NAP sample assessment

science literacy **2018** public report

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ACKNOWLEDGEMENTS

NAP – Science Literacy Working Group

Listed below are the working group members representing the Australian Government, jurisdictions and school sectors. These members have made a valuable contribution to the project throughout the development, implementation and reporting phases.

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FOREWORD

The NAP sample assessment in science literacy (NAP–SL) is one of three national sample assessments developed and managed by the Australian Curriculum, Assessment and Reporting Authority (ACARA) under the auspices of the Education Council. The other two are civics and citizenship, and information and communication technology literacy.

Every three years, ACARA assesses a stratified random sample of students. These assessments support measurement and reporting on progress towards the achievement of the objectives outlined in the Melbourne Declaration on Educational Goals for Young Australians (2008). They monitor the extent to which our schooling promotes equity and excellence, and the progress of young Australians towards becoming successful learners, confident and creative individuals, and informed citizens.

The findings from the 2018 NAP sample assessment presented in this report provide valuable information on the science literacy of Year 6 and Year 10 students across Australia. The report also analyses the performance of states and territories and various subgroups, including Aboriginal and Torres Strait Islander students, those living in remote and very remote areas, and students from language backgrounds other than English. The data provide insight into the level of science knowledge, understandings and skills of our Year 6 and Year 10 students. In addition, the student survey highlights the extent of students' interest in science, their engagement in science-related activities and their understanding of how science is relevant to their lives.

This report is the sixth in the series of three-yearly reports, which began in 2003. Previous cycles reported on Year 6 students. In 2018, Year 10 students were assessed for the first time.

Nationally, the results for Year 6 students have shown little change in average student achievement or the proportion of Year 6 students performing at or above the defined proficient standard in science literacy since 2003. The standards for Years 6 and 10 represent a challenging but reasonable expectation of student achievement. In 2018, 58 per cent of Year 6 students and 50 per cent of Year 10 students reached or exceeded their respective proficient standards.

The results of the student survey show that most students (over 80 per cent) appear to be interested in learning new concepts in science and doing science-based activities. This interest in science is a strong foundation on which to build student confidence, create student awareness of the role played by science in their everyday lives, and encourage students to consider science as a career choice.

I wish to acknowledge and thank the educators from all states and territories, who have contributed to the development of the 2018 NAP–SL sample assessment.

Thanks too to the principals, teachers, and students at government, Catholic and independent schools around Australia, whose participation provided valuable information about science literacy in schools.

I commend this report to ministers, senior education officials, teachers and community members committed to improving educational outcomes for all young Australians, and to those with a specific interest in helping young Australians to participate in a society where science plays an increasingly important role.

Ms Belinda Robinson
FAICD Board Chair
Australian Curriculum, Assessment and Reporting Authority

EXECUTIVE SUMMARY

Introduction

This report documents the findings of the sixth triennial National Assessment Program – Science Literacy (NAP–SL) assessment cycle.

The NAP–SL assessment provides the basis on which national key performance measures (KPMs) can be reported and a mechanism for monitoring progress towards the Melbourne Declaration on Educational Goals for Young Australians (Melbourne Declaration). Editions of this report for the five previous cycles are available on the ACARA NAP website.

Overview of the report

The Melbourne Declaration[1], adopted by state, territory and Commonwealth ministers of education in 2008, sets out educational goals for young Australians.

Prominent in the content of this document is the role of science education. Goal 2 in the Melbourne Declaration asserts, among other things, that all young Australians should become successful learners, creative and confident individuals, and active and informed citizens.

Further information relating to the historical context of the National Assessment Program and its connections to the Australian Curriculum is provided in chapter 1.

What is assessed in NAP–SL

The NAP – Science Literacy assessment measures the ability of students:

> *to use scientific knowledge, understanding, and inquiry skills to identify questions, acquire new knowledge, explain science phenomena, solve problems and draw evidence-based conclusions in making sense of the world, and to recognise how understandings of the nature, development, use and influence of science help us make responsible decisions and shape our interpretations of information.*

The 2018 NAP–SL Assessment Framework content is organised according to the strands of the Australian Curriculum: Science. The strands are:

- Science Understanding
- Science as a Human Endeavour
- Science Inquiry Skills.

All strands were assessed for Years 6 and 10 in the 2018 NAP–SL assessment.

Further information about the 2018 NAP–SL Assessment Framework is provided in chapters 1 and 2 and appendices 1 and 2.

[1]. In December 2019, the Melbourne Declaration on the Educational Goals for Young Australians was superseded by the Alice Springs (Mparntwe) Education Declaration.

NAP–SL and the Australian Curriculum: Science

The NAP–SL 2018 has been aligned to the Australian Curriculum: Science. The aims of the Australian Curriculum: Science are congruent with and reflected in the NAP–SL Assessment Framework. The specific aims of the Australian Curriculum: Science are:

- the understanding of important science concepts and processes, the practices used to develop scientific knowledge, science's contribution to society, and society's influence on science from a range of cultures
- the ability to think and act in a scientific way
- the ability to make informed decisions about local, national and global issues.

Every item used in the 2018 cycle was mapped against the Australian Curriculum: Science strands, sub-strands and the cognitive dimensions. Where applicable, items were also classified against the general capabilities, including the Critical and Creative Thinking capability.

Further information about the relationship between NAP–SL and the Australian Curriculum is provided in chapters 1 and 6.

Assessment administration

The assessment instrument was administered online to samples of students in Year 6 and Year 10 in October and November 2018. Data were collected from a total of 5,578 Year 6 students and 3,043 Year 10 students. After applying data analysis parameters including percentage of completed responses, the final participation numbers are 5,551 Year 6 students in 343 schools and 3,032 Year 10 students in 202 schools.

Detailed descriptions of the methods used to develop and administer the assessment are provided in chapter 2.

Assessment instrument

The NAP–SL 2018 assessment instrument included test items presented in units. Each unit comprised a set of items that were developed around a stimulus. The test contained multiple choice, interactive non-multiple choice short response and constructed response items.

The units of test items were allocated to clusters which in turn were allocated to test forms in such a way that the forms were 'equivalent' in terms of framework coverage, item types, reading load and overall difficulty. Each test form contained three components: a set of objective test items, an inquiry task and a set of survey items.

NAP–SL scale

The NAP–SL scale comprises proficiency levels that are used to describe the achievement of students both at Year 6 and Year 10. The scale was revised in 2006 to describe the performance of Year 6 students nationally and has a mean score of 400 with a standard deviation of 100 scale points. NAP–SL scale scores from the four previous assessment cycles have been reported using this same metric.

Following the 2017 pilot study, Year 10 students were included in the assessment sample for NAP–SL 2018. See the 2018 NAP–SL Technical Report for more detailed information.

The introduction of Year 10 students necessitated a standard setting process to determine the cut point, which would represent the proficient standard for Year 10.

The proficient standard is a point on the scale that represents a ‘challenging but reasonable’ expectation of student achievement at that year level. The proportion of students who meet or exceed the proficient standard is the key performance measure for science literacy at each year level.

As part of the inclusion of the new proficient standard for Year 10, a change was made to the width of the proficiency levels; therefore, the levels were relabelled so that the proficient standard for Year 6 is now the boundary between levels 2 and 3, and the proficient standard for Year 10 is the boundary between levels 3 and 4. The proficient standard for Year 6 remained unchanged. Therefore, the percentage of Year 6 students attaining or exceeding the proficient standard can be compared with previous assessments.

Furthermore, to ensure comparability of online results between the 2018, 2015 and previous cycles undertaken on paper, a mixed-mode study was conducted alongside the main study. This study, and a similar study in the previous cycle, was designed to compare the performance of online and paper items. The results informed the equating process and ensured 2018 results can be placed onto the historical NAP–SL scale. For further detail relating to this study, please refer to the 2018 NAP–SL Technical Report.

Chapters 3 and 4 describe the NAP–SL scale and provide a discussion of student achievement against the scale at the national and state or territory levels. Following this are the results for the specific student groupings such as gender, Indigenous status, language spoken at home, geographic location, and parental occupation and education.

Performance of Year 6 students

At the national level in 2018, 58 per cent of Year 6 students attained the proficient standard. This is significantly higher than the percentage achieved nationally in 2012, but not significantly different from the percentage achieved nationally in the other cycles of NAP – Science Literacy (table ES1).

There has been very little variation in the percentage of students attaining the proficient standard within each state and territory since 2006, except for Queensland, where the 2018 percentage is significantly higher than in all previous cycles, and in Western Australia, where the percentage is significantly higher than in 2006.

Table ES1
Percentages of Year 6 students attaining the proficient standard nationally and by state and territory since 2006

State/ territory	2018	2015	2012	2009	2006
NSW	54 (±5.1)	57 (±3.6)	51 (±4.3)	53 (±5.0)	57 (±4.3)
Vic.	56 (±4.8)	54 (±3.8)	51 (±4.7)	55 (±4.6)	58 (±5.0)
Qld	64 (±4.5)	↓54 (±4.6)	↓50 (±3.3)	↓49 (±3.8)	↓49 (±3.8)
WA	62 (±5.2)	58 (±3.3)	56 (±4.2)	53 (±4.5)	↓47 (±4.7)
SA	55 (±6.8)	51 (±3.9)	51 (±3.9)	47 (±5.0)	52 (±4.7)
Tas.	58 (±5.2)	59 (±4.7)	51 (±5.4)	50 (±6.0)	57 (±5.5)
ACT	67 (±6.7)	61 (±5.1)	65 (±5.3)	61 (±4.8)	62 (±5.6)
NT	37 (±7.4)	32 (±5.6)	31 (±7.6)	34 (±7.5)	38 (±6.5)
Aust.	58 (±2.4)	55 (±1.8)	↓51 (±2.0)	52 (±2.2)	54 (±2.1)

Confidence intervals (1.96*SE) are reported in brackets.
↑ if significantly higher than 2018.
↓ if significantly lower than 2018.

At the national level in 2018, the average scale score of students in Year 6 was 407 score points. This is not significantly different from the average in any other cycle (table ES2).

There has been very little variation in the average scale score of students in Year 6 within each state and territory since 2006, except for Queensland, where the 2018 average is significantly higher than all previous cycles, and in Western Australia, where the average in 2018 is significantly higher than in 2006.

Table ES2
Average scale scores nationally and by state and territory for Year 6 since 2006

State/ territory	2018	2015	2012	2009	2006
NSW	397 (±10.5)	411 (±8.6)	395 (±9.9)	396 (±12.1)	411 (±12.5)
Vic.	405 (±10.3)	399 (±8.9)	393 (±9.7)	398 (±9.2)	408 (±10.2)
Qld	426 (±8.5)	↓398 (±10.6)	↓392 (±6.4)	↓385 (±8.9)	↓387 (±8.6)
WA	415 (±14.5)	408 (±7.5)	406 (±9.5)	393 (±9.6)	↓381 (±10.0)
SA	400 (±15.5)	392 (±8.8)	392 (±7.9)	380 (±10.4)	392 (±10.0)
Tas.	405 (±14.9)	414 (±11.7)	395 (±12.3)	386 (±13.5)	406 (±12.1)
ACT	427 (±17.6)	414 (±12.1)	429 (±13.2)	415 (±10.6)	418 (±14.3)
NT	302 (±39.2)	320 (±25.6)	319 (±31.1)	326 (±28.6)	325 (±33.7)
Aust.	407 (±5.0)	403 (±4.3)	394 (±4.4)	392 (±5.1)	400 (±5.4)

Confidence intervals (1.96*SE) are reported in brackets.
↑ if significantly higher than 2018.
↓ if significantly lower than 2018.

Performance of Year 10 students

At the national level in 2018, 50 per cent of Year 10 students attained the proficient standard and the average scale score of students in Year 10 was 490 score points. (table ES3).

As 2018 was the transition year for Year 10 students undertaking NAP–SL, jurisdictions were given the option to indicate the size of their sample. New South Wales, Victoria and Western Australia requested larger sample sizes in order to contribute to both national and state level reporting. All other states and territories opted for smaller sample sizes and therefore contributed only to national estimates.

Table ES3
Percentages attaining the proficient standard and average scale score for Year 10 students by state and territory in 2018

State/ territory	Percentage attaining the proficient standard	Average scale score
NSW	49 (±4.8)	486 (±11.8)
Vic.	47 (±5.5)	487 (±15.3)
Qld	-	-
WA	58 (±7.3)	515 (±18.7)
SA	-	-
Tas.	-	-
ACT	-	-
NT	-	-
Aust.	50 (±2.8)	490 (±7.3)

Confidence intervals (1.96*SE) are reported in brackets.
(-) State or territory that did not participate in jurisdiction-level data collection.

Performance by background characteristics

Achievement by gender

At the national level, the average scale score of Year 6 female students was 409, and the average scale scores for male students was 405. These scores were not significantly different. The average scale score of Year 6 female students in 2018, while similar to the average scale score in 2015, was significantly higher than that of 2009. The percentage of Year 6 female students who attained the proficient standard in 2018 was significantly higher than in 2012. Overall, the results show some evidence for a positive trend in Science Literacy achievement for both male and female students since 2012.

At the national level, the average scale score of Year 10 female students was 494, and the average scale scores for male students was 485. These scores were not significantly different.

Achievement by Indigenous status

The 2018 average score for Year 6 Indigenous students was higher than the average scores of Indigenous students in 2012 and 2009. In 2018, the average score for Year 6 Indigenous students was 339, indicating that they did not perform as well as non-Indigenous students with an average score of 412. This difference was statistically significant, as it also was in all previous assessment cycles. The percentage of Year 6 Indigenous students attaining the proficient standard (35 per cent) was significantly higher than in 2015, 2012 and 2009 (23 per cent, 20 per cent and 20 per cent respectively).

At the national level, the average scale score of Year 10 Indigenous students was 408 whilst the average scale scores for non-Indigenous students was 494. These scores were significantly different. The percentage of Year 10 Indigenous students that attained the proficient standard in 2018 was 20 per cent compared with 51 per cent of non-Indigenous students.

Achievement by language background

At the national level, Year 6 students who speak English at home had a significantly higher average scale score (411) than students who speak a language other than English at home (398). In previous cycles, the differences between the average scale scores were not statistically significant. Fifty-nine per cent of students who speak English at home attained the proficient standard, compared with 56 per cent of students who speak a language other than English at home. The percentage of Year 6 English-speaking students who attained the proficient standard in 2018 was higher than in 2012.

No difference was observed in performance between the two groups for Year 10.

Achievement by geographic location

The pattern of results indicates that Year 6 students attending schools located in major cities perform significantly better than students attending schools in all other geographic locations. Year 10 students from major cities also perform significantly better than students from both remote and very remote areas.

Achievement by parental occupation

At the national level, Year 6 students with parents who were senior managers or professionals had average scale scores that were 66 points higher than those with parents who were recorded as unskilled labourers, office, sales or service staff. For Year 10 students, the difference in the average scale scores was 104 scale points.

Forty-nine per cent of Year 6 students and 30 per cent of Year 10 students whose parents were classified in the group comprising unskilled labourers, office, sales and service staff scored at or above their respective proficient standards. Among students with parents in the category of senior managers or professionals, 73 per cent of Year 6 and 70 per cent of Year 10 students had scores above their respective proficient standard.

Achievement by parental education

For both Year 6 and 10 students, there were considerable differences in achievement between levels of parental education. Year 6 students with parents who had a Bachelor's degree or higher obtained average scale scores that were 96 points above those with parents who had not exceeded Year 10 as their highest level of education. For Year 10, this difference was 125 points.

Seventy-two per cent of Year 6 students and 70 per cent of Year 10 students with parents who had a Bachelor's degree or higher reached their respective proficient standards. In the lowest education group, 36 per cent of Year 6 and 25 per cent of Year 10 students reached their proficient standard.

Survey results

Since 2009, students have also been required to complete a survey. The survey canvassed students' perceptions of, and attitudes to, science. It also asked students about their science-learning experiences at school.

Eighty-four per cent of Year 6 students responded that they would like to learn more science at school, and 65 per cent of Year 6 students indicated that they believe it would be interesting to be a scientist, indicating that a positive attitude towards this subject area exists.

More than 80 per cent of Year 6 and 10 students acknowledged that science is important for many jobs and for helping people to make informed decisions.

Only 25 per cent of Year 6 students and 20 per cent of Year 10 students indicated that guest speakers are invited to their school to talk about science topics. There is growing body of research that points to the benefits of the contextualisation of science, which can be achieved by the inclusion of outside specialists. The survey also showed that more than half of students disagreed with the idea that science is easy for most people to understand.

More detailed information about the results of the student survey can be found in chapter 5 and appendices 4 and 5.

CHAPTER 1

OVERVIEW OF THE NATIONAL ASSESSMENT

Introduction

The National Assessment Program (NAP) commenced as an initiative of ministers of education in Australia to monitor outcomes of schooling specified in the 1999 Adelaide Declaration on National Goals for Schooling in the 21st Century (Adelaide Declaration).

The assessment program was established to measure student achievement in relation to the national goals and to report this, using nationally comparable data in each of literacy, numeracy, science, information and communication technologies (ICT), and civics and citizenship.

In 2008, the Adelaide Declaration was superseded by the Melbourne Declaration on the Educational Goals for Young Australians (Melbourne Declaration). The work of NAP has continued and was refined, to accommodate the goals specified in the Melbourne Declaration[1].

The National Assessment Program – Science Literacy (NAP–SL) is one of a suite of three national sample assessments – together with civics and citizenship literacy, and information and communication technology (ICT) literacy – which are conducted in three-year cycles with stratified random samples of students. These assessments are developed and managed by the Australian Curriculum, Assessment and Reporting Authority (ACARA) under the auspices of the Education Council.

The first science literacy assessment was conducted in 2003. The assessment has been repeated with a new sample of Year 6 students every three years to identify trends over time. Similar national assessments were introduced for students in Years 6 and 10 in civics and citizenship (2004), and information and communications technology (ICT) literacy (2005). Each of these programs assesses a representative sample of Australian students and is repeated every three years.

In July 2016, the Education Council decided to extend the NAP–SL to Year 10 students from 2018. This decision was a response to the need to assess the science literacy progress of Australian students using assessments closely aligned to the Australian Curriculum, and by reference to international science-related assessments and surveys. Until 2018, the Programme for International Student Achievement (PISA) was the primary national measure of performance for science literacy among secondary school students. Australian students also participate in the Trends in International Mathematics and Science Study (TIMSS), which includes assessment of Years 4 and 8 students' knowledge of the Science and Mathematics curricula.

The 2018 assessment cycle was delivered to a representative sample of both Year 6 and Year 10 students. This report documents the findings from the 2018 NAP–SL assessment and includes comparisons with findings from previous assessment cycles.

What is assessed in NAP – Science Literacy?

NAP – Science Literacy definition

The NAP – Science Literacy assessment measures science literacy as defined in the Australian Curriculum: Science, that is the ability:

> *to use scientific knowledge, understanding, and inquiry skills to identify questions, acquire new knowledge, explain science phenomena, solve problems and draw evidence-based conclusions in making sense of the world, and to recognise how understandings of the nature, development, use and influence of science help us make responsible decisions and shape our interpretations of information.*

[1]. In December 2019, the Melbourne Declaration on the Educational Goals for Young Australians was superseded by the Alice Springs (Mparntwe) Education Declaration.

The definition of science literacy in the NAP–SL is consistent with recent definitions of science literacy internationally. For example, PISA 2015 defined science literacy as

> *the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen (OECD, 2016)[1].*

PISA's definition includes being able to explain phenomena scientifically, evaluate and design scientific enquiry, and interpret data and evidence scientifically.

NAP – Science Literacy Assessment Framework

The NAP – Science Literacy program was previously based on an assessment framework that predated the Australian Curriculum. Some mapping of items to the Australian Curriculum was done in preparation for the 2015 cycle but further and more comprehensive work was undertaken in 2017 to prepare for the introduction of a Year 10 assessment from 2018. The revised framework guided the development for the 2018 assessments. View the full 2018 NAP Science Literacy Assessment Framework.

NAP – Science Literacy strands

The 2018 NAP – Science Literacy Assessment Framework is organised according to the strands of the Australian Curriculum: Science. These strands guided the definition of the content to be covered in the NAP–SL assessment.

The Australian Curriculum: Science includes three strands:

- Science Understanding includes the facts, concepts, principles, laws, theories and models that have been established by scientists over time.
- Science as a Human Endeavour includes understandings about the development of science as a unique way of knowing and doing, and the importance of science in contemporary decision-making and problem-solving.
- Science Inquiry Skills is concerned with the practices used to develop scientific knowledge, including questioning, planning and conducting experiments and investigations, collecting and analysing data, drawing critical, evidence-based conclusions, and evaluating and communicating results.

Each of these strands is further divided into several sub-strands.

The 2018 NAP–SL assessment framework also includes three cognitive processes that underpin what students are required to do in a task. These are:

- Knowing and using procedures
- Reasoning, analysing and evaluating
- Synthesising and creating

See chapter 2 and appendix 1 for a more detailed breakdown of the strands, sub-strands and cognitive dimensions.

[1] OECD (2016). PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematic and Financial Literacy. Paris: OECD Publishing

NAP–SL and the Australian Curriculum: Science

The aims of the Australian Curriculum: Science are congruent with, and reflected in, the NAP–SL Assessment Framework. The specific aims of the Australian Curriculum: Science are:

- the understanding of important science concepts and processes, the practices used to develop scientific knowledge, science's contribution to society, and society's influence on science from a range of cultures;
- the ability to think and act in a scientific way;
- the ability to make informed decisions about local, national and global issues.

Every item used in the 2018 cycle was mapped against the Australian Curriculum strands, sub-strands and the cognitive dimensions. Where applicable, items were also classified against the general capabilities of the Australian Curriculum: Science, including the Critical and Creative Thinking capability.

How is this report organised?

This report provides educators and policymakers with the main findings of the 2018 NAP–SL assessment. The 2018 NAP–SL Technical Report provides more detailed information about the development of the assessment instruments, data collection and the analyses that underpin the findings presented in this report.

Chapter 1 provides an overview of the National Assessment Program and includes contextual information.

Chapter 2 describes the development of the assessment framework, assessment instruments, test administration and the sampling processes.

Chapter 3 describes the science literacy scale and provides example items to illustrate performance for each of the NAP–SL proficiency levels.

Chapter 4 presents the 2018 student performance in terms of means and distributions nationally and at a state/territory level, and in terms of proficiency levels on the science literacy scale. Additionally, the performance by specific groups of students, including male and female students, Indigenous and non-Indigenous students, students from various geographic locations, parental occupation and education and language backgrounds is outlined. Each section also contains comparisons of the performance of Year 6 students over the five cycles of NAP–SL assessments.

Chapter 5 presents the results of the student survey. In this chapter, students' opinions and ideas about science and the role of science in their lives and society are examined.

Chapter 6 is directed at teachers and provides linkages to the Australian Curriculum: Science, identifies several misconceptions that were demonstrated in the students' responses and suggests possible strategies to address these identified concepts and skills

Note on reading tables and figures in this report

This report includes multiple tables and figures providing insights into the results of the NAP sample assessment – Science literacy for 2018. When reading these tables and figures, the following should be noted:

- Percentages may not always add up to 100 per cent due to rounding.
- Due to a change in the structure of the assessment and the methodology for student sampling in 2006, results from 2003 have not been included.
- In several tables, numbers in parentheses refer to 95 per cent confidence intervals around the reported statistic; for example, (±2.5).
- Geographic location refers to where a student attends school. There are five geographic locations informed by the Australian Statistical Geography Standard (ASGS) Remoteness Structure and they are ‘major cities’, ‘inner regional’, ‘outer regional’, ‘remote’ and ‘very remote’.

CHAPTER 2

ASSESSING SCIENCE LITERACY

Introduction

This chapter describes the procedural foundations of the National Assessment Program – Science Literacy (NAP–SL) 2018. The chapter describes the development and composition of instruments, administration of the assessment and details about the sampled students, including the achieved participation rates and personal characteristics of student populations.

Science literacy assessment framework development

Historical description

In the previous NAP–SL cycles, the program was underpinned and guided by a science literacy progress map, which was based on the construct of science literacy defined by the OECD–PISA assessment and on the analysis of the state and territory curriculum and assessment frameworks. The progress map described the development of science literacy across three strands of assessment that predated the Australian Curriculum. The three main areas of scientific literacy that were assessed were:

- strand A: formulating or identifying investigable questions and hypotheses, planning investigations, and collecting evidence
- strand B: interpreting evidence and drawing conclusions from students' own or others' data, critiquing the trustworthiness of evidence and claims made by others, and communicating findings
- strand C: using science understandings for describing and explaining natural phenomena, and for interpreting reports about phenomena.

For a detailed description of previous assessment frameworks, see the 2015 NAP – Science Literacy public and technical reports.

2018 NAP–SL Assessment Framework

The NAP – Science Literacy Assessment Framework was reviewed and extended during 2017 and is now published. The primary focus of this multistep collaborative review was to:

- align the science literacy assessment with the Australian Curriculum
- identify and select content and contexts for scientific skills and conceptual knowledge that reflect the expectations set by the Year 10 Science achievement standard that are considered to be 'essential' for Year 10 students to confidently engage in scientific issues relating to everyday life experiences, as well as successfully transition into senior secondary science
- elaborate the progression of knowledge and skills shared between primary and secondary year levels, which could enable vertical linking of the Year 6 and Year 10 assessments.

The 2018 NAP – Science Literacy Assessment Framework underpinned the development of the 2018 assessments for both Years 6 and 10. The revised framework was guided by the Australian Curriculum: Science; it provides guidance on the content to be assessed, the cognitive engagement that is expected of students, and the types of assessment tasks and questions to be included in the assessment. The full assessment framework can be found on the 'Assessment frameworks' page of the NAP website.

The Australian Curriculum: Science requires students to develop an understanding of important science concepts and processes, the practices used to develop scientific knowledge, and science's contribution to our culture and society and its applications in our lives.

Accordingly, the Australian Curriculum: Science has three interrelated strands – Science Understanding, Science as a Human Endeavour and Science Inquiry Skills – which are designed to be taught in an integrated way. Table 2.1 lists the strands of the curriculum and the sub-strands within each strand.

Table 2.1
The strands and sub-strands of the Australian Curriculum: Science

Strand	Sub-strand
Science Understanding	Biological sciences
	Chemical sciences
	Earth and space sciences
	Physical sciences
Science as a Human Endeavour	Nature and development of science
	Use and influence of science
Science Inquiry Skills	Questioning and predicting
	Planning and conducting
	Processing and analysing data and information
	Evaluating
	Communicating

The seven general capabilities are the key dimension of the Australian Curriculum. They encompass knowledge, skills, behaviours and dispositions that, together with curriculum content in each learning area and the cross-curriculum priorities, can assist students to live and work successfully in the twenty-first century.

The capabilities, identified as being most relevant and appropriate to the assessment of Science and hence reflected in NAP–SL, include the following:

- Aspects of the Literacy capability are found within the reading comprehension demands of both the stimuli and the short-response items and the written responses to the extended text items where students demonstrate their level of knowledge and understanding about a given concept and/or skill.
- Aspects of the Numeracy capability are found within NAP–SL, including reading and construction of graphs and tables, calculations and measurement, as well as some elements of spatial reasoning.
- Aspects of the Information and Communication Technology (ICT) capability are found in items that refer to the use of digital technologies during scientific investigations and items that look at how science and technology have together assisted the changes in our knowledge about various scientific phenomena.
- Aspects of the Critical and Creative Thinking capability arise from important cognitive skills inherent in scientific inquiry.

Items and stimuli also drew on aspects of the Personal and Social capability, the Ethical Understanding capability, and the Intercultural Understanding capability, when appropriate.

An important new feature of the 2018 NAP–SL Assessment Framework is the explicit definition of a cognitive dimension within the assessment of science literacy and across all three content domains. The addition of cognitive dimensions is consistent with many national and international frameworks, such as TIMSS, PISA and NAP – Civics and Citizenship.

The cognitive dimension seeks to make explicit the thinking skills and intellectual processes that will be engaged by the students to respond to the assessment tasks. The cognitive dimension includes three cognitive processes that underpin what students are required to do in a task. These are:

- Knowing and using procedures
- Reasoning, analysing and evaluating
- Synthesising and creating.

See appendix 1 for full descriptions of the strands, sub-strands, general capabilities and cognitive dimensions included in the 2018 NAP–SL Assessment Framework.

Science literacy assessment instrument

Assessment items and response types

The NAP–SL assessment has two components – an objective test and an inquiry task. The objective test items require students to demonstrate their understanding, knowledge and skills of the nature of science, its concepts and uses in and for society.

The assessment items in the objective test are presented in sets that relate to a theme or stimulus. Each assessment item was mapped to the strands, sub-strands and cognitive dimensions of the Australian Curriculum: Science referenced in the 2018 Science Literacy Assessment Framework.

The online delivery of the NAP–SL assessment has broadened the types of test items that can be incorporated into the test. The test item types used in 2018 included multiple choice, interactive non-multiple choice short response items and constructed or extended text responses. Extended text responses required responses from a few words to a maximum of two paragraphs. See appendix 1 for a description of the various online item types.

The scores allocated to items varied: multiple choice items and the interactive non-multiple choice short response items had a maximum score of one point for correct responses and zero points for incorrect ones. For constructed or extended text response items, students could receive between zero and three points.

The Year 6 assessment was conducted using a total of 140 items including 37 historical links items (drawn from NAP–SL 2006–2015) and 35 vertical link items. The Year 10 assessment was conducted with 136 items including the 35 vertical links with Year 6.

Allocation of items to test forms

To address the scope of the NAP–SL Assessment Framework for each year level, it was necessary to distribute the full set of available content descriptions across a set of equivalent test forms. Eight test forms were created for use at Year 6 and Year 10.

Each test form contained three components: a set of objective test items, an inquiry task and a set of survey items. Each Year 6 test form contained objective test items averaging 40 score points, and inquiry task with around 10 items and 16 survey items. Each Year 10 test form contained objective test items averaging 50 score points, an inquiry task with around 12 items and 18 survey items.

There were three inquiry tasks delivered in 2018. The inquiry tasks contained between 10 and 12 items, which followed an experiment for a context. Each task provided a context, stepped the students through the components of the scientific method for a simulated investigation linked to the context and then required the students to apply the experimental results to the original context.

One task was common to both Years 6 and 10, while the other two tasks were specific for the respective year. Each student was presented with one inquiry task.

The item sets were allocated to clusters that in turn were allocated to test forms in such a way that the forms were 'equivalent' in terms of framework coverage, item types, reading load and overall difficulty. Each cluster was allocated to three test forms and was positioned near the beginning, near the middle and near the end of the different forms.

This test design intends to avoid the order of presentation of the clusters (and units within) from biasing the test results and allows for comparable measures of student achievement to be established, regardless of which test form students completed. The inclusion of secure historical link items supported the reporting of the 2018 Year 6 results on the existing NAP–SL scale. With the introduction of Year 10, the existing scale has been extended to include this new cohort. The standards setting process undertaken to incorporate Year 10 into the existing scale will be outlined in the NAP–SL 2018 Technical Report.

Additional detail relating to test construction can also be found in the NAP–SL 2018 Technical Report.

Student survey

In 2018, students were presented with a set of survey items to determine their attitudes to and interests in science and their science experiences in school. Students answered the survey after completing the objective test items and the inquiry task.

With each new cycle of NAP–SL the survey content has been reviewed and updated in consultation with ACARA curriculum experts and the NAP–SL Working Group. With the introduction of Year 10, new items were added which were directed specifically to Year 10, whilst some of the original Year 6 survey items remained unchanged and were presented to both Years 6 and 10. The inclusion of these original items allowed both historical comparisons for Year 6 students and vertical comparisons with Year 10 students.

The survey items required responses ranging from simple yes/no to Likert scale and frequency rating scale formats.

Full analysis of the student survey can be found in chapter 5 and appendices 4 and 5.

Assessment administration

The NAP–SL assessment was administered by classroom teachers to minimise disruption to the normal class environment.

Standardised administration procedures were developed, and published as, an online administration manual. Teachers and school administrators in all schools participating in NAP–SL were provided with access to the manual. Information was provided in relation to the possible exclusion of students with a disability and students from language backgrounds other than English.

Teachers were able to review the administration manual before the assessment date and raise questions with the NAP–SL coordinator in their jurisdiction or the ACARA helpdesk.

For each test session, sampled students were withdrawn from regular classes and completed the assessment in a designated area of the school where the computer equipment was located. Test administrators usually administered the assessment to groups of 20 students in one test session during the school day. For reasons of resourcing or school preference, however, it was sometimes necessary to run the assessment in two successive sessions with two groups of 10 students completing the assessment. The administration of the assessment took place between 15 October and 2 November 2018.

Additional detail of the test administration can be found in the NAP–SL 2018 Technical Report.

Sample

Sample design

The target populations for the study were Year 6 and Year 10 students enrolled in educational institutions across Australia. In 2018, Year 10 students were also included in the target population for the first time.

As 2018 was the first year of implementation of NAP–SL at the Year 10 level and occurred when both TIMSS and PISA were also delivered, there was concern about the burden of survey work across jurisdictions. Jurisdictions were consulted about whether they wished to have a Year 10 sample of a size to achieve similar precision to Year 6, or whether, for this first round of implementation, they wished to reduce the sample size to contribute to national estimates only.

New South Wales, Victoria and Western Australia opted for a sample size that would allow state-level data, whilst the Australian Capital Territory, the Northern Territory, Queensland, South Australia and Tasmania all opted for sample sizes that would only contribute to the national data set. Therefore, the overall sample size at the Year 10 level was reduced.

Achieved sample

Table 2.2 presents the number of schools and students in both the total and achieved samples. The total sample refers to those schools and students originally sampled using the sampling procedures described previously, after the removal of any school-level exclusions. The achieved sample denotes the number of schools and students that participated in the assessment.

Nationally, participation rates were 0.87 for Year 6 and 0.77 for Year 10. More detailed information about participation rates is provided in the NAP–SL 2018 Technical Report.

Table 2.2
Numbers of students and schools in the target and achieved samples

State/ territory	Year 6				Year 10			
	Schools		Students		Schools		Students	
	Total sample	Achieved sample	Total sample	Achieved sample	Total sample	Achieved sample	Total sample	Achieved sample
NSW	53	53	988	888	59	59	1,180	922
Vic.	53	52	1,006	880	47	45	886	678
Qld	52	47	922	769	39	37	720	539
WA	45	44	813	724	29	29	533	412
SA	50	48	888	767	14	13	259	190
Tas.	43	43	785	696	7	7	140	116
ACT	23	23	460	399	6	6	120	94
NT	34	33	553	428	7	6	120	81
Aust.	353	343	6,415	5,551	208	202	3,958	3,032

Sample characteristics

As per established NAP protocols, schools and education systems were required to provide background data for each of the participating students. The specific student background variables collected for NAP–SL were date of birth, gender, Indigenous status, parental occupation, parental education, main language spoken at home and geographic location. The structure of these student background variables follows NAP protocols as set out in the Data Standards Manual (ACARA, 2017).

Table 2.3 presents the background characteristics of the Year 6 and Year 10 students who participated in the NAP – Science Literacy assessment. Two sets of percentages are reported for each background variable by year level. The first column denotes the various percentages for all participating students (including those with missing data for a given background variable), while the second column provides these values based only on those students with a valid response to the background variable being examined.

Table 2.3
Distribution of student sample background characteristics (unweighted)

Student background characteristics	Year 6		Year 10	
	All Students (per cent)	Students with valid responses (per cent)	All Students (per cent)	Students with valid responses (per cent)
Student gender				
Male	51	51	49	49
Female	49	49	51	51
Total	**100**	**100**	**100**	**100**
Missing	0	0	0	0
Parental occupation				
Senior managers and professionals	28	30	28	31
Other managers and associate professionals	21	23	26	28
Tradespeople and skilled office, sales and service staff	20	22	22	24
Unskilled labourers, and office, sales and service staff	14	15	11	11
Not in paid work for 12 months	9	10	6	6
Total	**91**	**100**	**92**	**100**
Missing	9	0	8	0
Parental education				
Bachelor's degree or above	39	41	38	41
Advanced diploma/diploma	13	14	16	17
Certificates I–IV (including trade certificates)	26	27	23	25
Year 12 or equivalent	7	8	8	8
Year 11 or equivalent	3	3	2	2
Year 10 or equivalent or below	7	7	6	6
Total	**95**	**100**	**93**	**100**
Missing	5	0	7	0

Student background characteristics	Year 6		Year 10	
	All Students (per cent)	Students with valid responses (per cent)	All Students (per cent)	Students with valid responses (per cent)
Indigenous status				
Non Aboriginal or Torres Strait Islander	91	92	94	95
Aboriginal or Torres Strait Islander	8	8	5	5
Total	**99**	**100**	**99**	**100**
Missing	1	0	1	0
Language spoken at home				
English only	66	77	75	80
Language other than English	20	23	19	20
Total	**86**	**100**	**94**	**100**
Missing	14	0	6	0
Geographic location				
Major cities	61	61	66	66
Inner regional areas	22	22	20	20
Outer regional areas	14	14	11	11
Remote areas	2	2	3	3
Very remote areas	2	2	0	0
Total	**100**	**100**	**100**	**100**
Missing	0	0	0	0

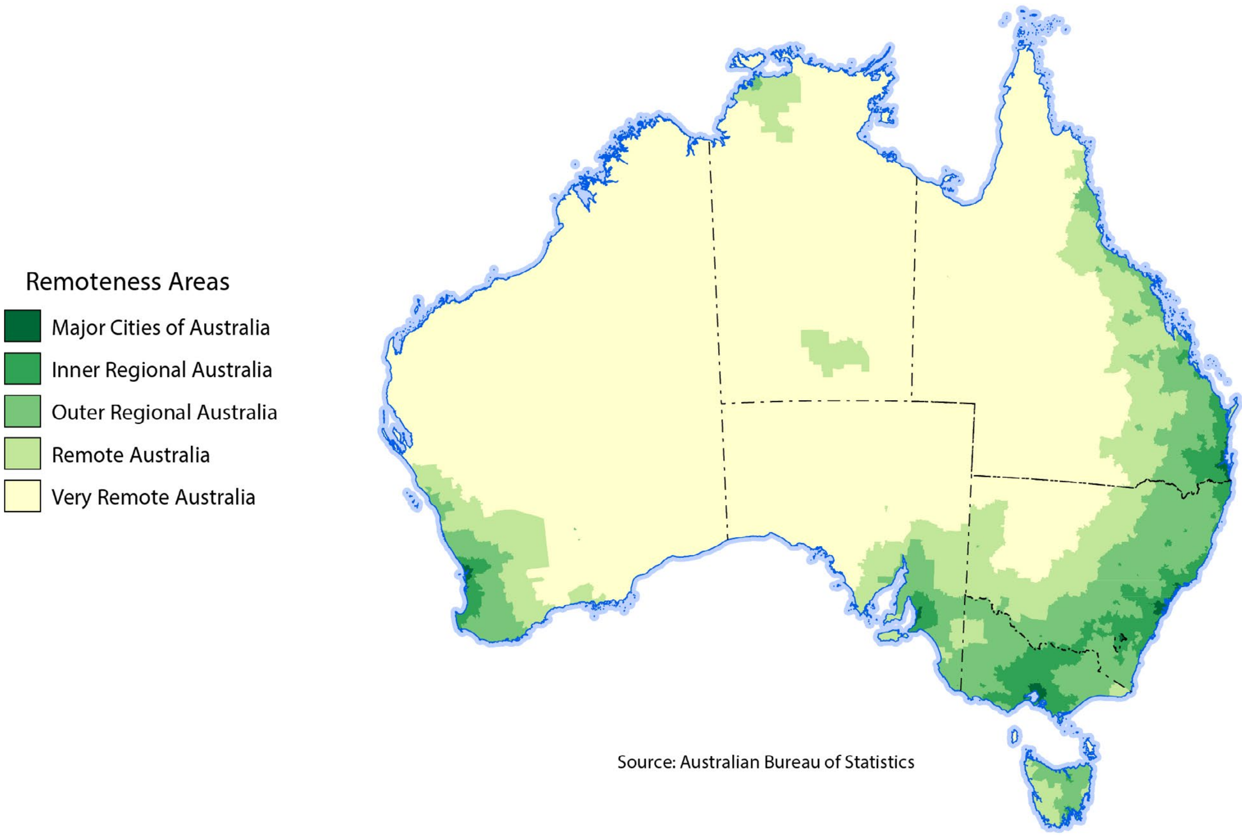
Regarding parental occupation and parental education variables, schools and educational authorities were asked to provide data about the occupational groups of parents or guardians of all students and the highest level of non-school education achieved by parents or guardians of participating students. For the purposes of reporting, parental occupation and parental education were both presented as combined variables that represent the highest parental occupation or education group indicated by either parent or guardian.

For the purposes of this report, geographic location refers to where a student attended school at the time of the assessment. There are five geographic locations informed by the Australian Statistical Geography Standard (ASGS) Remoteness Structure and they are:

- major cities
- inner regional
- outer regional
- remote
- very remote.

A map of the 2016 remoteness areas is provided in figure 2.1.

Figure 2.1
Map of the 2016 remoteness areas for Australia



Calculating the precision of estimates

For any sample survey, there is a level of uncertainty regarding the extent to which an estimate measured from the sample of students is the same as the true value for the population (that is, all students from the target population). An estimate derived from a sample is subject to uncertainty because data from the sample may not reflect the population precisely. Where relevant, data are reported as means +/- SE at a 95 per cent confidence interval. The magnitude of the confidence intervals varies depending on the exact ways in which the data have been collected. For example, in this report, larger confidence intervals are consistently seen around estimates based on smaller numbers of students (such as from the smaller states and territories). Details of how the confidence intervals are calculated can be found in the NAP–SL 2018 Technical Report.

CHAPTER 3

DESCRIBING THE SCIENCE LITERACY SCALE

Introduction

This chapter describes the new NAP–SL scale and provides examples of items that illustrate the skills and knowledge for each proficiency level.

The Science literacy scale

A science literacy scale was constructed in 2003, using the Rasch measurement model. The Rasch analysis produced information about the relative difficulty of the assessment items, as well as information about students' abilities. After the second NAP–SL cycle in 2006, it was decided to use the results of the 2006 assessment to reconstruct the science literacy scale (see the NAP–SL 2006 Technical Report for more information).

Proficiency levels and standards

One of the main objectives of NAP–SL is to monitor and report trends in science literacy performance. One convenient and informative way of doing so is to reference students' results to the NAP–SL proficiency levels. Typically, students whose results are located within a proficiency level can demonstrate the understandings and skills associated with that level and possess the understandings and skills of lower proficiency levels.

Prior to the 2018 cycle, the NAP–SL scale contained only one proficient standard for Year 6 students. The proficient standard is a point on the scale that represents a 'challenging but reasonable' expectation of student achievement at that year level. With the addition of Year 10 students, a standard setting process was conducted to establish a new Year 10 proficient standard.

The process involved a group of 20 expert teachers who reviewed the skills needed to respond correctly to items in the Year 10 assessment and identified a range on the scale where the proficient standard for Year 10 should be located. This exercise together with the addition of Year 10 material to the assessment scale resulted in an adjustment to the width of the proficiency levels particularly in relation to Year 10 students at the higher levels. The width of each level is slightly over 100 scale score points.

In addition to the adjustments, new labels were assigned to the levels (see table 3.1). Despite the changes in naming conventions, the location of the proficient standard for Year 6 remained unchanged. Therefore, the percentage of Year 6 students reaching or exceeding the proficient standard can be compared with previous cycles. The location of the proficient standard for Year 6 is between levels 2 and 3 (393 score points on the reporting scale) and the location of the new proficient standard for Year 10 is between level 3 and 4 (497 score points on the reporting scale).

It should be noted that because of the adjustments to the width of the levels, the new levels do not align exactly with the old levels, especially at the higher end of the scale; that is, the new Level 5 or above overlaps with the old Level 4 or above, but also includes some skills from the old Level 3.3.

Table 3.1
Revised labels for proficiency levels

Original label	Revised label
Level 4 or above	Level 5 or above
Level 3.3	Level 4
Level 3.2	Level 3
Level 3.1	Level 2
Level 2 or below	Level 1 or below

Appendix 2 provides the descriptions of the understandings and skills required of students at each proficiency level.

Sample items illustrating proficiency levels

The following sections provide sample items that illustrate the types of understandings and skills that students at a proficiency level are likely to display.

At each proficiency level, a wide range of items that varied in context, format and difficulty were used to give students the best opportunity to provide evidence of what they knew and could do.

Only a small number of items have been released in this report; other items have been retained as secure link items for use in future cycles of NAP–SL. Some of these items were presented to both Years 6 and 10.

The first item in each set included a preview version of the stimulus linked to that set. Students could expand the preview to see a larger version. The remaining items in the set did not include the stimulus preview panel; however, students were able to return to that screen if they wished. All text in the stimuli was accompanied by an audio recording. In the examples given below, the stimulus provided to students is not always shown.

Sample items illustrating performance within proficiency level 1

Proficiency level 1 is below the proficient standard for both Years 6 and 10.

Figure 3.1
Sample item 1 illustrating performance at proficiency level 1

A student decided to investigate which type of household rubbish produces the most heat when burnt.

She collected a sample of rubbish from her home and measured the mass of each type of rubbish. The table shows her initial observations.

Type of rubbish	Details	Amount (kg)
Paper	mostly white paper	3.5
Food waste	different foods including fruit and vegetables	5.2
Cardboard	mostly collapsed brown boxes	4.0

The student burnt one gram (g) of each type of rubbish. She will use a calorimeter, which measures the amount of heat that is produced when a material is burnt.

The heat energy will be measured in kilojoules (kJ).

The student plans to wear goggles during the investigation.

The **most likely** reason for wearing goggles would be to

- prevent any rubbish getting into her eyes
- help her to see the readings on the calorimeter
- help to keep other materials out of the samples
- make it easier to see the different types of rubbish

Strand	Science Inquiry Skills	**Sub-strand**	Planning & conducting
Cognitive dimension	Knowing and using skills	**Item type**	Multiple choice
Australian Curriculum: Science Content Description	Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS103, Year 6)		

This item was part of the *Dealing with all that rubbish* set. It illustrates performance at level 1 for both years. Eighty-eight per cent of Year 6 students and ninety per cent of Year 10 students answered the item correctly.

These students demonstrated a clear understanding of the reason for using safety goggles in this investigation. For the remaining students, the most frequently selected distractor was option 2 where the students were confused between wearing goggles for safety and wearing eye glasses for magnification.

Figure 3.2
Sample item 2 illustrating performance at proficiency level 1

Plants often provide shelter for animals. Grasses like spinifex usually grow in clumps up to one metre tall.

Click on the boxes to select which **two** adult animals could use spinifex for shelter in the desert.

☐ 

kangaroo

☐ 

emu

☐ 

shingle back lizard

☐ 

spinifex hopping mouse

Strand	Science Understanding	**Sub-strand**	Biological sciences
Cognitive dimension	Reasoning, analysing and evaluating	**Item type**	Multiple choices
Australian Curriculum: Science Content Description	Living things depend on each other and the environment to survive (ACSSU073, Year 4)		

This item was part of the *Living in a desert* set. It illustrates performance at level 1 for Year 6 students with 86 per cent of Year 6 students answering this item correctly.

These students linked the height of the spinifex, which was provided in the stem sentence, to their knowledge of the height of each of the four animals to decide which animals would be able to shelter under the spinifex. Most of the remaining students identified that either the shingle back lizard or the spinifex hopping mouse would be able to seek shelter under the spinifex, but they did not identify both animals.

Figure 3.3
Sample item 3 illustrating performance at proficiency level 1

Scientists who study the forces that exist and the motion of cars during crashes are known as

- biologists
- chemists
- geologists
- physicists

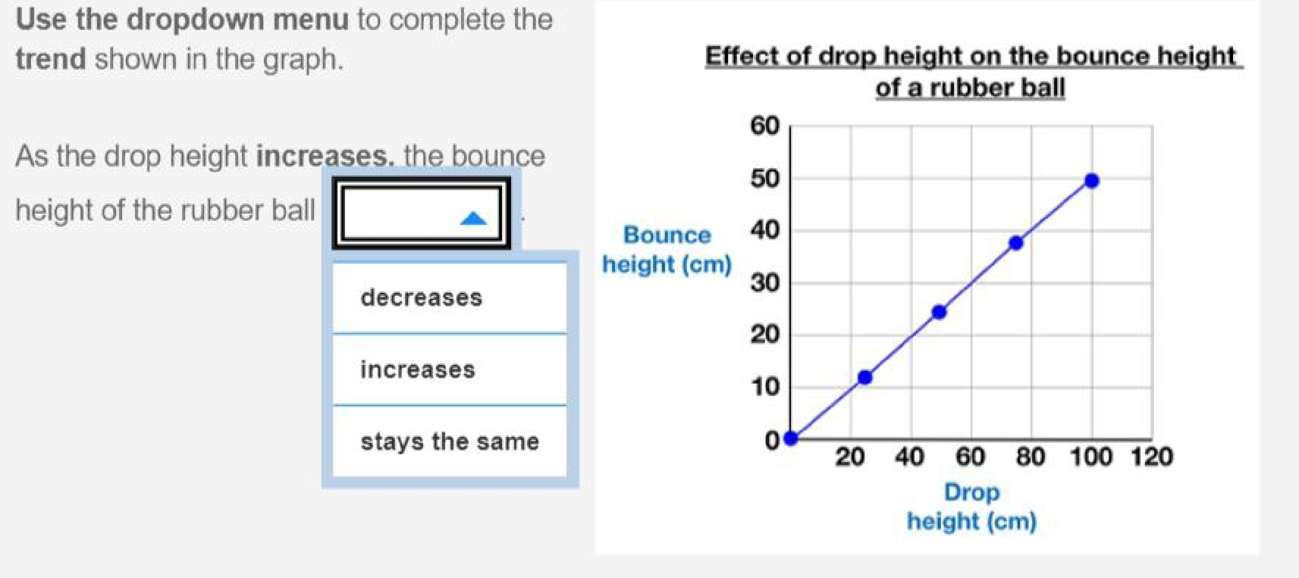
Strand	Science as a Human Endeavour	**Sub-strand**	Use and influence of science
Cognitive dimension	Knowing and using skills	**Item type**	Multiple choice
Australian Curriculum: Science Content Description	People use science understanding and skills in their occupations, and these have influenced the development of practices in areas of human activity (ACSHE121, Year 7)		

This item was part of the *Why wear a seat belt?* set. It illustrates performance at level 1. The 92 per cent of Year 10 students who answered this item correctly understood that physicists study forces and motion. The other three distractors were evenly selected by the remaining students.

Sample items illustrating performance within proficiency level 2

Proficiency level 2 is below the proficient standard for both Years 6 and 10.

Figure 3.4
Sample item 4 illustrating performance at proficiency level 2



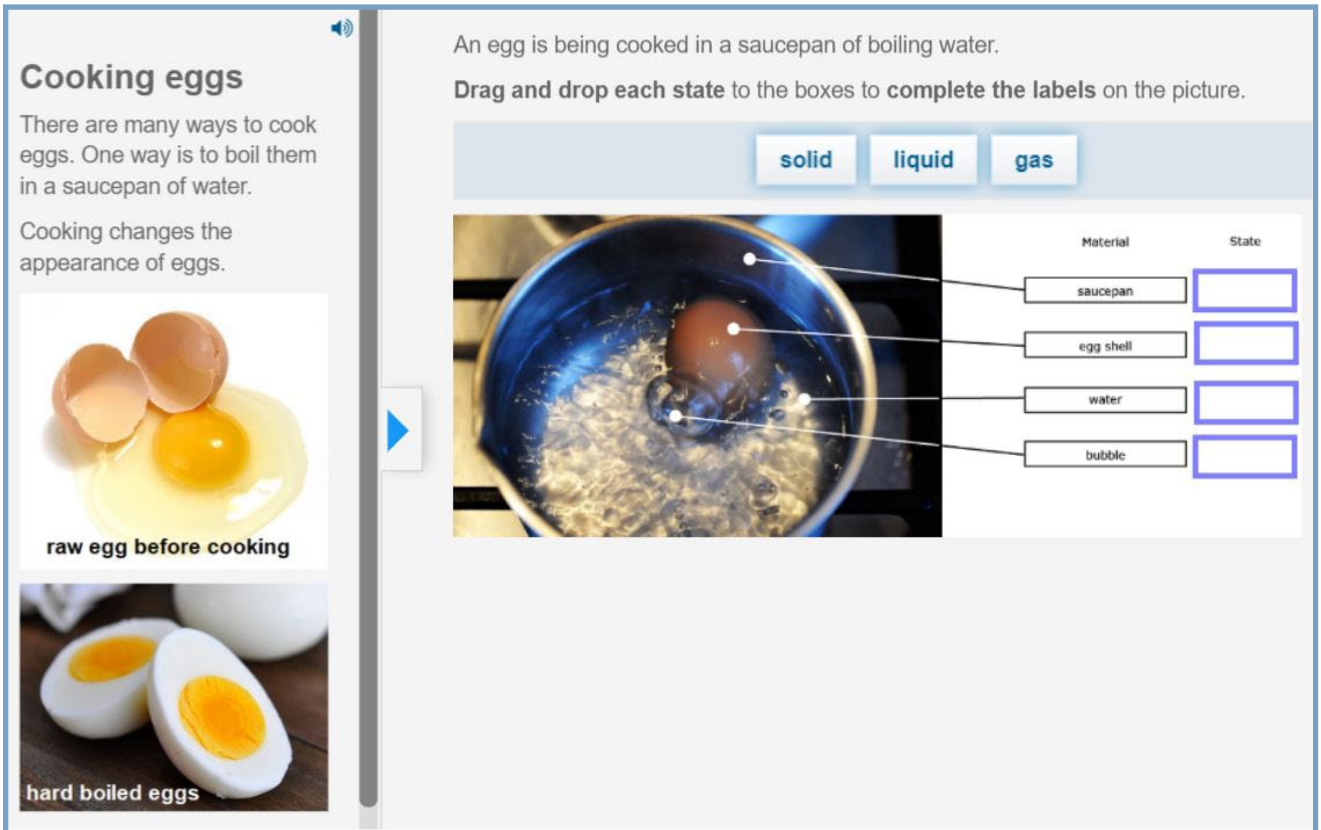
Strand	Science Inquiry Skills	**Sub-strand**	Processing and analysing data & information
Cognitive dimension	Reasoning, analysing and evaluating	**Item type**	Inline choice
Australian Curriculum: Science Content Description	Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS107, Year 6)		

This item was part of the *Bouncing balls* inquiry task. This inquiry task was used as the common inquiry task for both Years 6 and 10. This item was used for both year levels in the inquiry task.

This item illustrates performance at Level 2 with 78 per cent of Year 6 students and 92 per cent of Year 10 students answering this item correctly.

These students demonstrated the skill of reading a graph and then describing the trend shown in the data presented in graphical form. Of the remaining students in both years, many students selected *decreases* from the dropdown menu as opposed to *stays the same*. The students who selected *decreases* were indicating that they recognised that the graph was showing a change in the bounce height with a changing drop height.

Figure 3.5
Sample item 5 illustrating performance at proficiency level 2



Strand	Science Understanding	**Sub-strand**	Chemical sciences
Cognitive dimension	Knowing and using skills	**Item type**	Interactive gap match
Australian Curriculum: Science Content Description	Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077, Year 5)		

This item was part of the *Cooking eggs* set. It illustrates performance at level 2 as 80 per cent of Year 6 students answered this item correctly.

These students demonstrated a clear understanding of the definition of solids, liquids and gases by being able to correctly classify the four items in the photo. Of the remaining students, five per cent of students correctly classified the egg shell and saucepan as solids and the water as a liquid, but they were confused about the classification of the bubble. Another three per cent of students recognised that the bubble and water were different states and correctly classified them as gas and a liquid respectively, but they showed confusion around the classification of the saucepan and the egg shell. The remaining students demonstrated a very low understanding of the three states of matter.

Figure 3.6
Sample item 6 illustrating performance at proficiency level 2

Producers make their own food using energy from the sun in a process called

- absorption
- digestion
- photosynthesis
- respiration

Strand	Science Understanding	**Sub-strand**	Biological sciences
Cognitive dimension	Knowing and using skills	**Item type**	Multiple choice
Australian Curriculum: Science Content Description	Chemical reactions, including combustion and the reactions of acids, are important in both non-living and living systems and involve energy transfer (ACSSU179, Year 9)		

This item was part of the *Australian food web* set. It illustrates performance at level 2 as 85 per cent of Year 10 students answered this item correctly.

These students recognised that the description in the stem was referring to photosynthesis. For the remaining students, the most frequently selected distractor was option 1, where students selected the term for the intake of energy from the sun as *absorption* but did not link the absorption of energy to the ability of producers to make their own food by converting the absorbed light energy into chemical energy.

Sample items illustrating performance within proficiency level 3

Proficiency level 3 is above the proficient standard for Year 6, but is still below the proficient standard for Year 10.

Figure 3.7
Sample item 7 illustrating performance at proficiency level 3

The students planned to use a ruler as a marker for the drop height and to measure the height of the bounce.

They tried their investigation thinking that they would be able to easily measure the height of the bounce.

However, they found it difficult to make accurate measurements.

Click on the boxes to indicate the **two** reasons why it was difficult to make the measurements.

- ☐ The ball moved too fast.
- ☐ The ball was too heavy to bounce.
- ☐ The ruler was hard to read at a distance.
- ☐ The markings on the ruler were not correct.

Strand	Science Inquiry Skills	**Sub-strand**	Evaluating
Cognitive dimension	Reasoning, analysing and evaluating	**Item type**	Multiple choices
Australian Curriculum: Science Content Description	Reflect on and suggest improvements to scientific investigations (ACSIS108, Year 6)		

This item was part of the *Bouncing balls* inquiry task. This inquiry task was used as the common inquiry task for both Years 6 and 10.

This item illustrates performance at Level 3 with 56 per cent of Year 6 students and 69 per cent of Year 10 students answering this item correctly.

These students reflected on the inability of the students undertaking the investigation to make accurate measurements. They correctly indicated that the possible causes for this problem were the speed the ball was travelling and the distance between the ruler and the observers. Of the remaining students in both years, the majority of students identified either *the ball moved too fast* or *the ruler was hard to read at a distance* as possible causes, but did not identify both. Six per cent of Year 6 and three per cent of Year 10 students did not identify either of the possible causes.

The Year 6 students who answered this item correctly are demonstrating proficiency for this content description, whilst Year 10 students are performing below the proficient standard that has been set for Year 10.

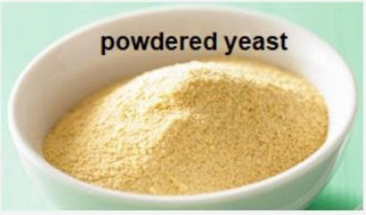
Figure 3.8
Sample item 8 illustrating performance at proficiency level 3

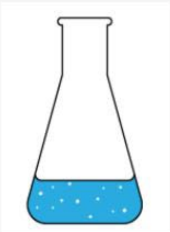
Growing yeast

Yeast is a fungus which produces carbon dioxide gas while it is alive. We use yeast to make several foods including bread and cakes.

The growth of yeast in different conditions can be investigated by measuring how much carbon dioxide is produced.

Some students want to find out if temperature affects how much the yeast grows in an hour. They mix powdered yeast, water and sugar in a conical flask and leave it for 60 minutes.





conical flask with yeast, water and sugar

What variable will the students need to change in their yeast investigation?

- size of the flasks
- amount of yeast added
- temperature of the water
- amount of carbon dioxide

Strand	Science Inquiry Skills	**Sub-strand**	Planning and conducting
Cognitive dimension	Knowing and using skills	**Item type**	Multiple choice
Australian Curriculum: Science Content Description	Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digitial technologies as appropriate (ACSIS087, Year 5)		

This item was part of the *Growing yeast* set. It illustrates performance at level 3 as 49 per cent of Year 6 students answered this item correctly.

These students understood the types of variables needed for a fair test and had correctly identified that *temperature of the water* was the variable that was changed in the described investigation. One in five students indicated that *amount of yeast added* would be changed. These students have confused a variable that should be held constant with one that would be changed. Another 21 per cent of students indicated that *amount of carbon dioxide* would be changed. These students have confused the variable that is deliberately changed with the variable that may change during the investigation but is the measured variable for the investigation.

The Year 6 students who answered this item correctly are demonstrating proficiency for this content description.

Figure 3.9
Sample item 9 illustrating performance at proficiency level 3

negative **no charge** **positive**

Drag and drop each label into the box to **match the atomic particle with its charge**.

Particle	Charge
electron	
neutron	
proton	

Strand	Science Understanding	**Sub-strand**	Chemical sciences
Cognitive dimension	Knowing and using skills	**Item type**	Interactive gap match
Australian Curriculum: Science Content Description	All matter is made of atoms that are composed of protons, neutrons and electrons; natural radioactivity arises from the decay of nuclei in atoms (ACSSU177, Year 9)		

This item was part of the *Radioactive isotopes* set. It illustrates performance at level 3 as 65 per cent of Year 10 students answered this item correctly.

These students have a clear understanding of the types of atomic particles and their associated electrical charges. Of the remaining students, the most frequent responses indicated that students knew that neutrons have no charge, but they were clearly confused about the charges for both electrons and protons.

Generally, students who achieve level 3 can also be expected to apply relevant scientific knowledge to interpret information, interpret data to identify patterns and/or relationships within the data and recognise the need to control variables to make an investigation valid.

Sample items illustrating performance within proficiency level 4

Proficiency level 4 is above the proficient standard for Year 6 and Year 10.

Figure 3.10
Sample item 10 illustrating performance at proficiency level 4

After the students discovered that yeast grows best between 30 °C and 45 °C, the students wanted to find out what else yeast needs to grow.

Ingredients in the flask	Conditions	Is carbon dioxide produced?
yeast, sugar, warm water	dark cupboard	yes
yeast, sugar, warm water	near a window	yes
yeast, sugar	dark cupboard	no
yeast, warm water	near a window	no

Click on the boxes for **yes** or **no** to show **all** the conditions that yeast need to grow.

	yes	no
Yeast needs light to grow.	☐	☐
Yeast needs water to grow.	☐	☐
Yeast needs sugar to grow.	☐	☐
Yeast needs warm temperatures to grow.	☐	☐

Strand	Science Inquiry Skills	**Sub-strand**	Processing and analysing data & information
Cognitive dimension	Reasoning, analysing and evaluating	**Item type**	Inline choice
Australian Curriculum: Science Content Description	Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS130, Year 7)		

This item was part of the *Growing yeast* set. It illustrates performance at level 4 for both years. Thirty-three per cent of Year 6 students and 44 per cent of Year 10 students answered this item correctly.

These students analysed the presented results table and then made the appropriate conclusions from the results namely that for yeast to grow it requires water, sugar and warm temperatures but does not require light. The remaining Year 6 students were evenly split between either identifying that yeast requires light to grow or does not require sugar to grow. A similar pattern was also evident in the remaining Year 10 students. These responses are suggesting that the students were thinking that yeast is a type of plant and so are identifying the growing needs of plants and may not have engaged with the results table to complete the item.

Both Year 6 and Year 10 students who answered this item correctly are demonstrating skills above their proficient standard.

Figure 3.11
Sample item 11 illustrating performance at proficiency level 4

There are many types of natural disasters.

Click in the boxes to identify **two** disasters caused by geological events.

- ☐ cyclone
- ☐ drought
- ☐ earthquake
- ☐ volcanic eruption

Strand	Science Understanding	**Sub-strand**	Earth and space sciences
Cognitive dimension	Knowing and using skills	**Item type**	Multiple choices
Australian Curriculum: Science Content Description	Sudden geological changes and extreme weather events can affect the Earth's surface (ACSSU096, Year 6)		

This item was part of the *Tsunami warning* set. It illustrates performance at level 4 as 38 per cent of Year 6 students answered this item correctly.

These students correctly distinguished between natural disasters caused by geological events from those caused by extreme weather events. The remaining Year 6 students showed a low level of understanding about the causes of natural disasters. Whilst 51 per cent of the students did classify either earthquakes and/or volcanic eruptions as geological events, their responses revealed misconceptions and confusion around the causes of cyclones and droughts.

Whilst the content description for this item is from Year 6, students who answered this item correctly were demonstrating knowledge above their proficient standard.

Figure 3.12
Sample item 12 illustrating performance at proficiency level 4

The limestone that is added to the blast furnace is composed of calcium carbonate.

What is the formula for calcium carbonate?

- ○ CO
- ○ CaO
- ○ CaO_3
- ○ $CaCO_3$

Strand	Science Understanding	**Sub-strand**	Chemical sciences
Cognitive dimension	Knowing and using skills	**Item type**	Multiple choice
Australian Curriculum: Science Content Description	Differences between elements, compounds and mixtures can be described at a particle level (ACSSU152, Year 8)		

This item was part of the *Getting iron from ores* set. It illustrates performance at level 4 as 57 per cent of Year 10 students answered this item correctly.

These students correctly identified the formula for a simple compound. Of the remaining Year 10 students, 23 per cent of students selected option 3 and 16 per cent of students selected option 2.

Whilst *recognising that elements and simple compounds can be represented by symbols and formulas* is one of the non-mandatory elaborations for this content description, the results for this item indicate that students are being prepared for the study of chemistry in higher years.

The content description for this item is from Year 8 and students who answered this item correctly were demonstrating knowledge above the Year 10 proficient standard.

Generally, students who complete items at this level of science literacy can also recognise the purpose of a control in an experimental design. They can explain the purpose of different steps in an investigation as well as the need to take a number of measurements to ensure the accuracy of their observations. They can describe and identify patterns in data and use their knowledge and experience to explain more complex processes.

Sample items illustrating performance at proficiency level 5 and above

Proficiency level 5 is well above the proficient standard for Year 6 and it is above the proficient standard for Year 10.

Figure 3.13
Sample item 13 illustrating performance at proficiency level 5 and above

This photo shows a kangaroo jumping.

Describe the features of a kangaroo that help it to jump. (3 marks)

Strand	Science Understanding	**Sub-strand**	Biological sciences
Cognitive dimension	Reasoning, analysing and evaluating	**Item type**	Extended text
Australian Curriculum: Science Content Description	Living things have structural features and adaptations that help them to survive in their environment (ACSSU043, Year 5)		

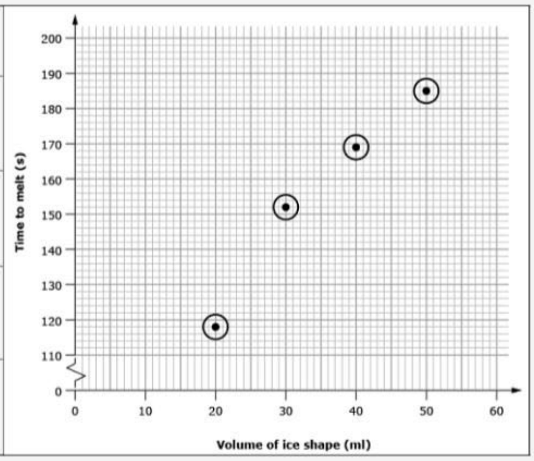
This item was part of the *How do animals move?* set. It illustrates performance at level 5 for Year 6 students.

This is an example of a three-mark item. The 18 per cent of students who achieved three marks for this item were able to explain how the adaptations of a kangaroo help it to jump and survive. A further 29 per cent of responses scored two marks as they described the role of a structural feature that is involved in helping a kangaroo to jump.

The students who scored two were performing at level 3. Another 50 per cent of students scored one mark as they just identified structures of a kangaroo, which are involved in jumping; for example, long legs, muscular legs, long tail, long feet and toes, without describing how these help the kangaroo to jump. Students who scored one mark were performing at level 1. Students who did not score any marks for this item were performing below level 1 by just listing some of the external features of kangaroos, some of which are not involved in jumping; for example, fur, small eyes, large ears, short front legs.

Figure 3.14
Sample item 14 illustrating performance at proficiency level 5 and above

Shape of ice block	Time taken to melt (s)
Cube	103
Rectangular prism	56
Pyramid	148
Hemisphere	79



Using the results from both investigations, explain how the results support the decision by the engineers to change from rectangular to pyramid shaped artificial glaciers. (3 marks)

Strand	Science as a Human Endeavour	**Sub-strand**	Use and influence of science
Cognitive dimension	Synthesising and creating	**Item type**	Extended text
Australian Curriculum: Science Content Description	People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities (ACSHE194, Year 10)		

This item was last in the *Artificial glaciers* inquiry task, which was presented to Year 10 students. This inquiry task led students through the steps of a simulated investigation to determine the most efficient way to build artificial glaciers in the Himalayan mountains.

This is an example of a three-mark item. Students who achieved three marks for this item were able to use the presented data from both investigations to explain the benefits that would be achieved for the villagers by creating large conical shaped artificial glaciers. The two per cent of students who scored the full three marks for this item were performing above level 5.

Another 25 per cent of students scored two marks as they were able to use data from one investigation as evidence for the decision to change glacier shape and/or size. The students who scored two marks were performing at level 5. The 31 per cent of students who scored one mark just stated that the decision to change the shape or size of the glaciers was supported by the results. Students who scored one mark were performing at level 4.

Figure 3.15
Sample item 15 illustrating performance at proficiency level 5 and above

Cooking on a BBQ

Cooking on a barbecue (BBQ) is very common in Australia and around the world. Barbecues use a variety of fuels but two of the most common fuels are natural gas and charcoal.

Natural gas is a fossil fuel whilst charcoal is made from plants.

BBQ fuelled by charcoal

BBQ fuelled by natural gas

Food is cooked on a barbecue (BBQ) when heat is transferred from the coals to the food.

Use the dropdown menus to complete each sentence with the correct type of heat transfer.

Heat transfers from the glowing coals in the BBQ by [▾].

The hot coals heat the air around them. The hot air rising from the coals transfers heat by [▾].

The metal grill leaves burn marks on the food. The bars of the metal grill transfer heat to the food by [▾].

Strand	Science Understanding	**Sub-strand**	Physical sciences
Cognitive dimension	Knowing and using skills	**Item type**	Inline choices
Australian Curriculum: Science Content Description	Energy transfer through different mediums can be explained using wave and particle models (ACSSU182, Year 9)		

This item was part of the *Cooking on a BBQ* set, which was presented to Year 10 students. This item illustrated performance at level 5 as 24 per cent of Year 10 students answered this item correctly.

These students correctly identified the instances of radiation, convection and conduction that exist in a BBQ. Of the remaining students, 23 per cent correctly identified that conduction occurs when the metal grill is in contact with the food; however, they reversed radiation and convection. Another 18 per cent of students correctly identified that the hot air rising from the coals involved convection, but they reversed conduction and radiation. A further 15 per cent of students correctly identified that heat is radiated from the coals, but they reversed convection and conduction.

Whilst *investigating the transfer of heat in terms of convection, conduction and radiation, and identifying situations in which each occurs* is one of the non-mandatory elaborations for this content description, the results for this item indicate that students are finding it very difficult to understand the concept of heat transfer.

It could be expected that students who could complete items at level 5 could also make suggestions for improving an investigation or recognise ways to get more accurate data. They were able to match a pattern in one set of data with one in another set and to integrate multiple ideas into one generalisation.

CHAPTER 4

STUDENT PERFORMANCE IN 2018

Chapter highlights

This chapter describes the new NAP–SL scale and provides examples of items that illustrate the skills and knowledge for each proficiency level.

- The average achievement score for the test in 2018 was 83 score points higher for Year 10 students than for Year 6 students.
- More than half of the Year 6 and half of the Year 10 students performed at or above the proficient standard.
- Even though the 2018 Year 6 results are similar to those of earlier cycles in terms of average achievement, the percentage of Year 6 students attaining the proficient standard in 2018 was higher than that of 2012.
- The average achievement score recorded for Northern Territory Year 6 students was significantly lower than in all other jurisdictions. Apart from that, students from the ACT, Queensland and Western Australia performed equally well. Year 6 students from the ACT and Queensland scored higher than students from New South Wales, South Australia and Victoria. Year 6 students in Queensland scored higher in 2018 than in all previous cycles.
- There was no statistically significant difference in the average achievement scores of female and male students.
- As in previous cycles, Indigenous students did not perform as well as non-Indigenous students. However, in 2018 approximately one in three Indigenous Year 6 students was operating at or above the proficient standard, and this was significantly higher than in all cycles since 2009, where approximately one in four or five Indigenous Year 6 students was operating at or above the proficient standard.
- In 2018, Year 6 students who speak English at home had higher average scores than students who speak a language other than English at home.
- The pattern of results for 2018 indicated Year 6 and 10 students from major cities had significantly higher mean scores than students from both remote and very remote areas.
- Year 6 and 10 students with parents who were senior managers or professionals had higher scores than those with parents who were recorded as unskilled labourers, office, sales or service staff.
- On average, Year 6 and 10 students with parents who had a Bachelor's degree or higher obtained scores that were higher than those with parents who had not exceeded Year 10 as their highest level of education.

Introduction

In this section, summary statistics for 2018 are shown in terms of average scale scores and distributions of these scores. Student achievement is reported as the percentage of students in each of the proficiency levels and the percentage of students attaining the proficient standard.

Student performance is reported at the national level, followed by student performance among the states and territories. The achievement for each of the population sub-groups such as gender, Indigenous status, language spoken at home, geographic location and parental occupation and education are also presented.

Where applicable, comparisons were made with results from the 2006, 2009, 2012 and 2015 assessments.

Student performance at the national level

Achievement by year level in 2018

The average scale score in 2018 was 407 for Year 6 students and 490 for Year 10 students. The Year 10 sample was smaller than the Year 6 sample, hence the larger confidence interval for Year 10 (±7.3) compared with Year 6 (±5.0). The difference between the year level average scale scores was 82, which was statistically significant.

The 2018 distribution of students across the proficiency levels is shown in table 4.1. Figure 4.1 shows the same results graphically. The proficient standard for each year level is also indicated.

Table 4.1 shows that 12 per cent of Year 6 students did not reach level 2. The percentage of Year 6 students achieving the standard in 2018 (level 3 and above) was 58 per cent.

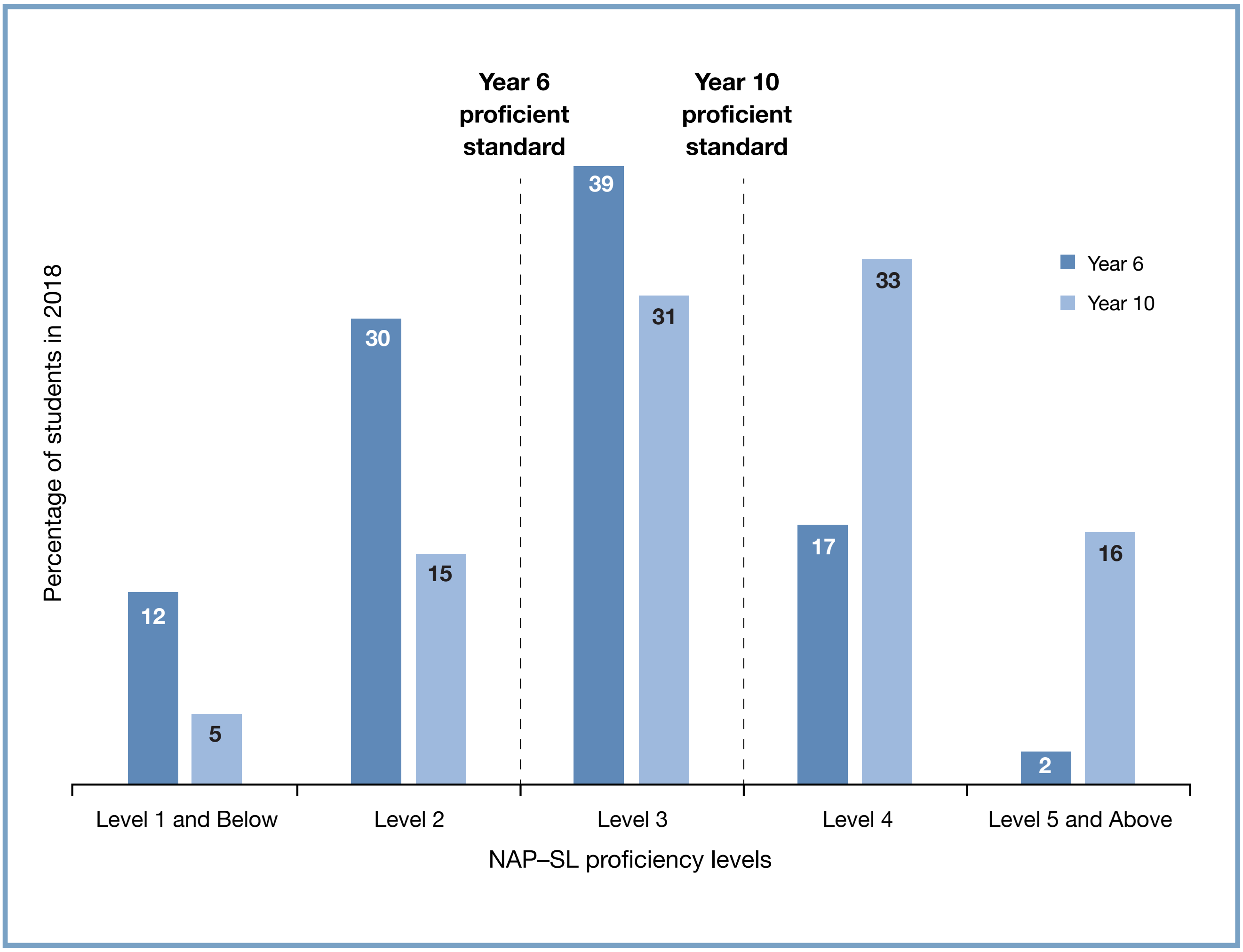
Most Year 10 students demonstrated the understandings and skills described at levels 3 and 4. The percentage of Year 10 students achieving the standard in 2018 (level 4 and above) was 50 per cent.

Table 4.1
Percentages of Year 6 and Year 10 students at each achievement level in 2018

Achievement level	Year 6	Year 10
Level 5 or above	2 (±0.6)	16 (±2.1)
Level 4	17 (±1.5)	33 (±2.7)
Level 3	39 (±2.2)	31 (±2.7)
Level 2	30 (±2.0)	15 (±2.2)
Level 1 or below	12 (±1.4)	5 (±1.5)

Confidence intervals (1.96*SE) are reported in brackets.
Note: Percentages may not add up to 100 per cent due to rounding.

Figure 4.1
Percentages of Year 6 and 10 students across achievement levels in 2018 (proficient standard indicated)



Changes in achievement since 2006

An overview of the trends in science literacy at the national level for 2006, 2009, 2012, 2015 and 2018 is provided below in table 4.2. No comparisons are possible for Year 10, but the 2018 Year 6 results are similar to those of earlier cycles both in terms of average scale scores and percentage of students attaining the proficient standard. The analysis shows that there are no statistically significant differences between the 2015 and 2018 results at the national level. Similarly, the average scale score for 2018 did not differ significantly from those of cycles earlier than 2015.

Table 4.2
Average scale scores for Year 6 and Year 10 since 2006

	2018	2015	2012	2009	2006
Year 6	407 (±5.0)	403 (±4.3)	394 (±4.4)	392 (±5.1)	400 (±5.4)
Year 10	490 (±7.3)				

Confidence intervals (1.96*SE) are reported in brackets.
↑ if significantly higher than 2018.
↓ if significantly lower than 2018.

The trend in percentages of Year 6 students attaining the proficient standard since 2006 is shown in Table 4.3. There were no statistically significant differences between 2018 and 2015 in the percentage of Year 6 students attaining the proficient standard. However, the percentage of Year 6 students attaining the proficient standard in 2018 was higher than that of 2012.

Table 4.3
Percentages of Year 6 and Year 10 students attaining the proficient standard since 2006

	2018	2015	2012	2009	2006
Year 6	58 (±2.4)	55 (±1.8)	↓51 (±2.0)	52(±2.2)	54 (±2.1)
Year 10	50 (±2.8)				

Confidence intervals (1.96*SE) are reported in brackets.
↑ if significantly higher than 2018.
↓ if significantly lower than 2018.

Student performance among the states and territories

Table 4.4 shows the average NAP–SL scores at both year levels across jurisdictions. Because of variation in sample sizes among the jurisdictions, there is some variation in the 95 per cent confidence intervals among the jurisdictions. Smaller jurisdictions have larger confidence intervals reflecting less precision in these estimates.

The Year 6 average scale scores for jurisdictions range from 302 in the Northern Territory to 427 in the ACT. Of the three jurisdictions that opted for Year 10 jurisdiction-level data collection, the scores for New South Wales and Victoria were similar at 486 and 487 respectively, and Western Australia was 515.

Table 4.4
Average scale scores nationally and by state and territory for Year 6 and Year 10 in 2018

State/territory	Year 6	Year 10
NSW	397 (±10.5)	486 (±11.8)
Vic.	405 (±10.3)	487 (±15.3)
Qld	426 (±8.5)	-
WA	415 (±14.5)	515 (±18.7)
SA	400 (±15.5)	-
Tas.	405 (±14.9)	-
ACT	427 (±17.6)	-
NT	302 (±39.2)	-
Aust.	407 (±5.0)	490 (±7.3)

Confidence intervals (1.96*SE) are reported in brackets.
- State/territory did not participate in jurisdiction-level data collection

Table 4.5 shows pair-wise comparisons of students' NAP–SL average scale scores between the states and territories in 2018 for Year 6. The table shows that the average score recorded for Northern Territory Year 6 students was significantly lower than in all other jurisdictions. Students from the ACT, Queensland and Western Australia performed equally well. Year 6 students from the ACT and Queensland scored higher than students from New South Wales, South Australia and Victoria.

Table 4.5
Pair-wise comparisons of Year 6 students' average scale scores between the states and territories in 2018

	Mean score	95% CI	ACT	Qld	WA	Tas.	Vic.	SA	NSW	NT
ACT	427	±17.6		●	●	●	↑	↑	↑	↑
Qld	426	±8.5	●		●	↑	↑	↑	↑	↑
WA	415	±14.5	●	●		●	●	●	●	↑
Tas.	405	±14.9	●	↓	●		●	●	●	↑
Vic.	405	±10.3	↓	↓	●	●		●	●	↑
SA	400	±15.5	↓	↓	●	●	●		●	↑
NSW	397	±10.5	↓	↓	●	●	●	●		↑
NT	302	±39.2	↓	↓	↓	↓	↓	↓	↓	

↑ Mean performance that is statistically significantly higher than in comparison state/territory
● No statistically significant difference from comparison state/territory
↓ Mean performance that is statistically significantly lower than in comparison state/territory

Table 4.6
Percentages of Year 6 and Year 10 students attaining the proficient standard nationally and by state and territory in 2018

State/territory	Year 6	Year 10
NSW	54 (±5.1)	49 (±4.8)
Vic.	56 (±4.8)	47 (±5.5)
Qld	64 (±4.5)	-
WA	62 (±5.2)	58 (±7.3)
SA	55 (±6.8)	-
Tas.	58 (±5.2)	-
ACT	67 (±6.7)	-
NT	37 (±7.4)	-
Aust.	58 (±2.4)	50 (±2.8)

Confidence intervals (1.96*SE) are reported in brackets.
- State/territory did not participate in jurisdiction-level data collection

Table 4.7 shows the percentages of Year 6 and 10 students at each achievement level nationally and by state and territory in 2018. At the national level, 12 per cent of Year 6 students did not reach level 2. The lowest percentage of Year 6 students who did not achieve level 2 was in Queensland where the seven per cent of students was almost half the national average. However, in the Northern Territory, 41 per cent of students did not demonstrate science literacy corresponding to level 2 or above. The majority of Year 10 students demonstrated the understandings and skills described at levels 3 and 4 for all three jurisdictions shown.

Table 4.7
Percentages of Year 6 and 10 students at each achievement level nationally and by state and territory in 2018

State/territory		Year 1 or below	Level 2	Level 3	Level 4	Level 5 or above
Year 6	NSW	14 (±3.0)	32 (±4.4)	39 (±4.6)	14 (±3.2)	1 (±0.9)
	Vic.	13 (±3.1)	31 (±3.8)	38 (±4.1)	15 (±3.2)	3 (±1.1)
	Qld	7 (±2.0)	28 (±4.1)	42 (±4.5)	19 (±4.6)	3 (±1.5)
	WA	13 (±5.3)	25 (±4.5)	40 (±5.0)	20 (±3.6)	3 (±1.6)
	SA	14 (±5.4)	30 (±4.7)	37 (±6.3)	16 (±3.4)	2 (±1.5)
	Tas.	14 (±5.5)	27 (±4.6)	39 (±4.7)	17 (±3.7)	2 (±2.3)
	ACT	10 (±4.4)	24 (±5.6)	43 (±5.0)	21 (±5.5)	3 (±2.0)
	NT	41 (±11.0)	22 (±6.8)	27 (±5.5)	9 (±3.1)	2 (±1.9)
	Aust.	12 (±1.4)	30 (±2.0)	39 (±2.2)	17 (±1.5)	2 (±0.6)
Year 10	NSW	4 (±1.9)	16 (±3.5)	32 (±4.1)	34 (±4.0)	15 (±3.2)
	Vic.	4 (±3.2)	14 (±3.6)	34 (±5.2)	33 (±5.1)	15 (±4.3)
	WA	3 (±2.2)	11 (±4.3)	28 (±6.2)	36 (±5.7)	23 (±7.1)
	Aust.	5 (±1.5)	15 (±2.2)	31 (±2.7)	33 (±2.7)	16 (±2.1)

Confidence intervals (1.96*SE) are reported in brackets.
Note: Percentages may not add up to 100 per cent due to rounding.

Student achievement among the states and territories since 2006

Table 4.8 shows the NAP–SL average scale scores nationally and by state and territory for Year 6 since 2006. Overall, there was little variation in student achievement across the five cycles, except for Queensland and Western Australia. Year 6 students in Queensland scored higher in 2018 than in all previous cycles and students in Western Australia scored higher in 2018 than in 2006.

Table 4.8
Average scale scores nationally and by state and territory for Year 6 since 2006

State/territory	2018	2015	2012	2009	2006
NSW	397 (±10.5)	411 (±8.6)	395 (±9.9)	396 (±12.1)	411 (±12.5)
Vic.	405 (±10.3)	399 (±8.9)	393 (±9.7)	398 (±9.2)	408 (±10.2)
Qld	426 (±8.5)	↓398 (±10.6)	↓392 (±6.4)	↓385 (±8.9)	↓387 (±8.6)
WA	415 (±14.5)	408 (±7.5)	406 (±9.5)	393 (±9.6)	↓381 (±10.0)
SA	400 (±15.5)	392 (±8.8)	392 (±7.9)	380 (±10.4)	392 (±10.0)
Tas.	405 (±14.9)	414 (±11.7)	395 (±12.3)	386 (±13.5)	406 (±12.1)
ACT	427 (±17.6)	414 (±12.1)	429 (±13.2)	415 (±10.6)	418 (±14.3)
NT	302 (±39.2)	320 (±25.6)	319 (±31.1)	326 (±28.6)	325 (±33.7)
Aust.	407 (±5.0)	403 (±4.3)	394 (±4.4)	392 (±5.1)	400 (±5.4)

Confidence intervals (1.96*SE) are reported in brackets.
↑ if significantly higher than 2018.
↓ if significantly lower than 2018.

Table 4.9 shows the percentages of Year 6 students attaining the proficient standard nationally and by state and territory since 2006. Overall, nationally and within most jurisdictions, there was little variation in the percentages of Year 6 students attaining the proficient standard across the five cycles. The percentage of Year 6 students attaining the proficient standard in Queensland in 2018 was significantly higher than in all previous cycles. The percentage of Year 6 students attaining the proficient standard in Western Australia in 2018 was significantly higher than in 2006. Nationally, there were no statistically significant differences between 2018 and 2015 but the percentage of Year 6 students attaining the proficient standard in 2018 was higher than that of 2012.

Table 4.9
Percentages of Year 6 students attaining the proficient standard nationally and by state and territory since 2006

State/territory	2018	2015	2012	2009	2006
NSW	54 (±5.1)	57 (±3.6)	51 (±4.3)	53 (±5.0)	57 (±4.3)
Vic.	56 (±4.8)	54 (±3.8)	51 (±4.7)	55 (±4.6)	58 (±5.0)
Qld	64 (±4.5)	↓54 (±4.6)	↓50 (±3.3)	↓49 (±3.8)	↓49 (±3.8)
WA	62 (±5.2)	58 (±3.3)	56 (±4.2)	53 (±4.5)	↓47 (±4.7)
SA	55 (±6.8)	51 (±3.9)	51 (±3.9)	47 (±5.0)	52 (±4.7)
Tas.	58 (±5.2)	59 (±4.7)	51 (±5.4)	50 (±6.0)	57 (±5.5)
ACT	67 (±6.7)	61 (±5.1)	65 (±5.3)	61 (±4.8)	62 (±5.6)
NT	37 (±7.4)	32 (±5.6)	31 (±7.6)	34 (±7.5)	38 (±6.5)
Aust.	58 (±2.4)	55 (±1.8)	↓51 (±2.0)	52 (±2.2)	↓54 (±2.1)

Confidence intervals (1.96*SE) are reported in brackets.
↑ if significantly higher than 2018.
↓ if significantly lower than 2018.

Student performance and background characteristics

Introduction

In this section, the differences in achievement in terms of average scale scores and percentages attaining the proficient standard are described for:

- male and female students
- Indigenous and non-Indigenous students
- students from diverse geographic locations
- students of diverse language backgrounds
- parental education of students
- parental occupation of students.

Where applicable, comparisons are made with the 2006, 2009, 2012 and 2015 assessments.

Achievement by gender since 2006

Table 4.10 shows the average scale scores achieved by male and female students at the national level, as observed in 2006, 2009, 2012, 2015 and 2018. Only in 2015, a significant gender gap was observed to the advantage of female students. The gender gap was not significant in 2018 or in other assessment cycles. The average score of Year 6 female students in 2018 was, however, higher than that of 2009.

Table 4.10
Average scale scores by gender since 2006

Gender		2018	2015	2012	2009	2006
Year 6	Males	405 (±6.7)	398 (±5.1)	394 (±5.6)	393 (±6.0)	402 (±6.4)
	Females	409 (±6.3)	408 (±5.1)	395 (±4.4)	↓391 (±5.2)	398 (±5.1)
	Difference (M – F)	-4 (±8.3)	**-10**	-1	2	4
Year 10	Males	485 (±11.4)				
	Females	494 (±8.1)				
	Difference (M – F)	-9 (±13.4)				

Confidence intervals (1.96*SE) are reported in brackets.
↑ if significantly higher than 2018.
↓ if significantly lower than 2018.
Statistically significant differences ($p<0.05$) are in bold.
Confidence intervals for differences were not reported in previous cycles.

Table 4.11 shows the percentages of students attaining the proficient standard by gender since 2006. The percentage of female students in Year 6 that attained the proficient standard in 2018 was higher than in 2012.

Table 4.11
Percentages of students attaining the proficient standard by gender since 2006

Gender		2018	2015	2012	2009	2006
Year 6	Males	57 (±3.0)	54 (±2.1)	52 (±2.6)	52 (±2.6)	55(±2.5)
	Females	59 (±3.9)	57 (±2.3)	↓51 (±2.2)	52 (±2.6)	54(±2.3)
Year 10	Males	49 (±4.4)				
	Females	50 (±3.8)				

Confidence intervals (1.96*SE) are reported in brackets.
↑ if significantly higher than 2018.
↓ if significantly lower than 2018.

Achievement by Indigenous status since 2006

Students from Aboriginal and/or Torres Strait Islander background were classified as Indigenous students and other students were classified as non-Indigenous students.

Table 4.12 shows the NAP–SL average scale scores by Indigenous status since 2006. The 2018 average score for Year 6 Indigenous students was higher than the average scores of Indigenous students in 2012 and 2009. In 2018, the average score for Year 6 Indigenous students was 339, indicating that they did not perform as well as non-Indigenous students with an average score of 412. This difference was statistically significant, as it also was in all previous assessment cycles. Year 10 Indigenous students also scored lower than non-Indigenous students in 2018 and the difference was statistically significant.

Table 4.12
Average scale scores by Indigenous status since 2006

Indigenous status		2018	2015	2012	2009	2006
Year 6	Non-Indigenous students	412 (±4.9)	408 (±4.2)	399 (±4.5)	397 (±5.0)	402 (±5.8)
	Indigenous students	339 (±21.8)	315 (±13.7)	↓303 (±15.1)	↓297 (±16.0)	311 (±29.4)
	Difference (non-Indigenous – Indigenous)	**73 (±21.8)**	**93**	**96**	**100**	**91**
Year 10	Non-Indigenous students	494 (±7.0)				
	Indigenous students	408 (±37.6)				
	Difference (non-Indigenous – Indigenous)	**86 (±37.4)**				

Confidence intervals (1.96*SE) are reported in brackets.
↑ if significantly higher than 2018.
↓ if significantly lower than 2018.
Statistically significant differences ($p<0.05$) are in bold
Confidence intervals for differences were not reported in previous cycles.

Table 4.13 shows the percentages of students attaining the proficient standard by Indigenous status. This table shows that in 2018, 35 per cent of Indigenous Year 6 students performed at or above the proficient standard, compared with 60 per cent of non-Indigenous students, the percentage of Indigenous students attaining the proficient standard was significantly higher than in all previous cycles except 2006. The percentage of non-Indigenous Year 6 students performing at or above the proficient standard in 2018 is significantly higher than in 2012. In 2018, 20 per cent of Indigenous Year 10 students performed at or above the proficient standard, compared with 51 per cent of non-Indigenous students.

Table 4.13
Percentages of students attaining the proficient standard by Indigenous status

Indigenous status		2018	2015	2012	2009	2006
Year 6	Non-Indigenous students	60 (±2.5)	57 (±1.8)	↓53 (±2.0)	54 (±2.3)	55 (±2.2)
	Indigenous students	35 (±9.1)	↓23 (±4.8)	↓20 (±5.8)	↓20 (±6.0)	26 (±10.0)
Year 10	Non-Indigenous students	51 (±2.9)				
	Indigenous students	20 (±10.5)				

Confidence intervals (1.96*SE) are reported in brackets.
↑ if significantly higher than 2018.
↓ if significantly lower than 2018.

Achievement by language spoken at home since 2009

The 2018 results for students from a language background other than English (LBOTE) were compared with the results of students who speak English at home. Table 4.14 shows the NAP–SL average scale scores by language spoken at home since 2009. In 2018, Year 6 students who speak English at home had a higher mean score (411) than students who speak a language other than English at home (398) and the difference was statistically significant. In previous cycles this difference was not statistically significant.

There was no statistically significant difference in the average scores of Year 10 students who speak English at home compared with those who speak languages other than English at home.

Table 4.14
Average scale scores by language spoken at home since 2009

Language spoken at home		2018	2015	2012	2009
Year 6	English	411 (±6.0)	405 (±4.6)	397 (±4.5)	396 (±4.7)
	Language other than English	398 (±10.5)	396 (±9.3)	389 (±13.7)	384 (±13.0)
	Difference (English – other)	**13 (±12.1)**	9	8	12
Year 10	English	493 (±8.3)			
	Language other than English	486 (±15.7)			
	Difference (English – other)	7 (±17.6)			

Confidence intervals (1.96*SE) are reported in brackets.
↑ if significantly higher than 2018.
↓ if significantly lower than 2018.
Statistically significant differences (p<0.05) are in bold
Confidence intervals for differences were not reported in previous cycles.

Table 4.15 shows the percentages of students attaining the proficient standard by language spoken at home. There was no statistically significant difference in percentage points between students who speak English at home and students who speak a language other than English at home. The percentage of Year 6 students who speak English at home attaining the proficient standard was higher in 2018 than in 2012.

Table 4.15
Percentages of students attaining the proficient standard by language spoken at home

Language spoken at home		2018	2015	2012	2009
Year 6	English	59 (±2.8)	56 (±2.0)	↓53 (±2.1)	53 (±2.3)
	Language other than English	56 (±5.2)	52 (±3.6)	48 (±5.4)	49 (±4.9)
Year 10	English	51 (±3.0)			
	Language other than English	49 (±6.6)			

Confidence intervals (1.96*SE) are reported in brackets.
↑ if significantly higher than 2018.
↓ if significantly lower than 2018.

Achievement by geographic location in 2018

Table 4.16 shows the average scale scores in 2018 for students attending schools in different geographic locations. No comparisons were made with previous cycles, because a new classification system was introduced since the last cycle. The pattern of results indicates that students attending schools located in major cities had significantly higher average scale scores than students attending schools in regional areas (inner or outer) and students attending schools located in regional areas scored significant higher than students attending schools in remote or very remote areas. The difference between regional and remote areas was larger than between major cities and regional areas.

Table 4.16
Average scaled scores in 2018 for students attending schools in different geographic locations

Geographic location	Year 6	Year 10
Major cities	418 (±6.4)	500 (±8.3)
Inner regional	396 (±13.0)	478 (±20.7)
Outer regional	382 (±17.3)	474 (±25.0)
Remote	350 (±34.0)	395 (±62.4)
Very remote	239 (±70.3)	400 (±40.2)
Difference (major – regional)	**26** (±11.0)	**23** (±18.3)
Difference (regional – remote or very remote)	**102** (±42.6)	**81** (±56.3)

Confidence intervals (1.96*SE) are reported in brackets.
Statistically significant differences ($p<0.05$) are in bold.

Table 4.17 shows the percentages of students attaining the proficient standard by geographic location in 2018. It shows that 61 per cent of Year 6 students from major cities were at or above the proficient standard in science literacy, which was significantly higher than the 48 per cent from outer regional areas, 35 per cent from remote areas and 11 per cent from very remote areas. Fifty-three per cent of Year 10 students from major cities were at or above the proficient standard in science literacy, which was significantly higher than the 16 per cent from remote areas and 2 per cent from very remote areas.

Table 4.17
Percentages of students attaining the proficient standard by geographic location in 2018

Geographic location	Year 6	Year 10
Major cities	61 (±2.8)	53 (±3.5)
Inner regional	56 (±6.1)	46 (±6.9)
Outer regional	48 (±8.6)	44 (±8.6)
Remote	35 (±9.9)	16 (±11.2)
Very remote	11 (±16.1)	2 (±10.7)

Confidence intervals (1.96*SE) are reported in brackets.

Achievement by parental occupation

Information on the occupations of parents was collected from school records and recoded into the following five categories:

- Senior managers and professionals
- Other managers and associate professionals
- Tradespeople & skilled office, sales and service staff
- Unskilled labourers, office, sales and service staff
- Not in paid work in last 12 months
- Not stated or unknown.

Where occupations were available for two parents, the highest coded occupation was used in the analyses. Table 4.18 shows the average scale scores by categories of parental occupation in 2018. Year 6 students with parents who were senior managers or professionals had scores that were 66 points higher than those with parents who were recorded as unskilled labourers, office, sales or service staff. For Year 10 students, the difference was 104 scale points.

Table 4.18
Average scale scores and differences by categories of parental occupation in 2018

Highest parental occupation	Year 6	Year 10
Senior managers and professionals	447 (±7.3)	541 (±8.6)
Other managers and associate professionals	412 (±8.5)	506 (±10.8)
Tradespeople and skilled office, sales and service staff	394 (±8.9)	462 (±11.4)
Unskilled labourers, office, sales and service staff	381 (±13.0)	438 (±16.9)
Not in paid work in last 12 months	365 (±10.9)	421 (±21.1)
Not stated or unknown	389 (±11.2)	484 (±22.8)
Difference (Senior - Unskilled)	**66 (±14.0**	**104 (±17.9)**

Confidence intervals (1.96*SE) are reported in brackets.
Statistically significant differences (p<0.05) in bold.

Table 4.19 shows the percentages at or above the proficient standard by categories of parental occupation. Forty-nine per cent of Year 6 students and 30 per cent of Year 10 students, whose parents were classified in the group comprising unskilled labourers, office, sales and service staff, scored at or above their respective proficient standards. Among students with parents in the category of senior managers or professionals, 73 per cent of Year 6 and 70 per cent of Year 10 students had scores above their proficient standard.

Table 4.19
Percentage of students attaining the proficient standard by categories of parental occupation in 2018

Highest parental occupation	Year 6	Year 10
Senior managers and professionals	73 (±3.2)	70 (±4.1)
Other managers and associate professionals	60 (±4.8)	56 (±4.8)
Tradespeople and skilled office, sales and service staff	52 (±4.5)	38 (±4.8)
Unskilled labourers, office, sales and service staff	49 (±6.0)	30 (±7.1)
Not in paid work in last 12 months	43 (±7.3)	23 (±7.1)
Not stated or unknown	52 (±6.0)	47 (±12.3)

Confidence intervals (1.96*SE) are reported in brackets.
Statistically significant differences (p<0.05) in bold.

Achievement by parental education

Information on the educational levels of parents were collected and recoded into the following seven categories:

- Bachelor's degree or above
- Advanced diploma/diploma
- Certificates I–IV (including trade certificates)
- Year 12 or equivalent
- Year 11 or equivalent
- Year 10 or equivalent or below
- Not stated or unknown.

Where educational levels were available for two parents, the higher educational level was used in the analysis. Table 4.20 shows the average scale scores and differences by categories of parental education in 2018. For both Year 6 and 10 students, there were considerable differences in achievement between levels of parental education. Year 6 students with parents who had a Bachelor's degree or higher obtained scores that were 96 points above those with parents who had not exceeded Year 10 as their highest level of education. For Year 10, this difference was even larger at 125 points.

Table 4.20
Average scale scores and differences by categories of parental education in 2018

Highest parental occupation	Year 6	Year 10
Bachelor's degree or above	443 (±6.5)	540 (±8.6)
Advanced diploma/diploma	398 (±10.5)	488 (±12.2)
Certificates I–IV (including trade certificates)	387 (±7.8)	454 (±9.6)
Year 12 or equivalent	388 (±14.9)	462 (±28.6)
Year 11 or equivalent	353 (±22.5)	431 (±29.2)
Year 10 or equivalent or below	347 (±16.2)	415 (±28.0)
Not stated or unknown	382 (±28.3)	485 (±23.4)
Difference (Bachelor - Year 10)	**96 (±17.5)**	**125 (±27.6)**

Confidence intervals (1.96*SE) are reported in brackets.
Statistically significant differences ($p<0.05$) in bold.

Table 4.21 shows the percentages at or above the proficient standard by categories of parental education. Seventy-two per cent of Year 6 and 70 per cent of Year 10 students with parents who had a Bachelor's degree or higher reached their proficient standard. In the lowest education group, 36 per cent of Year 6 students and 25 per cent of Year 10 students reached their proficient standard.

Table 4.21
Percentage of students attaining the proficient standard by categories of parental education in 2018

Highest parental occupation	Year 6	Year 10
Bachelor's degree or above	72 (±2.9)	70 (±3.9)
Advanced diploma/diploma	54 (±5.5)	49 (±6.0)
Certificates I–IV (including trade certificates)	50 (±4.8)	34 (±4.5)
Year 12 or equivalent	51 (±7.1)	41 (±11.3)
Year 11 or equivalent	40 (±11.2)	21 (±11.9)
Year 10 or equivalent or below	36 (±7.8)	25 (±8.5)
Not stated or unknown	50 (±9.7)	50 (±9.5)

Confidence intervals (1.96*SE) are reported in brackets.

CHAPTER 5

STUDENT SURVEY

Chapter highlights

- The majority of students are interested in science, enjoy science lessons and enjoy learning new scientific concepts.
- Slightly more than half of Year 10 students want to study one or more science subjects in Years 11 and 12 with 42 per cent of students considering a science-related career.
- The great majority of Year 6 and 10 students agreed that learning science is important for all students.
- Year 10 students appear less confident than Year 6 students in relation to their ability to easily and quickly learn and understand new scientific concepts.
- More than 80 per cent of Year 6 and 10 students acknowledged that science is important for many jobs and for helping people to make informed decisions.
- The great majority of students agreed that our scientific knowledge is constantly changing, and that science assists them to understand global issues that impact on people and the environment.
- Half of participating Year 6 students and slightly more than one-third of participating Year 10 students did not recognise the influence of science in their everyday lives.
- Over 70 per cent of both Year 6 and Year 10 participating students indicated that they work in groups to carry out scientific investigations.
- The majority of participating Year 6 students reported that they have science lessons at least once a week and that these lessons are taught by their regular teacher who appeared to enjoy teaching science.
- The majority of students from both years reported that they do not have visitors come to speak to them about science topics. Similarly, 64 per cent of Year 6 students and 74 per cent of Year 10 students reported that they do not go on science-related excursions.
- The NAP–SL survey provides rich insights into how students perceive and engage with science. Overall, Year 6 students appear to respond more positively to the survey questions than Year 10 students.
- Year 6 and 10 students who are engaged with science and see the value of science tend to do better overall on the NAP–SL scale.

Introduction

In 2018, both Year 6 and Year 10 students were presented with a set of survey items to determine their attitudes to, and interests in, science and science experiences in school. Students answered the survey after completing the objective test items and the inquiry task.

With each new cycle of NAP–SL, the survey content has been reviewed and updated in consultation with ACARA curriculum experts and the NAP–SL Working Group. With the introduction of Year 10, new items were added, which were specifically designed to gather information about students' perceptions of the importance of science for their future career paths and their potential intentions of pursuing careers in science-related fields. Some of the original Year 6 survey items remained unchanged and were presented to both Year 6 and Year 10. The inclusion of these original items allowed historical comparisons for Year 6 students and comparisons with Year 10 students.

The survey items required responses ranging from simple yes/no to Likert scale and frequency rating scale formats.

The survey items were divided into six groupings:

- Group 1. Interest in science
- Group 2. Self-concept of science ability
- Group 3. Value of science
- Group 4. Science teaching 1
- Group 5. Time spent on science
- Group 6. Science teaching 2

The items could be further organised into three broad categories:

- Student engagement with science (groups 1 and 2)
- Science as a human endeavour (group 3)
- Teaching and learning science (groups 4, 5 and 6).

Screen grabs of the 2018 student survey can be found in appendix 4. Appendix 5 provides a detailed comparison of the survey results for Year 6 students between 2015 and 2018.

Student engagement with science

Group 1. Interest in science

This group was designed to show students' interest and enjoyment in learning and doing science as well as their interest in following a career in science.

Table 5.1
Distributions of students' interest in science

Survey question		Year 6	Year 10
How much do you agree with the statements below?			
I would like to learn more science at school.	Strongly disagree	4 (±0.8)	
	Disagree	13 (±1.5)	
	Agree	59 (±2.0)	
	Strongly agree	25 (±1.6)	
I think it would be interesting to be a scientist.	Strongly disagree	9 (±1.0)	
	Disagree	26 (±1.6)	
	Agree	49 (±1.9)	
	Strongly agree	16 (±1.3)	
I enjoy doing science.	Strongly disagree	4 (±0.8)	11 (±1.3)
	Disagree	14 (±1.3)	20 (±1.7)
	Agree	56 (±2.0)	50 (±2.1)
	Strongly agree	26 (±1.8)	20 (±1.7)
I enjoy learning new things in science.	Strongly disagree	3 (±0.6)	7 (±1.2)
	Disagree	8 (±1.0)	12 (±1.3)
	Agree	54 (±1.7)	56 (±2.1)
	Strongly agree	35 (±1.9)	25 (±1.8)
I want to study one or more science subjects in Years 11 and 12.	Strongly disagree		20 (±1.8)
	Disagree		23 (±1.8)
	Agree		28 (±1.9)
	Strongly agree		29 (±2.4)
I am considering a science-related career.	Strongly disagree		26 (±2.0)
	Disagree		33 (±2.3)
	Agree		26 (±1.7)
	Strongly agree		15 (±1.7)

Confidence intervals (1.96*SE) are reported in brackets.
Note: Percentages may not add up to 100 per cent due to rounding.

Many Year 6 students indicated that they enjoy doing science, enjoy learning new things in science and would like to learn more science at school. These results were similar to the 2015 results in that the majority responded positively to the questions. However, the 2018 level of agreement was lower than in 2015 when 87 per cent reported that they enjoyed doing science, 93 per cent reported that they enjoyed learning new things in science and 86 per cent reported that they would like to learn more science. In 2018, 65 per cent of participating Year 6 students thought it would be interesting to be a scientist compared with 69 per cent in 2015.

Most of the Year 6 and 10 students indicated that they enjoy doing and learning new things in science. The attitude and positivity of Year 10 students towards learning and doing science was also reflected in 57 per cent of participating students having indicated that they want to study one or more science subjects in Years 11 and 12. The majority of students indicated they wish to continue their science studies into senior school and 42 per cent of participating students were considering a science-related career.

Group 2. Self-concept of science ability

This group included four statements to elicit students' own assessment of their abilities in science.

Table 5.2
Distributions of students' self-concept in their science ability

Survey question		Year 6	Year 10
How much do you agree with the statements below?			
I learn science topics quickly.	Strongly disagree	7 (±1.4)	15 (±2.1)
	Disagree	33 (±2.3)	33 (±2.5)
	Agree	48 (±2.5)	43 (±3.6)
	Strongly agree	12 (±1.6)	9 (±1.7)
I can understand new ideas about science easily.	Strongly disagree	5 (±1.1)	12 (±1.8)
	Disagree	29 (±2.2)	33 (±2.6)
	Agree	52 (±2.5)	45 (±3.4)
	Strongly agree	14 (±1.6)	10 (±1.9)
I can usually give good answers to science questions.	Strongly disagree	4 (±1.0)	9 (±1.9)
	Disagree	27 (±2.3)	24 (±2.6)
	Agree	56 (±2.5)	57 (±3.0)
	Strongly agree	13 (±1.7)	11 (±1.9)
It is important that all students learn science.	Strongly disagree	2 (±0.7)	5 (±1.5)
	Disagree	11 (±1.7)	17 (±2.3)
	Agree	45 (±2.8)	55 (±3.1)
	Strongly agree	42 (±2.9)	23 (±2.6)

Confidence intervals (1.96*SE) are reported in brackets.
Note: Percentages may not add up to 100 per cent due to rounding.

A large proportion of Year 6 students appeared to be confident in learning science, reporting that they had assessed themselves as being able to understand and learn science ideas easily and quickly. These results were like the 2015 results, although the 2018 levels of agreement were lower than in 2015 when 69 per cent reported that they learn science quickly and 75 per cent reported that they understand science easily.

Most participating Year 6 students assessed themselves as being able to provide good responses in science, 60 per cent indicated that they learn science topics quickly and 66 per cent of students reported that they understand new science concepts easily.

Sixty-seven per cent of participating Year 10 students assessed themselves as being able to provide good responses in science, 53 per cent indicated that they learn science topics quickly and 55 per cent of students reported that they understand new science concepts easily.

The great majority of students from both years agreed that learning science is important for all students.

Science as a human endeavour

Group 3. Value of science

This group included five statements designed to show student perceptions of the importance of science to society and themselves.

Table 5.3
Distribution of students' perceptions of the value and importance of science

Survey question		Year 6	Year 10
How much do you agree with the statements below?			
Science is part of my everyday life.	Strongly disagree	14 (±1.4)	11 (±1.5)
	Disagree	38 (±1.7)	26 (±1.7)
	Agree	33 (±1.6)	44 (±2.0)
	Strongly agree	16 (±1.3)	18 (±1.7)
Science is important for lots of jobs.	Strongly disagree	4 (±0.6)	5 (±0.9)
	Disagree	14 (±1.4)	15 (±1.5)
	Agree	48 (±2.0)	52 (±2.2)
	Strongly agree	35 (±1.7)	28 (±1.9)
Scientific information helps people make informed decisions.	Strongly disagree	2 (±0.4)	3 (±0.8)
	Disagree	8 (±1.0)	11 (±1.3)
	Agree	55 (±2.0)	55 (±2.2)
	Strongly agree	35 (±1.8)	31 (±2.1)
Our scientific knowledge is constantly changing.	Strongly disagree	1 (±0.3)	2 (±0.6)
	Disagree	5 (±0.7)	4 (±0.8)
	Agree	48 (±1.7)	46 (±2.0)
	Strongly agree	46 (±1.8)	49 (±2.0)
Science can help us understand global issues that impact on people and the environment.	Strongly disagree	1 (±0.3)	1 (±0.5)
	Disagree	3 (±0.6)	4 (±0.8)
	Agree	36 (±1.7)	40 (±2.2)
	Strongly agree	60 (±1.8)	54 (±2.2)

Confidence intervals (1.96*SE) are reported in brackets.
Note: Percentages may not add up to 100 per cent due to rounding.

Eight-three per cent of Year 6 students and 80 per cent of Year 10 students acknowledged that science is important for many jobs. Similarly, 90 per cent of Year 6 students and 86 per cent of Year 10 students acknowledged that science helps them to make informed decisions, and the level of agreement with that question for Year 6 students appeared higher in 2018 than in 2015 (84 per cent).

Both Year 6 students (94 per cent) and Year 10 students (95 per cent) agreed that our scientific knowledge is constantly changing, and they agreed that science assists them to understand global issues that impact on people and the environment.

However, the pattern of responses in Year 6 was not the same for the statement ‘Science is part of my everyday life.’ The students were almost evenly split regarding the contribution science makes to their everyday lives: 49 per cent agreed with the statement and 51 per cent disagreed with the statement, which generally mirrored the level of agreement in 2015, where 46 per cent agreed with the statement and 54 per cent disagreed with the statement.

The majority (62 per cent) of participating Year 10 students agreed that science contributes to their everyday lives and 38 per cent of Year 10 students mirrored Year 6 in that they do not recognise the influence of science in their everyday lives.

Teaching and learning science

These items explored student experience of science within school. Note that this is how students characterise their experience within schools. The data are not intended to necessarily show how science is being taught in the schools.

Group 4. Science teaching

These items asked students to respond to statements about the types of activities they do in school when learning science.

Table 5.4
Distribution of students' responses relating to types of activities they do when learning science

Survey question		Year 6	Year 10
How often do you do these things at school?			
During science lessons I get to plan and carry out my own investigations.	Never	7 (±0.9)	14 (±1.8)
	Sometimes	40 (±2.0)	49 (±2.3)
	Mostly	39 (±1.8)	29 (±2.0)
	Always	13 (±1.4)	8 (±1.1)
When our class investigates things in science, we work in groups to carry out the investigation.	Never	3 (±0.7)	4 (±1.0)
	Sometimes	23 (±1.9)	21 (±1.8)
	Mostly	50 (±1.8)	43 (±1.9)
	Always	24 (±1.8)	31 (±2.1)
Our class has in-depth discussions about science ideas.	Never	6 (±1.0)	10 (±1.4)
	Sometimes	32 (±1.8)	35 (±2.1)
	Mostly	37 (±1.7)	36 (±1.9)
	Always	24 (±1.7)	20 (±1.9)

Confidence intervals (1.96*SE) are reported in brackets.
Note: Percentages may not add up to 100 per cent due to rounding.

Just over half of participating Year 6 students reported that they 'always' or 'mostly' carried out their own self-directed investigations in science and 73 per cent reported that they carry out investigations in groups. The results for group work were similar to 2015 (60 per cent). For self-directed investigations, the 2018 results appeared higher than the 38 per cent in 2015 and the 27 per cent in 2012.

In Year 10, 37 per cent of participating students indicated that they carry out self-directed investigations and 74 per cent of students reported that they carry out investigations in groups.

Sixty-one per cent of Year 6 students and 56 per cent of Year 10 students reported that they 'always' or 'mostly' have in-depth discussions in class about science ideas.

Group 5. Time spent on science

Students were asked to report how often they had science lessons at school.

Table 5.5
Distribution of students' responses relating to how often they have science lessons

Survey question		Year 6	Year 10
How often do you have science lessons at school?			
How often do you have science lessons at school?	Hardly ever	25 (±3.2)	6 (±1.5)
	Once a week	51 (±4.0)	3 (±0.9)
	More than once a week	24 (±3.0)	91 (±1.7)

Confidence intervals (1.96*SE) are reported in brackets.
Note: Percentages may not add up to 100 per cent due to rounding.

The majority of Year 6 students reported that they had science lessons at least once a week. Ninety-one per cent of participating Year 10 students reported having science more than once a week.

The 2018 result for Year 6 was similar to the 2015 results with 68 per cent of participating students reporting that they have science lessons at least once a week.

Group 6. Science teaching 2

The statements in this group of items were focused on the teacher and organised activities.

Table 5.6
Distribution of students' responses relating to their teacher and organised activities

Survey question		Year 6	Year 10
Do you agree with the statements below?			
My classroom teacher teaches science to our class.	No	32 (±3.3)	
	Yes	68 (±3.3)	
I think my teacher enjoys teaching science.	No	15 (±1.6)	8 (±1.2)
	Yes	85 (±1.6)	92 (±1.2)
My teacher invites visitors to school to talk to us about science topics.	No	75 (±2.4)	80 (±1.9)
	Yes	25 (±2.4)	20 (±1.9)
Our class goes on excursions related to the science topics we are learning about.	No	64 (±2.9)	74 (±2.8)
	Yes	36 (±2.9)	26 (±2.8)

Confidence intervals (1.96*SE) are reported in brackets.
Note: Percentages may not add up to 100 per cent due to rounding.

Typically, students in Year 6 reported that they were taught science by their regular class teacher (68 per cent). In 2015, this percentage was 73.

In 2018, 85 per cent of Year 6 students believed that their teacher enjoyed teaching science. Ninety-two per cent of Year 10 students believed that their teacher enjoyed teaching science.

Three quarters of Year 6 students (69 per cent in 2015) and 80 per cent of Year Year 10 students reported that they do not have visitors come to speak to them about science topics. Similarly, 64 per cent of Year 6 students and 74 per cent of Year 10 students reported that they do not go on science-related excursions.

CHAPTER 6

NAP–SL FOR TEACHERS

Introduction

This chapter explores some of the results of the National Assessment Program – Science Literacy (NAP–SL) 2018 at the individual item level, with a view to providing support to teachers and curriculum specialists about how the Australian Curriculum: Science can be used to support teaching and learning of the knowledge, understanding and skills that underpin science literacy.

This chapter outlines items from the 2018 test together with student responses and offers suggestions for teaching and learning in schools. The chapter has been written as a stand-alone support for educators but offers more context when it is viewed as part of the full report.

NAP – Science Literacy and the Australian Curriculum

The NAP – Science Literacy assessment measures science literacy, as defined in the Australian Curriculum: Science, as the ability:

> *to use scientific knowledge, understanding, and inquiry skills to identify questions, acquire new knowledge, explain science phenomena, solve problems and draw evidence-based conclusions in making sense of the world, and to recognise how understandings of the nature, development, use and influence of science help us make responsible decisions and shape our interpretations of information.*

This definition encompasses three major components of science literacy, which are reflected in the form of three strands as the main organising principle of the Australian Curriculum: Science. These strands are:

Science Understanding addresses facts, concepts, principles, laws, theories and models that enable us to make sense of the physical world and help us understand and explain natural and technological phenomena.

Science as a Human Endeavour addresses understandings about the development of science as a unique way of knowing and doing, its application in contemporary decision-making, problem-solving and technology, and the mutual impacts between science and society.

Science Inquiry Skills is concerned with the practices used to develop and communicate scientific knowledge, including questioning, planning and conducting experiments and research investigations, collecting and analysing data, drawing critical, evidence-based conclusions, and evaluating and communicating results.

Each NAP–SL 2018 assessment item has been mapped to a specific cognitive domain category of the 2018 NAP–SL Assessment Framework, as well as to one of the strands and sub-strands outlined in the Australian Curriculum: Science, depending on whether it was designed to assess a student's understanding of a scientific concept, a specific inquiry skill or knowledge related to the nature of science. See chapters 1 and 2, and appendix 1 for further detail about the structure of the NAP–SL 2018 assessment, its historical development and its alignment to the Australian Curriculum: Science.

In the following sections, selected items are presented that exemplify student achievement in science literacy and highlight some common misconceptions demonstrated by students. These findings will be accompanied with suggestions for how the Australian Curriculum: Science may be used by systems, schools and teachers in planning their teaching and learning to support the development of science literacy in students.

For a detailed analysis of the NAP–SL 2018 results by gender, Indigenous status, schools' geographic location and student language background, please refer to chapter 4.

Exemplar items and student responses

This section enables teachers to see both items (questions) and responses (answers) from students from levels 2–5 of the NAP–SL proficiency scale. The exemplar items have been selected to cover a broad range of different item types and difficulty levels and are grouped according to the strands and sub-strands of the Australian Curriculum: Science. Where possible, exemplar items have been chosen that reveal insights into common misconceptions students may hold about important science concepts.

The items are presented as screenshots from the NAP–SL 2018 online tests. The selection of student responses provides indicative examples of student answers in each of the major curriculum areas. It should be noted that where student responses are given, each response is reproduced verbatim and should be viewed according to its demonstration of science literacy indicators rather than spelling, grammar or punctuation.

Following the analysis of student responses for each item is a list of suggested activities that may foster students' development of the conceptual understandings or inquiry skills addressed in the item. Where appropriate, some of the suggested activities reflect the new science elaborations published in October 2018, which demonstrate how core science concepts and skills may be taught within the context of Aboriginal and Torres Strait Islander Histories and Cultures. A detailed introduction and overview of the new science elaborations and the accompanying teacher background information can be found on the Australian Curriculum website.

Teachers, schools and systems may find it beneficial to use the following item response analyses and suggested activities to support the development of student science literacy proficiency in primary and secondary years.

To provide an overview of the range of content descriptions covered in the 2018 test, each of the following sections includes a table showing the content descriptions, which were assessed for each strand or sub-strand, and a sample of the item descriptions for each content description. (Please note that the number of item descriptions does not indicate the total number of items presented to the students for each content description.)

Science Understanding

Biological sciences

The key concepts developed within the *Biological sciences* sub-strand are: a diverse range of living things have evolved on Earth over hundreds of millions of years, living things are interdependent and interact with each other and their environment, and the form and features of living things are related to the functions that their body systems perform.

Through this sub-strand, students explore plant and animal life cycles, body systems, structural adaptations and behaviours, how these features aid survival, and how their characteristics are inherited from one generation to the next. Students are introduced to a cell as the basic unit of life and the processes that are central to its function *(Australian Curriculum: Science; Structure).*

Table 6.1 shows the 11 content descriptions that were assessed from the *Biological sciences* sub-strand and a sample of the item descriptions for each content description.

Table 6.1
Biological sciences content descriptions that were assessed in 2018

Content description and year	Item description
Living things have a variety of external features (ACSSU017, Year 1)	• identifies anatomical structures used for swimming or walking
Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044, Year 3)	• identifies an observable feature that can be used to group living things
Living things depend on each other and the environment to survive (ACSSU073, Year 4)	• selects two animals that can shelter under spinifex
Living things have structural features and adaptations that help them to survive in their environment (ACSSU043, Year 5)	• describes how long back legs help fleas to survive
The growth and survival of living things are affected by physical conditions of their environment (ACSSU094, Year 6)	• lists at least two basic human needs
Interactions between organisms, including the effects of human activities, can be represented by food chains and food webs (ACSSU112, Year 7)	• classifies predators and prey included in the food web
Cells are the basic units of living things, they have specialised structures and functions (ACSSU149, Year 8)	• identifies photosynthesis as the process on which producers rely for their energy
Multi-cellular organisms contain systems of organs carrying out specialised functions that enable them to survive and reproduce (ACSSU150, Year 8)	• identifies the body systems shown in a diagram
Multi-cellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment (ACSSU175, Year 9)	• identifies that the immune system responds to diseases
Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (ACSSU176, Year 9)	• classifies environmental features as abiotic or biotic
The theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence (ACSSU185, Year 10)	• sequences the steps in the process of natural selection

Year 6

A major focus of *Biological sciences* is the interaction between living things and their environment. In Year 5, students are exposed to the idea that plants and animals have developed special features and adaptations that help them to survive in their environment (ACSSU043).

Exemplar item 1 was part of the *Living in a desert* item set. It targeted students' understandings related to this idea. This item asks students to give two responses: one correct response demonstrated performance at level 3 on the NAP–SL scale, whilst two correct responses demonstrated performance at level 4.

Figure 6.1
Exemplar item 1 with a focus on *Biological sciences* sub-strand

Spinifex grass grows in the Simpson Desert.

Spinifex has thin, tough spiky leaves.

Spinifex roots can grow up to three metres long.

Explain how the **leaves** of spinifex grass help the plant survive in the desert. (1 mark)

Explain how the **roots** of spinifex grass help the plant survive in the desert. (1 mark)

Strand	Science Understanding	**Sub-strand**	Biological sciences
Cognitive dimension	Reasoning, analysing and evaluating	**Item type**	Extended text
Australian Curriculum: Science Content Description	Living things have structural features and adaptations that help them to survive in their environment (ACSSU043, Year 5)		

This item is part of an item set that explores the physical conditions that govern a Central Australian desert habitat and how the plants and animals living in this region have adapted to those conditions. The item presents one desert organism, spinifex grass, and describes two of its structural features or adaptations: thin, tough, spiky leaves and long roots.

In an extended text response, students are asked to explain how each of these features helps the organism to survive in the harsh desert environment. Students are prompted to:

1. identify essential functions that would increase the plant's chances of survival in desert conditions
2. reason how the described physical characteristics of the plant's features may be linked to those functions.

For the first feature, full marks were awarded for responses that linked the physical characteristics of the leaves to their ability to reduce water loss (thin/tough), protect against animals (tough/spiky), or reduce exposure to heat (thin). For the second feature, students were expected to link the plant's long roots to their ability to maximise water absorption or protect against animals or erosion (anchoring).

Twenty-three per cent of Year 6 students received full marks for this item and 31 per cent of students provided satisfactory explanations for one feature. Typical correct student responses included *"Long, thin, tough leaves prevent water from evaporating too fast"* and *"There 3m underground so the soil holds them so they don't fly away"*. Forty-six per cent of Year 6 students did not receive credit for this item on account of either failing to provide a response (6 per cent) or for providing a response that was irrelevant, vague or too generic (40 per cent) by referring to the recognised functions of all roots and leaves rather than explaining the specific features of the described plant in connection with its environment. Examples of such responses are *"roots help catch moisture"* or *"The leaves absorb sunlight and water. These help the plant make food".*

Year 10

Exemplar item 1 was also administered to Year 10 students. Although at secondary level, the content of the *Biological sciences* sub-strand focuses strongly on the internal structures and physiological functions of living things (ACSSU150, ACSSU175), the idea of organisms having adaptations that suit the environments they live in is retained as an underlying theme. Adaptations as a major focus resurfaces in Year 10 within the context of evolution (ACSSU185). Forty-three per cent of Year 10 students who responded received full marks for this item and 26 per cent explained only one of the spinifex's features. Thirty-one per cent of Year 10 students did not receive credit for this item on account of either failing to provide a response (5 per cent) or for providing an inadequate response (26 per cent).

To support students in the development and extension of the scientific knowledge and understanding associated with adaptations, primary teachers might consider using one or more of the following activities:

- explaining how particular adaptations help survival of plants and animals
- describing, and listing adaptations of, living things suited for Australian environments
- investigating Aboriginal and Torres Strait Islander peoples' knowledge of the adaptations of certain species and how those adaptations can be exploited
- exploring general adaptations for particular environments such as adaptations that aid water conservation in plants and animals living in deserts.

To develop and deepen students' understanding of adaptations within the context of evolution, secondary teachers might consider using one or more of the following activities:

- outlining processes involved in natural selection including variation, isolation and selection, and how they give rise to the development of specific adaptations
- investigating some of the structural and physiological adaptations of Aboriginal and Torres Strait Islander peoples to the Australian environment.

Chemical sciences

The key concepts developed within the *Chemical sciences* sub-strand are chemical and physical properties of substances determined by their structure at an atomic scale: substances change, and new substances are produced by rearranging atoms through atomic interactions and energy transfer.

In this sub-strand, students classify substances based on their properties, such as solids, liquids and gases, or their composition, such as elements, compounds and mixtures. They explore physical changes such as changes of state and dissolving, and investigate how chemical reactions result in the production of new substances. Students recognise that all substances consist of atoms, which can combine to form molecules, and chemical reactions involve atoms being rearranged and recombined to form new substances. They explore the relationship between the way in which atoms are arranged and the properties of substances, and the effect of energy transfers on these arrangements. *(Australian Curriculum: Science; Structure)*

Table 6.2 shows the 12 content descriptions that were assessed from the *Chemical sciences* sub-strand and a sample of the item descriptions for each content description.

Table 6.2
Chemical sciences content descriptions that were assessed in 2018

Content description and year	Item description
A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046, Year 3)	• describes the change of state during freezing
Natural and processed materials have a range of physical properties that can influence their use (ACSSU074, Year 4)	• describes a property common to glass and plastic bottles
Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077, Year 5)	• compares the properties of a solid and a liquid • classifies objects as solids, liquids or gases
Changes to materials can be reversible or irreversible (ACSSU095, Year 6)	• identifies an example of a reversible reaction
Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques (ACSSU113, Year 7)	• classifies a substance as a mixture
Properties of the different states of matter can be explained in terms of the motion and arrangement of particles (ACSSU151, Year 8)	• identifies two changes to water particles during evaporation
Differences between elements, compounds and mixtures can be described at a particle level (ACSSU152, Year 8)	• describes a model of a compound
Chemical change involves substances reacting to form new substances (ACSSU225, Year 8)	• provides evidence of a chemical reaction

Content description and year	Item description
All matter is made of atoms that are composed of protons, neutrons and electrons; natural radioactivity arises from the decay of nuclei in atoms (ACSSU177, Year 9)	• matches each subatomic particle with its charge
Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed (ACSSU178, Year 9)	• identifies the formula for carbon dioxide • identifies the formula for calcium carbonate
Chemical reactions, including combustion and the reactions of acids, are important in both non-living and living systems and involve energy transfer (ACSSU179, Year 9)	• identifies a combustion reaction • recognises the energy change that occurs during burning
The atomic structure and properties of elements are used to organise them in the Periodic Table (ACSSU186, Year 10)	• identifies the number of electrons in a neutral atom of carbon

Year 6

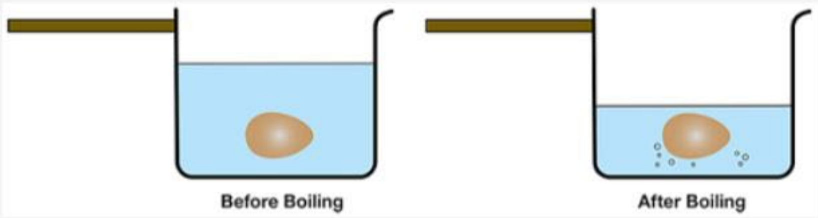
One of the key concepts in *Chemical sciences* is the idea that matter can exist in different states and that changes between states can be caused by adding or removing heat. This concept is first introduced in Year 3 in the Australian Curriculum: Science (ACSSU046) and then revisited at greater depth in Years 5 and 6 (ACSSU077, ACSSU095).

Exemplar item 2 was part of the *Cooking eggs* item set. It targeted students' basic understanding of liquids and gases, and the transformation between the two states.

This item set is placed in a domestic context most likely familiar to students. It explores the states of matter and the chemical and physical changes that can be observed while boiling eggs. This item asks students to select the best explanation for why there is less water in the saucepan after boiling the egg than there was before. This item is situated at level 2 of the NAP–SL scale.

Figure 6.2
Exemplar item 2 with a focus on *Chemical sciences* sub-strand

After cooking an egg in boiling water, there will be less water in the saucepan than when you started cooking.



Why is there less water in the saucepan after boiling?

- ◯ The water was absorbed by the egg.
- ◯ The water has leaked out of the saucepan.
- ◯ The water changed into a solid as it cooled.
- ◯ The water has become a gas and evaporated.

Strand	Science Understanding	**Sub-strand**	Chemical sciences
Cognitive dimension	Knowing and using procedures	**Item type**	Multiple choice
Australian Curriculum: Science Content Description	Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077, Year 5)		

A high percentage of Year 6 students correctly identified *The water has become a gas and evaporated* as the reason for this phenomenon. Eighteen per cent selected *The water was absorbed by the egg* as the best explanation. Three per cent of students selected *The water changed into a solid as it cooled* and one per cent considered *The water leaked out of the saucepan* as the most likely reason.

To support students in the development of a firm conceptual understanding of states of matter and the changes between them, primary teachers might consider using one or more of the following activities:

- investigating how familiar liquids and solids respond to changes in temperature; for example, water changing to ice, melting chocolate, making and melting ice cream and condensation on cold objects
- exploring how changes from solid to liquid and liquid to solid can help us recycle materials
- investigating how changes of state in materials used by Aboriginal and Torres Strait Islander peoples, such as beeswax or resins, are important for their use
- investigating how water changes between solid, liquid and gas in certain weather-related phenomena
- investigating Aboriginal and Torres Strait Islander peoples' knowledge and understanding of evaporation and how the effect of evaporation can be reduced to conserve water, such as by covering surfaces
- exploring some of the applications of phase changes used by Aboriginal and Torres Strait Islander peoples, such as the use of steam in the preparation of food and medicines.

Year 10

In the secondary years, students deepen their understanding of states of matter by explaining the various states in terms of the motion and arrangement of their constituent particles.

Exemplar item 3 was part of the *Cooking on a BBQ* item set. This item set explored physical and chemical phenomena associated with the transfer and transformation of energy. The context for the set was preparing food using cookers of different designs and using different types of fuels.

This item targeted students' understanding of what happens to matter at the particle level during a change of state that results from supplying heat energy. This item is situated at level 5 of the NAP–SL scale.

Figure 6.3
Exemplar item 3 with a focus on *Chemical sciences* sub-strand

When water is heated in a solar cooker, it changes from a liquid to a gas.

Click on the boxes to indicate what happens to water particles during this process.

The particles are vibrating more.

The particles are growing in size.

The particles are gaining energy.

The particles are increasing in number.

Strand	Science Understanding	**Sub-strand**	Chemical sciences
Cognitive dimension	Knowing and using procedures	**Item type**	Multiple choice
Australian Curriculum: Science Content Description	Properties of the different states of matter can be explained in terms of the motion and arrangement of particles (ACSSU151, Year 8)		

A correct response to this item is predicated on the understanding of several scientific concepts from the fields of chemical and physical sciences. Ideas about heat and changes of state are first introduced in Year 3 in the Australian Curriculum: Science. The concepts about matter and energy are progressively developed during upper primary and then are linked to the particle model of matter in Years 8–10.

To respond correctly to this item, a student needs to have understood that

- all matter is made up of particles
- supply of energy in the form of heat results in individual particles gaining more energy
- having more energy results in particles moving about more fiercely.

The last point requires an understanding that movement is a form of energy, a concept that is explored in depth in the Year 8 sub-strand *Physical sciences.* However, it should be noted that to understand the first option of the item, a student needs to be familiar with the term *vibration* as designating a form of movement.

To recognise the false options, a student would need to have realised that changing water from its liquid state to a gas is a physical process that does not involve the formation of new substances. Therefore, the number and size of particles remains unchanged.

One-third of Year 10 students answered this item correctly. About 20 per cent of students chose *particles are gaining energy* and roughly the same percentage selected *particles are vibrating more* as the correct answer, indicating either a failure to connect energy to movement or a lack of understanding of the term 'vibrating'. These results suggest that the majority of students have gained at least a partially correct understanding of the particle concept of matter in this context.

However, a significant number of students indicated that during the change of state from liquid to gas *particles are growing in size* (13 per cent) and/or *particles are increasing in number* (19 per cent). This finding may give teachers valuable insights about the kind of misconceptions students may have about the particle model of matter and about kinetic molecular theory. Students who are indicating that particles increase their size when they are heated are demonstrating a confused understanding about what is happening at particle level. These students would also suggest that an object expands due to the particles increasing their size when heat is applied.

To support students in the development and extension of their understanding of the fundamental scientific concepts assessed in this item, teachers may consider using one or more of the following activities:

- exploring animations, videos and simulations that model the arrangement of particles in solids, liquids and gases and how they behave during phase transitions
- explaining everyday phenomena involving a change of state by linking temperature changes to the energy of particles, their movements and their structural arrangements
- investigating solutions to contemporary issues that involve changes of state, such as water conservation efforts by reducing evaporation
- explaining the phenomenon of pressure in terms of particle energy and movement and exploring its significance in real-world contexts, such as scuba diving or space exploration.

Earth and space sciences

The key concepts developed within the *Earth and space sciences* sub-strand are: Earth is part of a solar system that is part of a larger universe; Earth is subject to change within and on its surface, over a range of timescales as a result of natural processes and human use of resources.

Through this sub-strand, students view Earth as part of a solar system, which is part of a galaxy, which is one of many in the universe, and explore the immense scales associated with space. They explore how changes on Earth, such as day and night and the seasons, relate to Earth's rotation and its orbit around the sun. Students investigate the processes that result in change to Earth's surface, recognising that Earth has evolved over 4.5 billion years and that the effect of some of these processes is only evident when viewed over extremely long timescales. They explore the ways in which humans use resources from Earth and appreciate the influence of human activity on the surface of Earth and its atmosphere. *(Australian Curriculum: Science; Structure).*

Table 6.3 shows the eight content descriptions that were assessed from the *Earth and space sciences* sub-strand and a sample of the item descriptions for each content description.

Table 6.3
Earth and space sciences content descriptions that were assessed in 2018

Content description and year	Item description
Earth's rotation on its axis causes regular changes, including night and day (ACSSU048, Year 3)	• identifies that Earth spinning on its axis causes night and day
Earth's surface changes over time as a result of natural processes and human activity (ACSSU075, Year 4)	• identifies an environmental change caused by nature
The Earth is part of a system of planets orbiting around a star (the sun) (ACSSU078, Year 5)	• identifies that today's model of the solar system has the sun in the centre
Sudden geological changes and extreme weather events can affect Earth's surface (ACSSU096, Year 6)	• identifies an impact of an earthquake
Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon (ACSSU115, Year 7)	• completes a diagram showing the position of Earth during various seasons
Some of Earth's resources are renewable, including water that cycles through the environment, but others are non-renewable (ACSSU116, Year 7)	• defines a non-renewable resource
The theory of plate tectonics explains global patterns of geological activity and continental movement (ACSSU180, Year 9)	• describes how a geological feature provides evidence for plate tectonics
The universe contains features including galaxies, stars and solar systems, and the Big Bang theory can be used to explain the origin of the universe (ACSSU188, Year 10)	• identifies that the Big Bang is the current theory about the origins of the universe

Year 6

The content in the sub-strand *Earth and space sciences* is designed to develop students' scientific understanding of processes occurring on Earth's surface as well as Earth's position in the universe. At primary level, the focus for 'Earth's position in the universe' is primarily on Earth's relationship with the sun, the moon and other celestial objects. It explores how this relationship governs the phenomena we experience in everyday life, such as day and night and the length of a year (ACSSU048, ACSSU078).

Exemplar item 4 is part of the *Our solar system* item set that explored the structure and components of our solar system and Earth's position within it. This item targeted students' understanding of, arguably, the most fundamental of these phenomena, that is, the cause of day and night. This item is situated at level 3 of the NAP–SL scale.

Figure 6.4
Exemplar item 4 with a focus on *Earth and space sciences* sub-strand

What causes day and night?

- the Moon moving around Earth
- the Earth moving around the Sun
- the Sun spinning on its own axis
- the Earth spinning on its own axis

Strand	Science Understanding	**Sub-strand**	Earth and space sciences
Cognitive dimension	Knowing and using procedures	**Item type**	Multiple choice
Australian Curriculum: Science Content Description	Earth's rotation on its axis causes regular changes, including night and day (ACSSU048, Year 3)		

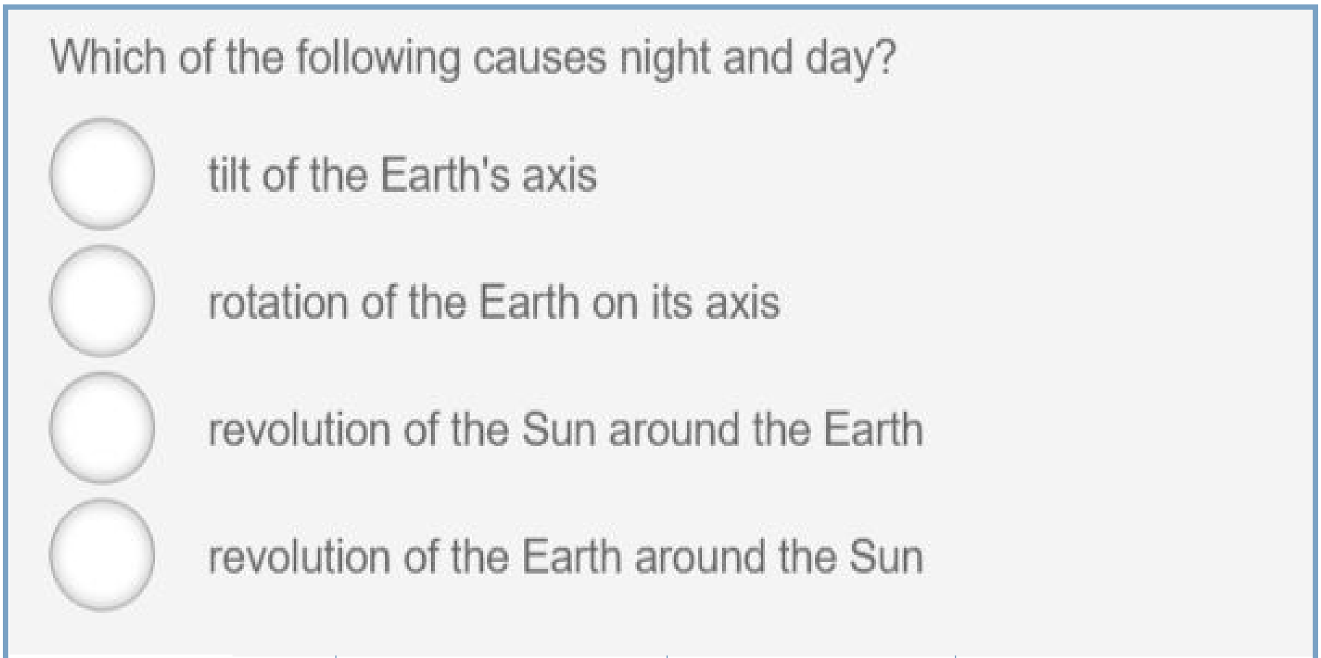
Just under half of Year 6 students (48 per cent) correctly identified *the Earth spinning on its own axis* as the cause of day and night. Thirty per cent of students attributed the reason for day and night to *the Earth moving around the Sun*, 18 per cent attributed the reason to *the Moon moving around the Earth*, and four per cent attributed the reason to *'the Sun spinning on its own axis'* as their answer.

The 30 per cent of students who selected option 2 were demonstrating a recognition that the Earth's orbit around the Sun is responsible for a phenomenon relating to the Earth and the Sun but they confused the cause of the length of Earth's year with the cause for day and night.

Year 10

A modified version of this item was also administered to Year 10 students. In this case, the item forms part of the *Eclipses* item set that explored several aspects of the relationship between Earth, the sun and the moon, including seasons and eclipses (ACSSU115). The distractors and scientific terminology in this item were changed to reflect the curriculum expectations for Year 10 students. However, the item still targets the same fundamental understanding.

Figure 6.5
Exemplar item 5 with a focus on *Earth and space sciences* sub-strand


Which of the following causes night and day?

- tilt of the Earth's axis
- rotation of the Earth on its axis
- revolution of the Sun around the Earth
- revolution of the Earth around the Sun

Strand	Science Understanding	**Sub-strand**	Earth and space sciences
Cognitive dimension	Knowing and using procedures	**Item type**	Multiple choice
Australian Curriculum: Science Content Description	Earth's rotation on its axis causes regular changes, including night and day (ACSSU048, Year 3)		

Close to two thirds (65 per cent) of Year 10 students responded correctly to this item. Analogous to the responses in the Year 6 assessment, the most frequently selected false option was *revolution of the Earth around the Sun* (22 per cent), followed by *revolution of the Sun around the Earth* (10 per cent) and *tilt of the Earth's axis* (4 per cent).

As with Year 6 students, the 22 per cent of students who selected option 4 were demonstrating a recognition that Earth's orbit around the Sun is responsible for a phenomenon relating to Earth and the Sun but they confused the cause of the length of Earth's year with the cause for day and night.

The small percentage of students (10 per cent) who selected option 3 *revolution of the Sun around the Earth* are still indicating the misconception that the solar system is geocentric instead of heliocentric.

These surprising and, some may even argue, worrying results should give teachers valuable insights about the kind of misconceptions students may have about the relationship between Earth, the sun and the moon.

To support the development of students' understanding of this relationship and its effects on everyday phenomena on Earth, teachers may consider using one or more of the following activities:

- modelling the relative sizes, distances and movements of the sun, Earth and the moon
- letting students enact the relative movements of the sun, Earth and the moon
- exploring computer models and virtual reality tours of the solar system
- investigate the causes of everyday phenomena such as day and night, seasons, eclipses and tides
- exploring how cultural stories of Aboriginal and Torres Strait Islander peoples explain the cyclic phenomena involving the sun, the moon and stars, and how those explanations differ from contemporary science understanding
- exploring different calendars and seasonal changes
- investigate the Apollo lunar missions as a context for understanding the relative sizes, distances and movements of Earth and moon
- researching Aboriginal and Torres Strait Islander peoples' understanding of the night sky and its use for timekeeping purposes as evidenced in oral cultural records, petroglyphs, paintings and stone arrangements.

Physical sciences

The key concepts developed within the *Physical sciences* sub-strand are forces that affect the behaviour of objects: energy can be transferred and transformed from one form to another.

Through this sub-strand, students gain an understanding of how an object's motion (direction, speed and acceleration) is influenced by a range of contact and non-contact forces such as friction, magnetism, gravity and electrostatic forces. They develop an understanding of the concept of energy and how energy transfer is associated with phenomena involving motion, heat, sound, light and electricity. They appreciate that concepts of force, motion, matter and energy apply to systems ranging in scale from atoms to the universe itself. *(Australian Curriculum: Science; Structure)*

Table 6.4 shows the nine content descriptions that were assessed from the *Physical sciences* sub-strand and a sample of the item descriptions for each content description.

Table 6.4
Physical sciences content descriptions that were assessed in 2018

Content description and year	Item description
Heat can be produced in many ways and can move from one object to another (ACSSU049, Year 3)	• recognises that heat can move from one object to another
Forces can be exerted by one object on another through direct contact or from a distance (ACSSU076, Year 4)	• identifies that friction is reduced for maglev trains
Light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080, Year 5)	• determines the position of the sun to form a shadow
Electrical energy can be transferred and transformed in electrical circuits and can be generated from a range of sources (ACSSU097, Year 6)	• describes the energy transformation in a given electrical circuit
Change to an object's motion is caused by unbalanced forces, including Earth's gravitational attraction, acting on the object (ACSSU117, Year 7)	• identifies the interaction of forces during a rocket launch • identifies the gravitational force acting on an astronaut
Energy appears in different forms, including movement (kinetic energy), heat and potential energy, and energy transformations and transfers cause change within systems (ACSSU155, Year 8)	• selects correct explanation for what happens during an energy transformation
Energy transfer through different mediums can be explained using wave and particle models (ACSSU182, Year 9)	• identifies why sound cannot be heard in the vacuum of space
Energy conservation in a system can be explained by describing energy transfers and transformations (ACSSU190, Year 10)	• explains why the bounce height of a ball is less than its drop height in terms of energy and forces
The motion of objects can be described and predicted using the laws of physics (ACSSU229, Year 10)	• identifies the unit of force

Year 6

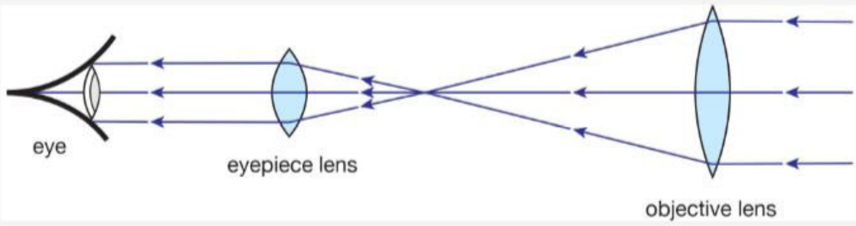
In Year 5, *Physical sciences* aims to develop students' understanding of the phenomenon of light. Students are encouraged to investigate some of the properties and behaviours of light, such as the formation of shadows, absorption, reflection and refraction (ACSSU080).

Exemplar item 6, which was part of the *Our solar system* item set, which explored our solar system and was described in more detail in the previous section. This item targeted students' understanding of some of the properties of light and their knowledge of the associated scientific terminology. This item is situated at level 4 of the NAP–SL scale.

Figure 6.6
Exemplar item 6 with a focus on *Physical sciences* sub-strand

For centuries, people have looked at the solar system using telescopes.

This image shows the path of light through an early telescope.



What property of light does this telescope use?

- absorption
- reflection
- refraction

Strand	Science Understanding	**Sub-strand**	Physical sciences
Cognitive dimension	Knowing and using procedures	**Item type**	Multiple choice
Australian Curriculum: Science Content Description	Light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080, Year 5)		

While one could argue that this item does not allow students to demonstrate their understanding of the properties of light to any great depth, it does address two important aspects of science literacy:

- familiarity with scientific vocabulary
- understanding of the scientific concept or phenomenon denoted by that vocabulary.

To respond correctly to this item, a student would have to

1. recall the meaning of the scientific term refraction,
2. understand that refraction involves light changing direction when passing from one medium to another, and
3. be able to recognise that the diagram is depicting an example of refraction.

One third of Year 6 students responded correctly to this item. Forty per cent of students selected *reflection* instead of *refraction* as their response, which may, at least in part, be attributed to the close similarity between the two terms. Another 28 per cent of students considered *absorption* to be the correct answer.

The selection of *reflection* over *refraction* may also be attributed to a recognition that a lens can cause a change to light as it passes through it, but they have confused the ability of lens to bend or refract light with the ability of mirrors to reflect light. The use of mirrors and lenses by teachers and students when covering this concept may contribute to the confusion demonstrated by the students.

To support the development of students' understanding of the fundamental properties of light, teachers may consider using one or more of the following activities:

- investigating optical instruments such as eye glasses, periscopes, telescopes and microscopes, and how they rely on various properties of light
- using lenses and mirrors to see the effect they can have on light rays
- drawing simple labelled ray diagrams to show the paths of light from a source to our eyes
- classifying materials as transparent, opaque or translucent, based on whether light passes through them or is absorbed
- recognising Aboriginal and Torres Strait Islander peoples' understanding of refraction as experienced in spear fishing and in shimmering body paint, and of absorption and reflection as evidenced by material selected for construction of housing.

Year 10

One of the most important concepts of the *Physical sciences* sub-strand is that of 'energy'. While students explore certain forms of energy, such as light, sound and heat, in the early primary years, energy as a physical quantity that can appear in different forms, be transferred from one object to another and transformed from one form to another, is first introduced in Year 6 within the context of electricity (ACSSU097). These ideas are revisited in more rigorous terms and at greater depth in Year 8 with *Energy appears in different forms, including movement (kinetic energy), heat and potential energy, and energy transformations and transfers cause change within systems* (ACSSU155), in Year 9 with *Energy transfer through different mediums can be explained using wave and particle models* (ACSSU182) and in Year 10 with *Energy conservation in a system can be explained by describing energy transfers and transformations* (ACSSU190).

Exemplar item 7 was part of the *Blast Off!* item set that explored the context of space travel and some of the important chemical and physical processes and phenomena encountered in this enterprise. This item targeted students' understanding of how energy can be transferred from one object to another through different mediums and by different mechanisms. This item is situated at level 5 of the NAP–SL scale.

Figure 6.7
Exemplar item 7 with a focus on *Physical sciences* sub-strand

Use the dropdown menus to identify each type of heat transfer.

The temperature around an astronaut can vary between 600 °C in the sunshine and -160 °C in the shadows.

Out in space, heat cannot be transferred by [▼] Heat can be lost only by [▼] when objects touch the space suit or by [▼]

Strand	Science Understanding	**Sub-strand**	Physical sciences
Cognitive dimension	Knowing and using procedures	**Item type**	Inline choices
Australian Curriculum: Science Content Description	Energy transfer through different mediums can be explained using wave and particle models (ACSSU182, Year 9)		

Like exemplar item 6 discussed in the previous section, a successful response to this item requires students not only to have a basic understanding of the physical phenomena described, but also to be familiar with the scientific terminology used for those phenomena. To answer correctly, a student would have to understand two fundamental aspects of the concept of energy and their (similar sounding) technical terms:

- Energy can come in different forms (in this case in the form of radiation or moving particles) and can change *(transform)* from one form to another.
- Flow *(transfer)* of energy from one object to another can happen through different mechanisms, which may or may not require a medium.

Further, the student would have to know the terms used for the three different mechanisms and to understand their essential characteristics:

- *Conduction* requires direct contact between the objects so that the kinetic energy of their constituting particles can be transferred from one to the other.
- *Convection* requires a medium where particles can flow in bulk from one place to another, thus ‘carrying’ their kinetic energy with them.
- *Radiation* is a form of energy that does not require a medium to travel from one object or place to another.

One quarter of Year 10 students selected the correct mode of heat transfer for all three interactions. Looking at each interaction individually, it is interesting to note that students were most successful in determining the correct mode for the last one, that is *radiation* (51 per cent). Almost one-third of students chose the correct option for the first interaction *(convection)* and 44 per cent for the second *(conduction)*. This may be at least partly because the concepts underlying those phenomena require a deeper understanding of the particle model of matter, as well as the fact that the two terms are more easily confused.

To support the development of students' understanding of energy transfer and transformation, teachers may consider using one or more of the following activities:

- investigating the transfer of heat in terms of convection, conduction and radiation, and identifying situations in which each occurs
- understanding the processes underlying convection and conduction in terms of the particle model
- exploring contexts in which heat transfer by convection plays a major role, such as weather phenomena, ocean currents and the movement of tectonic plates
- exploring contexts in which energy transfer by radiation plays a major role, such as solar energy generation, microwave ovens, Wi-Fi technology and laser applications
- investigating aspects of heat transfer and conservation in the design of Aboriginal and Torres Strait Islander peoples' bedding and clothing in the various climatic regions of Australia.

Science as a Human Endeavour

The *Science as a Human Endeavour* strand seeks to develop concepts related to the nature of science. Through science, humans seek to improve their understanding and explanations of the natural world. Science involves the construction of explanations based on evidence and science knowledge can be changed as new evidence becomes available. Science influences society by posing, and responding to, social and ethical questions, and scientific research is itself influenced by the needs and priorities of society.

This strand highlights the development of science as a unique way of knowing and doing, and the importance of science in contemporary decision-making and problem-solving. It acknowledges that in making decisions about science practices and applications, ethical and social implications must be considered. This strand also recognises that science advances through the contributions of many different people from different cultures and that there are many rewarding science-based career paths. This strand provides context and relevance to students and to our broader community. *(Australian Curriculum: Science; Structure)*

Table 6.5 shows the nine content descriptions that were assessed from the *Science as a Human Endeavour* strand and a sample of the item descriptions for each content description.

Table 6.5
Science as a Human Endeavour content descriptions that were assessed in 2018

Content description and year	Item description
Science knowledge helps people to understand the effect of their actions (ACSHE051 & ACSHE062, Year 3 & 4)	• explains why wood is a good material for stirring hot food, based on its heat conducting properties
Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081 & ACSHE098, Year 5 & 6)	• shows awareness that science involves using evidence to develop explanations of events • explains how the investigation models how a heron catches its food
Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083 & ACSHE100, Years 5 & 6)	• recommends the best type of a ball for handball based on the results of an investigation • describes advantages and disadvantages of burning rubbish
Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available (ACSHE119 & ACSHE134, Years 7 & 8)	• identifies evidence as the reason why scientists change and accept new theories
People use science understanding and skills in their occupations, and these have influenced the development of practices in areas of human activity (ACSHE121 & ACSHE136, Years 7 & 8)	• identifies that physicists study forces and motion
Solutions to contemporary issues that are found using science and technology may impact on other areas of society and may involve ethical considerations (ACSHE120 & ACSHE135, Years 7 & 8)	• classifies management strategies to reduce malaria
People use scientific knowledge to evaluate whether they accept claims, explanations or predictions; and advances in science can affect people's lives, including generating new career opportunities (ACSHE160 & ACSHE194, Years 9 & 10)	• uses data from an investigation as evidence for the decision to change the shape of artificial glaciers • selects two benefits for society from space research

Year 6

At primary level, the sub-strand *Nature and development of science* deals with the questions of how scientific knowledge is created and who contributes to that knowledge. The sub-strand *Use and influence of science* focusses on how scientific knowledge is applied to solve problems and inform personal and community decisions.

Exemplar item 8 was part of the *Early Warning!* item set that explored the context of tsunamis as examples of sudden geological changes that can affect Earth's surface and introduced students to the concept of tsunami early warning systems.

Figure 6.8
Exemplar item 8 with a focus on the *Science as a Human Endeavour* strand

Governments in areas that are prone to tsunamis have to develop tsunami management plans. They have to consider many factors when developing these plans.

What is **one** factor they would need to consider about the **people** that live in the area? (1 mark)

What is **one** factor they would need to consider about the **buildings** that are in the area? (1 mark)

Strand	Science as a Human Endeavour	**Sub-strand**	Use and influence of science
Cognitive dimension	Reasoning, analysing and evaluating	**Item type**	Extended text
Australian Curriculum: Science Content Description	Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083 & ACSHE100, Years 5 & 6)		

This item exemplified the idea that science is used to inform community decisions. It prompted students to think about how a tsunami might affect the people and buildings in an at-risk area. In an extended text response, students were asked to identify two factors that would need to be considered when devising a tsunami management plan.

The first factor related to people living in an at-risk area, such as:

- size of population
- age/mobility of people
- access to technology/communications
- how to evacuate people or where to evacuate people to.

The second factor related to the buildings in the area, such as:

- location of buildings (elevation/distance from shore)
- age of buildings/stability/building materials
- size/number of floors or ease to evacuate.

Just over one-third of Year 6 students received full credit for this item by correctly identifying two factors, and another one-third of students identified one factor to receive partial credit. Students who correctly identified two factors were performing at level 4, whilst those students who only identified one factor were performing at level 2.

Typical correct student responses included *"They need to fing the fastest route to get people out of the area"* and *"How tall the buildings are, as they could be knocked over and then create distasters for the things around them"*. One in four students were not awarded any credit for this item due to irrelevant, incorrect or vague responses, such as *"tell them to move inland"* or *"most buildings would get damaged"*.

To develop students' thinking about ideas relating to the nature of science, teachers may consider embedding *Science as a Human Endeavour* content into their teaching of the scientific concepts prescribed by the *Science Understanding* strand. This may be achieved by prompting students to research questions such as:

- How do we know this?
- Who contributed to that knowledge?
- Why is this knowledge important?
- Which real-world problems have been solved using this knowledge?

By contemplating questions such as the above, students may gain a better understanding of the purpose for learning science and may engage more readily with the content. Teachers may consider using one or more of the following activities that are given as examples of embedding the idea that *'Scientific knowledge is used to inform personal and community decisions'* (ACSHE083, ACSHE100) into the teaching of disciplinary content:

- investigating how Torres Strait Islander peoples and Aboriginal peoples of arid regions of Australia use scientific knowledge to manage precious water resources (Year 5, *Chemical sciences*, ACSSU077)
- considering how decisions are made to grow particular plants and crops depending on environmental conditions (Year 5, *Biological sciences*, ACSSU043)
- discussing how modern approaches to fire ecology in Australia are being informed by Aboriginal and Torres Strait Islander peoples' traditional ecological knowledge and fire management practices (Year 6, *Biological sciences*, ACSSU094)
- recognising that science can inform choices about where people live and how they manage natural disasters (Year 6, *Earth and space sciences*, ACSSU096)
- considering how scientific knowledge informs personal and community choices regarding the use of sustainable sources of energy (Year 6, *Physical sciences*, ACSSU097).

Year 10

At secondary level, the same concepts relating to Science as a Human Endeavour are extended and explored in greater depth. In the sub-strand *Use and influence of science*, students are exposed to the idea that scientific knowledge and technological developments may impact on other areas of society and may involve ethical considerations. In the sub-strand *Nature and development of science*, the importance of evidence is stressed as being the prime motivator for reviewing, refining or even replacing long-held scientific understandings, models and theories. It also acknowledges the role of technological advancements in creating new evidence.

Exemplar item 9 was part of the *Floating plates* item set that explored the structures and processes occurring in the Earth's crust. In the stimulus, students are given a brief historical perspective of the various scientific ideas put forward to explain the shape and distribution of the major landmasses on our planet. This is followed by a high-level description of the central idea underpinning the theory of plate tectonics, which describes our current best understanding of this question.

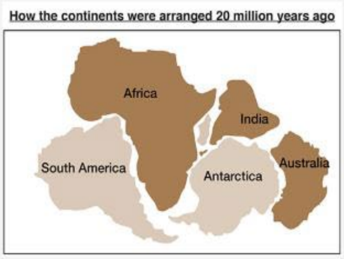
This item targets students' understanding of how scientific theories develop. Students were asked to choose the best explanation for why scientists eventually abandon one theory and accept another. This item is situated at level 2 of the NAP–SL scale.

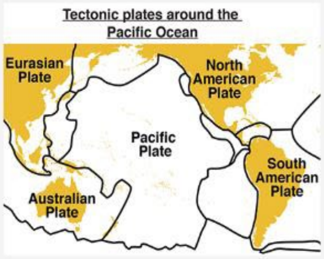
Figure 6.9
Exemplar item 9 with a focus on the *Science as a Human Endeavour* strand

Floating plates

Since the early 1600s, scientists have been suggesting that the continents are moving and drifting on Earth's surface.

In the early 1900s, the theory of continental drift attempted to explain why the continents looked as though they would fit together like puzzle pieces.





With the development of new technologies to collect data, scientists have expanded their thinking regarding the motion of continents. This new data led to the theory of plate tectonics.

Plate tectonics is the theory that Earth's crust is divided into several continental plates that move over the Earth's mantle over many millions of years.

There were several theories in the past about how the continents have moved and formed. The currently accepted theory is plate tectonics.

Which is the best explanation for why scientists accept new theories?

- Scientists do more experiments.
- Scientists discover new evidence.
- Scientists are able to tell more people about their opinions.
- Scientists today are much cleverer than scientists in the past.

Strand	Science as a Human Endeavour	**Sub-strand**	Nature and development of science
Cognitive dimension	Knowing and using procedures	**Item type**	Multiple choice
Australian Curriculum: Science Content Description	Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available (ACSHE119 & ACSHE134, Year 7 & 8)		

A large majority of Year 10 students (84 per cent) correctly identified the discovery of new evidence as the primary reason for scientists to accept a new theory. Eight per cent considered scientists doing more experiments to be the correct answer, four per cent opted for scientists being able to tell more people about their opinions and four per cent believed that scientists of today are much cleverer than those in the past.

The idea that scientific knowledge is refined as new evidence becomes available (ACSHE119 & ACSHE134) is central to the discipline of science. It is developed further in Years 9 and 10 through the content description *'Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community'* (ACSHE157 & ACSHE191). While this idea may seem an obvious feature of scientific practice to professional scientists, students are often unaware of the tentative nature of scientific knowledge.

Students also hold misconceptions regarding the length of time it takes for a new idea to be accepted by the scientific community or by society at large and by what mechanisms this shift of understanding occurs.

To support the development of students' understanding of how scientific knowledge develops, teachers may consider using one or more of the following activities, which are given as examples of embedding the idea that scientific knowledge, models and theories develop over time into the teaching of disciplinary content:

- investigating developments in the understanding of cells and how this knowledge has impacted on areas such as health and medicine (Year 8, *Biological sciences,* ACSSU149)
- investigating how prior to germ theory Aboriginal and Torres Strait Islander peoples used their scientific observations to develop traditional medicines to treat wounds and infections of the skin (Year 9, *Biological sciences*, ACSSU175)
- investigating how fire research has evaluated the effects of traditional Aboriginal and Torres Strait Islander peoples' fire regimes and how these findings have influenced fire management policy throughout Australia (Year 9, *Biological sciences*, ACSSU176)
- investigating the historical development of models of the structure of the atom or the work of scientists such as Ernest Rutherford, Pierre Curie and Marie Curie on radioactivity and subatomic particles (Year 9, *Chemical sciences*, ACSSU177)
- investigating how the theory of plate tectonics developed, based on evidence from sea floor spreading and occurrence of earthquakes and volcanic activity (Year 9, *Earth and space sciences*, ACSSU180)
- considering the role of different sources of evidence including biochemical, anatomical and fossil evidence for evolution by natural selection (Year 10, *Biological sciences*, ACSSU185)
- considering the role of science in identifying and explaining the causes of climate change (Year 10, *Earth and space sciences,* ACSSU189).

Science Inquiry Skills

Science inquiry involves identifying and posing questions; planning, conducting and reflecting on investigations; processing, analysing and interpreting evidence; and communicating findings. This strand is concerned with evaluating claims, investigating ideas, solving problems, drawing valid conclusions and developing evidence-based arguments. The skills students develop give them the tools they need to achieve deeper understanding of the science concepts and how scientific thinking applies to these understandings. *(Australian Curriculum: Science; Structure).*

The Australian Curriculum: Science puts a strong emphasis on developing students' science inquiry skills. Through conducting their own research, laboratory and field investigations, students gain an understanding of how scientific knowledge is created. Such activities also provide opportunities for students to develop important skills such as collecting, organising and analysing data, establishing relationships between variables and determining trends, estimating uncertainties and assessing the quality of their data, critically evaluating methods, drawing conclusions and communicating results.

Planning and conducting

This sub-strand aims to develop students' skills in making decisions about how to investigate or solve a problem and how to carry out an investigation, including the collection of data.

Table 6.6 shows the four content descriptions that were assessed from the *Planning and conducting* sub-strand and a sample of the item descriptions for each content description.

Table 6.6
Planning and conducting content descriptions that were assessed in 2018

Content description and year	Item description
Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS086 & ACSIS103, Years 5 & 6)	• provides a reason for wearing safety goggles • sequences the steps in an investigation • selects appropriate equipment for the investigation • recognises a step required to make an investigation valid
Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087 & ACSIS104, Years 5 & 6)	• identifies the variable that will be changed in the investigation • classifies variables in an investigation as 'to be changed', 'to be measured' and 'to be kept the same' • converts centimetres to metres
Measure and control variables, select equipment appropriate to the task and collect data with accuracy (ACSIS126 & ACSIS141, Years 7 & 8)	• selects the most accurate piece of equipment to measure volume • classifies the variables in each investigation as independent, dependent and controlled • identifies the independent variable in the investigation
Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS165 & ACSIS199, Years 9 & 10)	• designs and describes an investigation identifying independent, dependent and controlled variables and explains how to ensure accuracy or reliability

Year 6

An important step in planning an experiment is to decide which variable to change freely (the independent variable) and which variable to measure (the dependent variable). A crucial additional aspect in this decision process is the realisation that there may be a variety of other factors (variables) that can affect the outcome of the experiment. Consequently, these variables need to be identified and kept the same (controlled) during the experiment in order to keep it a ‘fair test’. This idea is first introduced in Year 3, and it remains a strong focus of skill development throughout upper primary and secondary stages.

Exemplar item 10 is part of an inquiry task in which students are taken through the major stages of an experimental investigation designed to determine the best type of ball for a game of handball. The investigation is based on the premise that the bounciest ball would be optimal for the game and that students can determine this by measuring the bounce heights of various types of balls. This item targeted the students’ ability to identify the different types of variables that need to be considered when planning the described investigation.

Figure 6.10
Exemplar item 10 with a focus on the *Planning and conducting* sub-strand

The students are thinking about the variables for their investigation. They want to plan a fair test.

Click on the boxes to select **all** the **variables** the students should **keep the same**.

- [ ] type of ball used
- [ ] how the ball is dropped
- [ ] height the ball is dropped from
- [ ] surface the ball is dropped onto
- [ ] height of the ball bounce

Strand	Science Inquiry Skills	**Sub-strand**	Planning and conducting
Cognitive dimension	Knowing and using procedures	**Item type**	Multiple choices
Australian Curriculum: Science Content Description	Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087 & ACSIS104, Year 5 & 6)		

This item illustrates performance at level 5 of the NAP–SL scale. Students were given a list of variables and asked to identify all the variables that need to be kept the same during the experiment.

Twenty-five per cent of Year 6 students correctly identified all three variables that need to be controlled (kept the same or constant) in this experiment; namely, how the ball is dropped, height the ball is dropped from, and surface the ball is dropped onto. Nineteen per cent of students selected only one or two of these options while still recognising that the type of ball used was the independent variable and the height of the ball bounce was the dependent variable and so are not being kept the same in this experiment. However, the majority (57 per cent) of students included either the independent variable or the dependent variable or both in their response.

Year 10

A slightly modified version of this item was also administered to Year 10 students. In this version, students were asked to categorise each variable as either ‘controlled’, ‘dependent’ or ‘independent’. A successful response to this item is not solely predicated on students being able to differentiate between each of the technical terms for the variables, as the meaning of each type of variable is explained in the stem of the item.

Figure 6.11
Exemplar item 11 with a focus on the *Planning and conducting* sub-strand

The students are thinking about the variables in their investigation.

They know that investigations involve an independent (changed) variable, a dependent (measured) variable and controlled variables which are kept the same.

Use the dropdown menus to **classify** the variables in their investigation.

Variable	Type of variable
surface the ball is bounced on	
height of the bounce	
type of ball used	
height the ball is dropped from	

Strand	Science Inquiry Skills	**Sub-strand**	Planning and conducting
Cognitive dimension	Knowing and using procedures	**Item type**	Inline choices
Australian Curriculum: Science Content Description	Measure and control variables, select equipment appropriate to the task and collect data with accuracy (ACSIS126 & ACSIS141, Year 7 & 8)		

Thirty-four per cent of Year 10 students were able to correctly classify each of the variables. The success rates for each individual variable ranged from 57 per cent (type of ball used) to 68 per cent (height of the bounce). This result suggests that about a third of Year 10 students have a firm understanding of the various types of variables to be considered in an experimental investigation and between one half to two-thirds can be considered as having partial understanding.

To support the development of students’ understanding of the concept of a ‘fair test’ and their ability to plan an experimental investigation, teachers may consider using one or more of the following activities:

- discussing in groups how investigations can be made as fair as possible
- challenging students to find as many variables as possible that may have an influence on the outcome of the planned experiment and discussing how they can be kept the same
- linking the concept of dependent and independent variables to the idea of cause and effect by framing the investigation as measuring the effect of changing one chosen variable
- critiquing experimental investigations where the control of variables has not been executed appropriately and discussing the effects of this failure on the investigations’ conclusions.

Processing and analysing data and information

This sub-strand aims to develop the skills involved in representing data in meaningful and useful ways; identifying trends, patterns and relationships in data; and using this evidence to justify conclusions.

Table 6.7 shows the seven content descriptions that were assessed from the *Processing and analysing data and information* sub-strand and a sample of the item descriptions for each content description.

Table 6.7
Processing and analysing data and information content descriptions that were assessed in 2018

Content description and year	Item description
Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends (ACSIS057 & ACSIS068, Years 3 & 4)	• describes the trend in tabulated data • extracts information from a table • uses simple column graphs to represent data • provides labels on a column graph
Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS090 & ACSIS107, Years 5 & 6)	• calculates the missing average in a data table • uses a table to order the results for a series of trials • selects the most suitable graph to display the results • uses a line graph to interpolate data
Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS090 & ACSIS107, Years 5 & 6)	• uses a graph to rank the results • extracts information from a life cycle diagram • uses a diagram to complete a flowchart of blood circulation • makes a comparison based on data provided in a table
Compare data with predictions and use as evidence in developing explanations (ACSIS218 & ACSIS221, Years 5 & 6)	• uses a table to confirm the prediction of an investigation and refers to relevant data as evidence • uses a table to interpret results and draws a conclusion • draws a conclusion based on evidence provided

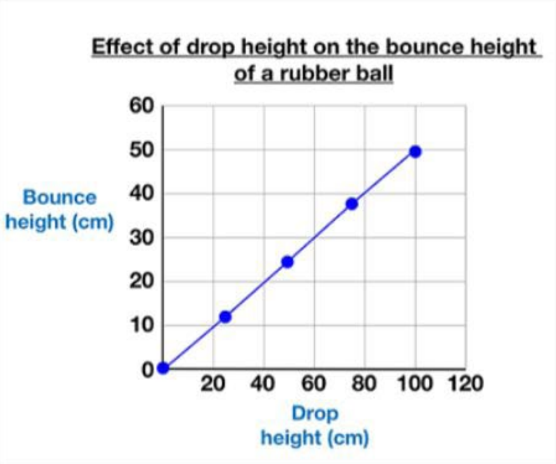
Content description and year	Item description
Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate (ACSIS129 & ACSIS144, Years 7 & 8)	• identifies a correct prediction, trend and conclusion based on data from a graph • uses diagrams to describe lunar and solar eclipses • calculates missing data in a table • interprets a diagram of the life cycle of a star
Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS130 & ACSIS145, Years 7 & 8)	• draws conclusions from tabulated results • sequences the events during a crash test
Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies (ACSIS169 & ACSIS203, Years 9 & 10)	• uses a diagram to calculate available energy • uses a graph to complete the equation for speed
Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS170 & ACSIS204, Years 9 & 10)	• suggests the cause for an abnormal result in a trial • uses diagram to identify that earthquakes occur at plate boundaries • uses a diagram to sequence the processes that occur at a subduction zone • identifies two conclusions from the described scenario about seat belts

Year 6

When analysing data from a scientific investigation, a crucial skill is the ability to read the correct information from tables and graphs. Mastering this skill is a prerequisite for being able to correctly determine trends in data, to estimate values between measured data points or beyond the measurement range, and, ultimately, to draw the right conclusions from the results of an investigation.

Figure 6.12
Exemplar item 12 with a focus on the *Processing and analysing data and information* sub-strand

The second group of students carried out their investigation and then graphed the results.



Using the graph, what was the bounce height when the ball was dropped from 40 cm?

- 10 cm
- 20 cm
- 40 cm
- 80 cm

Strand	Science Inquiry Skills	**Sub-strand**	Processing and analysing data and information
Cognitive dimension	Knowing and using procedures	**Item type**	Multiple choice
Australian Curriculum: Science Content Description	Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS090 & ACSIS107, Year 5 & 6)		

In exemplar item 12, students are given a standard line graph displaying the relationship between an independent and dependent variable. By reading the information from the graph, students are asked to identify the expected value of the bounce height (dependent variable) when given a value for the drop height (independent variable) that lies between two measurement points. Trend line and gridlines have been included in the graph and values have been chosen to avoid any possible ambiguity in the correct answer. This item is situated at level 3 of the NAP–SL scale.

Fifty-four per cent of Year 6 students identified the expected value *(20 cm)* correctly. Twenty-nine per cent of students chose *80 cm* as their response, indicating that they confused the identities of x-axis and y-axis when reading the information. Thirteen per cent of students opted for *40 cm* and four per cent selected *10 cm.*

Year 10

The same item was also administered to Year 10 students, who demonstrated a higher mastery of this skill. Eighty per cent of Year 10 students answered this item correctly. Fourteen per cent of students selected *80 cm* and this suggests that a considerable proportion of students still struggled with identifying the correct axes used to represent dependent and independent variables. Four per cent of students opted for *40 cm* and two per cent for *10 cm.*

It could be argued that this item targets a pure numeracy skill rather than a science inquiry skill. However, given the central role of data processing and analysis in science, the ability to correctly read information from a graph is essential for developing the full range of science inquiry skills, including those that follow data analysis, such as drawing conclusions and evaluating the quality of data and methods.

In this context, it is important to note that in the Australian Curriculum: Mathematics linear and non-linear relationships between variables and their graphical representations are not formally explored until the secondary school years. At primary level, the *Data representation and interpretation* sub-strand of the *Australian Curriculum: Mathematics* focuses primarily on the representation of statistical and categorical data, usually in the form of column graphs. Consequently, it is likely that primary students' familiarity with line graphs and their ability to construct and use them may develop exclusively through appropriate learning experiences in science classes.

To support the development of students' ability to correctly interpret data presented in graphical form, teachers may consider using one or more of the following activities:

- discussing how to best graph data presented in a table
- understanding different types of graphical representation and considering their advantages and disadvantages
- discussing the reasons for using column graphs for categorical or discrete data and line graphs for continuous data
- discussing the conventions commonly used in graphical representations of scientific data, such as using the x-axis for the independent variable and the y-axis for the dependent variable or displaying units in the axis captions
- designing and constructing appropriate graphs to represent data collected from students' own investigations and from secondary sources
- analysing graphs for trends and patterns and exploring relationships between variables using spreadsheets and graphing software
- exploring how different representations can be used to show different aspects of relationships, processes or trends.

Evaluating

This sub-strand aims to develop the skills involved in evaluating the quality of available evidence and the merit or significance of a claim, proposition or conclusion with reference to that evidence.

Table 6.8 shows the four content descriptions that were assessed from the *Evaluating* sub-strand and a sample of the item descriptions for each content description.

Table 6.8
Evaluating content descriptions that were assessed in 2018

Content description and year	Item description
Reflect on investigations, including whether a test was fair or not (ACSIS058 & ACSIS069, Years 3 & 4)	• identifies why an investigation is a fair test • provides a reason why an investigation may not be fair
Reflect on and suggest improvements to scientific investigations (ACSIS091 & ACSIS108, Years 5 & 6)	• suggests a method to increase the accuracy of measurements • identifies two reasons why measurements may be difficult in a given investigation • identifies a suitable change to an experimental design • identifies a way to improve the quality of the results
Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements (ACSIS131 & ACSIS146, Years 7 & 8)	• identifies a way to improve reliability in the investigation • identifies a reason for multiple trials in an investigation
Critically analyse the validity of information in primary and secondary sources and evaluate the approaches used to solve problems (ACSIS172 & ACSIS206, Years 9 & 10)	• recognises that government websites are the most reliable sources of information

When reflecting on a scientific investigation, it is important to evaluate the reliability of the measured data and to consider ways in which the accuracy of data collection could be improved. This skill requires not only an awareness of the inherent uncertainty of measurements but also some technical and scientific knowledge about possible alternative measuring techniques, as well as an intuitive knowledge about the relative magnitudes of uncertainty associated with these methods. Improving an experimental design, even a hypothetical one, also engages students' critical and creative thinking skills.

In exemplar item 13, students were asked to suggest changes to the experimental design of an investigation that would improve the accuracy of their measurements. This item is situated at level 5 of the NAP–SL scale. It formed part of the inquiry task on the bounce heights of different types of balls.

Figure 6.13
Exemplar item 13 with a focus on the *Evaluating* sub-strand

What change could the students make to the design of their investigation to help them make more accurate measurements? (1 mark)

Strand	Science Inquiry Skills	**Sub-strand**	Evaluating
Cognitive dimension	Reasoning, analysing and evaluating	**Item type**	Extended text
Australian Curriculum: Science Content Description	Reflect on and suggest improvements to scientific investigations (ACSIS091 & ACSIS108, Years 5 & 6)		

Eighteen per cent of Year 6 students successfully suggested a valid and practical method that would increase the accuracy of the measurements. Typical correct student responses included *'they could bounce it the same way but film it so they could replay and measure the height of the bounce on video'* and *'They could use lasers to measrue our could put the measurements on the wall so when the ball pass the mark you tell how high it went'.*

Irrelevant or vague responses, such as *'Get a ladder and lots of rulers'* or *'Count the amount of times the ball bounces before it stops'* did not receive credit. Also, impractical suggestions, such as *'slow down the pace of the drop'* or *'they could drop all the balls at the same time and from the same hieght to see what ball bounced the highest'* received a zero mark.

The same item was also administered to Year 10 students. Thirty-six per cent of Year 10 students answered this item correctly. This may be an indication that, despite their wide distribution among adults as well as students, handheld video-recording devices are not yet widely considered as potential measurement tools.

To support the development of students' skills in evaluating experimental designs and to foster their critical and creative thinking skills in designing and improving measurement techniques, teachers may consider using one or more of the following activities:

- working collaboratively to identify flaws in experimental investigations, including where testing was not fair
- reflecting on students' own investigations, discussing improvements to the methods used, and explaining how these methods would improve the quality of the data obtained
- identifying and considering indicators of the quality of the data when analysing results, such as the spread of values in repeated measurements
- critiquing actual or simulated investigation designs and measurement techniques used by others
- researching technological advancements in measurement techniques
- exploring video-based measurement apps available for tablets and smart phones.

Year 10

While, at primary level, the *Science Inquiry Skills* strand focuses on students' own investigations, at secondary level it seeks to also develop students' skills in critically evaluating the validity and reliability of scientific information in secondary sources.

Exemplar item 14 formed part of an item set that explored students' understanding of the structure of atoms and asked students to interpret information about elements and isotopes as conventionally presented in the periodic table of elements. This item targeted students' ability to gauge the reliability of information given in secondary sources based only on the title, URL and the summary information given in a typical web-search result. Given the huge number of sources that can be accessed through internet search engines and the vast differences in the quality of information they contain, the skill of selecting sources that promise to provide reliable information is a crucial component of secondary scientific research investigations.

Students were presented with four web-search results about radioactive isotopes as they would typically appear in the most commonly used search engines. They were asked to select the source that would be considered as providing the most reliable information. This item is situated at level 3 of the NAP–SL scale.

Figure 6.14
Exemplar item 14 with a focus on the *Evaluating* sub-strand

Some students wanted to research facts about radioactive isotopes. Here are some of the websites they found.

Applications of Radioisotopes in Different Fields - ...
fiziknota.blogspot.com/2013/01/**applications-of-radioisotopes-in**.html
13/01/2013 · Some **radioisotopes** exist naturally. For example 3H1, 17O8, 40K19. While other **radioisotopes** are produced artificially by ...

What are 3 uses of radioactive isotopes? - Quora
https://www.quora.com/**What-are-3-uses-of-radioactive-isotopes**
Well there are loads of **radioactive isotopes** and I couldn't even name my top **3** favourite because they're all awesome. I'll tell you about a few though: Fluorine-18 ...

Radioisotopes - ANSTO
www.ansto.gov.**au**/NuclearFacts/AboutNuclearScience/**Radioisotopes**
What are **radioisotopes**? **Radioisotopes** are widely used in medicine, industry and scientifi and new **applications** for their use are constantly being developed.

Radioisotopes in Consumer Products - World Nuclear Association
www.world-nuclear.org/.../**radioisotopes-in-consumer-products**.aspx
Radioisotope uses for consumer products. Non-power uses of **nuclear** technology for medicine, industry or transport, information from the **World Nuclear Association**.

Which website would provide the most reliable information?

- fiziknota.blogspot.com
- www.quora.com
- www.ansto.gov.au
- www.world-nuclear.org

Strand	Science Inquiry Skills	**Sub-strand**	Evaluating
Cognitive dimension	Knowing and using procedures	**Item type**	Multiple choice
Australian Curriculum: Science Content Description	Critically analyse the validity of information in primary and secondary sources and evaluate the approaches used to solve problems (ACSIS172 & ACSIS206, Years 9 & 10)		

Sixty-nine per cent of Year 10 students were able to identify *www.ansto.gov.au* as the most reliable source of information. Twenty-one per cent of students considered *www.world-nuclear.org* as the most trustworthy source, five per cent selected *fiziknota.blogspot.com* and five per cent selected *www.quora.com.*

This result indicated that most students were aware of the importance of critically evaluating internet-based sources and were familiar with the cues given in website hostnames. Successful students were able to identify the top-level domain name *.gov* as belonging to a government organisation and, consequently, considered it to be the most trustworthy source. The second-most selected option contained *.org* in the host name, which indicates a public interest registry and/or non-profit organisation. While this type of website can be considered less reliable than a government organisation, it is more trustworthy than the other two options.

To support the development of students' skills in critically analysing the validity and reliability of scientific information in secondary sources, teachers may consider using one or more of the following activities:

- discussing what is meant by 'validity' and 'reliability' and how we can evaluate the trustworthiness of information in secondary sources
- researching the methods used by scientists in studies reported in the media
- judging the validity of science-related media reports and how these reports might be interpreted by the public
- describing how scientific arguments, as well as ethical, economic and social arguments, are used to make decisions regarding personal and community issues.

Concluding comments

The Australian Curriculum: Science provides opportunities for teachers to engage students in the skills, knowledge and understandings, and attitudes associated with science education and practices as set out in the NAP–SL proficiency levels.

The Australian Curriculum: Science content descriptions align with the NAP – Science Literacy concepts, as mapped out in appendix 2, and in the NAP – Science Literacy Assessment Framework, as outlined in appendix 1.

Each of these knowledge and understanding content descriptions, and their associated inquiry skills at each year level can be used by teachers, schools and systems to support the development of student proficiency in science literacy.

The Australian Curriculum: Science is designed to foster knowledge, understanding and skills for students to become scientifically literate individuals who are confident to engage with science-related issues, investigate and explain science phenomena, solve problems, and draw evidence-based conclusions that help them make responsible decisions. It provides a lens through which student performance and proficiency in the NAP – Science Literacy assessment can be viewed, analysed and supported.

Appendices

APPENDIX 1. NAP – SCIENCE LITERACY ASSESSMENT FRAMEWORK

Structure of the assessment framework

The Assessment Framework NAP – Science Literacy 2018 is strongly aligned to the Australian Curriculum: Science. It provides guidance on the content to be assessed (content dimension), the cognitive engagement that is expected of students (cognitive dimension), and the types of assessment tasks and online question types to be included in the assessment. The full assessment framework is published on the NAP website.

Content dimension

The content dimension defines the content domains – the specific subject matter covered in the assessment. The content is organised according to the strands and sub-strands outlined in the Australian Curriculum: Science.

Table A1.1
Strands and sub-strands in the Australian Curriculum: Science

Strand	Sub-strand
Science Understanding	Biological sciences
	Chemical sciences
	Earth and space sciences
	Physical sciences
Science as a Human Endeavour	Nature and development of science
	Use and influence of science
Science Inquiry Skills	Questioning and predicting
	Planning and conducting
	Processing and analysing data and information
	Evaluating
	Communicating

Cognitive dimension

The cognitive dimension describes the targeted thinking skills and intellectual processes as students respond to the assessment tasks.

Item types

Item types describes the type of assessment items and response formats that would be required to capture the variability and different levels of complexity of performance.

Content dimension

The Australian Curriculum: Science includes three strands: *Science Understanding, Science as a Human Endeavour*, and *Science Inquiry Skills.*

Science Understanding

Science Understanding includes the facts, concepts, principles, laws, theories and models that have been established by scientists over time.

The *Science Understanding* strand comprises four sub-strands:

Biological sciences is related to living things. Key concepts include:

- A diverse range of living things have evolved on Earth over hundreds of millions of years.
- Living things are interdependent and interact with each other and their environment.
- The form and features of living things are related to the functions that their body systems perform.

Chemical sciences is related to the composition and behaviour of substances. Key concepts include:

- The chemical and physical properties of substances are determined by their structure at an atomic scale.
- Substances change.
- New substances are produced by rearranging atoms through atomic interactions and energy transfer.

Earth and space sciences is about Earth's dynamic structure and its place in the cosmos. Key concepts include:

- Earth is part of a solar system that is part of a larger universe.
- Earth is subject to change within and on its surface over a range of timescales as a result of natural processes.
- Human use of resources has an impact on Earth's systems on a local and global level.

Physical sciences is related to the nature of forces and motion, matter and energy. Key concepts include:

- Forces affect the behaviour of objects.
- Energy can be transferred and transformed from one form to another.

The framework also includes content sequences for Years 6 and 10. The content sequences for the Science Understanding domain describe the essential elements for each key concept in the domain and, to the extent possible, articulate increasingly more complex ways of thinking about the concept. See appendix 2 for a description of the content sequences with relevant links to the Australian Curriculum: Science.

Table A1.2

Table A1.2 *Science Understanding* content sequences

<table>
<tr><th>Biological sciences</th><th>Chemical sciences</th><th>Earth and space sciences</th><th>Physical sciences</th></tr>
<tr><td>Interdependence of life</td><td rowspan="5">Matter – structure, properties and changes</td><td>Earth in space</td><td rowspan="2">Forces and motion</td></tr>
<tr><td>Flow of matter and energy in ecosystems</td><td>Earth structure and processes</td></tr>
<tr><td>Multi-cellular systems</td><td rowspan="3">Earth’s resources and geochemical cycles</td><td rowspan="3">Energy forms, transfer and conservation</td></tr>
<tr><td>DNA and inherited characteristic</td></tr>
<tr><td>Diversity and evolution</td></tr>
</table>

Science as a Human Endeavour

Science as a Human Endeavour includes understandings about the development of science as a unique way of knowing and doing, and the importance of science in contemporary decision-making and problem-solving.

The *Science as a Human Endeavour* strand comprises two sub-strands:

Nature and development of science covers the key concepts of:

- Science involves the construction of explanations based on evidence, and science knowledge can be changed as new evidence becomes available.
- Current knowledge has developed over time through the actions of many people.
- Developments in science affect technology, and developments in technology affect science.

Use and influence of science covers the key concepts of:

- Science knowledge and applications affect people’s lives.
- Science can be used to inform decisions and actions but, in making decisions about science applications, social implications must also be considered.
- Scientific research is itself influenced by the needs and priorities of society.

Science Inquiry Skills

Science Inquiry Skills is concerned with the practices used to develop scientific knowledge, including questioning, planning and conducting experiments and investigations, collecting and analysing data, drawing critical, evidence-based conclusions, and evaluating and communicating results.

The *Science Inquiry Skills* strand comprises five sub-strands:

Questioning and predicting includes the key abilities of identifying and constructing questions that can be investigated scientifically, proposing hypotheses and suggesting possible outcomes.

Planning and conducting includes the key abilities of making decisions about how to investigate or solve a problem, and carrying out an investigation, including the collection of data.

Processing and analysing data and information includes the key abilities of representing data in meaningful and useful ways, identifying trends, patterns and relationships in data and using this evidence to justify conclusions.

Evaluating includes the key abilities of considering the quality of available evidence and the merit or significance of a claim, proposition or conclusion with reference to that evidence.

Communicating includes the key abilities of conveying information or ideas to others through appropriate representations, text types and modes.

General capabilities

The Australian Curriculum includes seven general capabilities. They encompass knowledge, skills, behaviours and dispositions that can assist students to live and work successfully in the twenty-first century. The capabilities identified as being most relevant and appropriate to the assessment of science, and hence reflected in NAP–SL, include:

Literacy: aspects of the Literacy capability are found within the reading comprehension demands of both the stimuli and the short-response items and the written responses to the extended text items where students demonstrate their level of knowledge and understanding of a given concept and/or skill.

Numeracy: aspects of the Numeracy capability are found within NAP–SL, including the reading and construction of graphs and tables, calculations and measurement, as well as some elements of spacial reasoning.

Information and Communication Technology (ICT): aspects of the ICT capability are found in items that refer to the use of digital technologies during scientific investigations and items that look at how science and technology together have assisted the changes in our knowledge about various scientific phenomena.

Critical and Creative Thinking: aspects of the Critical and Creative Thinking capability arise from important cognitive skills inherent in scientific inquiry.

Items and stimulus could draw on aspects of the Personal and Social capability, the Ethical Understanding capability and the Intercultural Understanding capability, when appropriate.

Cognitive dimension

An important new feature of the NAP–SL 2018 assessment framework is the explicit definition of a cognitive dimension within the assessment of science literacy and across all three content domains. The addition of cognitive dimensions is consistent with many national and international frameworks, such as TIMSS, PISA and NAP – Civics and Citizenship.

The cognitive dimension seeks to make explicit the thinking skills and intellectual processes that will be engaged by students to respond to assessment tasks. The cognitive dimension includes three cognitive processes that underpin what students are required to do in a task.

Tables A1.3 to A1.5 further specify and define the cognitive processes within the three cognitive areas. The tables focus on cognitive processes that can be used to characterise cognitive tasks that students may perform in science assessments (or in real life) when they use science knowledge and skills.

Relevant elements of the Australian Curriculum general capability Critical and Creative Thinking, which are assessable in the context of a large-scale assessment, have been integrated into these tables.

Knowing and using procedures

Knowing and using procedures requires knowledge of facts and definitions as well as the ability to illustrate concepts and generalisations with examples, and to relate science concepts to phenomena and observations. It also includes knowing simple procedures, the ability to perform simple science processes or procedures and the knowledge and use of (practical) skills and procedures.

Table A1.3
Knowing and using procedures

Knowing and using procedures	
Recognise	Make or identify accurate statements about science phenomena, concepts, relationships, procedures or statements about the scientific endeavour; recognise an instance of a concept/entity/ generalisation (e.g. producers or decomposers in a food web)
Define	Identify statements that define particular concepts and content
Describe	Make straightforward observations of features/objects; identify and extract information from simple data sources or diagrams; describe factual information, processes and relationships about science or the scientific endeavour
Illustrate with examples	Identify or provide examples that support/clarify statements about the scientific endeavour or statements about particular science concepts, relationships and theories
Relate	Relate science concepts to phenomena and observations
Use tools and procedures	Demonstrate skills in the use of science equipment, tools, measurement devices/scales, mechanical aspects of constructing and reading graphs and tables

Reasoning, analysing and evaluating

Reasoning, analysing and evaluating requires students to engage in applying knowledge, skills, processes, equipment and methods in familiar and unfamiliar contexts. It also requires students to analyse information and evaluate evidence and arguments with respect to quality and sufficiency of data.

In the context of *Science Inquiry Skills* specifically, this area also encompasses the application of procedural understanding related to inquiry processes (for example, when students need to make decisions about what and when to measure, how many times, and over what time period).

Table A1.4
Reasoning, analysing and evaluating

Reasoning, analysing and evaluating	
Compare/contrast/classify	Identify similarities and differences between objects, processes or ideas; organise and process information; classify objects or processes based on characteristics/properties
Represent	Make representations (e.g. diagrams) to describe and illustrate aspects of concepts, structures, relationships, processes; make or use representations to communicate or find solutions to problems
Collect, analyse and interpret data	Make decisions about variables to be investigated and controlled, measurements to conduct; represent data in tables and graphs using appropriate labelling and scales; identify and summarise patterns in the data; interpolate/extrapolate from data
Make inferences	Make inferences from data, information given and/or own knowledge; give reasons/evidence to support an inference
Predict/explain	Make predictions based on evidence and concepts; give reasons to support predictions; construct and defend explanations based on evidence and/or concepts; transfer knowledge into new contexts by making predictions and constructing explanations in new situations
Analyse information, evidence and arguments	Pose questions to probe assumptions, to identify gaps in information, evidence or arguments, or to investigate ideas or issues; prioritise information/ evidence required to draw a conclusion or to make a decision; identify facts, observations or data that can be used as evidence to support an explanation, conclusion or argument; identify whether there is sufficient evidence to justify a claim, explanation or conclusion; identify evidence needed to decide among competing claims, explanations or solutions; integrate new information or evidence into ideas
Evaluate information, evidence, procedures and arguments	Evaluate information and evidence according to criteria such as relevance, bias, validity and/or reliability; evaluate claims, conclusions and arguments with respect to quality of evidence and reasoning supporting them; recognise flaws (e.g. gaps) in reasoning; consider and evaluate alternative explanations, processes and solutions; evaluate steps of investigations

Synthesising and creating

Synthesising and creating requires students to consider several different factors or concepts, put elements together into a coherent whole or compile elements in new ways or into something new and different. Tasks in *Synthesising and creating* are generally more open-ended or unstructured and can involve more than one approach or strategy, they require considerable cognitive effort because there is not likely to be a well-rehearsed method or pathway to approaching the task.

In the context of *Science Inquiry Skills* specifically, this area encompasses creating and using models, planning and designing scientific investigations, and carrying out full-blown extended investigations to solve a problem (from specifying a problem to designing and conducting the investigation, to analysing and evaluating the data [critically interpreting the data and methods of data collection], and forming conclusions drawing on concepts and evidence).

Table A1.5
Synthesising and creating

Synthesising and creating	
Generate hypotheses	Generate hypotheses based on background knowledge, preliminary observations, and logic; generate and test alternative hypotheses; identify and justify the thinking processes behind such hypotheses
Construct arguments and draw conclusions	Construct sound and valid arguments supported by evidence and logical reasoning; draw conclusions that address questions/hypotheses and are supported with evidence; draw or support conclusions using evidence and scientific understanding; adapt conclusions as new evidence becomes available; draw general conclusions that go beyond the experimental or given conditions
Create and use models	Create models to explain a phenomenon or make a prediction (using imagery or analogies, as relevant); adapt models as new evidence becomes available; use computer simulations to test models under different conditions
Plan and design investigations	Plan and design whole investigations appropriate for answering scientific questions or solving problems
Make connections	Make connections between different concepts and areas of science; make decisions considering both scientific and social factors and trade-offs; synthesise complex information to inform a course of action
Solve problems	Seek and provide solutions to problems that require consideration of different factors and/or concepts; identify, assess and test options, implications and consequences when seeking solutions; propose alternative solutions to problems; justify the reasons behind choosing particular options/solutions; design solutions to problems of social significance, using science knowledge, considering a range of perspectives and trade-offs, and assessing risks

Item types and tasks

This table outlines the online test item types used in 2018.

Table A1.6
Online item types used in 2018

Main type	Description
Multiple choice	Select one option from radio buttons
Multiple choices	Select two or more options from check boxes
Interactive gap match	Drag from a set of source options (text or images) into blank spaces within a passage of text or into a table
Match	Select which source objects match which destination categories by clicking a grid of radio buttons or checking checkboxes
Inline choices	Select text from a dropdown menu to complete tables, statements, labels

Main type	Description
Hotspot	Select one or more predefined areas on an image
Interactive graphic gap match	Drag objects (images/text) into tables or graphics
Interactive order	Drag and drop objects (images/text) show a sequence of events
Extended text	Type one sentence up to a paragraph into a text box.

To help maintain a consistent construct with past NAP–SL cycles, a similar proportion of extended text item type was included. These items required students to give longer, more open-ended responses that were then marked by expert markers in a similar way to the marking of long constructed response items in previous cycles.

Inquiry tasks

All NAP–SL cycles have included a practical component. The purpose of this component was to provide students with an opportunity to experience practical aspects of science within a formal assessment and test the conventions of science literacy in more depth than was possible in the objective component.

Prior to 2015, NAP–SL practical tasks used a two-stage structure. Groups of students initially participated in a classroom-based practical task. They then individually answered a range of items on the practical task they had just completed. These items included data representation tasks, writing conclusions and evaluating aspects of an experiment.

In 2015, the practical task was delivered online. To allow comparability with previous NAP–SL cycles, 2015 NAP–SL contained an inquiry task that achieved similar objectives but by different means. See the 2015 NAP–SL Public Report for more information about the 2015 inquiry tasks.

There were three inquiry tasks delivered in 2018. The inquiry tasks contained between 10 and 12 items, which followed an experiment for a particular context. Each task provided a context and then stepped the students through the components of the scientific method for a simulated investigation linked to the presented context. The students were then required to apply the experimental results to the original context introduced at the beginning of the task. One task was common to both Years 6 and 10, whilst the other two tasks were specific for the respective year. Each student was presented with one inquiry task.

APPENDIX 2. THE NAP–SL ASSESSMENT DOMAIN

The 2012 NAP–SL assessment domain

During the previous cycles of NAP–SL, a science literacy progress map was developed based on the construct of science literacy and the analysis of state and territory curriculum and assessment frameworks. The progress map described three main areas of science literacy that were assessed. They were:

Strand A: formulating or identifying investigable questions and hypotheses, planning investigations, and collecting evidence.

Strand B: interpreting evidence and drawing conclusions from students' own or others' data, critiquing the trustworthiness of evidence and claims made by others, and communicating findings.

Strand C: using science understandings for describing and explaining natural phenomena, and for interpreting reports about phenomena.

In addition, the items drew on four major scientific concept areas: Earth and space; energy and force; living things; and matter. These concept areas, found most widely in state and territory curriculum documents, were used by item developers to guide item and test development.

Revisions for the Australian Curriculum: Science

With the implementation of the Australian Curriculum: Science in all states and territories from 2015, it was important to revise the NAP–SL construct to better reflect the Australian Curriculum: Science.

Table A2.1 shows how the previous three strands have been mapped to the strands/sub-strands of the Australian Curriculum: Science.

Table A2.1
The NAP–SL progress map links to the strands/sub-strands of the Australian Curriculum: Science

The NAP–SL progress map strand	Australian Curriculum: Science strand/sub-strand
Strand A: formulating or identifying investigable questions and hypotheses; planning investigations; and collecting evidence	Science Inquiry Skills – Questioning and predicting Science Inquiry Skills – Planning and conducting
Strand B: interpreting evidence and drawing conclusions from students' own or others' data; critiquing the trustworthiness of evidence and claims made by others; and communicating findings	Science Inquiry Skills – Processing and analysing data and information Science Inquiry Skills – Evaluating Science Inquiry Skills – Communicating
Strand C: using science understandings for describing and explaining natural phenomena; and for interpreting reports about phenomena	Science Understanding Science as a Human Endeavour

There is a high degree of alignment between strands A and B and the *Science Inquiry Skills* strand of the Australian Curriculum: Science, whilst strand C aligns best with *Science Understanding* and *Science as a Human Endeavour.*

The 2015 NAP–SL progress map described the progression in the proficiency levels. Typically, students whose results are located within a particular proficiency level can demonstrate the understandings and skills associated with that level and possess the understandings and skills of lower proficiency levels.

In previous cycles, NAP–SL focused on levels 2, 3 and 4 of the progress maps, with level 3 being divided into 3.1, 3.2 and 3.3. See the 2015 NAP–SL Public Report for a full description of the 2015 progress map.

NAP–SL proficiency levels

Using the descriptions in the progress map, the descriptions for the NAP–SL proficiency levels were also developed for Year 6 students.

With the introduction of Year 10 students in 2018 and subsequent to the standard-setting workshop in 2019, a review of the level labels occurred and resulted in the suggestion that the original NAP–SL level labels be changed to remove 3.1, 3.2 and 3.3. The suggested label changes are below.

Table A2.2
Suggested NAP–SL level label changes

Original NAP–SL level	Suggested new level
Level 4	Level 5 or above
Level 3.3	Level 4
Level 3.2	Level 3
Level 3.1	Level 2
Level 2	Level 1 or below

Table A2.3 gives the summary of the proficiency levels with the new labels.

Table A2.3
Proficiency level descriptors for NAP–SL

Proficiency level	Level descriptors
Level 5 or above	Explains interactions that have been observed in terms of an abstract science concept. Summarises conclusions and explains the patterns in the data in the form of a rule and are consistent with the data. When provided with an experimental design involving multiple variables, can identify the questions being investigated.
Level 4	Applies knowledge of relationship between variables to explain a reported phenomenon. Extrapolates from an observed pattern to describe an expected outcome or event. Demonstrates awareness of the principles of conducting an experiment and controlling variables.
Level 3	Interprets information in a contextualised report by application of relevant science knowledge. Interprets data and identifies patterns in – and/or relationships between – elements of the data. Collates and compares data set of collected information. Gives reason for controlling a single variable.
Level 2	Selects appropriate reason to explain reported observation related to personal experience. Interprets simple data set requiring an element of comparison. Makes simple standard measurements and records data as descriptions.
Level 1	Describes a choice for a situation based on a first-hand concrete experience, requiring an application of limited knowledge. Identifies simple patterns in the data and/or interprets a data set containing some interrelated elements. Makes measurements or comparisons involving information or stimulus in a familiar context.

The proficient standard for Year 6 in previous cycles was the boundary between levels 3.1 and 3.2.

The substantial psychometric analysis on the judgements made during the standard-setting workshop have supported the recommended and generally agreed upon range in which the proficient standard for Year 10 should be located.

Using the new level labels, the proficient standard for Year 6 will be the boundary between levels 2 and 3 whilst the proficient standard for Year 10 will be the boundary between levels 3 and 4. (See chapter 2 and NAP–SL 2018 Technical Report for more details on the standard-setting workshop.)

NAP–SL major scientific concepts

In previous NAP–SL cycles, Strand C of the progress map provided guidance for the development of items that reflect levels of increasing complexity and abstraction in students' understanding of science concepts.

The *Science Understanding* strand of the Australian Curriculum: Science now provides the guidance about the specific concepts to be assessed in the NAP–SL tests. Table A2.4 shows the content of the *Science Understanding* strand with the specific Australian Curriculum: Science links that can be assessed in the NAP–SL tests.

Table A2.4
Science links for the *Science Understanding* strand

Biological Sciences	Australian Curriculum: Science links
Interdependence of Life	Living things have basic needs, including food and water (Foundation, ACSSU002) Living things live in different places where their needs are met (Year 1, ACSSU211) Living things, including plants and animals, depend on each other and the environment to survive (Year 4, ACSSU073) The growth and survival of living things are affected by the physical conditions of their environment (Year 6, ACSSU094) Interactions between organisms, including the effects of human activities can be represented by food chains and food webs (Year 7, ACSSU112) Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (Year 9, ACSSU176)
Flow of matter and energy in ecosystems	Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (Year 9, ACSSU176)
Multi-cellular systems	Cells are the basic units of living things; they have specialised structures and functions (Year 8, ACSSU149) Multi-cellular organisms contain systems of organs carrying out specialised functions that enable them to survive and reproduce (Year 8, ACSSU150) Multi-cellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment (Year 9, ACSSU175)
Inherited characteristics and DNA	Living things grow, change and have offspring similar to themselves (Year 2, ACSSU030) Living things have life cycles (Year 4, ACSSU072) Living things have structural features and adaptations that help them to survive in their environment (Year 5, ACSSU043)
Diversity and evolution	Living things have a variety of external features (Year 1, ACSSU017) Living things can be grouped on the basis of observable features and can be distinguished from non-living things (Year 3, ACSSU044) Living things have structural features and adaptations that help them to survive in their environment (Year 5, ACSSU043) The growth and survival of living things are affected by the physical conditions of their environment (Year 6, ACSSU094) Classification helps organise the diverse group of organisms (Year 7, ACSSU111) The theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence (Year 10, ACSSU185) Transmission of heritable characteristics from one generation to the next involves DNA and genes (Year 10, ACSSU184)

Chemical Sciences	Australian Curriculum: Science links
Matter – structure, properties and changes	Objects are made of materials that have observable properties (Foundation, ACSSU003) Natural and processed materials have a range of physical properties; These properties can influence their use (Year 4, ACSSU074) Everyday materials can be physically changed in a variety of ways (Year 1, ACSSU018) Different materials can be combined, including by mixing, for a particular purpose (Year 2, ACSSU031) A change of state between solid and liquid can be caused by adding or removing heat (Year 3, ACSSU046) Changes to materials can be reversible or irreversible (Year 6, ACSSU095) Solids, liquids and gases have different observable properties and behave in different ways (Year 5, ACSSU077) Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques (Year 7, ACSSU113) Differences between elements, compounds and mixtures can be described at a particle level (Year 7, ACSSU152) Properties of the different states of matter can be explained in terms of the motion and arrangement of particles (Year 8, ACSSU151) Chemical change involves substances reacting to form new substances (Year 8, ACSSU225) Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed (Year 9, ACSSU178) Chemical reactions, including combustion and the reactions of acids, are important in both non-living and living systems and involve energy transfer (Year 9, ACSSU179) Different types of chemical reactions are used to produce a range of products and can occur at different rates (Year 10, ACSSU187) All matter is made of atoms that are composed of protons, neutrons and electrons; natural radioactivity arises from the decay of nuclei in atoms (Year 9, ACSSU177) The atomic structure and properties of elements are used to organise them in the Periodic Table (Year 10, ACSSU186)

Earth and Space	Australian Curriculum: Science links
Earth in space	Observable changes occur in the sky and landscape (Year 1, ACSSU019) Earth's rotation on its axis causes regular changes, including night and day (Year 3, ACSSU048) Earth is part of a system of planets orbiting around a star (the sun) (Year 5, ACSSU078) Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon (Year 7, ACSSU115) The universe contains features including galaxies, stars and solar systems, and the Big Bang theory can be used to explain the origin of the universe (Year 10, ACSSU188)
Earth structure and processes	The earth's surface changes over time as a result of natural processes and human activity (Year 4, ACSSU075) Sudden geological changes or extreme weather conditions can affect the earth's surface (Year 6, ACSSU096) Sedimentary, igneous and metamorphic rocks contain minerals and are formed by processes that occur within Earth over a variety of timescales (Year 8, ACSSU153) The theory of plate tectonics explains global patterns of geological activity and continental movement (Year 9, ACSSU180)
Earth's resources and geochemical cycles	The earth's resources, including water, are used in a variety of ways (Year 2, ACSSU032) Some of Earth's resources are renewable, including water that cycles through the environment, but others are non-renewable (Year 7, ACSSU116) Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere (Year 10, ACSSU189)

Physical Sciences	Australian Curriculum: Science links
Forces and motion	A push or a pull affects how an object moves or changes shape (Year 2, ACSSU033) Forces can be exerted by one object on another through direct contact or from a distance (Year 4, ACSSU076) Change to an object's motion is caused by unbalanced forces, including Earth's gravitational attraction, acting on the object (Year 7, ACSSU117) The motion of objects can be described and predicted using the laws of physics (Year 10, ACSSU229)

Physical Sciences	Australian Curriculum: Science links
Energy forms, transfer and conservation	Light and sound are produced by a range of sources and can be sensed (Year 1, ACSSU020) Heat can be produced in many ways and can move from one object to another (Year 3, ACSSU049) Light from a source forms shadows and can be absorbed, reflected and refracted (Year 5, ACSSU080) Electrical energy can be transferred and transformed in electrical circuits and can be generated from a range of sources (Year 6, ACSSU097) Energy appears in different forms, including movement (kinetic energy), heat and potential energy, and energy transformations and transfers cause change within systems (Year 8, ACSSU155) Energy transfer through different mediums can be explained using wave and particle models (Year 9, ACSSU182) Energy conservation in a system can be explained by describing energy transfers and transformations (Year 10, ACSSU190)

APPENDIX 3. ORDERED MAP OF NAP – SCIENCE LITERACY 2018 TASKS

Below are all the items that appeared in the NAP–SL 2018 tests ranked according to their scale score and proficiency level. The table also indicates the cognitive process that was required for each item. The three cognitive processes are:

KUS = Knowing and using skills
RAE = Reasoning, analysing and evaluating
S&C = Synthesising and creating.

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 10	973	Above 5	explains how forces and energy contribute to maglev trains travelling very fast	RAE
Year 10	895	Above 5	uses data from both investigations to explain the benefits for the villagers of changing glacier shapes	S&C
Year 6	827	Above 5	explains how the investigation models how a heron catches its food	RAE
Year 10	827	Above 5	describes the processes occurring at two tectonic features which provide evidence for plate tectonics	RAE
Year 10	819	Above 5	justifies the steps in a valid investigation	S&C
Year 10	796	Above 5	uses a diagram to sequence the processes that occur at a subduction zone	KUS
Year 6	789	Above 5	describes an environmental impact of biodegradable plastic bottles	RAE
Year 6	787	Above 5	identifies two variables for a presented investigation	KUS
Year 10	777	Above 5	uses diagrams to compare the circulatory systems of humans and fish	RAE
Year 10	758	Above 5	explains why it is important to use the ruler in this investigation	S&C
Year 10	756	Above 5	completes a diagram showing the position of Earth during various seasons	KUS
Year 10	753	Above 5	describes an environmental impact of biodegradable plastic bottles	RAE

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 10	751	Above 5	describes the processes occurring at one tectonic feature and states the type of plate boundary of another tectonic feature	RAE
Year 10	740	Above 5	explains how three basic human needs could be satisfied on Mars	S&C
Year 10	738	Above 5	uses data from both investigations to support the ball recommendation	RAE
Year 10	733	Above 5	describes an accurate and reliable investigation	RAE
Year 10	732	Above 5	uses diagrams to extract information about isotopes of uranium	RAE
Year 10	711	Above 5	identifies the two diagrams representing isotopes of carbon	RAE
Year 10	707	Above 5	recognises that heat can move from one object to another	KUS
Year 10	698	5	selects two benefits for society from space research	RAE
Year 10	698	5	identifies two variables for a presented investigation	KUS
Year 10	697	5	classifies example of heat transfer that occurs when cooking on a BBQ	KUS
Year 10	685	5	classifies three examples of heat transfer that can occur in space	KUS
Year 10	685	5	draws conclusions from tabulated data	KUS
Year 6	684	5	applies knowledge of the properties of materials in an everyday situation	S&C
Year 10	683	5	identifies the electrical components needed to build a circuit with an electromagnet	KUS
Year 10	683	5	describes an impact of feral goats on the herbivores and carnivores in the food web	RAE
Year 10	681	5	identifies two correct pieces of information from a graph	RAE
Year 6	669	5	applies knowledge of electrical circuits as a means of transforming electricity	RAE
Year 10	666	5	describes that hovering leads to no contact between the train and the tracks and hence no friction	RAE

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 10	656	5	identifies the type of plate boundary of two tectonic features	RAE
Year 6	652	5	suggests a method to increase the accuracy of measurements	KUS
Year 10	652	5	explains the role of energy and forces in determining bounce height of balls	S&C
Year 10	647	5	classifies the variables in a given investigation	KUS
Year 10	646	5	uses data from one investigation as evidence for the decision to change glacier shape	RAE
Year 10	645	5	identifies two changes to water particles during evaporation	KUS
Year 6	644	5	identifies two factors to consider when placing solar panels on a roof	KUS
Both	643	5	explains why a syringe is the most suitable measuring device for a given investigation	RAE
Year 10	642	5	interprets a diagram of the life cycle of a star	KUS
Year 6	635	5	identifies two variables to be controlled in an experiment	KUS
Year 10	633	5	classifies and defines fuels used in BBQs	KUS
Year 6	628	5	explains how two basic human needs could be satisfied on Mars	S&C
Year 6	626	5	draws conclusions from tabulated data	KUS
Year 10	625	5	describes an accurate or reliable investigation	RAE
Year 6	622	5	identifies variables held constant in a given investigation	KUS
Year 10	621	5	correctly compares the orbit lengths for Earth and Earth's Moon	KUS
Year 6	619	5	selects the variables that will be held constant in the investigation	KUS
Year 10	618	5	matches each force acting on a maglev train with the source of the force	KUS
Year 10	618	5	states that the ruler is needed to ensure investigation is fair	KUS

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 6	617	5	provides a reason why an investigation may not be fair	KUS
Year 10	609	5	links the decrease in barn owls to the reduction in the population of mice and crickets	S&C
Year 10	608	5	describes how two adaptations help a barn owl to hunt	RAE
Year 10	606	5	suggests a method to increase the accuracy of measurements	KUS
Year 6	605	5	explains how the adaptations of a kangaroo help it to jump	RAE
Year 10	604	5	uses a diagram to sequence the steps to form an artificial glacier	RAE
Year 10	601	4	sequences the steps in the process of natural selection	S&C
Year 10	597	4	identifies three components of a fair test	KUS
Year 10	592	4	uses a graph to complete the equation for speed	RAE
Both	592	4	explains how the leaves and roots of spinifex grass help it survive in the desert	RAE
Year 10	590	4	identifies that convection transfers heat in Earth's mantle	KUS
Both	590	4	uses scales to identify the diagram that is consistent with the sowing instructions	KUS
Year 6	587	4	uses a scale to make a calculation	RAE
Year 10	586	4	describes a model of a compound	KUS
Year 10	579	4	classifies the variables in a given investigation	KUS
Year 10	578	4	describes an impact of feral goats on the herbivores or carnivores in the food web	RAE
Both	574	4	selects two ways to increase recycling of plastic bags	RAE
Both	573	4	provides relevant data as evidence that the prediction was supported	RAE
Year 6	571	4	sequences the steps in an investigation	KUS
Both	568	4	extracts information from a graph	KUS

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 6	566	4	selects factors which are relevant when assessing the risk posed by a tsunami	RAE
Year 6	563	4	extracts information from the table	KUS
Year 10	562	4	uses diagrams to show the arrangement of magnets for a maglev train and tracks	RAE
Year 10	562	4	identifies the type of plate boundary of one tectonic feature	RAE
Year 10	560	4	uses data from one investigation to support the ball recommendation	RAE
Year 10	560	4	identifies the independent variable in the investigation	KUS
Year 10	559	4	provides evidence of a chemical reaction	KUS
Year 6	559	4	uses experimental data to describe a property of wood	RAE
Year 6	558	4	states that the prediction was not supported by the results	RAE
Year 6	557	4	identifies that light is refracted as it moves through a lens	KUS
Year 6	557	4	explains how one basic human need could be satisfied on Mars	S&C
Both	551	4	identifies variables to be controlled in a given investigation	KUS
Both	551	4	draws conclusions from tabulated results	RAE
Year 10	549	4	identifies two conclusions from the described scenario about seat belts	RAE
Year 6	544	4	classifies rubbish into recyclable and non-recyclable	RAE
Year 10	543	4	describes a property common to glass and plastic bottles	KUS
Year 6	540	4	states that plant-based plastic bottles decompose faster than other plastic bottles	KUS
Year 6	539	4	describes one factor about people and buildings that are considered in a management plan	RAE
Year 10	536	4	defines an energy transformation	KUS
Year 10	535	4	identifies the gravitational force on an astronaut	KUS

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 6	534	4	draws an inference from data in a table and information provided	RAE
Year 10	534	4	uses a diagram to calculate available energy	KUS
Both	530	4	identifies the role of leaves	KUS
Year 10	527	4	identifies the body systems shown in a diagram	KUS
Year 10	526	4	sequences the events during a crash test	KUS
Year 10	526	4	identifies the role of energy or forces in determining the bounce height of balls	KUS
Year 10	522	4	classifies environmental features as abiotic or biotic	RAE
Year 10	522	4	recognises that telescopes use refraction	KUS
Year 10	519	4	identifies two components of a fair test	KUS
Year 6	517	4	provides an observable property of gases	KUS
Year 6	514	4	identifies natural disasters caused by geological events	KUS
Year 10	514	4	identifies the formula for calcium carbonate	KUS
Year 10	510	4	identifies the reason for mosquitos laying large numbers of eggs	KUS
Both	510	4	describes an advantage of a parasite not killing its host	RAE
Year 6	509	4	uses data from the investigation to support the ball recommendation	RAE
Year 10	509	4	identifies the testable question for the investigation	KUS
Year 6	508	4	recognises a step required to make an investigation valid	KUS
Year 10	507	4	identifies that friction is reduced for maglev trains	RAE
Year 10	506	4	states that the decision to change glacier shapes was supported by the results	RAE
Year 10	506	4	indicates on a map locations most likely to experience geological activity	RAE
Year 10	502	4	identifies the independent variable in the investigation	KUS

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 10	499	4	states that plant-based plastic bottles decompose faster than other plastic bottles	KUS
Year 10	497	4	classifies the management strategies to reduce malaria	RAE
Year 10	493	3	identifies the unit of force	KUS
Year 6	493	3	draws a conclusion based on evidence provided	RAE
Year 10	492	3	defines a non-renewable resource	KUS
Year 10	491	3	calculates missing data in a table	KUS
Year 10	490	3	sequences the steps in an investigation	KUS
Year 6	490	3	provides an advantage and a disadvantage using a solar powered toy	RAE
Year 6	489	3	classifies variables in an investigation	KUS
Year 6	489	3	describes a property common to glass and plastic bottles	KUS
Year 10	488	3	classifies a substance as a mixture	KUS
Year 10	484	3	selects two adaptations of the described animal	KUS
Year 10	482	3	identifies a way to improve reliability in the investigation	KUS
Year 6	482	3	identifies that a state of change occurs during melting	KUS
Year 6	479	3	identifies that Earth spinning on its axis causes night and day	KUS
Both	479	3	identifies the relationship between two organisms as parasitic	KUS
Year 10	479	3	identifies the cause of night and day	KUS
Year 6	478	3	links a structure with the role it plays when a kangaroo jumps	RAE
Year 6	478	3	explains why variables should be changed and measured in fair tests	KUS
Both	477	3	describes why a syringe allows more accurate measurements	RAE
Year 6	474	3	extrapolates data from a table	RAE
Year 10	474	3	suggests the cause for an abnormal result in a trial	KUS

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 10	473	3	matches each atomic particle with its charge	KUS
Year 10	471	3	identifies that newton is the unit of force	KUS
Year 6	470	3	identifies the variable that will be changed in the investigation	KUS
Year 10	463	3	identifies the number of electrons in a neutral atom of carbon	RAE
Both	462	3	explains how the leaves or roots of spinifex grass help it survive in the desert	RAE
Year 6	459	3	identifies an observable feature that can be used to group living things	KUS
Year 6	457	3	describes that large numbers of eggs increases chance of hatching	KUS
Year 10	456	3	recommends the best type of ball for handball (based on the provided results)	KUS
Both	455	3	identifies the question to be tested in an investigation	KUS
Year 10	454	3	recognises that government websites are the most reliable sources of information	KUS
Year 10	453	3	describes how one adaptation helps a barn owl to hunt	RAE
Year 10	453	3	converts centimetres to millimetres	KUS
Year 10	450	3	completes the energy transformation that occurs during a dive	KUS
Year 10	450	3	identifies a specific section of a distance-time graph	KUS
Year 10	449	3	states that mice and crickets would have less food if crops were no longer grown	RAE
Both	445	3	identifies a suitable change to an experimental design	RAE
Year 6	444	3	identifies why an investigation is a fair test	KUS
Year 6	444	3	interprets provided text and a diagram	RAE
Year 10	444	3	identifies that feral goats compete with the herbivores	KUS
Year 6	442	3	identifies a point on a graph	KUS
Year 6	441	3	describes objects that form shadows as opaque	KUS

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 6	437	3	selects two adaptations of the described animal	RAE
Year 6	437	3	identifies two reasons why measurements may be difficult in a given investigation	KUS
Year 6	436	3	describes the effect of a parasite killing its host	KUS
Year 6	433	3	describes how long back legs help fleas to survive	KUS
Both	430	3	states that the prediction was supported by the results	KUS
Year 10	425	3	extracts information from text	KUS
Year 6	421	3	identifies a way to improve the quality of the results	RAE
Year 10	418	3	classifies substances as elements or compounds	KUS
Year 6	415	3	matches the parts of a tsunami early warning system with their function	RAE
Year 6	415	3	interprets information provided in a table	KUS
Year 6	414	3	draws a conclusion about the observed properties of liquids in an investigation	RAE
Year 6	414	3	identifies the most appropriate graph for the experiment results	KUS
Year 10	413	3	extracts information from a diagram	KUS
Year 10	412	3	uses a graph to extrapolate data	KUS
Year 10	410	3	uses a graph to rank the results	KUS
Year 10	408	3	calculates the missing average in a data table	KUS
Year 10	406	3	uses a diagram to describe the malaria microorganism	KUS
Year 6	406	3	selects a point on a graph	KUS
Year 10	404	3	identifies a reason for multiple trials in an investigation	KUS
Year 6	392	2	describes one factor about people or buildings that are considered in a management plan	RAE
Year 6	391	2	uses a diagram to identify and predict an outcome	RAE
Year 6	390	2	identifies and defines an irreversible change	KUS

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 10	390	2	identifies one component of a fair test	KUS
Year 6	388	2	uses information in a diagram to identify an object shown in a photograph	KUS
Both	387	2	extracts information from a life cycle diagram	KUS
Both	387	2	indicates the benefits of using plant-based plastic bags	RAE
Year 6	387	2	uses simple column graphs to represent data	KUS
Year 10	383	2	correctly compares the sizes of the sun, Earth and Earth's moon	KUS
Year 6	380	2	identifies a requirement when planning an appropriate investigation method	KUS
Both	379	2	selects two environmental impacts of plastic bags	KUS
Year 6	377	2	identifies that astronomers study the solar system	KUS
Year 6	377	2	identifies one variable to be controlled in an experiment	KUS
Year 10	377	2	identifies a point on a graph	KUS
Year 6	376	2	locates a point on a line graph	KUS
Year 10	374	2	uses a diagram to complete a flowchart of blood circulation	KUS
Year 10	374	2	selects most suitable measuring device for an investigation	KUS
Year 10	373	2	identifies that distances in space are measured in light years	KUS
Year 6	372	2	identifies that seismometers can detect earthquakes	KUS
Year 10	371	2	identifies that gravity acts on all objects in the universe	KUS
Both	369	2	identifies an environmental change caused by nature	KUS
Year 10	369	2	defines kinetic energy	KUS
Year 6	368	2	extrapolates information from the text	RAE
Year 10	367	2	applies experimental data to a real-life situation	RAE
Year 6	367	2	interprets a graph to determine the trend	RAE

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 6	364	2	recommends the best type of ball for handball (based on the provided results)	KUS
Year 10	363	2	identifies a situation with similar energy changes to a pool dive	KUS
Year 10	363	2	selects the most accurate piece of equipment to measure volume	KUS
Year 10	360	2	identifies a specific section of a distance-time graph	RAE
Year 6	357	2	identifies a component in an electrical circuit that performs a given function	KUS
Year 10	357	2	identifies a combustion reaction	KUS
Year 10	357	2	identifies the interaction of forces during a rocket launch	KUS
Year 6	356	2	identifies that today's model of the solar system has the Sun in the centre	KUS
Year 6	353	2	provides an advantage or disadvantage using a solar powered toy	RAE
Year 6	353	2	identifies a method of separating steel waste from glass waste	KUS
Year 6	350	2	identifies an accurate way to measure time	KUS
Year 6	349	2	shows awareness that science involves using evidence to develop explanations of events	RAE
Year 6	347	2	identifies a testable question for a given investigation	KUS
Year 6	346	2	identifies the question being investigated in a scientific investigation	KUS
Year 10	345	2	describes why scientists change and accept new theories	KUS
Year 6	344	2	identifies three planets in our Solar System	KUS
Year 6	342	2	describes the energy transformation in a given electrical circuit	KUS
Year 6	341	2	predicts the change of state when temperature is deceased	KUS
Year 6	340	2	describes the change of state during freezing	KUS
Year 6	337	2	ranks the sun, Earth and Earth's moon from largest to smallest	KUS
Year 10	330	2	identifies that sound cannot be heard in the vacuum of space	KUS

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 6	327	2	identifies an example of a reversible reaction	KUS
Year 10	326	2	defines photosynthesis	KUS
Year 10	324	2	identifies that the Big Bang is the current theory about the origins of the universe	KUS
Both	321	2	converts centimetres to metres	KUS
Year 10	319	2	classifies the advantages and disadvantages of maglev trains	RAE
Year 6	319	2	identifies correct observations from a diagram	KUS
Year 6	316	2	interprets data in a table to make a comparison	RAE
Year 6	316	2	lists two or three basic human needs	KUS
Year 10	316	2	uses diagram to identify that earthquakes occur at plate boundaries	KUS
Year 6	314	2	compares the properties of a solid and a liquid	KUS
Year 10	311	2	identifies prey of a barn owl in the food web	RAE
Year 6	311	2	identifies that boiling water changes into a gas and evaporates	KUS
Year 6	307	2	determines the position of the sun to form a shadow	KUS
Year 6	303	2	describes how buildings form shadows	KUS
Year 6	302	2	identifies a simple scientific question for testing	KUS
Year 6	301	2	selects most suitable measuring device for an investigation	KUS
Year 6	300	2	identifies that geologists study earthquakes and tsunamis	KUS
Year 10	298	2	uses diagrams to describe lunar and solar eclipses	KUS
Both	297	2	selects the most suitable graph to display the results	KUS
Year 6	296	2	classifies objects as solids, liquids or gases	KUS
Year 6	296	2	describes cause and effect in the context of changes due to natural processes	RAE
Both	295	2	identifies the trend in graphical data	RAE
Both	295	2	locates a point on a graph	KUS

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 10	292	2	identifies the formula for carbon dioxide	KUS
Year 6	290	2	extracts information from a table	KUS
Year 10	289	2	describes the function of the lungs	KUS
Year 10	287	1	identifies that a dog has a similar heart to humans	KUS
Year 6	286	1	uses a table to draw conclusions about relationships in data	RAE
Year 10	282	1	recognises that reflection of light forms an image	KUS
Year 6	282	1	describes the trend in tabulated data	KUS
Year 6	279	1	selects two reasons why a given circuit may stop working	KUS
Year 10	278	1	selects the correct data from a table	KUS
Year 6	278	1	lists one basic human need	KUS
Both	275	1	uses a table to order the results for a series of trials	RAE
Year 6	270	1	identifies an impact of an earthquake	KUS
Year 10	269	1	identifies that the immune system responds to diseases	KUS
Year 6	269	1	identifies the scientific question being tested	KUS
Year 6	263	1	interprets tabulated data	RAE
Year 6	261	1	describes advantages and disadvantages of burning rubbish	RAE
Year 6	259	1	describes the change of state when liquids are cooled	KUS
Year 6	259	1	identifies that wings help animals to fly	KUS
Year 6	254	1	identifies the purposes of different types of animal feet	RAE
Year 6	253	1	extracts information from a graph	RAE
Year 10	251	1	identifies the producers in the food web	KUS
Year 6	250	1	selects two animals that can shelter under spinifex	RAE
Year 6	250	1	classifies objects as solids or liquids	KUS
Year 6	247	1	provides labels on a column graph	KUS
Year 10	237	1	classifies predators and prey included in the food web	KUS

Year level	Scale score	Level	Item Descriptor	Cognitive progress
Year 6	235	1	defines an irreversible reaction	KUS
Year 10	235	1	identifies that physicists study forces and motion	KUS
Year 6	233	1	uses a diagram to order the planets from closest to furthest from the Sun	KUS
Year 6	224	1	selects appropriate equipment for the investigation	KUS
Both	221	1	describes the role of fertilisers	RAE
Both	220	1	extracts information from a table	KUS
Year 6	211	1	uses a diagram to determine the number of wires in a circuit	KUS
Year 6	208	1	makes a comparison based on data provided in a table	RAE
Both	198	1	provides a reason for wearing safety goggles	KUS
Year 6	171	Below 1	identifies that batteries were the energy source in a given electrical circuit	KUS
Year 6	154	Below 1	interprets information provided in a diagram	KUS
Year 6	133	Below 1	identifies an indicator that an electrical circuit is operating	KUS
Year 10	114	Below 1	shows awareness that animals depend on each other and the environment to survive	KUS
Year 6	93	Below 1	identifies two electrical devices in the home	KUS
Year 6	79	Below 1	uses a life cycle to complete a flowchart	KUS
Year 6	79	Below 1	classifies waste products into different categories	KUS
Year 6	68	Below 1	identifies structures that are involved in jumping	RAE
Year 6	-5	Below 1	identifies that decreasing temperatures will change a liquid to a solid	KUS
Year 6	-29	Below 1	identifies anatomical structures used for swimming or walking	KUS
Year 6	-29	Below 1	identifies that warmer temperatures can melt frozen solids	KUS

APPENDIX 4. 2018 NAP–SL: STUDENT SURVEY

Interest in science – Year 6

	Strongly agree	Agree	Disagree	Strongly disagree
I would like to learn more science at school.	○	○	○	○
I think it would be interesting to be a scientist.	○	○	○	○
I enjoy doing science.	○	○	○	○
I enjoy learning new things in science.	○	○	○	○

Interest in science – Year 10

	Strongly agree	Agree	Disagree	Strongly disagree
I enjoy doing science.	○	○	○	○
I enjoy learning new things in science.	○	○	○	○
I want to study one or more science subjects in Years 11 and 12.	○	○	○	○
I am considering a science-related career.	○	○	○	○

Self-concept of science ability – Years 6 and 10

	Strongly agree	Agree	Disagree	Strongly disagree
I learn science topics quickly.	○	○	○	○
I can understand new ideas about science easily.	○	○	○	○
I can usually give good answers to science questions.	○	○	○	○
It is important that all students learn science.	○	○	○	○

Value of science – Years 6 and 10

	Strongly agree	Agree	Disagree	Strongly disagree
Science is part of my everyday life.	○	○	○	○
Science is important for lots of jobs.	○	○	○	○
Scientific information helps people make informed decisions.	○	○	○	○
Our scientific knowledge is constantly changing.	○	○	○	○
Science can help us understand global issues that impact on people and the environment.	○	○	○	○

Science teaching – Years 6 and 10

	Always	Mostly	Sometimes	Never
During science lessons I get to plan and carry out my own investigations.	○	○	○	○
When our class investigates things in science, we work in groups to carry out the investigation.	○	○	○	○
Our class has in-depth discussions about science ideas.	○	○	○	○

Time spent on science – Year 6

How often do you have science lessons at school?

- ○ More than once a week
- ○ Once a week
- ○ Hardly ever

Science teaching 2 – Year 6

	Yes	No
My classroom teacher teaches science to our class.		
I think my teacher enjoys teaching science.		
My teacher invites visitors to school to talk to us about science topics.		
Our class goes on excursions related to the science topics we are learning about.		

Science teaching 2 – Year 10

	Yes	No
I think my teacher enjoys teaching science.		
My teacher invites visitors to school to talk to us about science topics.		
Our class goes on excursions related to the science topics we are learning about.		

APPENDIX 5. COMPARISON OF 2015 AND 2018 SURVEY RESULTS

The following tables provide a comparison of survey questions that appeared in both the 2015 and the 2018 student survey. The percentages have been weighted to account for sampling affects across states and territories.

Table A5.1
Comparison of Year 6 student responses to common questions in the 2015 and 2018 student surveys.

Group number	Survey question		2015 Per cent	Standard Error	2018 Per cent	Standard Error
Group 1	**How much do you agree with the statements below?**					
1	I would like to learn more science at school.	Strongly disagree	2	0.2	4	0.4
		Disagree	11	0.5	13	0.8
		Agree	58	0.7	59	1.0
		Strongly agree	28	0.8	25	0.8
2	I think it would be interesting to be a scientist.	Strongly disagree	7	0.4	9	0.5
		Disagree	23	0.6	26	0.8
		Agree	51	0.6	49	1.0
		Strongly agree	18	0.5	16	0.7
3	I enjoy doing science.	Strongly disagree	3	0.2	4	0.4
		Disagree	11	0.4	14	0.7
		Agree	56	0.7	56	1.0
		Strongly agree	31	0.8	26	0.9
4	I enjoy learning new things in science.	Strongly disagree	2	0	3	0.3
		Disagree	6	0.3	8	0.5
		Agree	50	0.8	54	0.9
		Strongly agree	43	0.8	35	1.0

Group number	Survey question		2015 Per cent	Standard Error	2018 Per cent	Standard Error
Group 2	**How much do you agree with the statements below?**					
1	I learn science topics quickly.	Strongly disagree	4	0.3	7	0.7
		Disagree	27	0.6	33	1.2
		Agree	55	0.7	48	1.3
		Strongly agree	14	0.5	12	0.8
2	I can understand new ideas about science easily.	Strongly disagree	3	0.2	5	0.6
		Disagree	22	0.5	29	1.1
		Agree	55	0.7	52	1.3
		Strongly agree	20	0.6	14	0.8
3	I can usually give good answers to science questions.	Strongly disagree	3	0.2	4	0.5
		Disagree	23	0.6	27	1.2
		Agree	60	0.7	56	1.3
		Strongly agree	14	0.5	13	0.9
4	It is important that all students learn science.	Strongly disagree			2	0.4
		Disagree			11	0.8
		Agree			45	1.4
		Strongly agree			42	1.5

Group number	Survey question		2015 Per cent	Standard Error	2018 Per cent	Standard Error
Group 3	How much do you agree with the statements below?					
1	Science is part of my everyday life.	Strongly disagree	12	0.4	14	0.7
		Disagree	41	0.6	38	0.8
		Agree	32	0.6	33	0.8
		Strongly agree	14	0.5	16	0.7
2	Science is important for lots of jobs.	Strongly disagree	2	0.2	3	0.3
		Disagree	15	0.5	14	0.7
		Agree	52	0.6	47	1.0
		Strongly agree	31	0.6	35	0.9
3	Scientific information helps people make informed decisions.	Strongly disagree	2	0.2	2	0.2
		Disagree	14	0.4	8	0.5
		Agree	51	0.7	55	1.0
		Strongly agree	33	0.6	35	0.9
4	Our scientific knowledge is constantly changing.	Strongly disagree			1	0.2
		Disagree			5	0.4
		Agree			48	0.9
		Strongly agree			46	0.9
5	Science can help us understand global issues that impact on people and the environment.	Strongly disagree			1	0.2
		Disagree			3	0.3
		Agree			36	0.9
		Strongly agree			60	0.9
Group 4	How often do you do these things at school?					
1	During science lessons I get to plan and carry out my own investigations.	Never	14	0.6	7	0.5
		Sometimes	48	0.7	40	1.0
		Mostly	30	0.6	39	0.9
		Always	8	0.3	13	0.7
2	When our class investigates things in science, we work in groups to carry out the investigation.	Never	4	0.3	3	0.3
		Sometimes	25	0.7	23	1.0
		Mostly	49	0.8	50	0.9
		Always	22	0.9	24	0.9
3	Our class has in-depth discussions about science ideas.	Never	10	0.5	6	0.5
		Sometimes	39	0.7	32	0.9
		Mostly	32	0.7	37	0.9
		Always	19	0.6	24	0.9

Group number	Survey question		2015 Per cent	Standard Error	2018 Per cent	Standard Error
Group 5	**How often do you have science lessons at school?**					
1	How often do you have science lessons at school?	hardly ever	15	0.9	25	1.7
		less than once a week	17	0.9		
		once a week	46	1.5	51	2.0
		more than once a week	22	1.2	24	1.5
Group 6	**Do you agree with the statements below?**					
1	My classroom teacher teaches science to our class.	No	27	1.3	32	1.7
		Yes	73	1.3	68	1.7
2	I think my teacher enjoys teaching science.	No	15	0.7	15	0.8
		Yes	85	0.7	85	0.8
3	My teacher invites visitors to school to talk to us about science topics.	No	69	1.0	75	1.2
		Yes	31	1.0	25	1.2
4	Our class goes on excursions related to the science topics we are learning about.	No	61	1.1	64	1.5
		Yes	39	1.1	36	1.5

Note: Percentages may not add up to 100 per cent due to rounding.

APPENDIX 6. SAMPLE CHARACTERISTICS

Table A6.1 shows the averages of ages of student by the state and territory in 2018 and 2015.

Table A6.1
Average ages of students in the sample by state and territory in 2018 and 2015 (unweighted)

State/territory		Average age at time of testing NAP–SL 2018	Average age at time of testing 2015 NAP–SL
Year 6	NSW	12 years 1 month	12 years 1 month
	Vic.	12 years 2 month	12 years 3 months
	Qld	11 years 10 month	11 years 11 months
	WA	11 years 10 month	11 years 10 months
	SA	12 years 0 month	12 years 1 month
	Tas.	12 years 3 month	12 years 4 months
	ACT	12 years 0 month	12 years 1 month
	NT	11 years 11 month	11 years 11 months
Year 10	NSW	16 years 0 months	
	Vic.	16 years 2 months	
	Qld	15 years 10 months	
	WA	15 years 10 months	
	SA	16 years 0 months	
	Tas.	16 years 3 months	
	ACT	16 years 1 months	
	NT	16 years 0 months	

Table A6.2 shows the age percentages of students by year level, nationally and by state and territory.

Table A6.2
Age percentages of students by year level, nationally and by state and territory

State/territory		Mode	10	11	12	13	14	15	16	17	18	Missing
Year 6	NSW	12	0	13	19	0						68
	Vic.	12	0	33	63	2						2
	Qld	11	0	63	37	0						0
	WA	11	0	63	37	0						0
	SA	12	0	47	52	1						0
	Tas.	12	0	18	80	0						1
	ACT	12	0	46	54	0						1
	NT	11	0	63	36	1						0
	Aust.	**12**	**0**	**38**	**40**	**1**						**22**
Year 10	NSW	16					0	44	54	2	0	0
	Vic.	16					0	31	64	5	0	0
	Qld	15					0	63	36	1	0	0
	WA	15					1	60	38	1	0	1
	SA	16					0	42	57	1	0	0
	Tas.	16					0	20	78	2	0	0
	ACT	16					1	35	59	5	0	2
	NT	16					0	38	54	1	0	8
	Aust.	**16**					**0**	**45**	**53**	**2**	**0**	**0**

Note: Percentages may not add up to 100 per cent due to rounding.

Tables A6.3 and A6.4 provide a breakdown of the achieved sample across states and territories according to gender, Indigenous status, students' language background and school geographic location.

Table A6.3
Percentage distribution of Year 6 characteristics by jurisdiction

	State/territory (per cent)								Aust. (per cent)
	NSW	Vic.	Qld	WA	SA	Tas.	ACT	NT	
Student gender									
Female	58	49	50	47	51	50	48	53	49
Male	52	51	50	53	49	50	52	48	51
Missing	0	0	0	0	0	0	0	0	0
Indigenous status									
Indigenous	8	1	7	6	9	11	2	41	6
Non-Indigenous	93	99	93	92	89	87	95	57	93
Missing	0	0	0	2	2	2	4	0	1
Language background									
English speaking background	64	73	87	61	35	93	81	29	69
Language background other than English	37	25	13	21	9	5	19	40	24
Missing	0	2	0	18	56	2	1	32	7
Geographic location									
Major cities	71	77	64	74	71	0	100	0	69
Inner regional areas	22	19	24	9	11	73	0	0	20
Outer regional areas	6	4	8	11	14	26	0	53	8
Remote areas	0	0	3	2	0	1	0	17	1
Very remote areas	1	0	0	3	4	0	0	31	1

Table A6.4
Percentage distribution of Year 10 characteristics by jurisdiction

	State/territory (per cent)								Aust. (per cent)
	NSW	Vic.	Qld	WA	SA	Tas.	ACT	NT	
Student gender									
Female	54	52	48	51	52	35	45	48	51
Male	47	48	52	50	49	65	55	52	49
Missing	0	0	0	0	0	0	0	0	0
Indigenous status									
Indigenous	6	1	9	6	2	7	2	29	5
Non-Indigenous	93	99	91	94	95	90	95	63	94
Missing	0	0	0	1	3	4	3	8	1
Language background									
English speaking background	75	75	90	71	36	89	79	57	74
Language background other than English	25	22	10	12	9	7	19	35	19
Missing	0	4	0	17	55	5	2	8	7
Geographic location									
Major cities	73	74	56	73	62	0	100	0	67
Inner regional areas	18	25	22	11	0	78	0	0	20
Outer regional areas	7	1	16	11	24	22	0	93	10
Remote areas	2	0	6	2	14	0	0	7	3
Very remote areas	0	0	0	4	0	0	0	0	0

Tables A6.5 and A6.6 provide a breakdown of the number of students in the achieved sample by Indigenous status across the five geographic location categories.

Table A6.5
Percentage distribution of Year 6 by Indigenous status and geographic location

Geographic location	Percentage of students by Indigenous status		
	Indigenous	Non-Indigenous	Missing
Major cities	4	96	1
Inner regional areas	6	94	0
Outer regional areas	11	89	0
Remote areas	48	52	0
Very remote areas	67	33	0
AUST.	**6**	**93**	**1**

Table A6.6
Percentage distribution of Year 10 by Indigenous status and geographic location

Geographic location	Percentage of students by Indigenous status		
	Indigenous	Non-Indigenous	Missing
Major cities	3	97	0
Inner regional areas	6	94	0
Outer regional areas	12	85	3
Remote areas	29	71	0
Very remote areas	67	11	22
AUST.	**5**	**94**	**1**

APPENDIX 7. REPORTING OF RESULTS

Reporting of results

The students assessed in NAP–SL 2018 were selected using a two-stage stratified sampling procedure. At the first stage, schools were sampled from a sampling frame with a probability proportional to their size as measured by student enrolments in the relevant year level. In the second stage, a number of students at each year level were randomly sampled within schools. Applying cluster sampling techniques is an efficient and economical way of selecting students in educational research. However, as these samples were not obtained through (one-stage) simple random sampling, standard formulae to obtain sampling errors of population estimates are not appropriate. In addition, NAP–SL estimates were obtained using plausible value methodology, which allows for estimating and combining the measurement error of achievement scores with their sampling error.

This chapter describes the method applied for estimating sampling as well as measurement error. In addition, it contains a description of the types of statistical analyses and significance tests that were carried out for reporting of results in the NAP–SL 2018 Public Report.

Computation of sampling and measurement variance

Unbiased standard errors from studies should include both sampling variance and measurement variance. One way of estimating sampling variance on population estimates from cluster samples is by utilising the application of replication techniques. The sampling variances of population means, differences, percentages and correlation coefficients in NAP–SL studies were estimated using the jackknife repeated replication technique (JRR). The other component of the standard error of achievement test scores, the measurement variance, can be derived from the variance among the five plausible values for NAP–SL. In addition, for comparing achievement test scores with those from previous cycles (2006, 2009, 2012 and 2015), an equating error was added as a third component of the standard error.

Replicate weights

When applying the JRR method for stratified samples, primary sampling units (PSUs) – in this case schools – are paired into pseudo-strata, also called sampling zones. The assignment of schools to these sampling zones needs to be consistent with the sampling frame from which they were sampled (to obtain pairs of schools that were adjacent in the sampling frame) and zones are always constructed within explicit strata of the sampling frame. This procedure ensures that schools within each zone are as similar to each other as possible.

Within each sampling zone, one school was randomly assigned a value of two whereas the other one received a value of zero. To create replicate weights for each of these sampling zones, the jackknife indicator variable was multiplied by the original sampling weights of students within the corresponding zone so that one of the paired schools had a contribution of zero and the other school had a double contribution, whereas schools from all other sampling zones remained unmodified.

Standard errors

In order to compute the sampling variance for a statistic *t*, *t* is estimated once for the original sample *S* and then for each of the jackknife replicates J_h. The JRR variance is computed using the formula:

$$Var_{jrr}(t) = \sum_{h=1}^{H} \left[t(J_h) - t(S) \right]^2$$

where *H* is the number of replicate weights, *t(S)* the statistic *t* estimated for the population using the final sampling weights, and $t(J_h)$ the same statistic estimated using the weights for the h_{th} jackknife replicate. For all statistics that are based on variables other than student test scores (plausible values), the standard error of *t* is equal to:

$$\sigma(t) = \sqrt{Var_{jrr}(t)}$$

The computation of JRR variance can be obtained for any statistic. However, many standard statistical software packages like SPSS® do not generally include any procedures for replication techniques. Therefore, specialist software, the SPSS® replicates add-in, was used to run tailored SPSS® macros to estimate JRR variance for means and percentages.

Population statistics for NAP–SL scores were always estimated using all five plausible values with standard errors reflecting both sampling and measurement error. If *t* is any computed statistic and ti is the statistic of interest computed on one plausible value, then:

$$t = \frac{1}{M} \sum_{i=1}^{M} t_i$$

with *M* being the number of plausible values.

The sampling variance *U* is calculated as the average of the sampling variance for each plausible value U_i :

$$U = \frac{1}{M} \sum_{i=1}^{M} U_i$$

Using five plausible values for data analysis allows the estimation of the error associated with the measurement of NAP–SL due to the lack of precision of the test instrument. The measurement variance or imputation variance B_m was computed as:

$$B_m = \frac{1}{M-1}\sum_{i=1}^{M}(t_i - t)^2$$

To obtain the final standard error of NAP–SL statistics, the sampling variance and measurement variance were combined as:

$$SE = \sqrt{U + \left(1 + \frac{1}{M}\right) B_m}$$

with *U* being the sampling variance.

The 95 per cent confidence interval, as presented in the NAP–SL 2018 Public Report, was computed as 1.96 times the standard error. The actual 95 per cent confidence interval of a statistic is between the value of the statistic *minus* 1.96 times the standard error and the value of the statistic *plus* 1.96 times the standard error.

Reporting of mean differences

The NAP–SL 2018 Public Report included comparisons of achievement test results across states and territories; that is, means of scales and percentages were compared in graphs and tables. Each population estimate was accompanied by its 95 per cent confidence interval. In addition, tests of significance for the difference between estimates were provided, in order to flag results that were significant at the 5 per cent level ($p < 0.05$) which indicate a 95 per cent probability that these differences are **not** a result of sampling and measurement error.

The following types of significance tests for achievement mean differences in population estimates were reported:

- between states and territories
- between student sub-groups
- between this assessment cycle and previous ones in 2015, 2012, 2009 and 2006.

Mean differences between states and territories and year levels

Pairwise comparison charts allow the comparison of population estimates between one state or territory and another or between Year 6 and Year 10. Differences in means were considered significant when the test statistic *t* was outside the critical values ±1.96 ($\alpha = 0.05$). The *t* value is calculated by dividing the difference in means by its standard error, which is given by the formula:

$$SE_{dif\_ij} = \sqrt{SE_i^2 + SE_j^2}$$

where *SEdif_ij* is the standard error of the difference and *SEi* and *SEj* are the standard errors of the two means *i* and *j.* This computation of the standard error was only applied for comparisons between two samples that had been drawn independently from each other (for example, jurisdictions or year levels).

Mean differences between dependent sub-groups

The formula for calculating the standard error described in the previous section is not appropriate for sub-groups from the same sample. Here, the covariance between the two standard errors for sub-group estimates needs to be taken into account and JRR should be used to estimate correct sampling errors of mean differences. Standard errors of differences between statistics for sub-groups from the same sample (for example, groups classified according to student background characteristics) were derived using the SPSS® replicates add-in. Differences between sub-groups were considered significant when the test statistic t was outside the critical values ±1.96 (α = 0.05). The value t was calculated by dividing the mean difference by its standard error.

Mean differences between assessment cycles (2006, 2009, 2012, 2015 and 2018)

The NAP–SL 2018 Public Report also included comparisons of achievement results across assessment cycles. The process of equating tests across different achievement cycles introduced a new form of error when comparing population estimates over time: the equating or linking error. When computing the standard error, equating error as well as sampling and measurement error were taken into account.

The value of the equating error between 2018 and the previous assessment in 2015 was 4.39 score points on the NAP–SL scale for both year levels. When testing the difference of a statistic between these two assessment cycles, the standard error of the difference was computed as follows:

$$SE(t_{18} - t_{15}) = \sqrt{SE_{18}^2 + SE_{15}^2 + EqErr_{18\_15}^2}$$

Where *t* can be any statistic in units on the NAP–SL scale (mean, percentile, gender difference, but **not** percentages), SE^2_{18} is the respective standard error of this statistic in 2018, SE^2_{15} the corresponding standard error in 2015 and $EqErr^2_{18\_15}$ the equating error for comparing 2018 with 2015 results.

When comparing population estimates between 2018 and the third assessment in 2012, two equating errors (between 2018 and 2015 and between 2015 and 2012) had to be taken into account. This was achieved by applying the following formula for the calculation of the standard error for differences between statistics from 2018 and 2012:

$$SE(\mu_{18}-\mu_{12}) = \sqrt{SE_{18}^{2} + SE_{12}^{2} + EqErr_{18\_12}^{2}}$$

where $EqErr^2_{18\_12}$ reflects the uncertainty associated with the equating between the assessment cycles of 2018 and 2015 (4.39 score points) as well as between 2015 and 2012 (5.03 score points). This combined equating error was equal to 6.68 score points and was calculated as:

$$EqErr_{18\_12} = \sqrt{EqErr^{2}_{18_{15}} + EqErr^{2}_{15_{12}}}$$

Similarly, for comparisons between 2018 and the first NAP–SL assessment in 2006, the equating errors between each adjacent pair of assessments had to be taken into account and standard errors for differences were computed as:

$$SE(\mu_{18}-\mu_{06}) = \sqrt{SE_{18}^{2} + SE_{06}^{2} + EqErr_{18\_06}^{2}}$$

$EqErr^2_{18\_06}$ reflects the uncertainty associated with the equating between the assessment cycles of 2018 and 2015 (4.39 score points), between 2015 and 2012 (5.03 score points), between 2012 and 2009 (3.24 score points) and between 2009 and 2006 (3.68 score points). The combined equating error was equal to 8.28 score points, and was calculated as

$$EqErr_{18\_06} = \sqrt{EqErr^{2}_{18_{15}} + EqErr^{2}_{15_{12}} + EqErr^{2}_{12_{09}} + EqErr^{2}_{09_{06}}}$$

To report the significance of differences between percentages at or above proficient standard s, the corresponding equating error had to be estimated using a different approach. To obtain an estimate, the following replication method was applied to estimate the equating error for percentages at the proficient standard *s*.

For the cut-point that defines the corresponding proficient standard at each year level (393 for Year 6 and 497 for Year 10), a number of *n* replicate cut-points were generated by adding a random error component with a mean of 0 and a standard deviation equal to the estimated equating error of 4.39 score points for comparisons between 2018 and 2015, 6.68 score points for comparisons between 2018 and 2012, 7.42 score points for comparisons between 2018 and 2009, and 8.28 score points for comparisons between 2018 and 2006. Percentages of students at or above each replicate cut-point (ρ_n) were computed and the equating error was estimated as:

$$EquErr(\rho) = \sqrt{\frac{(\rho_n - \rho_o)^2}{n}}$$

where ρ_o is the percentage of students at or above the (reported) proficient standard. The standard errors of the differences in percentages at or above proficient standardsbetween 2018 and 2015 were calculated as:

$$SE(\rho_{18}-\rho_{15})=\sqrt{SE(\rho_{18})^2+SE(\rho_{15})^2+EqErr(\rho_{18\_15})^2}$$

where $\rho18$ is the percentages at or above the proficient standard in 2018 and $\rho15$ in 2015, SE ($\rho18$) and SE ($\rho15$) their respective standard errors, and $EqErr$ ($\rho18\_15$) the equating error for comparisons. For estimating the standard error of the corresponding differences in percentages at or above proficient standards between 2018 and 2012, the following formula was used:

$$SE(\rho_{18}-\rho_{12})=\sqrt{SE(\rho_{18})^2+SE(\rho_{12})^2+EqErr(\rho_{18\_12})^2}$$

Likewise, for estimating the standard error of the corresponding differences in percentages at or above proficient standards between 2018 and 2009 and between 2018 and 2006, the following formulae were used:

$$SE(\rho_{18}-\rho_{09})=\sqrt{SE(\rho_{18})^2+SE(\rho_{09})^2+EqErr(\rho_{18\_09})^2}$$

$$SE(\rho_{18}-\rho_{06})=\sqrt{SE(\rho_{18})^2+SE(\rho_{06})^2+EqErr(\rho_{18\_06})^2}$$

For NAP–SL 2018, equating errors on percentages were estimated for each sample or subsample of interest. Table A7.1 shows the values of these equating errors of Year 6.

Table A7.1
Year 6 equating errors for comparisons between percentages

Group	2018/2015	2018/2012	2018/2009	2018/2006
Aust.	**1.89**	**2.79**	**3.08**	**3.41**
NSW	1.78	2.64	2.92	3.25
Vic.	2.18	3.08	3.37	3.71
Qld	1.93	2.91	3.21	3.56
WA	2.07	3.03	3.32	3.63
SA	1.60	2.33	2.59	2.90
Tas.	1.94	2.99	3.32	3.68
ACT	1.19	1.87	2.11	2.39
NT	1.22	1.91	2.15	2.43
Females	1.96	2.85	3.14	3.47
Males	1.83	2.75	3.04	3.36
Non-Indigenous	1.94	2.85	3.14	3.47
Indigenous	1.23	1.93	2.18	2.47
Not LBOTE	1.85	2.76	3.05	3.40
LBOTE	2.06	2.97	3.25	3.55