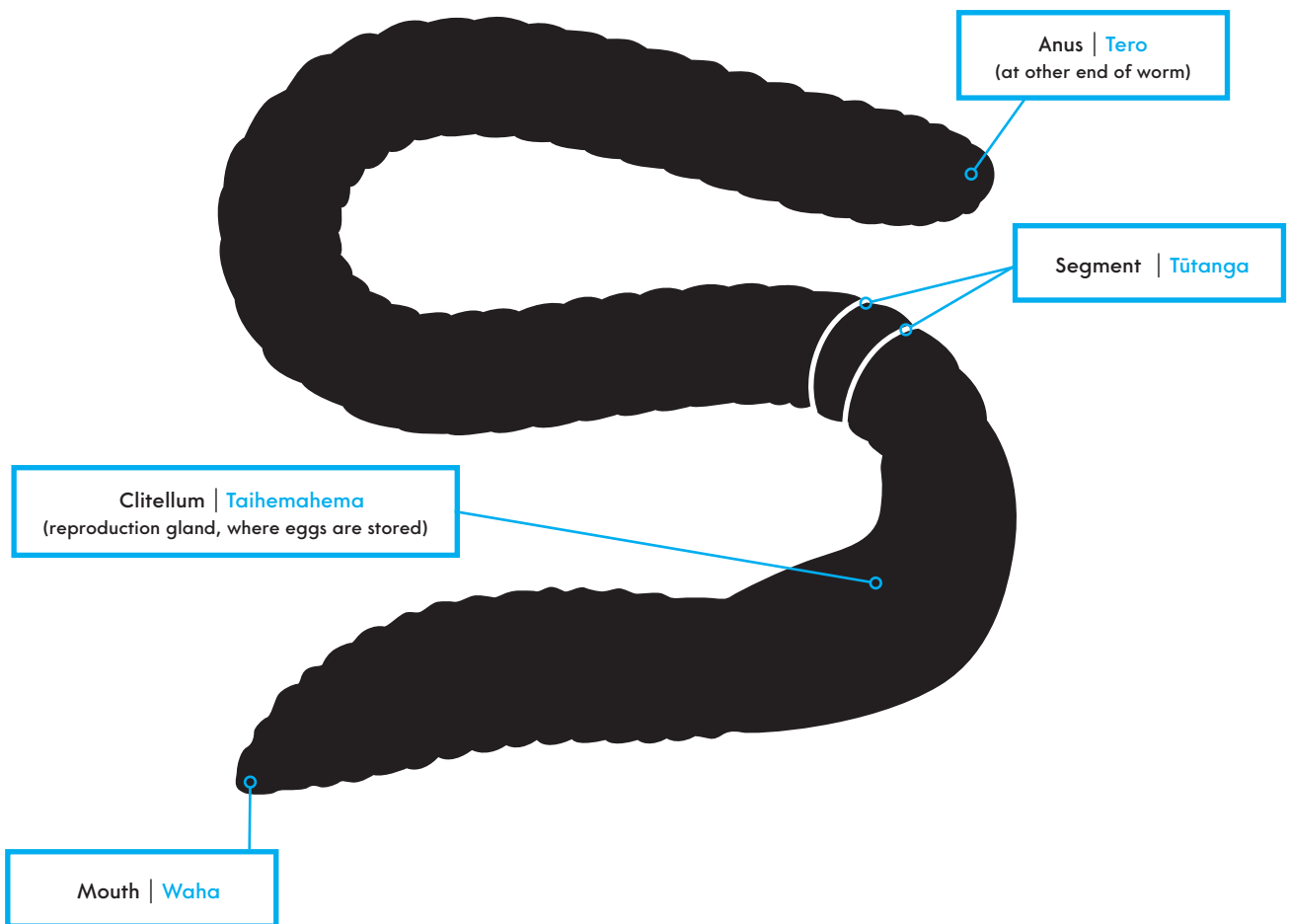
Molluscs

– Like a snail



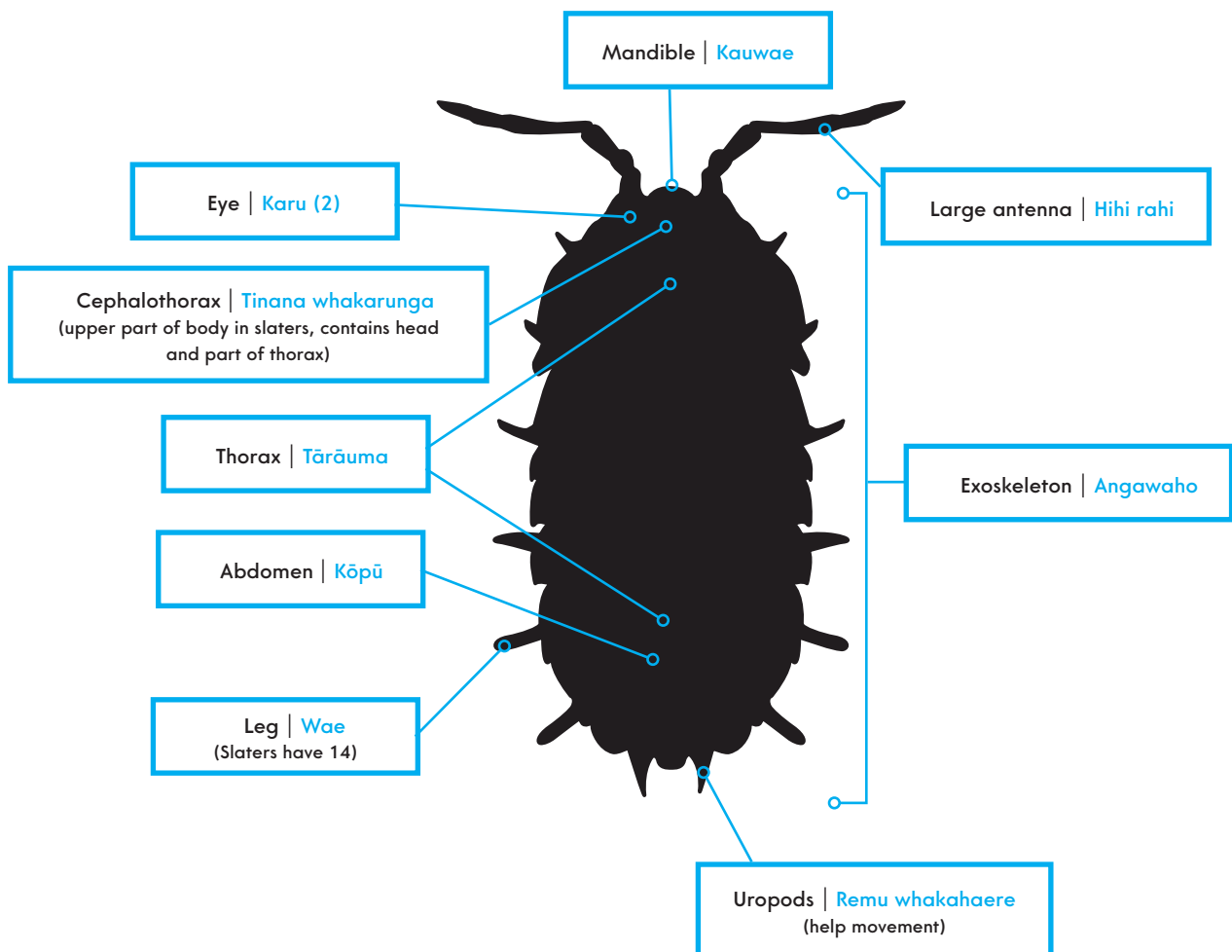
Annelids

– Like a worm



Crustacea

- Like a slater





TEMPLATES

Planning template page 126

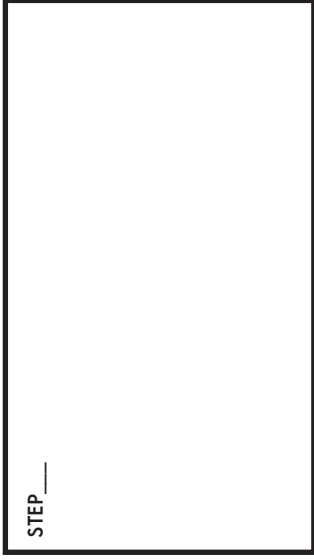
Observation template page 127

Tally sheet template page 128

Planning

How will I find out more?

STEP ____

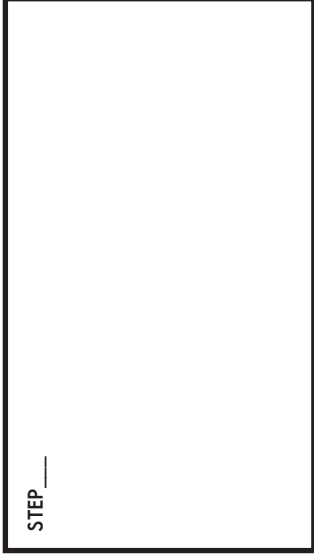


CHILD'S VOICE

What equipment will I need?



STEP ____



CHILD'S VOICE

STEP ____



CHILD'S VOICE

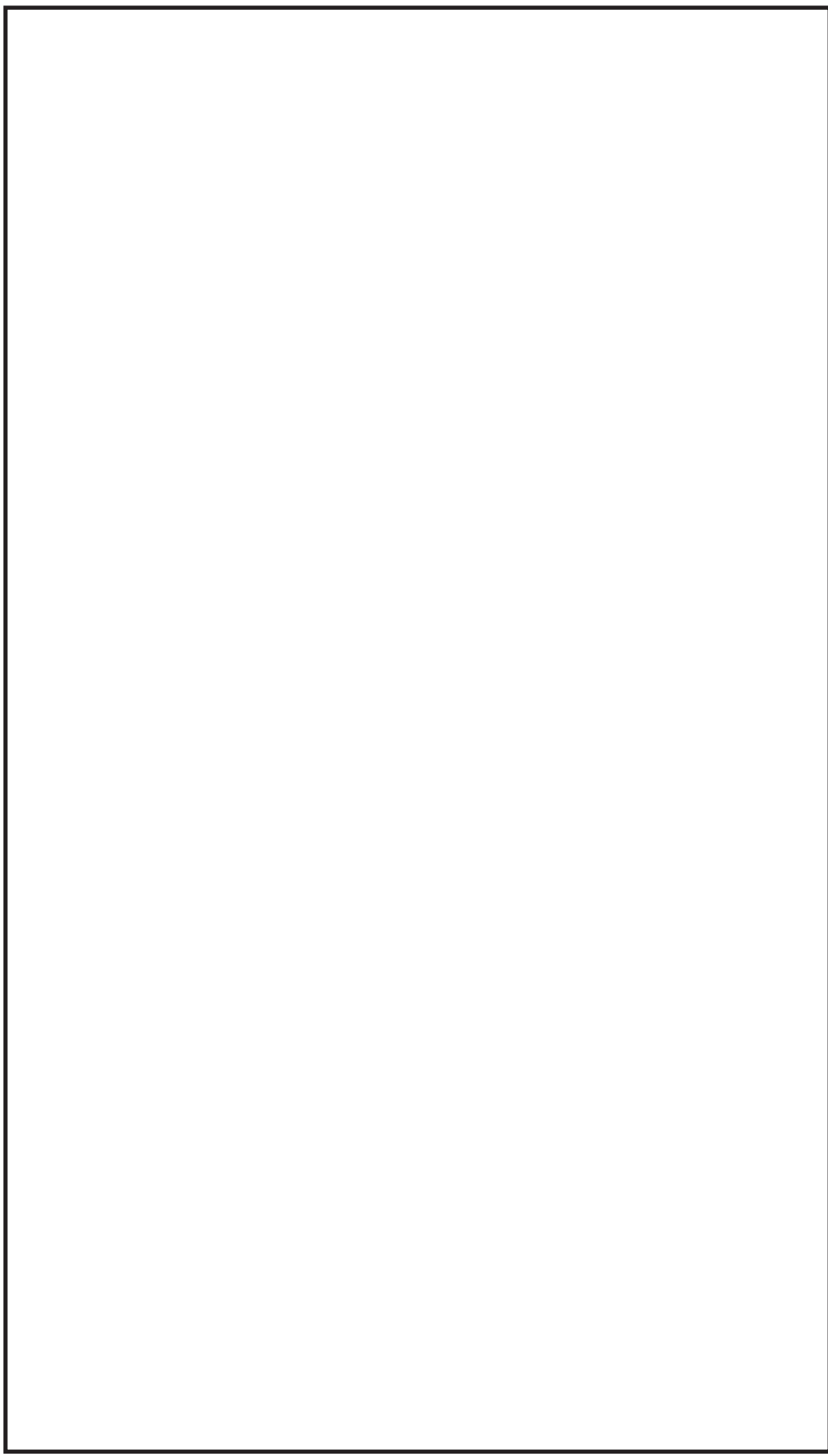
STEP ____



CHILD'S VOICE

Observations

Name: _____

A large, empty rectangular box with a black border, intended for students to write their observations.

Tally Sheet

Invertebrate

Number
found

Invertebrate

Number
found



Recommended reading

BOOKS FOR CHILDREN

There are many useful reference books and videos available in bookshops and libraries that will help you identify land invertebrates from other bugs.

Te Papa's entomologist (insect scientist), Phil Sirvid, recommends the following books for identifying bugs with children:

Crowe, A. *The Life-Size Guide to Insects and Other Land Invertebrates of New Zealand*. Penguin, 1999

Crowe, A. *Which New Zealand Insect?* Penguin, 2002

Crowe, A. *Which New Zealand Spider?* Penguin, 2007

ARTICLES FOR TEACHERS

Tash, kaiako at Raumati South Kindergarten, recommended the following further reading.

Teaching science at early childhood and junior primary levels

Bell, P, Lewenstein, B, Shouse, and A W, Feder, eds. Committee on Learning Science in Informal Environments. *Learning Science in Informal Environments: People, Places, and Pursuits* (bit.ly/2fegnp1). Board on Science Education, Center for Education. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press, 2009

Bull, A. 'A junior version of the "whole game" of science' (bit.ly/2fSqsQ6). Working paper. New Zealand Council for Educational Research (NZCER), 2011

Bull, A. 'Library of experiences' (bit.ly/2f1V6Ba). Working paper. NZCER, 2011

Edwards, K. 'Learning scientific knowledge from and with others' (bit.ly/2fe65FB). *Early Childhood Folio*, 15 (1), 2011

Edwards, K, and Loveridge, J. 'The inside story: Looking into early childhood teachers' support of children's scientific learning' (bit.ly/2gdMWZd). *The Australasian Journal of Early Childhood* (AJEC), 36 (2), 2011

Heap, R. 'Myth busting and tenet building: Primary and Early Childhood teachers' understanding of the Nature of Science' (bit.ly/2fVm6Up). Unpublished master's thesis, Massey University, Auckland, 2006

Trundle, K.C. 'Teaching science during the early childhood years' (bit.ly/2fDIDmT). *National Geographic Science*, 2010. Accessed June 17 2016

Place-based education

Penetito, W. 'Place Based Education: Catering for Curriculum, Culture, and Community' (bit.ly/2fTOPFw). *New Zealand Annual Review of Education*, 18 (5-29), 2008

Educating for ecological sustainability

Ritchie, J. 'Narratives of relatedness in ecological sustainability in early childhood education in Aotearoa' (bit.ly/2fVmrGC). In *NZARE Conference & Annual Meeting 2009* (CD-Rom Ed). Wellington: New Zealand Association for Research in Education, 2009

Samuelsson, I P, and Kaga, Y (eds), UNESCO. *The contribution of early childhood education to a sustainable society* (bit.ly/2fTPwyC). Paris: UNESCO, 2008

Basile, C, and White, C. 'Environmental Literacy: providing an interdisciplinary context for young children' (bit.ly/2fej1ez). *Contemporary Issues in Early Childhood*, 1(2), 2000



TE PAPA
OUR PLACE



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