NZCER
Rangahau Mātauranga o Aotearoa

# Junior Science: Thinking with Evidence Teacher Manual

This information guides teachers in the use of *Junior Science: Thinking with Evidence* tests. It replaces the usual printed teacher manual that accompanies NZCER's other assessments.

On these pages you will find:

- features of the tests
- instructions on how to gain access the assessment, take the test, and read your students' results
- information about the assessment tasks and their links to science in *The New Zealand Curriculum*
- a description of how the tests assess students' ability to think in the context of science
- information about how NZCER conducted the research to standardise this assessment
- how to use the reports for analysing students' thinking and how to support next steps.

## What is this test and how do I get started?

The tests are for assessment of students in Years 4-6. They can only be used at our online assessment and survey platform NZCER Assist (www.nzcerassist.org.nz) and take about an hour to run.

They complement Science: Thinking with Evidence (Years 7-10) but are scored on a separate scale.

The tests include:

- a range of interactive question types made possible by the on-line testing environment
- a wide variety of contexts that we hope students will find interesting, engaging, and relevant.

## What is the purpose of this test?

**The tests provide evidence of learning in science**

This assessment is intended to help teachers gather evidence of learning in science. Schools can monitor student progress or compare students' results against a national sample.

*Junior Science: Thinking with Evidence* is a standardised science assessment designed for students in Years 4, 5, and 6.

**The tests link to science in *The New Zealand Curriculum***

- Like the Year 7-10 version, *Junior Science: Thinking with Evidence* is designed to assess how students use evidence to think about scientific contexts and issues, rather than assessing science facts.
- Items draw on contexts from all contextual strands (*Living World, Material World, Physical World, and Planet Earth and Beyond*).
- Questions model the Nature of Science strand by focusing on the science capabilities.
- Engaging contexts range from the familiar in the first test (JS1) to the unfamiliar and more complex for older students. Teachers can use or adapt ideas for their own science lessons.

**The tests are designed to be used formatively**

Formative assessment resources can be accessed through each school's reports section on the NZCER Assist website.

Used formatively the reports can help teachers:

- Identify patterns in strengths and weaknesses in science understanding and capability
- determine next steps for student learning
- find links to similar questions and further resources

## What are the features of the tests?

The tests can only be completed online.

- Each student will need a computer device, preferably with a full-size screen. The tests will run on IPAD tablets or Chromebooks. Be aware that the smaller the screen size, that more difficult it will be for students to read the text.
- All questions are automatically marked.
- Scale scores and reports are available as soon as your students have completed the test.

You can administer the test at any time during the school year. The trial to gather data to establish test norms was conducted in March 2017. If tests are used at the end of the school year, your students will be closer in age to the next year level up, and you should consider comparing your students to the norms for the next year level.

The tests take an hour to run.

- Allow 15 minutes for test set up and administration and 45 minutes testing time.

There are three tests, each with 30 questions.

- The first test (JS1) is recommended for Year 4, the second test (JS2) for Year 5, and the third test (JS3) for Year 6.
- In each test there is a range of interactive question types including:
    - multiple choice, dragging and dropping, selecting the correct image, filling in blanks in sentences, and sorting images.

- We recommend teachers make sure students practise each question type before starting the test.

## Which test should I use?

Each of the *Junior Science: Thinking with Evidence* tests has been designed with a year level in mind. Each test can, however, be used productively at other year levels. When selecting a test, it is important to consider whether the level of difficulty of the test is appropriate for the students. Tests that are too easy or too difficult will not provide precise achievement measures and could also be demotivating.

The table below shows the year levels for which each test will be most useful. These recommendations have been based on data collected at the start of the school year.

Teachers are encouraged to preview the tests before choosing a test. In particular they should consider the reading demand that the test entails, especially at Year 4.

If necessary, you can choose to read the questions to students. Please note however, that this will invalidate comparisons with the normative information (high, medium, low) as the students in the norming study were generally not provided with reading support.

**The recommended year levels for each test**

| Test number | Recommended year levels* |
|---|---|
| JS1 | **4**,5 |
| JS2 | **5**,6 |
| JS3 | **6** |
| *Bold print indicates the year level for which the test was originally developed. | |

## How do I get started?

Your school needs to subscribe to NZCER Assist to access the assessment and reports.

Follow the steps below to access and use the *Junior Science: Thinking with Evidence* assessment.

1. Subscribe to NZCER Assist
2. In NZCER Assist run an SMS upload to set up classes ready for testing
3. Administer the test online
4. View your class reports

## How do these tests help teachers?

The focus of science in schools has changed from simply *having* knowledge to being able to *use* knowledge.

*The New Zealand Curriculum* (NZC) gives schools a lot of freedom to develop science programmes that reflect the needs of their students.

The challenges for schools include deciding:

- how students' learning experiences in science help them gain capabilities for living and lifelong learning, (NZC vision statement)
- how to focus on the Nature of Science (NOS)
- what science knowledge is important
- what science capabilities students should be developing as they move through their primary school years.

These challenges are also challenges for assessment.

This section explains how the science capabilities have been embedded into each item to help teachers develop a picture of their student's' thinking in science.

## How the items embed the science capabilities

The science learning area is organised into two strands:

1. The Nature of Science (NOS) and its 4 sub strands - Understanding about science, Investigating in science, Communicating in science, and Participating and contributing. The Nature of Science is the overarching core strand and is required learning up to Year 10.
2. Four contextual strands - Living World, Planet Earth and Beyond, Physical World, and Material World provide the contexts.

A school curriculum integrates the NOS and contextual strands. The science capabilities were designed as a weaving tool to help teachers do this.

The table shows how the science capabilities link to the Nature of Science achievement objectives.

| **Nature of Science sub strands** | **Understanding about science** *When the focus is on scientists work* | | | **Investigating in science** *When the focus is on student investigations* | | | **Communicating in science** *Make meaning of scientific representations* | **Participating and contributing** *Is about taking action* |
|---|---|---|---|---|---|---|---|---|
| **Matching science capabilities** | Gather and interpret data | Use evidence | Critique evidence | Gather and interpret data | Use evidence | Critique evidence | Interpret representations | Engaging in science |

## Understanding about science

The Understanding about science items in the test require students to reason "like scientists". Students may be asked to:

- Identify the scientific method that answers a question.
- Decide what the evidence means.
- Select an inference that supports an action.
- Identify which statement is supported by the evidence.
- Select the best inference that is supported by an observation or from the evidence provided.

The example below shows an Understanding about science item from test JS1. Included with the example is a description of the item, the NOS focus, the science capability focus and an explanation of the item difficulty.

**NATURE OF SCIENCE FOCUS:**
Understanding about science

**SCIENCE CAPABILITY:**
Gather and interpret data.
*Students are asked to identify the best inference from the evidence provided.*

**Test JS 1 – Year 4**

### What's in my garden?

**If you visit a wildlife reserve you might see tracking tunnels placed in the bush alongside the walking track.**

▼ 15 Why do you think people use tracking tunnels in wildlife reserves?

- To feed small animals in case they run out of their usual food supply.
- To count the numbers of small animals in the area.
- To make a place for small animals to hide in.
- **To find out what sorts of small animals live in the area.**
- To trap pest animals so they don't eat native animals.

**DIFFICULTY LEVEL:** *medium to hard*

| Context: | Text demand: | Cognitive demand: |
|---|---|---|
| Could be unfamilair | Image may be unfamiliar; subject specific vocabularly. | Brings several pieces of information together to make an inference. |

## Investigating in science

Items in this test require students to recognise the key features of scientific investigations.

Students may be asked to:

- Identify variables in fair testing.
- Use observations to identify patterns.
- Select inferences that are supported by evidence.
- Identify questions that can be answered by the evidence presented, or identify questions for further investigation, or identify the question of an investigation.
- Identify the best method to investigate a question.
- Identify explanations that are supported by evidence.
- Construct a casual explanation.

The example below shows an Investigating in science item from test JS2. Included with the example is a description of the item, the NOS focus, the science capability focus and an explanation of the item difficulty.

**NATURE OF SCIENCE FOCUS:**
Investigating in science

**SCIENCE CAPABILITY:**
Critique evidence
*Students are asked to identify the best method to investigate an investigation.*

**Test JS 2 – Year 5**

### Worm juice

**Gabriel's class has a worm farm. Once a week they take the worm juice that drains from the worm farm, and pour it onto the vegetables in their school garden.**
**Gabriel decided to do an experiment to see if the worm juice really does help plants grow. He compared how mustard seeds grew when fed with a bought fertiliser, worm juice, and water. The picture below shows what his plants looked like after 2 weeks.**


▼ 14 Over the two weeks Gabriel thought he could see some plants were growing more than others. What could he **measure** to help him find out **how fast** the plants were growing?

- ○ How long it took for the seeds to start to grow.
- ○ Compare photographs taken of the plants at the end.
- ○ How long it took for plants to die.
- ● The height of the plants every few days.

**DIFFICULTY LEVEL:** *medium*

| **Context:** | **Text demand:** | **Cognitive demand:** |
|---|---|---|
| Familiar | Simple visual text, written text detailed and could present unfamiliar evidence; some science specific vocabularly. | Some challenging scientific understandings; bringing together multiple pieces of evidence. |

## Communicating in science

Items in this test require students to read and correctly interpret scientific texts.

Students may be asked to:

- Interpret models.
- Read, interpret and/or order diagrams.
- Read and interpret tables.
- Read and interpret graphs.
- Read and interpret the strengths of different representations.
- Identify patterns in photographs and images.
- Construct a causal explanation.
- Construct a food chain.

The example below shows a Communicating in science item from test JS2. Included with the example is a description of the item, the NOS focus, the science capability focus and an explanation of the item difficulty.

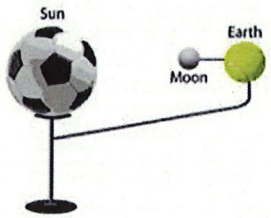
**NATURE OF SCIENCE FOCUS:**
Communicating in science

**SCIENCE CAPABILITY:**
Interpreting representations.
*Students are asked to interpret a model.*

**Test JS 2 – Year 5**

### Earth, Sun, and Moon

Sara made a model of Earth, Sun, and Moon, using different sized balls.
Here is her model.
Use her model to decide the size of Earth, Sun and Moon.
Drag the words into the right parts of the table.




Earth

| Solar system objects | | Sun | Moon |
|---|---|---|---|
| Approximate distance around (km) | 40,000 | 4,400,000 | 11,000 |

**DIFFICULTY LEVEL:** *Easy*

| Context: | Text demand: | Cognitive demand: |
|---|---|---|
| More familar and/or known. | Several text types (numeric and visual); written language more familiar. | Makes direct links between pictures and size; science knowledge is provided. |

## Participating and contributing

Participating and contributing is about taking action.

Students may be asked to:

- Make judgements.
- Weigh up possible alternatives.
- Apply what is known in one context to a new context.
- Recognise which action to take and the reason for an action.
- Make predictions about possible consequences of an event or action.

The example below shows a Participating and contributing item from test JS 3. Included with the example is a description of the item, the NOS focus, the science capability focus and an explanation of the item difficulty.

**NATURE OF SCIENCE FOCUS:**
Participating and contributing

**SCIENCE CAPABILITY:**
Engage with science
*Students apply what is known in one context to another.*

**Test JS 3 – Year 6**

### Coral reefs

Many islands in the Pacific Ocean are made of coral reefs.
Corals are tiny animals that live in warm, shallow seas.
They attach themselves to rocks and grow stony skeletons that can look like underwater trees.
When the corals die, the skeletons remain and more corals settle on them.
Slowly a colourful rocky forest grows.

▼ 11 What human activities can cause the **same sort of damage** to a coral reef as storms?
*(Choose **two**)*

- [x] Scuba divers and swimmers standing on it.
- [ ] Letting sewage or cleaning products run into drains.
- [ ] Dropping rubbish onto the beach or into the sea.
- [x] Fishing boats dragging a fishing net along the sea floor.

**DIFFICULTY LEVEL:** *Easy*

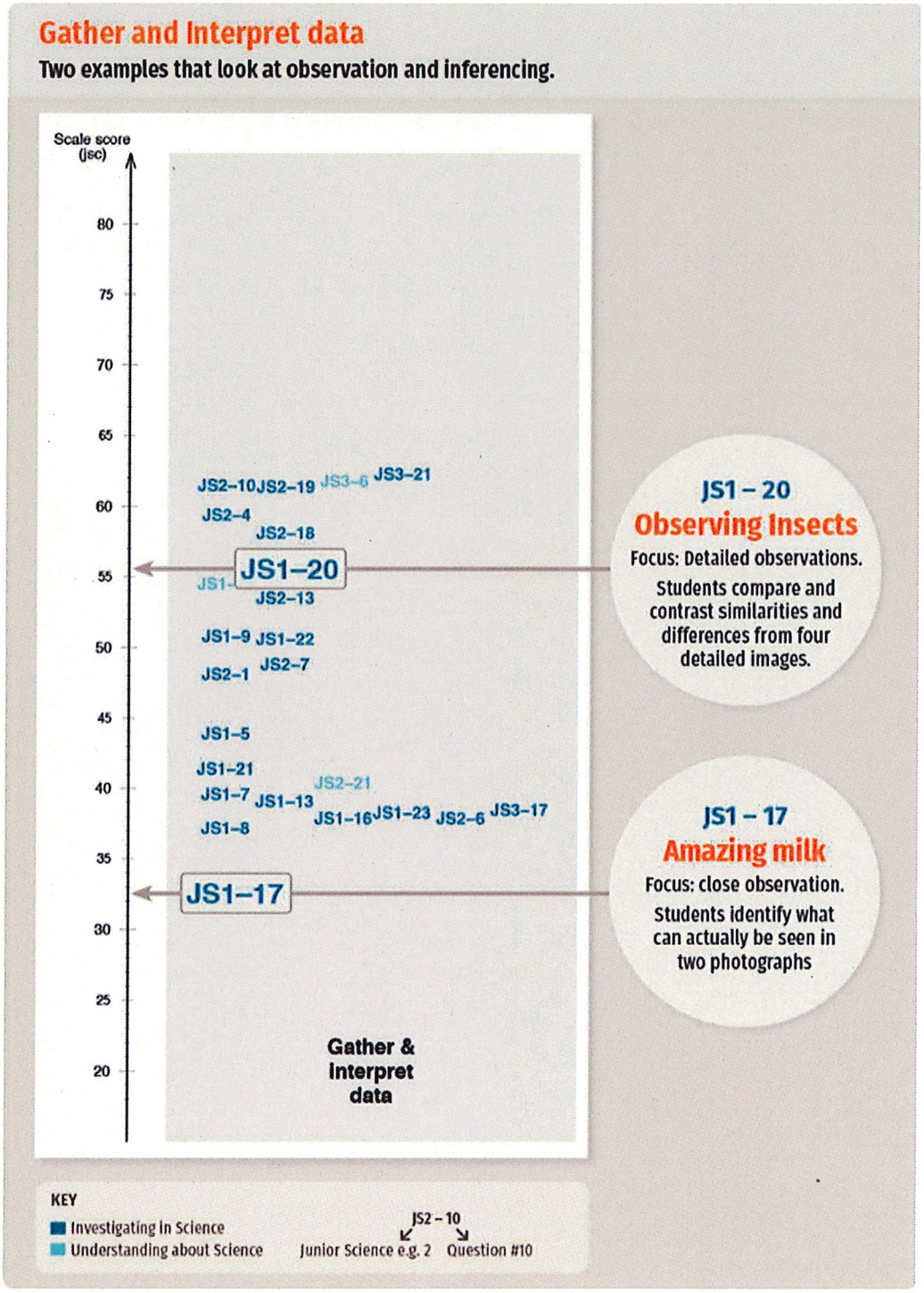
| Context: | Text demand: | Cognitive demand: |
|---|---|---|
| Familiar | Written text has more familiar language. | Apply actions to a context; less competing evidence provided. |

## Students' thinking in science

*Junior Science: Thinking with Evidence* tests students' ability to think within the context of science. The tests focus on the science capabilities which link the Nature of Science (NOS) achievement objectives and the key competency-*thinking*. The different capabilities require different types of thinking.

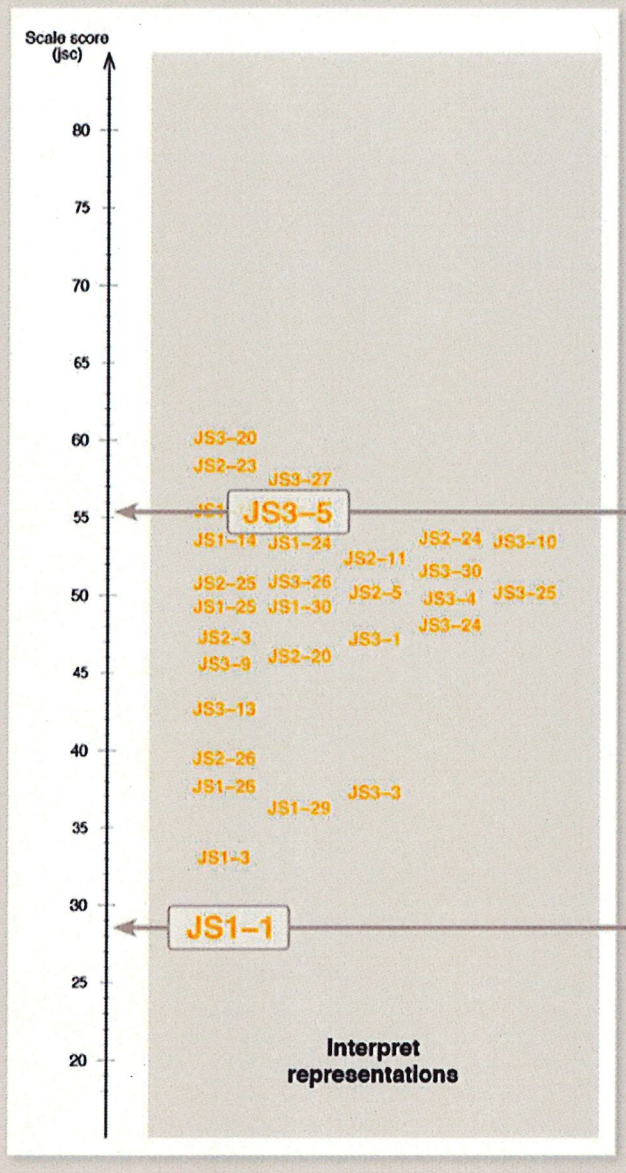
Within the science capabilities student thinking requires more complex science understandings as the items become more difficult.

Below are examples of how students need to think in easy and more difficult items in the five science capabilities.



## Interpret representations

**Two examples that look at reading and interpreting graphs and tables.**




**JS3 – 5**

**Safe in the sun**

Focus: Interpreting and comparing two different representations.

Students compare and contrast four statements across a graph and a diagram.

**JS1 – 1**

**Magnets**

Focus: Interpreting a simple representation.

Students read a simple form of a graph.

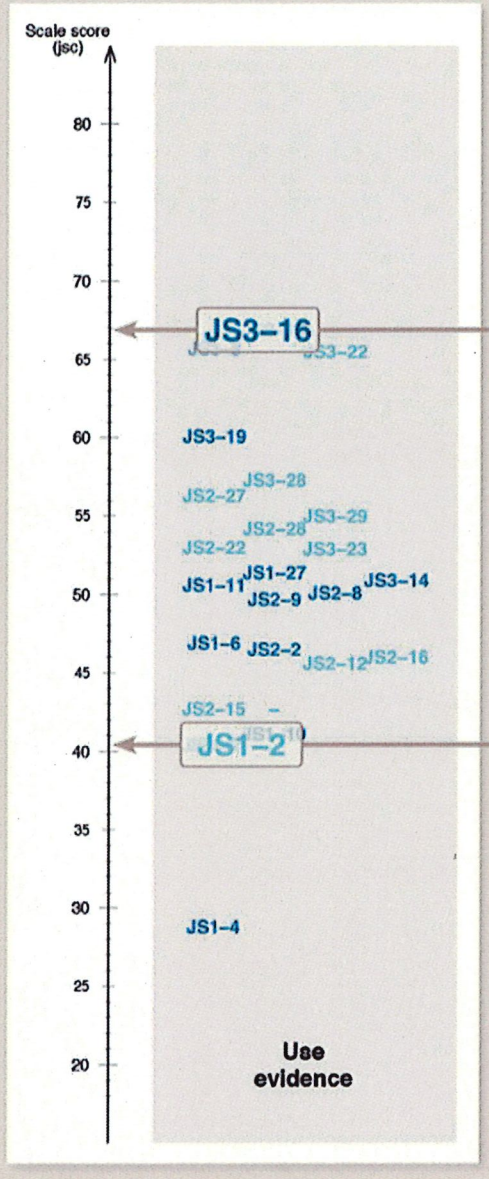
KEY

Communicating in Science

JS2 – 10
↙ ↘
Junior Science e.g. 2 Question #10

## Use evidence

**Two examples that look at causal explanations.**




**JS3 – 16**

**Reducing drag**

Focus: Creating a causal explanation.

Students construct a conclusion by interpreting information given in a table.

**JS1 – 2**

**Magnets**

Focus: Identify a causal explanation.

Students identify one causal explanation from four that match an accompanying graph.

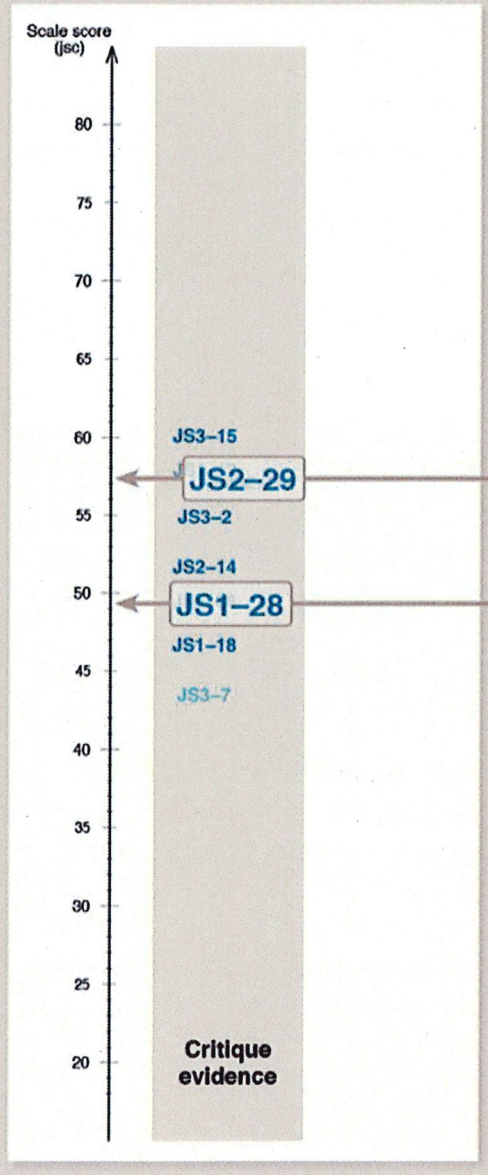
KEY

- Investigating in Science
- Understanding about Science

JS2 – 10
Junior Science e.g. 2 Question #10

## Critique evidence

**Two examples that look at features of scientific investigations.**




**JS2–29**

**Cleaning teeth**

Focus: Identify scientific method.

Students recognise the appropriate scientific method from four different investigations.

**JS1–28**

**Toy cars**

Focus: Identify an aspect of an investigation

Students identify how to use a variable in an investigation.

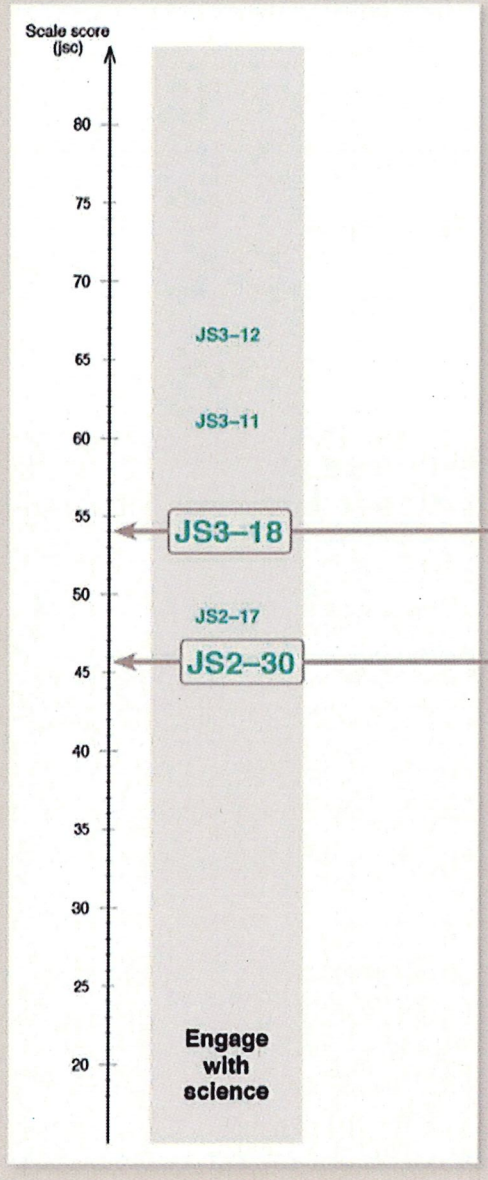
KEY

- Investigating in Science
- Understanding about Science

JS2 – 10
Junior Science e.g. 2 Question #10

## Engage with science

**Two examples that look at taking action.**




**JS3 – 18**

**Forest or beach**

Focus: Predict what action will happen.

Students make a prediction that relates to a specific action.

**JS2 – 30**

**Kaimoana**

Focus: Identify the reason for an action.

Students select the most plausible reason for an action.

KEY

Participating and Contributinge

JS2 – 10
Junior Science e.g. 2 Question #10

## How was the test designed?

The *Junior Science: Thinking with Evidence* tests were designed to integrate the Nature of Science strand of the NZC with more traditional content. Assessment tasks are contextually based and focus on 1 (or more) of the science capabilities. In providing all necessary information as stimulus material at the beginning of each question set (or unit), the test assesses what students can do with knowledge, rather than simply demonstrating what they know.

This section gives further information about how the test was structured and provides insight into what makes items assessed in this way easy or difficult for students.

### A closer look at the test structure

Each test is made up of several units. A unit has two parts:

- stimulus material that provides information
- items that ask questions about the stimulus material.

The diagram below describes how the shows how units are designed.

Unit

**Stimulus material**

- reflects themes from the contextual strands of science in The New Zealand Curriculum; Living World (LW), Material World (MW), Physical World (PW), and Planet Earth and Beyond (PE)
- is relevant and engaging
- is easily adaptable to science lessons
- may be written and/or visual text

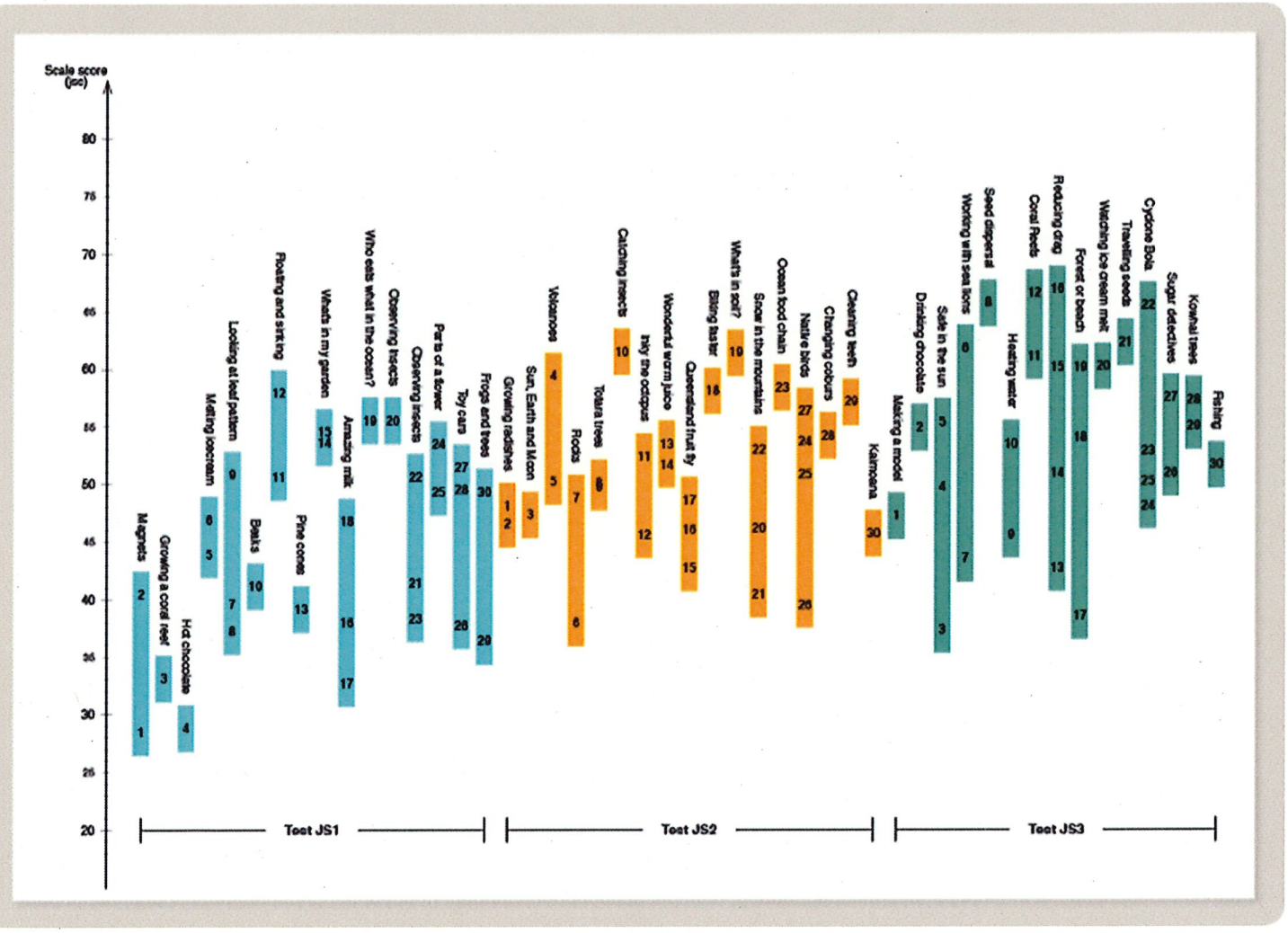
| Written texts could be: | Visual representations include: |
|---|---|
| short descriptive paragraph | tables |
| speech bubbles or concept cartoons | graphs |
| fact file | photographs |
| description of a student's experiment | drawings |
| | diagrams |
| | models |

**Items**

- mainly focus on the Nature of Science (NOS) sub strands; Communicating in science and Investigating in science
- mainly focus on one science capability.

## Unit difficulty

Within each unit, item difficulty can either be quite varied, or more clustered. The graph below shows all the JS items against the scale, organised into units. We can see how the items become gradually more difficult by test, and how item difficulties are distributed within the units.




## What makes items easy or difficult?

*Junior Science: Thinking with Evidence* tests students' ability to think within the context of science. To answer any of the items, a student must think through the following:

- the evidence provided in the stimulus material (includes vocabulary and written, visual and numeric texts)
- what the question asks
- the plausibility and relevance of the distractors in relation to the question asked.

Students may also have to think about the context and sometimes apply their understanding to an unfamiliar context or situation. They are likely to have to think about the scientific concepts involved.

Each one of the elements above contributes to the cognitive load of the items. The table below summarises less difficult to more difficult demands of items within the *Junior Science: Thinking with Evidence* assessment.

| Less difficult items | More difficult items |
|---|---|
| **Context**<br>• familiar context<br>• familiar or provided scientific knowledge | **Context**<br>• unfamiliar context/s<br>• challenging scientific knowledge or concepts |
| **Evidence**<br>• familiar and/or less complex text type/s and/or text, e.g., simple/ familiar vocabulary, photographs, evidence in simple tables. | **Evidence**<br>• unfamiliar and/or more complex text and/or text type/s, e.g., scientific vocabulary, graphs, flow diagrams. |
| **Cognitive load**<br>• few thinking steps<br>• making simple or direct links<br>• less competing evidence | **Cognitive load**<br>• more thinking steps<br>• synthesising more than one text and/or evidence<br>• more competing evidence<br>• complex thinking, e.g., orientating evidence in space and/or time<br>• evaluating evidence<br>• recognising positive, personal actions |

## The science capability focus is slightly different in each test

The number of items assessing each science capability and NOS sub-strand varies from test to test. The decision about which test each unit was placed in was influenced by how students in all three-year levels responded to the questions in the norming trial.

### The assessment focus in test JS1

Test JS1 has an emphasis on gathering and interpreting data and interpreting simple representations. This reflects the importance, in the early years of science learning, of careful observation to identify patterns and being able to read and understand simple graphs, diagrams and tables.

The table below shows how the number of items fit within each NOS sub-strand, contextual strand, and science capability for test JS1.

## Nature of Science

| Capability | Contextual strand | Understanding about science (UAS) LW | MW | PW | PE | UAS Total | Investigating in science (IIS) LW | MW | PW | PE | IIS Total | Communicating in science (CIS) LW | MW | PW | PE | CIS Total | Participating and contributing (PAC) LW | MW | PW | PE | PAC Total | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gather/interpret data | 1 | 0 | 0 | 0 | 1 | 8 | 3 | 0 | 0 | 11 | | | | | | | | | | | 12 ← |
| | Interpret representations | | | | | | | | | | | 7 | 0 | 2 | 0 | 9 | | | | | | 9 ← |
| | Use evidence | 0 | 0 | 1 | 0 | 1 | 1 | 2 | 2 | 0 | 5 | | | | | | | | | | | 6 |
| | Critique evidence | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 3 | | | | | | | | | | | 3 |
| | Engage with science | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 |
| | Grand Total | 1 | | 1 | 0 | 2 | 9 | 7 | 3 | 0 | 19 | 7 | 0 | 2 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 30 |

Capability n/a to NOS sub-strand

LW - Living world
MW - Material world
PW - Physical world
PE - Planet earth and beyond

### The assessment focus in test JS2

In JS2 there is a more even spread of items across the capabilities; gather and interpret data, interpret representations and use evidence. Students are making inferences from the data, comparing representations and deciding which explanations are backed up with evidence.

The table below shows the number of items that fit within each NOS sub-strand, contextual strand, and science capability for test JS2.

## Nature of Science

| Capability | Contextual strand | Understanding about science (UAS) LW | MW | PW | PE | UAS Total | Investigating in science (IIS) LW | MW | PW | PE | IIS Total | Communicating in science (CIS) LW | MW | PW | PE | CIS Total | Participating and contributing (PAC) LW | MW | PW | PE | PAC Total | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gather/interpret data | 0 | 0 | 0 | 1 | 1 | 3 | 0 | 1 | 4 | 8 | | | | | | | | | | | 9 ← |
| | Interpret representations | | | | | | | | | | | 5 | 0 | 0 | 3 | 8 | | | | | | 8 ← |
| | Use evidence | 5 | 0 | 0 | 1 | 6 | 1 | 2 | 0 | 0 | 3 | | | | | | | | | | | 9 ← |
| | Critique evidence | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | | | | | | | | | | | 2 |
| | Engage with science | | | | | | | | | | | | | | | | 2 | 0 | 0 | 0 | 2 | 2 |
| | Grand Total | 5 | 0 | 0 | 2 | 7 | 5 | 3 | 1 | 4 | 13 | 5 | 0 | 0 | 3 | 8 | 2 | 0 | 0 | 0 | 2 | 30 |

Capability n/a to NOS sub-strand

LW - Living world
MW - Material world
PW - Physical world
PE - Planet earth and beyond

### The assessment focus in test JS3

In JS3 interpreting representations is the main focus but now the representations are more complex. Students are comparing and interpreting the strengths of different representations, interpreting scientific representations and using evidence from representations to make and construct causal explanations.

The table below shows the number of items that fit within each NOS sub-strand, contextual strand, and science capability for test JS3.

**Nature of Science**

| | | Understanding about science (UAS) | | | | UAS Total | Investigating in science (IIS) | | | | IIS Total | Communicating in science (CIS) | | | | CIS Total | Participating and contributing (PAC) | | | | PAC Total | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Contextual strand | LW | MW | PW | PE | | LW | MW | PW | PE | | LW | MW | PW | PE | | LW | MW | PW | PE | | |
| Capability | Gather/interpret data | 1 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 2 | | | | | | | | | | | 3 |
| | Interpret representations | | | | | | | | | | | 1 | 3 | 1 | 6 | 13 | | | | | | 13 ← |
| | Use evidence | 2 | 2 | 0 | 0 | 4 | 2 | 0 | 2 | 0 | 4 | | | | | | | | | | | 8 ← |
| | Critique evidence | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 2 | | | | | | | | | | | 3 |
| | Engage with science | | | | | | | | | | | | | | | | 3 | 0 | 0 | 0 | 3 | 3 |
| | Grand Total | 4 | | | 0 | 6 | 4 | | 4 | | 8 | 1 | 3 | 6 | 3 | 13 | 3 | | | | 3 | 30 |

Capability n/a to NOS sub-strand

LW - Living world
MW - Material world
PW - Physical world
PE - Planet earth and beyond

## How can I use my test results?

Test results are available on the NZCER Assist website immediately after students have completed their test.

### The scale score

Test results are reported as both a raw score and a scale score. The scale score is a student's location on the *Junior Science: Thinking with Evidence* scale. All three tests use the same (JS) scale which is a continuum that represents increasing ability in 'thinking with evidence'.

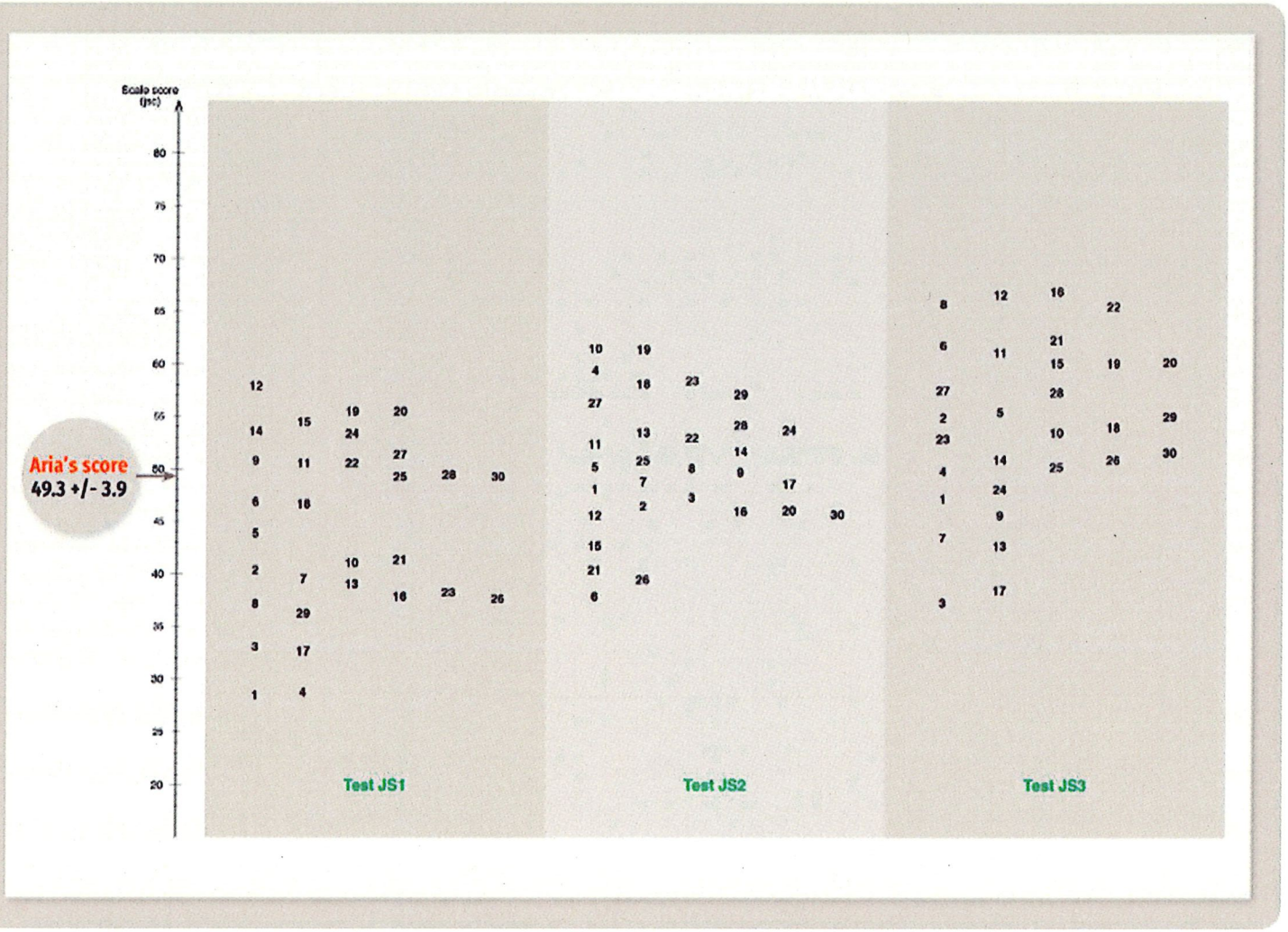
It is important to note that the JS scale is a different scale from the original *Science: Thinking with Evidence* (Year 7-10) tests. Scores cannot be compared between these two assessments.

Each scale score is presented with a margin of error. This is shown as a 'plus or minus' range and represents a band of scores within which you can be reasonably confident that a student's achievement lies. For instance, a scale score of 49 +/- 3.9 jsc units means we can be reasonably confident that the student's achievement level lies somewhere between 45.1 and 52.9 jsc units. The margin of error should be considered in all comparisons of scale scores, especially scores which are close together.

Every item in the *Junior Science: Thinking with Evidence* tests is also located on the JS scale.

The graph below shows the scale location of each item in the three tests. Question 1 in the first test (JS1), for example, is the easiest item overall; it has a JS scale location of 28.5 jsc units.

**The distribution of items in each test on the JS scale**



**Using the JS scale enables some useful comparisons to be made**

*The difficulty of the items can be compared with a student's achievement level on the scale*

- e.g., the graph above shows a student, Aria, achieved a scale sore of 49.3+/- 3.9 jsc units sitting JS1. This is the same position as items 25 and 30 on the scale. She has a 50% chance of getting the answers to these questions correct. Aria's chance of answering items correctly decreases as items with scale locations rise above her scale score and increases as items with scale locations fall below her scale score.

*The achievement of students in different year levels and sitting different tests can be compared*

- e.g., a student in Year 5 sitting JS1 gets 22 out of 30 questions correct and is placed at 56 +/- 4.4 on the scale. Another student is in Year 6 sitting JS3 gets 16 out of 30 questions correct and is placed at 55.9 +/- 3.9 on the scale. Because they have a similar scale score the two students have achieved the same level of 'thinking with evidence' even though they are in different year levels, sat different tests and had different raw scores

*Students' scale scores achieved at different time points can be compared, even though they may have sat different Junior Science: Thinking with Evidence tests*

- e.g., a Year 4 student sitting JS1 achieves a raw score of 18 out of 30, which corresponds to a scale score of 49.2 +/- 4.0. Two years later he sits JS3 and gets a raw score of 18 out of 30 and a scale score of 59 +/- 4.0. Overall, the student has shown an improvement in 'thinking with evidence'.
- the achievement level of your class with that of each year level of a nationally representative sample

## The norming study

**Comparing a student's achievement with the achievement of a nationally representative sample**

A student's achievement level on the JS scale can be compared with the achievement of nationally representative samples of students at Years 4, 5, and 6 who sat the test in March of 2017.

The table below shows sample statistics for the distributions of Year 4, 5 and 6 students on the JS scale.

**Summary statistics for the JS norming sample measured in Term 1, 2017**

| | Number of students | Mean (jsc) | Standard deviation (jsc) |
|---|---|---|---|
| **Year 4** | 908 | 41.3 | 9.9 |
| **Year 5** | 951 | 46.4 | 9.8 |
| **Year 6** | 1089 | 50.1 | 9.4 |
| Note: This assessment was tested on reference groups in Years 4, 5, and 6 only. There is no normed reference data for Year 3 or Year 7 | | | |

The NZCER Assist site allows you to choose which year level is used for comparisons. The comparisons are reported as representing either 'high', 'middle' or 'low' achievement for the year level selected. A 'high' achievement indicates that the student score falls in the top 23 percent of scores for the year level. A 'middle' achievement indicates that the score falls in the next 54 percent of scores. Finally, a 'low' achievement indicates that the score falls in the lowest 23 percent of scores. The graph below shows the distribution of student achievement on the JS scale, by year level.

As noted, the *Junior Science: Thinking with Evidence* 'norming study' was completed in March 2017. If you test your students at the end of the year, they will have had almost one more year of instruction than the norming study reference group for their year level. One way to adjust for this is to compare your students with the nationally representative sample for the year level above. For example, if you test your Year 5 class in December, it would be better to compare their results to the Year 6 sample. Choose the Year 6 reference year when viewing their reports.

## Technical information

This section explains some of the technical background behind the construction of the *Junior Science: Thinking with Evidence* assessment. You will find:

- an explanation of how the measurement scale (JS) was developed and how it can be used
- information about how NZCER conducted the research to standardise this assessment
- summary statistics for the tests based on the JS scale
- a discussion about the reliability, validity, and differential performance of the items across subgroups of the population
- tables that show the connection between raw score, scale score and reference levels for each year.

## What can the reports tell me?

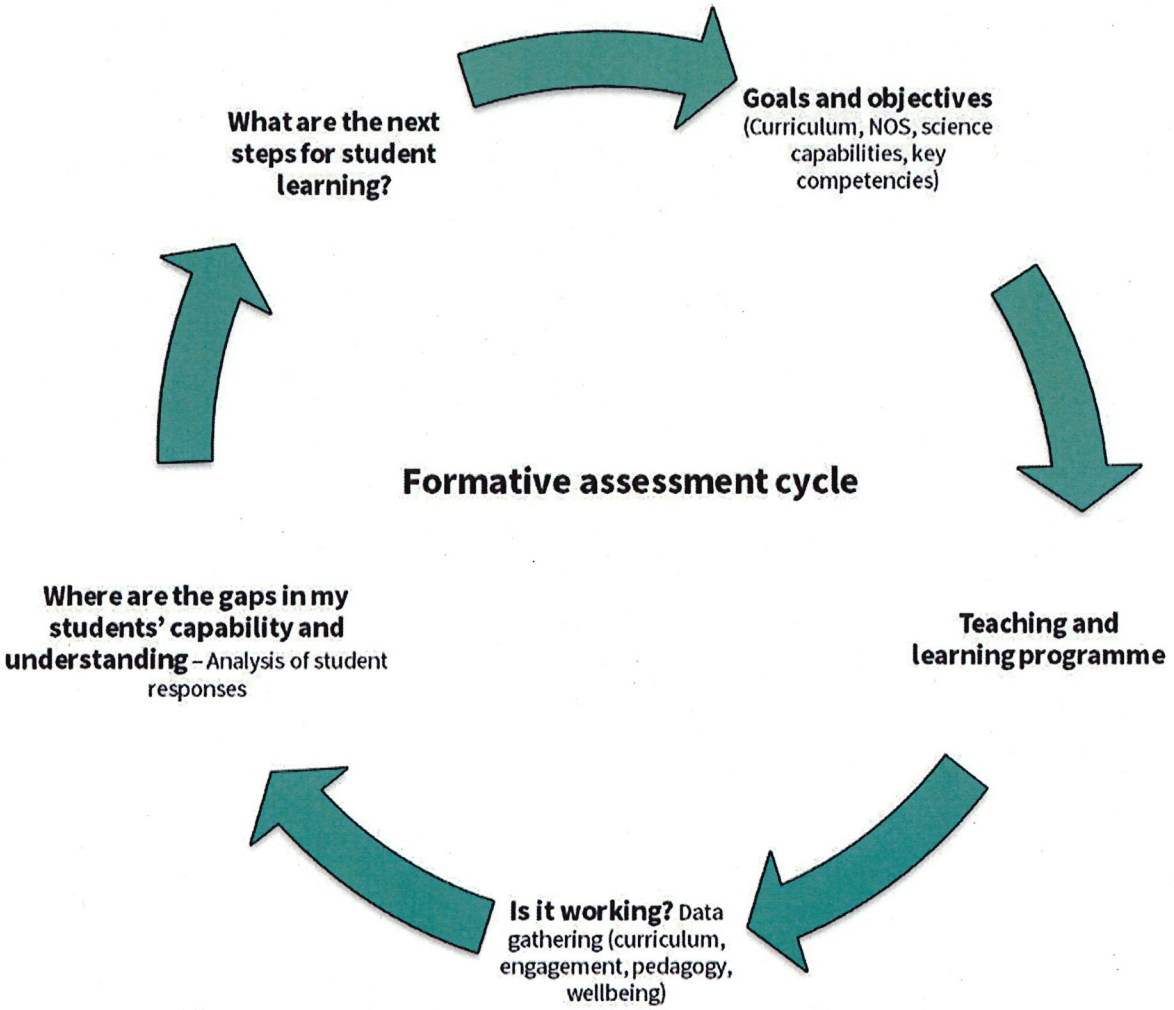
Reports are available on the NZCER Assist website immediately after your students have completed their test.

There are a range of types of report available and each one provides a different perspective on student achievement. Used together the reports can:

- present a snapshot of where students are on the *Junior Science: Thinking with Evidence* (JS) scale at certain time point.
- provide rich descriptive information about patterns in student thinking, providing a useful starting point in the formative assessment cycle.

### Formative assessment

*Junior Science: Thinking with Evidence can* be used in a variety of ways to help inform formative assessment (see the cycle below).




In this teacher manual there is information about the NZC, and how the science capabilities are used to weave together the Nature of Science (NOS) and the contextual strands.

The reports help teachers gather information about gaps in student capability and understanding.

Ideas for next steps can help teachers address the student learning challenges they find.

The test questions model possible contexts teachers can use in developing their science programmes.

**Finding out what students were thinking in their responses**

An important aspect of formative assessment is in finding out how students use their prior knowledge and the misconceptions to answer each question. The best strategy is to ask students what they were thinking when they gave a particular response. Some useful questions to ask students who answered questions incorrectly are:

- Why do you think that?
- What evidence is there to support your idea?
- Can you justify that?
- What were you thinking when you did that
- Do you agree with your classmate? Why or why not?

## List report

The List report provides a summary of results for a group of students who have taken the same test. Features of the List report include:

- each individual's results listed in a table
- summary statistics for the whole group compared to the relevant national reference group
- data can be ordered by first name, last name, test score, JS scale score, omits (number of questions students didn't answer), and year reference group level (high–top 23%, medium–middle 54%, or low–bottom 23% of students)
- search function (on student name and year reference group level).

**Using the List report**

Use the list report to gain a snapshot of:

- individual student results–you can search for any student in the group, or order the results on any of the fields (first name, last name, test score, scale score, omits, and year reference group level)
- groups of students who are working at particular levels of thinking in science - use the search function, for example, to find all of the students who achieved a high, medium, or low score compared with students in the same year level as the reference group.

*Sample of a List report:*

# List Report

**Junior Science: Thinking with Evidence : Test JS1**

***NZCER Demo School Year 4 Junior Science Test 1 (Reference Group Used: Year 4)***

Summary of Results

| Number of Students | Mean Scale Score (jsc) | Standard Deviation Score (jsc) |
|---|---|---|
| 7 | 45.2 (41.3) | 5.2 (9.9) |

*Number in brackets provide national reference group statistics*

Search:

*Search by Name or Reference Group*

| First Name | Last Name | Test Score | Scale Score | Number of Omits | Year 4 Reference Group |
|---|---|---|---|---|---|
| Eugenio | Di Giuseppe | 12 / 30 | 39.8 ± 4 | 0 | Middle |
| George | Ford | 16 / 30 | 46 ± 3.9 | 0 | Middle |
| Caleb | Morrell | 12 / 30 | 39.8 ± 4 | 0 | Middle |
| Aaliyah | Munro-Tupangaia | 21 / 30 | 54.2 ± 4.2 | 0 | High |
| Aaron | Sarcia | 14 / 30 | 42.9 ± 3.9 | 0 | Middle |
| Breea | Wedderburn | 15 / 30 | 44.5 ± 3.9 | 0 | Middle |
| Caitlin | Winchester | 18 / 30 | 49.2 ± 4 | 0 | High |

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Term 1 2017

**Examples of how to read the data**

This class has 7 students. The mean scale score is 45.2 which is 3.9 above the national reference group mean of 41.3. A comparison of the standard deviation shows the class has a lower spread than the national reference group.

Student George Ford achieved 16 correct answers out of 30. His scale score is 46.0 +/- 3.9. This means we can be reasonably sure George's true level is between 42.1 and 49.9 jsc units. He answered all questions (no omits) and his score is in the middle 54% of students.

## Scale score report

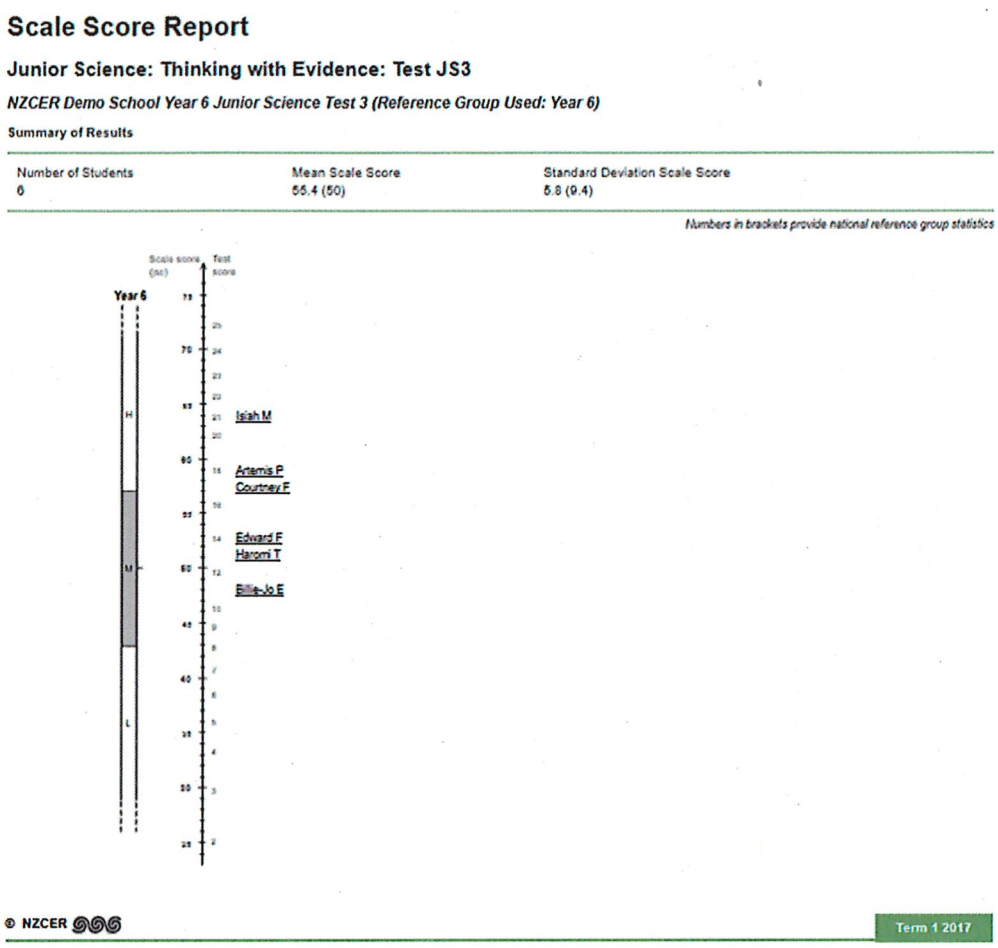
The Scale score report is a graph that shows how the students in a group, who have taken the same test, are distributed along the *Junior Science: Thinking with Evidence* (JS) scale. It also provides a comparison with the national reference group by showing the reference group level distribution for a chosen year group. Features of the Scale score report include:

- each individual's position on the JS scale.
- summary statistics for the whole group and the relevant national reference group
- comparison of the group with the reference group level distribution (high--top 23%, medium--middle 54%, or low – bottom 23% of students)

**Use the scale score report to:**

- gain a snapshot of the spread of results in your group
- group cohorts of students in diverse ways (for example, you may want to group students together with similar achievement levels to focus on identified issues or by diverse achievement levels for peer tutoring)
- access a particular individual student report (click on the student name) to find out how why they were placed in the position on the JS scale.

*Sample of a Scale score report:*



**Scale Score Report**

**Junior Science: Thinking with Evidence: Test JS3**

*NZCER Demo School Year 6 Junior Science Test 3 (Reference Group Used: Year 6)*

**Summary of Results**

| Number of Students | Mean Scale Score | Standard Deviation Scale Score |
|---|---|---|
| 6 | 55.4 (50) | 5.8 (9.4) |

*Numbers in brackets provide national reference group statistics*





Term 1 2017

**Examples of how to read the data**

The scale score report above shows the mean scale score of the 6 Year 6 students in the group was 55.4 jsc units compared with the national reference group mean (in brackets) of 50 jsc units. The spread of scores in the group, at 5.8, was less than the national reference group spread of 9.4.

Students in the group have all achieved scores in the middle and high range when compared to Year 6 students in national reference group.

## Item report

The Item report provides a curricular breakdown (by Nature of Science (NOS) sub-strand and science capability) of all questions (items) within a test. It indicates what percentage of the group of students answered each item successfully. It also compares the success of the group on the questions with the success of students from the national reference group at a given year level. Features of the Item report include:

- description of each test item with the identified NOS sub-strand and science capability categories
- graphical representation of group performance on each question compared to the national reference group

- links to the individual item report
- data in each field (question number, NOS sub-strand, science capability, percentage correct and national percentage correct) can be ordered.

**Using the Item report**

This report can provide a very useful summary of the interpretation of the '*Thinking with Evidence*' required in the tests. Use the item report to:

- find trends and patterns, strengths, and weaknesses that exist in the test group by NOS sub-strand and/or capability
- compare what students in your group find difficult with what students in the norming study, found difficult and ask why
- click on the question number to link to the individual item report to investigate the skills needed to answer any particular item
- identify next learning steps or learning opportunities
- identify specific cohorts who require more in-depth teaching in defined areas
- follow hunches, "informal conclusions", to identify actual needs.

*Sample of an Item report:*

## Item Report

**Junior Science: Thinking with Evidence: Test JS1**

***NZCER Demo School Year 4 Junior Science Test 1 (Reference Group Used: Year 4, Number of students: 7 )***

| Question Number | NoS Strand | Science Capability | Description of Item | Percentage Correct (%) | National Percentage (%) |
|---|---|---|---|---|---|
| 1 | CIS | IR | Relate strength of magnets to a bar graph representation. | 71.4 | (75) |
| 2 | UAS | UE | Choose the correct conclusion about magnet strength. | 85.7 | (52) |
| 3 | CIS | IR | Order images of growth of a coral reef. | 100 | (66) |
| 4 | IIS | UE | Analyse data, identifying best cup for heat retention. | 100 | (74) |
| 5 | IIS | GI | Match temperatures to images of melting ice cream. | 42.9 | (45) |
| 6 | IIS | UE | Identify the correct conclusion about melting ice cream. | 71.4 | (39) |
| 7 | IIS | GI | Identify similarities between two leaves. | 42.9 | (54) |
| 8 | IIS | GI | Identify differences between two leaves. | 85.7 | (58) |
| 9 | IIS | GI | Match written descriptions of leaves to images. | 0 | (31) |
| 10 | IIS | UE | Choose the best inference about adult and baby bird beaks. | 85.7 | (50) |
| 11 | IIS | UE | Identify true and false statements from test results on floating and sinking | 0 | (32) |
| 12 | IIS | CE | Decide the best method to further investigate a question about floating and sinking. | 57.1 | (20) |
| 13 | IIS | GI | Relate method of seed dispersal to image of seed. | 71.4 | (55) |

**Examples of how to read the data**

Question 7 is from the NOS sub-strand; Investigating in science, and assesses the science capability, Gather and interpret data. The item is described as identifying **similarities** between two leaves. 42.9% of the group got this question correct (green shading) compared with 54% of the national reference group (red triangle).

Question 8 is also is from the NOS sub-strand; Investigating in science, and assesses the science capability, Gather and interpret data. The item is described as identifying **differences** between two leaves. 85.7% of the group got this question correct (green shading) compared with 58% of the national reference group (red triangle).

If you compare questions 7 and 8 you can see that the class found identifying differences much easier than identifying similarities in leaf patterns. If this was your class, you might like to find opportunities for students to practice looking for similarities in patterns.

## Individual test item report

An individual test item report provides an insight into the thinking required to answer a question and a summary of how the students in a group responded to each test item. Features of the Individual test item report include:

- a preview of each test question
- for multiple choice questions (with one correct answer) - a graph of the percentage of students answering each option
- for all other question types (including multichoice questions with more than one answer) - a graph of percentage of students answering the question correctly or incorrectly
- names of students answering each option
- examples of questions teachers can use to gain insight into the thinking students used to answer each question
- ideas for next steps
- links to similar questions in the same test
- links to further resources

**Using the Individual test item report**

This report can be used to look carefully at the cognitive demands and science capability focus of each question and how the students responded. Teachers are supported in finding the likely reasons for response patterns they have observed and potential learning challenges they might want to address.

*Sample of an Individual test item report:*

***Junior Science: Thinking with Evidence***

**Individual Test Item Report**

**Test JS2 - Question 11 (Inky the octopus)**

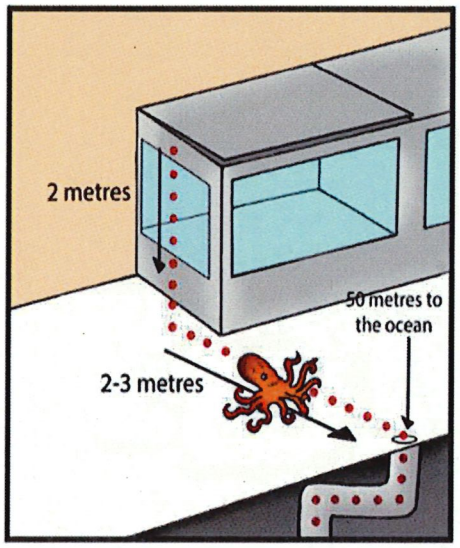
***Response Information***

(Reference Group Used: Year 5, Number of students 6)



Graph and Analysis | Item Image

Inky the octopus is famous for one night escaping from his tank at the Napier Aquarium and finding his way back into the ocean. This diagram shows how the aquarium workers think he did it.




***Question 11***

**Which can you tell from looking at the diagram?**

- **Inky escaped at night when no people were around.**
- **Inky had to travel about 55 metres to get to the ocean.**
- **Inky knew the drainpipe went out to the ocean.**
- **Inky liked living in the ocean better than the aquarium.**

*Sample of Graph and Analysis:*

***Junior Science: Thinking with Evidence***

**Individual Test Item Report**

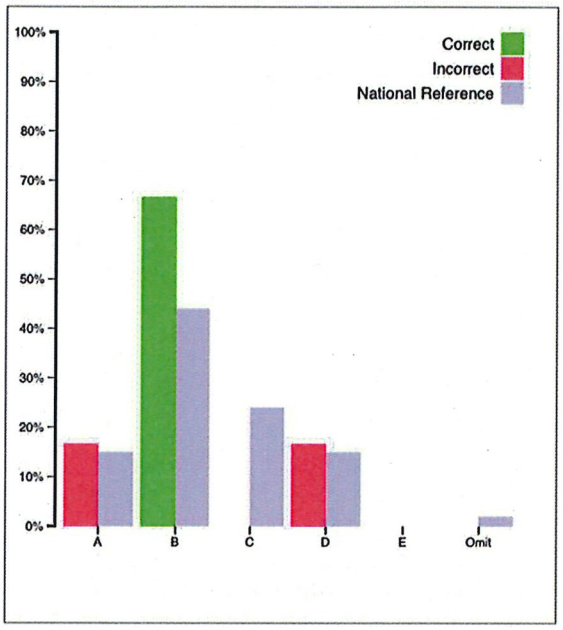
**Test JS2 - Question 11 (Inky the octopus)**

***Response Information***

(Reference Group Used: Year 5, Number of students 6)

Prev | 1 | 2 | ... | 9 | 10 | 11 | 12 | 13 | ... | 29 | 30 | Next

Graph and Analysis | Item Image




**Item Description**
Identify what can be observed from a diagram about an octopuses escape.

**Nature of Science**
Communicating in science

**Contextual strand**
Living world

**Science capability**
Interpret representations: Use observations to interpret a diagram

**Analysing student responses**
Discuss with students:
- if they used the diagram to answer the question
- how they interpreted the diagram (e.g., the dots, arrows, image)
- if they focused on an assumption of human characteristics for the octopus (e.g., "Inky liked..." or "Inky knew...").

**Next steps**
To support students, give them opportunities to look at diagrams and gather evidence from actual observation (not making inferences).

**Related questions**
3, 5, 23

| A (17%) | B (67%) | C (0%) | D (17%) | E (0%) | Omitted (0%) |
|---|---|---|---|---|---|
| Harris Matthews | Halayna Scott<br>Ngauru Rawiri-Gordon<br>Gus Falwasser-Logan<br>Malia Suluka | | Marisa Hannah | | |
| 1 student | 4 students | 0 student | 1 student | 0 student | 0 student |

***Key to use of shading***

**Based on the student's overall result**

this student had about an even chance of a correct response.

this student has high expectancy to correctly answer this question.

## Examples of how to read the data

The above graph shows how the students in the class answered the question compared with how the students in the reference group answered the question. e.g., 66% of the class group answered B (the correct option) and 17% of the group answered A and D.

Below the graph teachers can see the names of the students answering each option.

To the right of the graph are suggestions for questions teachers can use to analyse student thinking. You will also find ideas for next steps in teaching and links to other related questions in the same test.

## Individual student report

The individual student report is an item map which shows how the student has performed on each of the items within a test. The report displays the items positioned according to their location on the scale and grouped by Nature of Science (NOS) sub-strand. The overall level of the student's achievement is indicated on the report. Features of the Individual student report include:

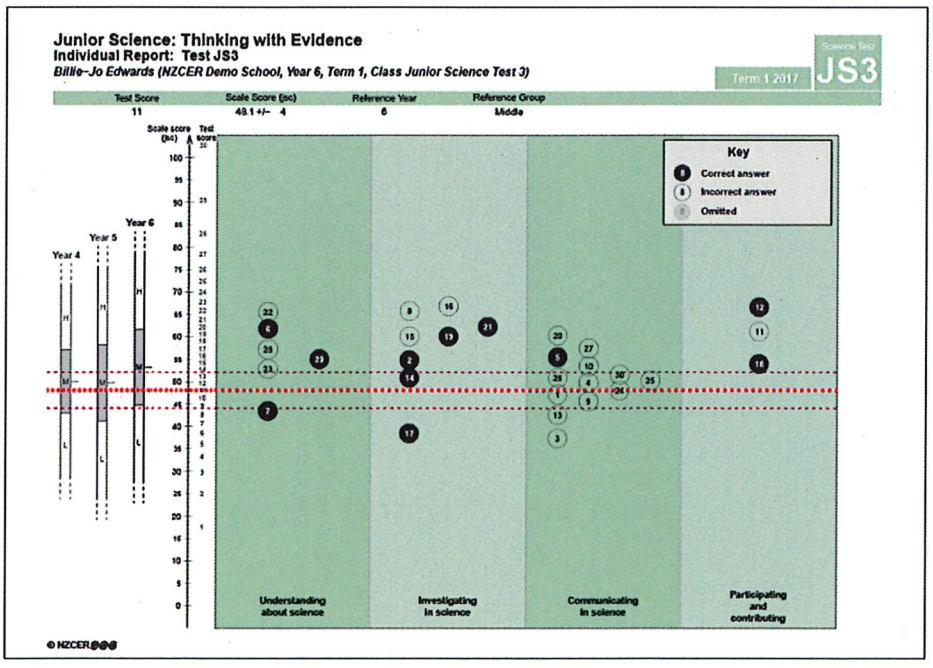
- shows the location of each the test items on the JS scale and which of the items the student got correct, incorrect, or omitted
- items grouped by NOS sub-strand (coming soon: option to group items by science capability)
- student's position on JS scale is compared with year group reference level (low, medium, or high)
- find out more about each item by clicking on the item number (link to the individual item report)

### Using the Individual student report

This report is used mainly to identify and inquire into trends and patterns in an individual student's response to the test items. You can use it to ask:

- What are the gaps or strengths in student capability or achievement, e.g., in NOS sub-strand?
- How can this student be supported, and what are the next logical steps for this student's learning?
- What are the reasons for the discrepancies in expected student results (e.g., are there questions the student was expected to answer correctly but didn't or expected to answer incorrectly but got right)?
- Can the observed patterns be attributed to prior knowledge, familiarity, or experience?

*Sample of an Individual student report:*



**Examples of how to read the data**

This Year 6 student got 11 out of 30 questions correct. The dotted line shows her scale score is 48.1 with a margin of error of +/- 4 which puts her in the middle reference level.

In the Nature of Science (NOS) sub-strand Communicating in science, she only answered question 5 correctly. Based on her scale score she would be expected to get questions 1, 9, 13 and 3 correct. This could indicate she has difficulty reading and interpreting representations.