Numeracy learning progression and Science

Purpose of the literacy and numeracy progressions

The purpose and intent of the progressions are to provide a tool to:

- locate the literacy and numeracy development of students
- plan for student progress in literacy and numeracy
- facilitate shared professional understanding of literacy and numeracy development
- support a whole school approach to literacy and numeracy development.

Literacy and numeracy in the learning areas

The learning areas provide rich opportunities for extending and enriching literacy and numeracy. To effectively plan for differentiated teaching of literacy and numeracy in the learning areas, teachers draw on their knowledge of the Australian Curriculum and their knowledge of their students. Recognising that students learn at different rates, the progressions provide a continuum for teachers to identify and build on students' literacy and numeracy skills. The intention is that students will develop their literacy and numeracy expertise purposefully, in meaningful contexts.

Using this advice and the progressions to plan for student progress in literacy and numeracy

This advice illustrates how the progressions can be used in Science to support student progress in literacy and numeracy. This advice:

- identifies the sub-elements of the progressions that are most relevant to studying Science
- identifies some aspects of an achievement standard that include literacy or numeracy demands
- lists some relevant indicators at one or more levels of the progressions to illustrate how the progressions might be unpacked to support student progress in literacy and numeracy in the study of Science.

Figure 1 illustrates how the progressions are to be used by teachers to identify where students are at on the literacy and numeracy continuum and plan for their ongoing progression within the learning areas. Therefore, this advice can support use of the progressions in developing explicit and targeted programs to ensure students are able to access discipline-specific knowledge, concepts, understanding and skills. While advice is provided on the most relevant sub-elements of each progression for the discipline of Science, whole school planning may address other sub-elements to progress students' literacy and numeracy.

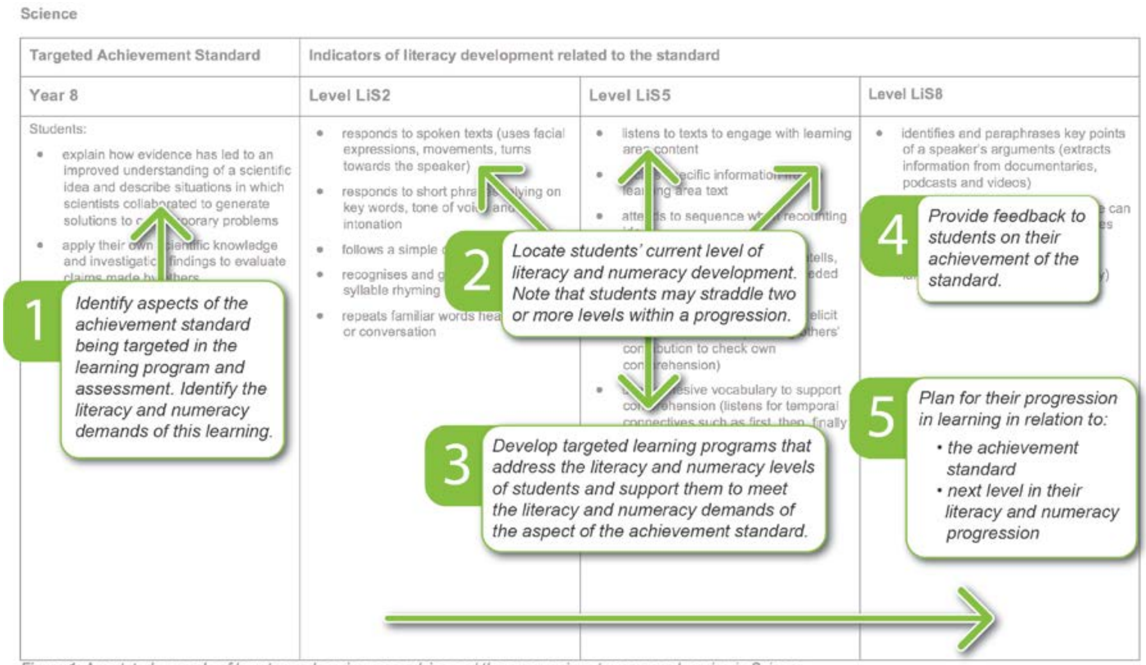

Figure 1: Annotated example of how to use learning area advice and the progressions to progress learning in Science

Numeracy in Science

Students develop numeracy capability as they engage in the scientific inquiry process and learn how to organise and interpret data gathered during the study of scientific phenomena. Numeracy content within the study of Science can involve the construction and interpretation of timelines, graphs, tables, diagrams, scales and statistics. Students develop confidence and proficiency in applying these skills to analyse, comprehend and represent quantitative data to make meaning of the world. Analysing numerical data enables students to elicit, interpret and analyse evidence, critically evaluate claims, and supports students to develop a deeper understanding of scientific concepts.

Using the numeracy progression to support students in Science

The most relevant sub-elements of the numeracy progression for Science are: *Quantifying numbers, Operating with percentages, Number patterns and algebraic thinking, Comparing units, Understanding units of measurement* and *Interpreting and representing data.*

Quantifying numbers

This sub-element involves students becoming increasingly able to recognise, read, estimate and interpret large and small numbers. In Science, students are required to quantify physical properties of objects, time, distance and scale.

Targeted Achievement Standard	**Examples of how indicators relate to the AC standard.** *Individual student numeracy may be at different levels of the progression as indicated in Figure 1.*
Year 7-10	**QuN12**
It is important to note that, even though the achievement standards in Year 7 – 10 Science do not include overt references to Quantifying numbers, dealing with very small and very large numbers and how they are represented is essential to the study of Science. Students: • explain global features and events in terms of geological processes and timescales • explain chemical processes and natural radioactivity in terms of atoms and energy transfers and describe examples of important chemical reactions.	**Understanding place value (directed numbers)** • orders negative numbers (recognises that −10°C is colder than −2.5°C) **Representing place value** • recognises, reads and interprets very large and very small numbers • expresses numbers as powers of 10 in scientific notation and determines the order of magnitude of quantities (a nanometre has an order of magnitude of –9) • relates place value parts to indices (1000 is 100 times larger than 10, and that is why $10^1 \times 10^2 = 10^3$ and why 10^3 divided by 10^1 is equal to 10^2)

Operating with percentages

This sub-element involves students using percentages to represent quantities. It is particularly useful to Science for developing an understanding of the representation of relative amounts. Percentages can also be used by students to express compositions, yields and efficiencies and to gather quantitative evidence as part of an inquiry process.

Targeted Achievement Standard	Examples of how indicators relate to the AC standard. *Individual student numeracy may be at different levels of the progression as indicated in Figure 1.*
Year 7-10	**OwP1**
It is important to note that, even though the achievement standards in Year 7 – 10 Science do not include overt references to *Operating with percentages*, understanding percentages is essential to interpreting information gathered from sources. Students: • analyse how the sustainable use of resources depends on the way they are formed and cycle through Earth systems.	**Understanding percentages and relative size** • interprets per cent as meaning 'out of 100' • recognises that 100% is a complete whole • interprets a percentage as an operator (percentage is of an amount, 21% of the air is oxygen) • uses percentages to describe and compare relative size (selects which beaker is 75% full, describes an object as 50% larger)

Number patterns and algebraic thinking

This sub-element describes how a student becomes increasingly able to identify a pattern as something that is a discernible regularity in a group of numbers or shapes. Figuring out how a pattern works brings predictability and allows the making of generalisations. As students become increasingly able to connect patterns with the structure of numbers, they create a foundation for algebraic thinking (that is, thinking about generalised quantities and the relationships between quantities expressed as scientific laws). Algebra enables the 'generalisation' of patterns from one situation to another.

Number patterns are evident in nature in the growth patterns of plants and animals (Fibonacci sequence, fractals) and in the structure of molecules and crystals (snowflake, periodic table of elements). Algebraic thinking is used to capture the relationship between quantities such as F=ma or force equals mass multiplied by acceleration.

<table>
<tr><th>Targeted Achievement Standard</th><th>Examples of how indicators relate to the AC standard. Individual student numeracy may be at different levels of the progression as indicated in Figure 1.</th></tr>
<tr><td>Year 10</td><td>NPA5</td></tr>
<tr><td rowspan="3">Students:
• analyse how the periodic table organises elements and use it to make predictions about the properties of elements
• apply relationships between force, mass and acceleration to predict changes in the motion of objects
• explain the processes that underpin heredity and evolution.</td><td>Representing unknowns
• uses words or symbols (including letters) to express relationships involving unknown values (v = d / t)
• finds the value of formulae or algebraic expressions by substituting
• creates algebraic expressions from word problems involving one operation (finds the number of neutrons given the atomic mass and number of protons)</td></tr>
<tr><td>NPA9</td></tr>
<tr><td>Algebraic relationships
• interprets and uses formulae and algebraic representations that describe relationships in various contexts (F = ma)</td></tr>
</table>

Comparing units

This sub-element addresses comparing units in ratios, rates and proportions. The sub-element can be applied in Science to identify patterns and relationships between quantities. It is an essential component in formulating scientific laws, assists with developing an understanding of cause and effect, and can be used to elicit evidence to support conclusions.

<table>
<tr><th>Targeted Achievement Standard</th><th>Examples of how indicators relate to the AC standard. Individual student numeracy may be at different levels of the progression as indicated in Figure 1.</th></tr>
<tr><td>Year 9</td><td>CoU2</td></tr>
<tr><td>Students:
explain chemical processes and natural radioactivity in terms of atoms and energy transfers and describe examples of important chemical reactions</td><td rowspan="2">Ratios
interprets ratios as a comparison between the same units of measure (ratio of hydrogen to oxygen in water is 2:1)
uses a ratio to increase or decrease quantities to maintain a given consistency (adjusts reaction amounts)</td></tr>
<tr><td>Year 10</td></tr>
<tr><td rowspan="3">analyse how the periodic table organises elements and use it to make predictions about the properties of elements
explain how chemical reactions are used to produce particular products and how different factors influence the rate of reactions
explain the processes that underpin heredity and evolution
apply relationships between force, mass and acceleration to predict changes in the motion of objects.</td><td>Rates
interprets rates as a relationship between two different types of quantities (change of concentration of reactants per time)
uses rates to determine how quantities change</td></tr>
<tr><td>CoU3</td></tr>
<tr><td>Applying proportion
uses common fractions and decimals for proportional division (Mendelian ratios)
explains and applies the difference between direct and indirect proportion (direct – increasing the mass will increase the force provided that acceleration remains constant; indirect – travelling at a greater speed will mean the journey takes less time)</td></tr>
</table>

Understanding units of measurement

This sub-element describes how a student becomes increasingly able to recognise attributes that can be measured and how units of measure are used and calculated. In Science, this sub-element provides an important foundation for making accurate measurements and for developing a sense of scale.

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<tr><td>Year 9</td><td>UuM7</td></tr>
<tr><td rowspan="5">It is important to note that, even though the achievement standards in Year 7 – 10 Science do not include overt references to Understanding units of measurement, these skills are essential and implied in the methodology of the scientific investigation.

Students:

• design methods that include the control and accurate measurement of variables and systematic collection of data.</td><td>Using formal units

• measures, compares and estimates length, area, mass, volume and capacity using standard formal units</td></tr>
<tr><td>UuM8</td></tr>
<tr><td>Converting units

• converts between formal units of measurement
• recognises the relationship between metric units of measurement and the base-ten place value system</td></tr>
<tr><td>UuM9</td></tr>
<tr><td>Calculating measurements

• identifies appropriate levels of precision with measurement (significant figures)</td></tr>
</table>

Interpreting and representing data

This sub-element describes how a student becomes increasingly able to recognise and use visual and numerical displays to describe data associated with scientific investigations. Making sense of data is vital to studying Science. Students use data to develop appropriate displays to explore cause and effect relationships and patterns of continuity and change. They interpret representations of data to support their own interpretations and to think critically about claims made by others, either questioning or confirming them.

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<tr><th>Targeted Achievement Standard</th><th>Examples of how indicators relate to the AC standard. Individual student numeracy may be at different levels of the progression as indicated in Figure 1.</th></tr>
<tr><td>Year 10</td><td>IRD5</td></tr>
<tr><td rowspan="3">Students:
• explain how different factors influence the rate of [chemical] reactions
• apply relationships between force, mass and acceleration to predict changes in the motion of objects
• describe and analyse interactions and cycles within and between Earth’s spheres
• identify where digital technologies can be used to enhance the quality of data
• explain any sources of uncertainty.</td><td>Graphical representations of data
• uses graphical representations relevant to the purpose of the collection of the data (selects a line graph for continuous variables and bar graphs for discrete and categorical variables)
• interprets graphs depicting motion such as distance–time graphs
• interprets and describes patterns in graphical representations in real-life situations (roller-coasters, flight trajectory)
• interprets the impact of outliers in data (determines the factors that may cause the occurrence of outliers and decide how to handle them in the subsequent analysis)</td></tr>
<tr><td>IRD6</td></tr>
<tr><td>Recognising bias
• applies an understanding of distributions to evaluate claims based on data (the greater the number of readings taken, the more accurate the data is likely to be)
• justifies criticisms of data sources that include biased statistical elements (inappropriate sampling through poor experimental design)</td></tr>
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