PAT Science

Achievement band descriptions

Australian Council *for* Educational Research

Contents

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Background

Each PAT Science achievement band qualitatively describes what is assessed by the items located in its range of scale scores, detailing the skills and understandings a student has directly or indirectly demonstrated by responding to the items of a PAT Science test.

Using the PAT Science achievement bands

While a scale score indicates a student's achievement level and can be used to quantitatively track a student's growth, it is only in understanding what the number represents that teachers can successfully inform their practice to support student learning. For this reason, the PAT Science scale has been divided into achievement bands that include written descriptions of what students are typically able to demonstrate at that band (band description). A student scoring within a particular band can be expected to have at least some proficiency as described in that band and be progressively more proficient with the Science knowledge, skills and understanding described in lower bands.

Two students whose test performance places them into the same achievement band are operating at approximately the same achievement level within a learning area, regardless of their respective school year levels. Viewing student achievement in terms of achievement bands may assist teachers to group students of similar abilities. By referencing the PAT achievement band descriptions, teachers can understand the types of skills typical of students according to their PAT band. For example, a PAT Science scale score of 129 could be considered to be at the upper end of achievement band 120–129 or at the lower end of achievement band 130–139. In cases like these, it is important to consult the descriptions of both achievement bands to understand the student's abilities.

Four overarching elements guide PAT Science assessment development and are reflected in the achievement band descriptions:

- Strands
- Cognitive skills
- Key ideas
- Content progressions

More detailed information on these elements can be found in the separate PAT Science assessment framework.

Strands

The two key aspects of the construct (what students know and can do) are evident in the three interrelated strands of the Australian Curriculum: Science.

Science understanding

The Science understanding strand is concerned with the scientific knowledge (facts, concepts, principles, laws, theories, and models) that students need to acquire in order for them to explain and predict phenomena and be able to apply to new situations.

Science as a human endeavour

The Science as a human endeavour strand provides contexts for science's contribution to our culture and society, and its applications, as well as considerations of global issues.

Science inquiry

The Science inquiry strand follows the scientific investigation pathway so that ideas and predictions can be made, tested, analysed and represented to gain in an in-depth understanding of scientific understandings and concepts.

Cognitive skills

A second aspect of the construct is the cognitive skill that students need to use to engage with and respond to items. The PAT Science cognitive skills are based on the classifications used in the Trends in Mathematics and Science Study (TIMSS) and are elaborated here (Mullis et al., 2017):

Knowing

Items in this domain assess students' knowledge of facts, relationships, processes, concepts, and equipment. Accurate and broad-based factual knowledge enables students to successfully engage in the more complex cognitive activities essential to the scientific enterprise.

Applying

Items in this domain require students to engage in applying knowledge of facts, relationships, processes, concepts, equipment, and methods in contexts likely to be familiar in the teaching and learning of science.

Reasoning

Items in this domain require students to engage in reasoning to analyse data and other information, draw conclusions, and extend their understandings to new situations. In contrast to the more direct applications of science facts and concepts exemplified in the applying domain, items in the reasoning domain involve unfamiliar or more complicated contexts. Answering such items can involve more than one approach or strategy. Scientific reasoning also encompasses developing hypotheses and designing scientific investigations.

Key ideas

The Australian Curriculum: Science is framed by six key ideas, which are considered during item development for PAT Science.

The inclusion of these key ideas in the Australian Curriculum is designed to support the coherence and developmental sequence of science knowledge across disciplines and year levels (Australian Curriculum: Science, Key Ideas, 2010). The key ideas assist in 'seeing' the progress students are likely to make across year levels with respect to each of these ideas.

Content progressions

The scope of the Australian Curriculum: Science is such that not all material can be assessed adequately in the time allotted to testing across eight tests. Therefore 'mini-progressions' of learning were identified and aligned with the overarching key ideas of the Australian Curriculum. These mini-progressions focus on the development of major concepts that are progressively advanced as the tests move to higher levels. The term mini-progression encapsulates the idea that we can drill down in the literature to find out more about conceptual and process skills development at a fine level to support item writing. Whilst the Australian Curriculum: Science provides a good scaffold for progression across major concepts (and connections to the inquiry skills that support their development), it sometimes 'jumps' across several year levels without referencing a specific concept. Test developers used the mini-progressions to write 'up' or 'down' a progression to ensure cohesion within content (conceptual understanding or skill development) of the Australian Curriculum.

PAT Science achievement bands

The following are general indicators of the abilities and skills that students at each band typically possess.

140 and above

Students identify the difference in mass between subatomic particles, elements, and molecules, determine whether a reaction is endothermic or exothermic and completely balance chemical equations.

Students describe ecological relationships and interpret classification keys to identify closely related animals. They relate human body parts to their function, identify cell organelles and recall their function.

Students understand the concept of a closed energy system. They describe the conversion of electrical potential energy to kinetic energy. They recall the different methods of heat transfer including radiation and understand its properties.

Students identify a type of rock as sedimentary, igneous, or metamorphic based on physical and chemical properties. They determine the hottest star based on spectral class and temperature scale.

Students identify dependent, independent, and controlled variables and the relationship between them. They identify the appropriate equipment to accurately collect data. They analyse, construct, and interpret pie charts, scatter plots, line graphs, and multi-variable numerical tabular data to draw and support conclusions about scientific investigations. They identify the sources of uncertainty when calculating distance from direct observation.

130–139

Students apply their knowledge of the particle model and separation techniques in the home such as when dissolving medication, cooking, and describing common materials. They recognise the difference between physical and chemical change and apply this to a range of situations, including the consequences of reactions such as corrosion. Students recognise the products and reactants in a chemical reaction and balance a part of a chemical equation. They interpret and compare historical data of elements and recall the properties of subatomic particles. They know that carbon is the basis of organic compounds.

Students predict the outcomes of change within an ecosystem. They use unfamiliar classification keys such as those based on animal products (e.g. spider webs, to identify species). They identify the physiological changes of body systems during physical activity. Students understand the concept of surface area to volume ratio. They can determine the correct phenotypic ratio of offspring from a dihybrid cross.

Students recognise that current flow requires a completed circuit. They apply their knowledge of balanced and unbalanced forces to investigations and use the Law of Conservation of Energy to explain observations (e.g. when tracing the main energy conversions in a power station).

Students interpret the interactions between the planets and the Sun from a model of our solar system and identify evidence that supports the Big Bang Theory. Students identify the nature of trace fossils and define the components of the biosphere.

Students identify and test hypotheses or research questions based on prior knowledge, choose all appropriate variables for an experimental design, and understand the relationship between these selected variables. They evaluate, analyse, and validate data sets, including numerical data with unfamiliar units (e.g. electrical, and thermal conductivity). They interpret summarised data (e.g. data averaged in tables and graphs), to draw conclusions about experiments. They determine the most effective means of data presentation, compare data sources, and synthesise and use this data to support conclusions. Students make suggestions to improve experimental data quality.

Students consider some of the economic, moral, and scientific aspects of research.

120–129

Using correct terminology, students describe how matter changes state and apply information to determine how plasma is formed. They identify atomic structure and the basic electron configuration of a given atom, and of isotopes. They identify reactants and products in a chemical reaction and recognise the patterns and organisation of elements in the periodic table.

Students classify once-living things from non-living objects and recognise external features of organisms and their functions. They use these features to categorise groups of animals and identify reasons for classifying organisms. Students identify the roles of organisms in food webs and determine the impact of introduced species. Students recall the main function of organ systems. They interpret evidence that supports evolution and natural selection.

Students identify observable energy transformations in a system (e.g. chemical to light energy in an electrical circuit). They apply their knowledge of friction and magnets to explain their observations. They use reasoning to identify advantages of parallel circuits and how gears are used. Students apply their knowledge of the particle model to explain heat transfer and how this differs between objects. They calculate speed from direct observations of moving objects, and know which objects allows the transmission of light.

Students relate features of Earth to other planets to determine other planets' seasons and day length. They consider effective methods for detecting star temperature. Students understand the timescale for fossilisation to occur and that this evidence can be used to infer features on Earth at the time of fossilisation. Students know that land clearing contributes to erosion. They understand the process of carbon cycling in the biosphere and the gases contributing to the greenhouse effect.

Students identify hypotheses and research questions relevant to a given investigation. They establish the purpose of experiments and determine what data is required to be collected to answer a scientific question. They plan experiments and select dependent and independent variables, and those to be controlled. They accurately read scales on equipment. They interpret and analyse patterns and trends in a range of graphs including simple scatter plots with lines of best fit, explain deviations between data points, and choose appropriate ways to present data to explain results. They compare a number of data sources to draw and validate conclusions.

Students recognise how specific new technologies benefit the community and identify some limitations of that technology.

110–119

Students recognise that materials change state due to changes in temperature, but their mass does not change. They identify reversible and irreversible changes in common substances (e.g. metal's rusting is irreversible).

Students use simple identification keys with limited decision points. They identify the specific features of plants and animals at different stages of their life cycles. They identify the physical conditions affecting growth, and the interdependence between animals, plants, and decomposers.

Students identify methods of heat generation and simple energy conversions in everyday and familiar contexts (e.g. chemical energy to heat and light energy). They recognise contact and non-contact forces and apply this knowledge to real-world examples.

Students use shadows to determine the position of the Sun in the sky. They can model the size of the Moon, Sun, and Earth with common objects (e.g. marble and tennis ball). Students describe renewable and non-renewable resources and how some of these resources are used. They understand how erosion can be prevented.

Student's plan simple two factor experimental designs recognising appropriate steps and identify some variables. They suggest appropriate familiar equipment to use. Students interpret scientific diagrams and make predictions based on observations. They identify trends and patterns from tables and graphs (e.g. bar and line graphs) where only one or two factors need to be considered. They recognise which graphs are appropriate to represent certain data types and can construct these graphs. Students draw conclusions from these experiments and data.

Students apply scientific ideas to reduce risks (e.g. when using electricity), find solutions to everyday problems (e.g. water storage and collection), including those that help communities.

100–109

Students relate the properties of materials to their use. They classify organisms based on common features and recognise a range of familiar and unfamiliar plant and animal life cycles. They use evidence to determine where a shadow will be cast when light is blocked by an object.

Students construct pictographs, identify trends in bar graphs and tables with one-to-one correspondence, and interpret maps. They identify questions that can be answered by conducting simple scientific investigations using everyday materials in familiar situations. They suggest measurements to be taken, record data and form conclusions from these investigations.

99 and below

Students recall and identify the basic properties of materials. They recognise the stages of life cycles for familiar animals and distinguish between living and non-living things. They use a model of the Earth to make observations about its movement on its axis.

Students make direct experimental observations and read single variable data tables with and construct graphs (e.g. bar graphs with one-to-one correspondence).