Australia

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Introduction

Overview of Education System

Australia does not have a single national education system; its individual states and territories are responsible for their own education administration. However, due to increasing collaboration, there is increasing consistency in the way in which education is provided across Australia. Most schools are owned and operated by state and territory governments, with the national government providing supplementary funding. In addition, approximately one-third of students attend nongovernment schools.[1] Nongovernment schools receive the majority of their public funding from the national government, with state and territory governments providing supplementary funding, along with other funding sources (including fees paid by parents). Policy collaboration takes place in joint governmental councils that include national, state, and territorial government representatives.

State education departments recruit and appoint teachers to government schools; supply buildings, equipment, and materials; and provide limited discretionary funding for use by schools. In most jurisdictions, regional offices and schools have responsibility for administration and staffing, although the extent of responsibility varies across jurisdictions. Central authorities specify the curriculum and standards framework from Foundation (Year 0) to Year 10 (since 2011, the Australian Curriculum). However, individual states and territories decide how the curriculum is implemented in their schools, and schools have autonomy in deciding curriculum details, textbooks, and teaching methodology, particularly at the primary and lower secondary levels. State authorities specify curriculum for Years 11 and 12, and are responsible for examining and certifying final year student achievement for both government and nongovernment schools.

In the last decade, the degree of involvement of the national government and the degree of collaboration between state and territorial governments have increased. In 2008, ministers of education agreed to the Melbourne Declaration on the Educational Goals for Young Australians, which outlines future directions and aspirations for Australian schooling.[a, 2] Following this agreement, the Australian Education Act 2013, which contains a broad range of national targets to

[a] In December 2019, education ministers agreed to The Alice Springs (Mparntwe) Declaration (https://www.education.gov.au/schooling-0), which sets out the national vision for Australian education from 2020.

ensure that Australia remains a high quality and highly equitable system, was passed.[3] Since then, Australia's national reform agenda has included the development of a national curriculum, and the introduction of national standards for teachers and school leaders. Two national agencies—the Australian Curriculum, Assessment, and Reporting Authority (ACARA)[4] and the Australian Institute for Teaching and School Leadership (AITSL)[5]—were established to support these initiatives.

Children in Australia generally attend preschool part time for one or two years before starting school. Preschools are typically run by local councils, community groups, or private organizations (including within long daycare), with some states also offering state-run preschools. Preschool is offered to children ages 3 to 5, though attendance varies widely. Since 2008, national policy and funding agreements aim to ensure at least 600 hours of preschool per year (15 hours a week) in the year before full-time school.[6] Preschool education is primarily play-based and since 2009 has been supported by the Early Years Learning Framework.[7] The Early Years Learning Framework also supports other early childhood programs, such as long day care and family day care (home-based childcare), ensuring that all children have access to high quality and consistent early childhood education and care.

The Australian school system is organized around year levels. Since 2007, all jurisdictions provide a Foundation year (known as kindergarten, preparatory (prep), transition, preprimary, or reception), in the year before Year 1. As of 2015, all states, except for South Australia, include Foundation to Year 6 in primary school, and Years 7 to 12 in secondary school.[b] Schooling becomes compulsory at age 6 in most states and territories.[c] However, in practice, most children start the Foundation year of primary school at between 4 years, 6 months and 5 years, 6 months old. Following a decision by the Council of Australian Governments (COAG) in July 2009, there is national agreement on a mandatory requirement for young people to complete Year 10 and then participate full time in education, training, or employment until age 17.[8]

Primary school and the first two years of secondary school typically provide a general program that all students follow. In subsequent years of schooling, a basic core of subjects is supplemented with optional subjects for students. In the final two years of secondary school, students have the opportunity to choose five or six subjects from a range of elective studies in which to specialize. It is common for mathematics to be taught at different levels, and for students to choose the level appropriate to their future plans.

Australia has no common national policy on ability streaming, grouping, or tracking students. Streaming is a school-based decision and is not promoted officially in any state. Some schools choose to stream students according to ability, and some offer special enrichment or remedial programs for select groups of students.

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[b] South Australia retains Year 7 in primary school so that its structure is Foundation to Year 7, and Year 8 to Year 12. However, from 2020, schools will be transitioning Year 7 to secondary school so that, by 2022, South Australia's school structure will be in line with all other jurisdictions.

[c] In Queensland, it is 6 years, 6 months, and in Tasmania, 5 years of age at January 1.

Use and Impact of TIMSS

Australia has participated in every cycle of TIMSS since 1995, at Grades 4 and 8, including the video study. This long and continual participation has ensured the position of TIMSS as an important source of information for educators and policymakers across Australia.

The Australian Government's National Assessment Program includes TIMSS as one of several international assessments used as key performance measures for collecting data on the progress of Australian students toward the National Goals for Schooling. Information from international assessments such as TIMSS has highlighted certain areas of concern for Australia that are being addressed by government policy. In particular, the Office of the Chief Scientist has included TIMSS data in reports looking at the status of science, technology, engineering, and mathematics (STEM) in Australia,[9] which influenced the Australian Government's National Innovation and Science Agenda (NISA), announced in December 2015.[10] In addition, TIMSS (particularly the video study) was used to help guide the development of the new Australian Curriculum.[11]

At the state and territory level, TIMSS is used similarly to evaluate student progress across the system. For example, TIMSS results are used in South Australia to evaluate progress against the South Australian STEM Learning Strategy 2017–2020.[12]

The Mathematics Curriculum in Primary and Lower Secondary Grades

The Australian Curriculum was introduced from 2012 and revised in 2015. Prior to this, states and territories authored their own curricula. The description that follows is a summary of the Australian Curriculum based on materials downloaded from the Australian Curriculum website in 2019.[13] For information on prior versions of the curricula, please refer to earlier editions of the *TIMSS Encyclopedia*.[14,15]

In the Australian Curriculum, mathematics is organized around the interaction of three content strands and four proficiency strands. The content strands are Number and Algebra, Measurement and Geometry, and Statistics and Probability. They describe what is to be taught and learned. The proficiency strands are Understanding, Fluency, Problem Solving, and Reasoning. They describe how content is explored or developed—that is, thinking mathematically and doing mathematics. They provide a meaningful basis for the development of concepts in mathematics learning and have been incorporated into the content descriptions of the three content strands. This approach has been adopted to ensure students' proficiency in mathematical skills develops throughout the curriculum and becomes increasingly sophisticated over the years of schooling.

The proficiency strands for mathematics in Year 4 may be summarized as follows:

- Understanding—Making connections between representations of numbers, partitioning and combining numbers flexibly, extending place value to decimals, using appropriate language to communicate time, and describing properties of symmetrical shapes
- Fluency—Recalling multiplication tables, communicating sequences of simple fractions, using instruments to measure accurately, creating patterns with shapes and their transformations, and collecting and recording data

- Problem Solving—Formulating, modeling, and recording authentic situations involving operations; comparing large numbers; comparing time durations; and using properties of numbers to continue patterns
- Reasoning—Generalizing from number properties and results of calculations, deriving strategies for unfamiliar multiplication and division tasks, comparing angles, communicating information using graphical displays, and evaluating the appropriateness of different displays

The achievement standards for mathematics in Year 4 include the following skills: choosing appropriate strategies for calculations involving multiplication and division; recognizing common equivalent fractions in familiar contexts and making connections between fraction and decimal notations up to two decimal places; solving simple purchasing problems; identifying and explaining strategies for finding unknown quantities in number sentences; describing number patterns resulting from multiplication; comparing areas of regular and irregular shapes using informal units; solving problems involving time duration; interpreting maps; identifying dependent and independent events; describing methods of data collection and representation and evaluating their effectiveness; using the properties of odd and even numbers; recalling multiplication facts up to 10×10 and related division facts; locating familiar fractions on a number line; continuing number sequences involving multiples of single-digit numbers; using scaled instruments to measure temperatures, lengths, shapes and objects; converting between units of time; creating symmetrical shapes and patterns; classifying angles in relation to a right angle; listing the probabilities of everyday events; and constructing data displays from given or collected data.

The proficiency strands for mathematics in Year 8 may be summarized as follows:

- Understanding—Describing patterns involving indices and recurring decimals, identifying commonalities between operations with algebra and arithmetic, connecting rules for linear relations with their graphs, explaining the purpose of statistical measures, and explaining measurements of perimeter and area
- Fluency—Calculating accurately with simple decimals, indices, and integers; recognizing equivalence of common decimals and fractions including recurring decimals; factorizing and simplifying basic algebraic expressions; and evaluating perimeters and areas of common shapes and volumes of three-dimensional objects
- Problem Solving—Formulating and modeling practical situations involving ratios, profit and loss, and areas and perimeters of common shapes, and using two-way tables and Venn diagrams to calculate probabilities
- Reasoning—Justifying the result of a calculation or estimation as reasonable, deriving probability from its complement, using congruence to deduce properties of triangles, and finding estimates of means and proportions of populations

The achievement standards for mathematics in Year 8 include the following skills: solving everyday problems involving rates, ratios, and percentages; describing index laws and applying them to whole numbers; describing rational and irrational numbers; solving problems involving profit and loss; making connections between expanding and factorizing algebraic expressions; solving problems relating to the volume of prisms; making sense of time in real applications; identifying conditions for the congruence of triangles and deducing the properties of quadrilaterals; modeling authentic situations with two-way tables and Venn diagrams; choosing appropriate language to describe events and experiments; explaining issues related to the collection of data and the effect of outliers on means and medians in that data; using efficient mental and written strategies to carry out the four operations with integers; simplifying a variety of algebraic expressions; solving linear equations and graphing linear relationships on the Cartesian plane; converting between units of measurement for area and volume; calculating the perimeter and area of parallelograms, rhombuses, and kites; naming the features of circles and calculating the areas and circumferences of circles; determining the probabilities of complementary events; and calculating the sum of probabilities.

The Science Curriculum in Primary and Lower Secondary Grades

The Australian Curriculum was introduced in 2012 and revised in 2015. Prior to this, states and territories authored their own curricula. The description that follows is a summary of the Australian Curriculum based on materials downloaded from the Australian Curriculum website in 2019.[16] For information on prior versions of the curricula, please refer to earlier editions of the *TIMSS Encyclopedia*.[17,18]

In the Australian Curriculum, science is organized around three interrelated strands: Science Understanding, Science as a Human Endeavor, and Science Inquiry Skills. Together, the three strands of the science curriculum provide students with understanding, knowledge, and skills through which they may develop a scientific view of the world. Students are challenged to explore the concepts, nature, and uses of science through clearly described processes of inquiry.

Science understanding is evident when a person selects and integrates appropriate science knowledge to explain and predict phenomena, and applies that knowledge to new situations. Science knowledge refers to 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, Chemical Sciences, Earth and Space Sciences, and Physical Sciences.

The Science as a Human Endeavor 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. There are two sub-strands of Science as a Human Endeavor:

- Nature and Development of Science—Helps students develop an appreciation of the unique nature of science and scientific knowledge, including how current knowledge has developed over time through the actions of many people
- Use and Influence of Science—Explores how science knowledge and applications affect people's lives, including their work, and how science is influenced by society and can be used to inform decisions and actions

Science inquiry involves identifying and posing questions; planning, conducting, and reflecting on investigations; processing, analyzing, and interpreting evidence; and communicating findings. The Science Inquiry Skills strand is concerned with evaluating claims, investigating ideas, solving problems, drawing valid conclusions, and developing evidence-based arguments. There are five sub-strands of Science Inquiry Skills:

- Questioning and Predicting—Identifying and constructing questions, proposing hypotheses, and suggesting possible outcomes
- Planning and Conducting—Making decisions regarding how to investigate or solve a problem and carrying out an investigation, including data collection
- Processing and Analyzing Data and Information—Representing data in meaningful and useful ways; identifying trends, patterns, and relationships in data, and using this evidence to justify conclusions
- Evaluating—Considering the quality of available evidence and the merit or significance of a claim, proposition, or conclusion with reference to that evidence
- Communicating—Conveying information or ideas to others through appropriate representations, text types, and modes

In Years 3 to 6, students develop their understanding of a range of systems operating at different time and geographic scales. In Year 4, students broaden their understanding of classification and form and function through an exploration of the properties of natural and processed materials. They learn that forces include noncontact forces and begin to appreciate that some interactions result from phenomena that cannot be seen with the naked eye. They begin to appreciate that current systems, such as Earth's surface, have characteristics that have resulted from past changes and that living things form parts of systems. They understand that some systems change in predictable ways, such as through cycles. They apply their knowledge to make predictions based on interactions within systems, including those involving the human actions.

The achievement standards for science in Year 4 include the following skills: applying the observable properties of materials to explain how objects and materials can be used; describing how contact and noncontact forces affect interactions between objects; discussing how natural processes and human activity cause changes to Earth's surface; describing relationships that assist the survival of living things and sequencing key stages in the life cycle of plants and animals; identifying when science is used to understand the effect of their action; following instructions to identify investigable questions about familiar contexts and make predictions based on prior knowledge; describing ways to conduct investigations and safely use equipment to make and record observations with accuracy; using tables and column graphs to organize data and identify patterns; suggesting explanations for observations and comparing findings with predictions; suggesting reasons why a test was or was not fair; and using formal and informal ways to communicate their observations and findings.

In Years 7 to 10, students develop their understanding of microscopic and atomic structures, and how systems at a range of scales are shaped by flows of energy and matter and interactions due to forces. They also develop the ability to quantify changes and relative amounts.

In Year 8, students are introduced to cells as microscopic structures that explain macroscopic properties of living systems. They link form and function at a cellular level and explore the organization of body systems in terms of flows of matter between interdependent organs. Similarly, they explore changes in matter at a particle level, and distinguish between chemical and physical change. They begin to classify different forms of energy and describe the role of energy in causing change in systems, including the role of heat and kinetic energy in the rock cycle. Students use experimentation to isolate relationships between components in systems and explain these relationships through increasingly complex representations. They make predictions and propose explanations, drawing on evidence to support their views while considering other points of view.

The achievement standards for science in Year 8 include the following skills: comparing physical and chemical changes and using the particle model to explain and predict the properties and behaviors of substances; identifying different forms of energy and describing how energy transfers and transformations cause change in simple systems; comparing processes of rock formation, including the time scales involved; analyzing the relationship between structure and function at the cellular, organ, and body system levels; examining the different science knowledge used in occupations; explaining how evidence has led to an improved understanding of scientific ideas and describing situations in which scientists collaborated to generate solutions to contemporary problems; reflecting on implications of these solutions for different groups in society; identifying and constructing questions and problems for scientific investigation; considering safety and ethics when planning investigations, including designing field or experimental methods; identifying variables to be changed, measured, and controlled; constructing representations of their data to reveal and analyze patterns and trends, and using them when justifying their conclusions; explaining how modifications to methods could improve the quality of data; applying scientific knowledge and investigation findings to evaluate claims made by others; and using appropriate language and representations to communicate science ideas, methods, and findings in a range of text types.

Professional Development Requirements and Programs

AITSL was established in 2010 to provide national leadership in promoting excellence in the profession of teaching and school leadership. The institute is responsible for creating and maintaining national professional standards for teaching and school leadership as well as promoting high quality professional development for teachers and school leaders (including national oversight of the accreditation of preservice teacher education).

The Australian Professional Standards for Teachers (implemented in 2011) describe expectations for teachers across three domains—Professional Knowledge, Professional Practice, and Professional Engagement—and four career stages—Graduate, Proficient, Highly Accomplished, and

Lead.[19] The Graduate and Proficient stages enumerate the mandatory requirements for entry into the profession.

Australian education authorities recognize that professional development is imperative for maintaining the vitality of the profession. This belief is reflected in the Australian Charter for the Professional Learning of Teachers and School Leaders,[20] which describes the importance and characteristics of high quality professional development in improving teacher and school leader practice, and the Australian Teacher Performance and Development Framework (developed at the same time),[21] which outlines the critical factors for creating a performance and development culture in schools.

There are no specific professional development requirements for mathematics and science teachers beyond the general requirement for teacher registration that all teachers record 20 hours of professional learning a year. However, teachers have access to a broad range of professional development activities, many of which focus on mathematics and science. Some systemwide initiatives include:

- Primary Connections: Linking Science with Literacy—This national program links science teaching with literacy teaching in Australian primary schools and provides both a professional learning program for teachers and curriculum resources designed to develop students' knowledge, understanding, and skills in science and literacy, through an inquiry-based approach.[22]
- reSolve: Maths by Inquiry—This national program provides teaching and professional learning resources that promote relevant and engaging mathematics teaching and learning for students from Foundation to Year 10, through an inquiry-based approach.[23]
- Thinking Maths—This professional learning program in South Australia builds teachers' capabilities to engage middle school students' mathematics learning to improve their mathematics achievement.[24]

Monitoring Student Progress in Mathematics and Science

As part of the national reform agenda, jurisdictions committed to increasing accountability and transparency and established the National Assessment Program in 2002, which has been managed by ACARA since 2009. The program involves the following:

- A full cohort assessment of students in Grades 3, 5, 7, and 9 in literacy and numeracy
- A program of sample assessments at Grades 6 and 10 in science, civics and citizenship, and Information and Communications Technology conducted every three years
- Participation in international surveys, including TIMSS

The purpose of these programs is to report on student achievement based on standardized testing to parents, teachers, and schools, and to monitor the overall performance of the education system.[25]

At the local level, the requirement for increased accountability includes providing plain language reports on the progress and achievement of each student to their parents or caregivers. This national approach requires all schools to report student achievement against national standards using a five-point rating scale and an assessment relative to the performance of the student's peer group. School-based or teacher-led assessment is used at the primary and lower secondary levels to evaluate student progress against the national standards. At the primary level, this assessment is mainly informal, including checklists, observations, projects, and portfolios. At the lower secondary level, assessment becomes more formalized, including teacher-made tests, essays, and laboratory assignments. Growing interest in formative assessments has led to the development of assessment libraries, such as the Victorian Curriculum and Assessment Authority's Digital Assessment Library to support teachers' use of formative assessments.

At the end of secondary school in the 12th grade, all states conduct formal assessments of student performance in subjects. The purpose of these assessments is to certify student achievement at the end of school while also providing a basis for course selection in higher education. In most states, assessments are based on a combination of curriculum-specific formal examinations conducted by a state authority and school-based assessments of student performance on specified tasks or assignments. Queensland[d] and the Australian Capital Territory conduct no external examinations; however, internal school assessments are adjusted against students' scores on an aptitude test so as to introduce a measure of continuity across schools.

Special Initiatives in Mathematics and Science Education

Much work has been done by the Chief Scientist of Australia to highlight the importance of STEM for Australia's future.[26] A number of initiatives have flowed from this work, including the National STEM School Education Strategy 2016–2026, which aims to ensure that students have a strong foundation in STEM and are inspired to take on challenging STEM subjects,[27] and the National Innovation and Science Agenda—Inspiring all Australians in Digital Literacy and STEM, which aims to ensure all Australian students have the opportunity to embrace the digital age and develop the STEM skills they need for the jobs of tomorrow.[28]

These broad funding initiatives support a large range of smaller programs including the following:

- Supporting Artificial Intelligence in Schools—This program is the school education component of the Artificial Intelligence Capability Fund measure. It aims to develop a range of curriculum resources to assist with the delivery of artificial intelligence and emerging technologies content and the associated general capabilities in the Australian Curriculum.[29]

[d] From 2019, students entering Year 11 will complete the new Queensland Certificate of Education, which will include external assessment as well as internal school-based assessment.

- STEM Professionals in Schools—This program links practicing STEM professionals with classroom teachers and their students to provide real world, contemporary experiences that engage and motivate students and promote careers in STEM.[30]
- Early Learning STEM Australia (ELSA) project—This initiative includes the development of play-based digital learning programs for children in preschool to explore STEM.[31]

The STEM Program Index, released by the Office of the Chief Scientist in January 2016, provides an overview of the many programs in Australia that focus on engaging school-age students with STEM.[32] Some state-specific programs include:

- The six Science and Mathematics Specialist Centres in Victoria, which offer a variety of on-site, online, and outreach programs related to science and mathematics for teachers, students and families[33]
- The Caroline Chisholm School, Centre for Innovation and Learning, an ACT Government Educational Facility built to deliver STEM programs to students and teachers[34]

Suggested Readings

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