THE STATE OF MATHEMATICAL SCIENCES 2024

8TH DISCIPLINE PROFILE OF MATHEMATICS AND STATISTICS IN AUSTRALIA

AMSI AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

About **AMSI**

The Australian Mathematical Sciences Institute (AMSI) is a not-for-profit peak body for the mathematical sciences with a breadth of members including Australian universities, professional societies, government agencies and industry. We champion mathematics, statistics and data science for Australia's advancement through advocacy, facilitation, and collaboration.

The common purpose we share with our members and partners is the radical improvement of mathematical capacity and facility, both in Australia and Asia-Pacific. AMSI's impact is underpinned by our convening power across the mathematical sciences ecosystem.

AMSI's activities fall largely into three strategic areas – school education, research and higher education, and industry engagement. In school education, we focus on teacher professional development to foster teaching excellence and inspire students to study mathematics to year 12. Research and higher education delivers advanced research training and research workshops to continue the development of undergraduate and postgraduate maths students, in preparation for careers in academia and industry. Our industry division is home to the national PhD internship program, APR.Intern, which has successfully grown to an all-discipline all-sector program working with Australian universities and industry.

Vision

Australia has a vibrant mathematical culture that is valued as a national asset. That the mathematical sciences enrich Australian society and are recognised as a fundamental driver of its economy.

That all Australians have the opportunity to develop their mathematics skills and knowledge, to enhance their careers, acquire essential life skills and to enrich their lives.

Mission

Sustained advocacy of the mathematical sciences through the provision of authoritative information and influence of national policy.

Enhancing mathematical sciences education and research to support the development of world-class mathematical scientists.

Facilitating employment linkages for graduates in the mathematical sciences.

Influencing the mathematical sciences student pipeline to increase the number and diversity of students studying mathematics at school and university.

Engaging stakeholders in the mathematical sciences ecosystem to strengthen the impact of the Mission, enhance reputation and global profile.

Contents

Authors: Professor Tim Marchant & Sophie Kennedy
Design: Michael Shaw

Acknowledgments

We acknowledge and thank Dr. Maaike Wienk, who previously held the role of AMSI's Finance, Policy and Advocacy Officer. She made substantial contributions to the preparation of this 8th Discipline Profile and to previous versions of the Profile. This publication includes information from many sources and would not have been possible without the input from many people. It provides a helicopter view of data and analysis published and provided by government, government agencies, non-government organisations and societies. Every effort has been made to accurately and clearly present any data, graphs and tables generated by other organisations. Any errors or omissions are entirely our own.

AMSI Members

Full Members

University of Adelaide
Australian National University
La Trobe University
University of Melbourne
Monash University
University of Newcastle
University of New South Wales
University of Queensland
Queensland University of Technology
RMIT University
University of Sydney
University of Western Australia

Associate Members

Aboriginal & Torres Strait Islander Mathematics Alliance (ATSIMA)
Australian and New Zealand Association of Mathematical Physics (ANZAMP)
Australian and New Zealand Industrial and Applied Mathematics (ANZIAM)
Australian Bureau of Statistics (ABS)
Australian Institute of Physics (AIP)
Australian Mathematical Society (AustMS)
Australian Signals Directorate (ASD)
Citadel Securities Australia Pty Ltd
Computing Research and Education Association of Australasia (CORE)
Curtin University
Deakin University
Flinders University
Griffith University
James Cook University
Macquarie University
Mathematics Education Research Group of Australia (MERGA)
Murdoch University
New Zealand Mathematical Society (NZMS)
New Zealand Statistical Association (NZSA)
Optiver
Reserve Bank of Australia
Statistical Society of Australia (SSA)
Swinburne University of Technology
The Mathematical Association of Victoria (MAV)
University of New England
University of South Australia
University of Southern Queensland
University of Tasmania
University of Technology, Sydney
University of Wollongong
Victoria University
Western Sydney University

AMSI and its members acknowledge the significant contribution of the University of Melbourne as our Lead Agent and host.

List of members as of September 2024.

Director's comment

The mathematical sciences play an increasingly vital role in addressing the challenges and demands of the 21st century. These disciplines—encompassing mathematics, statistics, and data science—are central to innovation across various sectors. From finance and healthcare to artificial intelligence and machine learning, mathematical sciences provide the analytical frameworks necessary for making informed decisions in a data-driven world. Their applications not only drive technological advancements but also shape critical processes in industries that depend on precision, efficiency, and data insights.

Moreover, the mathematical sciences serve as the backbone of cutting-edge research across numerous fields. Whether applying complex algorithms in artificial intelligence or using statistical models in climate science, mathematics underpins many of today's most significant advancements. The past decade has seen a notable increase in students pursuing degrees in mathematical sciences at universities, indicating a positive shift in student interest and growing recognition of the field's importance.

Recent developments, including the OECD's 2022 Programme for International Student Assessment (PISA) results, highlight both progress and challenges for Australia. While Australian students performed relatively well compared to their international peers, long-term trends reveal a concerning decline in participation in advanced mathematics at the secondary level. This decline is particularly alarming given the rapid expansion of demand for mathematical science professionals. Industries increasingly require these skills to remain competitive, and our education system must respond accordingly.

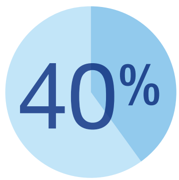
As the need for expertise in mathematical sciences continues to rise, Australia must prioritise participation and performance in mathematics education. Additionally, efforts should focus on addressing diversity issues, particularly among underrepresented groups, to enhance student engagement in these critical fields. Ensuring a robust pipeline of students at the secondary level will be essential for meeting future workforce needs and strengthening Australia's competitive edge in a rapidly evolving global economy.

Professor Tim Marchant
Director

KEY INDICATORS

School Education

Out-of-Field Teaching



There is a shortage of mathematically qualified teachers in Australian secondary schools. Research indicates that up to 40% of those teaching secondary school mathematics are teaching out-of-field. There is a pressing need for upskilling initiatives to reverse the decline in student interest in mathematics and promote effective maths teaching. **See page 28**

Student Engagement

Half of Australia's Year 8 students do not enjoy studying mathematics. There is a positive correlation between enjoyment and achievement in the subject — students who enjoy mathematics tend to perform better. **See page 22**

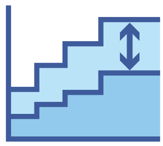
Year 12 Mathematics Enrolments

Enrolments in higher-level mathematics courses are at an all-time low — significantly lower than the previous decade in which participation already could be described as minimal. **See page 25**

Inequality in Mathematical Outcomes

The gap between low-performing and high-performing 15-year-olds is widening, indicating increasing inequity among students and deepening disparities in educational outcomes. **See page 13**

Impact on Disadvantaged Students



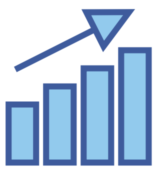
Students from low socio-economic backgrounds can lag up to five years behind their peers academically. **See page 14**

Core Subject Requirements

Mathematics and statistics are foundational for degrees in science, engineering, management, commerce, information technology, education, and health. However, most universities do not require Year 12 mathematics for entry into these programs. **See page 27**

Higher Education

Enrolment Trends



Enrolments in mathematical sciences degrees are on the rise, particularly in coursework masters programs, which have increased by 223% since 2015. **See page 35**

Pandemic Impact

The mathematical sciences student — and teaching — load was impacted by the pandemic, particularly among the international student cohort. While there are signs of recovery post-pandemic, visa restrictions and student caps introduced in 2024 will further impact mathematical sciences departments. **See pages 33–34**

Data Science Growth

There has been significant growth in data science degrees, many of which combine computer science and mathematical sciences, co-taught across various faculties. Nearly 100 coursework masters degrees in data science, analytics, or artificial intelligence are available across 35 universities.

Student Satisfaction

Mathematical sciences students report high satisfaction levels regarding teaching quality and learning resources, however learner engagement and skills development is consistently rated lower than other students.

Female Representation in Mathematical Sciences Departments

There has been an improvement in female representation at senior academic levels, specifically among Associate Professors and Professors.

Workforce

Occupational Growth

The category 'Other Information and Organisational Professionals', which includes data science roles, has surged by nearly 1300% in the past five years, and is now ranked as the top occupation for mathematical scientists. **See page 47**

Salary Trends

Median starting salaries for mathematical sciences graduates have increased substantially in recent years, especially for those holding masters degrees.
See page 48

Workforce Demographics

The ageing mathematical sciences workforce is being revitalised by a growing influx of young professionals, particularly recent immigrants who came to study at Australian universities as international students. **See page 49**

Gender Disparity

While gender parity was nearly achieved among older cohorts of mathematical science degree holders, the gap has widened in younger age groups, resulting in fewer females represented.
See page 51

Numeracy Skills and Outcomes

Strong numeracy skills contribute to better employment, higher wages, and improved health outcomes. Although most Australian adults possess basic numeracy skills, a significant gap exists between those with low and advanced skills. **See page 53**

Research

Funding Sources

Higher Education Research and Development (HERD) funding for mathematical sciences has declined, representing just 1.26% of total funding in 2022 — the lowest since 2008. Despite increasing industry demand, the business sector contributes less than 1% of its total funding to the mathematical sciences.
See page 57–58

ARC Funded Projects

The number of Australian Research Council (ARC) funded projects in the mathematical sciences has decreased to less than half of what it was in 2012, with the most significant declines in funding for pure and applied mathematics research.
See page 61

Research Ratings

Most Australian universities are rated above or well above world standards for research in mathematical sciences. All assessed institutions maintained or improved their ratings over the past decade. **See page 65–66**

Top Institutions

The University of New South Wales, Australian National University, The University of Melbourne, and Monash University rank as the top universities for mathematics and statistics in 2024. Monash University has been ranked the top university for statistics for three consecutive years. **See page 67**

Out-of-Field Teaching

There is a shortage of mathematically qualified teachers in Australian secondary schools. Research indicates that **up to 40%** of those teaching secondary school mathematics are **teaching out-of-field**. There is a pressing need for upskilling initiatives to reverse the decline in student interest in mathematics and promote effective maths teaching. **See page 28**

Student Engagement

Half of Australia's Year 8 students do not enjoy studying mathematics. There is a positive correlation between enjoyment and achievement in the subject – students who enjoy mathematics tend to perform better. **See page 22**

Inequality in Mathematical Outcomes

The gap between low-performing and high-performing 15-year-olds is widening, **indicating increasing inequity** among students and deepening disparities in educational outcomes. **See page 13**

Impact on Disadvantaged Students

Students from low socio-economic backgrounds can **lag up to five years behind** their peers academically. **See page 14**

Year 12 Mathematics Enrolments

Enrolments in higher-level mathematics courses are **at an all-time low** — significantly lower than the previous decade in which participation already could be described as minimal. **See page 25**

Core Subject Requirements

Mathematics and statistics are foundational for degrees in science, engineering, management, commerce, information technology, education, and health. However, **most universities do not require Year 12 mathematics** for entry into these programs. **See page 27**

1 SCHOOL EDUCATION

After a prolonged decline, Australian students' performance in numeracy and mathematics benchmark tests has stabilised. The OECD's 2022 Programme for International Student Assessment (PISA), the first international survey data available post-COVID-19 pandemic, reveals that while the performance of Australian 15-year-olds declined slightly, the drop was significantly less than the OECD average.

Australia seems to have navigated the challenges of the pandemic better than other countries. In 2022, only nine countries significantly outperformed Australia, compared to 23 in 2018. This improvement in relative performance is encouraging, but it conceals declines in absolute performance, particularly among students in the lower socio-economic quartiles.

Participation in intermediate and higher-level mathematics (calculus-based) subjects has reached an all-time low over the past three years, both in the number of students and as a proportion of the total student cohort—markedly lower than in the previous decade. As this report will show, the demand for mathematical science knowledge and skills is rising, making it essential to maintain a strong pipeline of future students to meet current and future need.

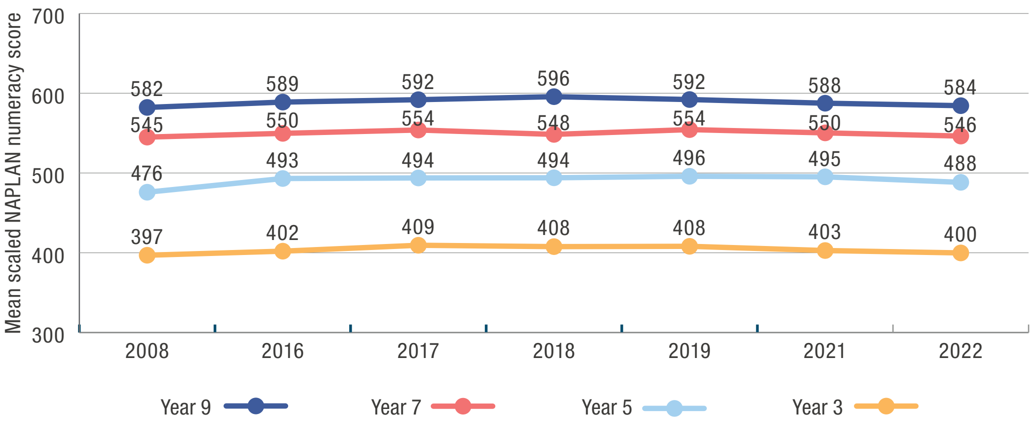
1.1 Student performance in numeracy and mathematics

Average student performance in numeracy and mathematics in Australia has remained relatively stable over the past two decades. Results from the annual National Assessment Program — Literacy and Numeracy (NAPLAN) assessments to 2022 indicate that there has been no substantial change, either improvement or decline, with the exception of an increase in numeracy achievement in Year 5 compared to 2008, the first year NAPLAN testing was conducted (Figure 1.1). The table below displays the average student achievement in numeracy in Years 3, 5, 7, and 9, as well as the percentage of students meeting the national minimum standard.

The time series below includes most, but not all, years from 2016–2022 (NAPLAN testing was skipped in 2020, and reporting changes were introduced in 2023). The 2021 and 2022 results did not show a major decline in numeracy during the pandemic, not even in Victoria, where students studied remotely for extended periods. Average numeracy achievement was not significantly lower in 2021 and 2022 than before the pandemic across all year levels. However, these averages conceal differences in the pandemic's impact, particularly on more vulnerable students.

Figure 1.1 Student achievement in numeracy (NAPLAN) (2008–2022)

Source: *ACARA (2022), page 45.*



Students		2008	2016	2017	2018	2019	2021	2022	2008 vs 2022	2021 vs 2022
Year 9	Mean	582.2	588.9	591.9	595.7	592.1	587.5	584.4	■	■
	(S.D)	(70.2)	(66.8)	(63.5)	(66.3)	(63.9)	(64.2)	(62.1)		
	% at or above NMS	93.6	95.2	95.8	95.5	96.0	94.7	95.0	■	■
Year 7	Mean	545.0	549.7	553.9	548.4	554.4	550.3	546.3	■	■
	(S.D)	(73.2)	(70.4)	(71.1)	(69.1)	(75.5)	(77.3)	(80.0)		
	% at or above NMS	95.4	95.5	95.4	95.6	94.3	93.2	92.0	▽	■
Year 5	Mean	475.9	493.1	493.8	494.0	495.9	495.2	488.3	▲	▽
	(S.D)	(68.8)	(70.6)	(65.5)	(65.4)	(67.1)	(67.3)	(65.6)		
	% at or above NMS	92.7	94.3	95.4	95.7	95.4	95.0	95.1	△	■
Year 3	Mean	396.9	402.0	409.4	407.7	408.1	402.8	399.8	■	■
	(S.D)	(70.4)	(73.4)	(73.9)	(71.6)	(73.9)	(72.6)	(74.8)		
	% at or above NMS	95.0	95.5	95.4	95.8	95.5	95.4	95.0	■	■

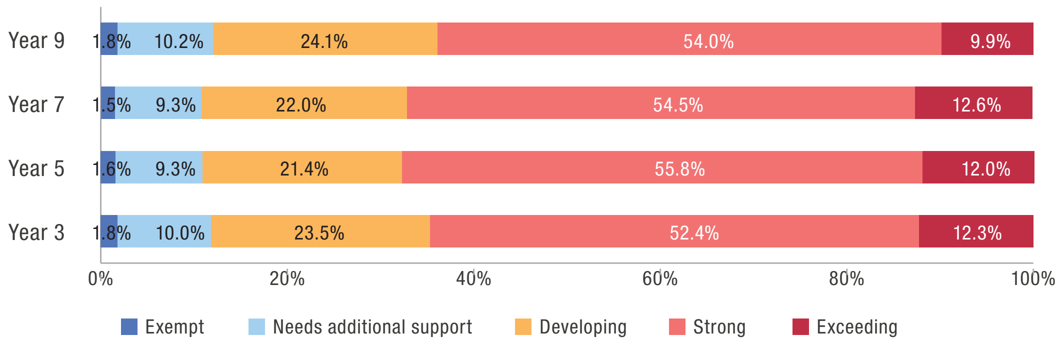
Comparison of means

- ▲ Average achievement is substantially above and is statistically significantly different from the comparison calendar year.
- △ Average achievement is above and is statistically significantly different from the comparison calendar year.
- ■ Average achievement is close to or not statistically different from the comparison calendar year.
- ▽ Average achievement is below and is statistically significantly different from the comparison calendar year.
- ▼ Average achievement is substantially below and is statistically significantly different from the comparison calendar year.

NMS: national minimum standard.

In 2023, the national minimum standard benchmark was replaced by a set of four proficiency standards, ranging from exceeding expectations to strong, developing, and needs additional support. These new standards more clearly identify which students are meeting or exceeding reasonable expectations for their year level (performing at the "strong" and "exceeding" levels), and which students are still "working towards" meeting the expectations ("developing") or require additional support. The 2023 results indicate that across all year levels, about one-third of students either need additional support or are not yet demonstrating the proficiency expected for their cohort (see Figure 1.2). This shift in focus highlights the need for significant improvement in overall numeracy achievement.

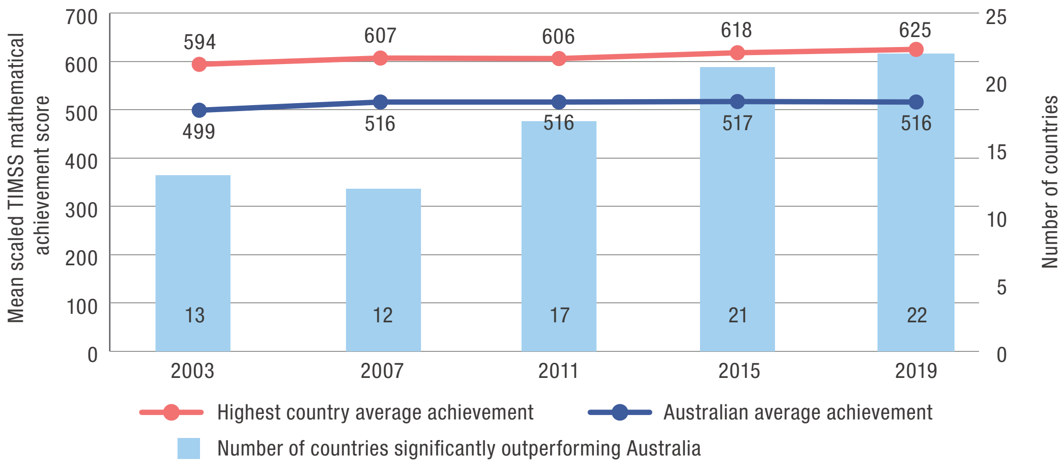
Figure 1.2 Student achievement in numeracy (NAPLAN) (2023)



Source: *ACARA (2023a).*

Results from the Trends in International Mathematics and Science Study (TIMSS) also show little change in mathematics outcomes over time, with the educational achievement of Australian students in Year 4 and Year 8 remaining fairly steady since 2003 (Figures 1.3 and 1.4).

Figure 1.3 TIMSS: comparative educational achievement of Australian students in mathematics in Year 4 (2003–2019)



Source: *Mullis et al. (2020); Thomson et al. (2020b), page 18.*

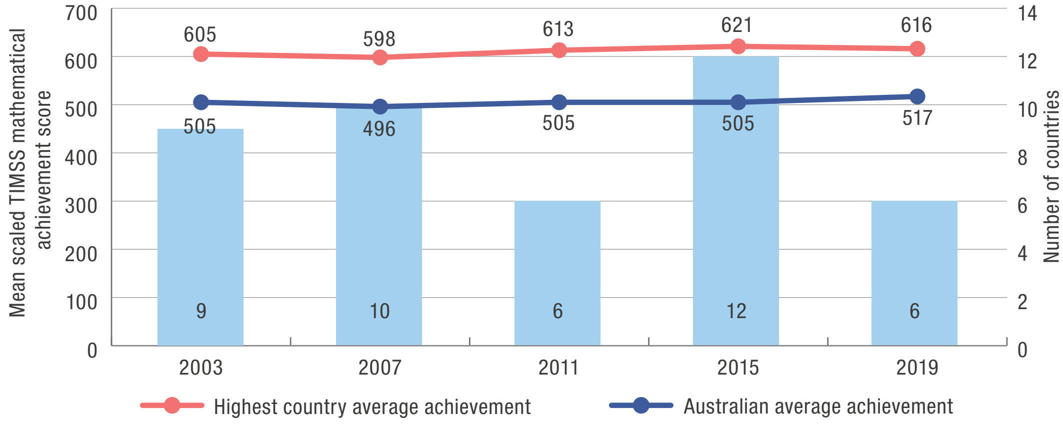
Note: *Countries are free to choose if they participate in either the Year 4, Year 8, or both surveys. 2019, 58 countries participated in the TIMSS fourth grade assessment, and 39 countries participated in the eighth-grade assessment.*

The only Australian state where Year 8 students showed improvement in 2019 compared to 2015 was New South Wales (NSW), while student performance in all other states and territories remained relatively unchanged (Thomson et al., 2020, pp. 57–59). The gap between Australia and top-performing countries like Singapore, Japan, and South Korea, where students achieve significantly higher in mathematics, has also remained roughly the same. TIMSS data does not yet reflect the impact of the pandemic on student outcomes.

Figure 1.4 TIMSS: comparative educational achievement of Australian students in mathematics in Year 8 (2003–2019)

Source: Mullis et al (2020); Thomson et al. (2020b), page 47.

Note: Countries are free to choose if they participate in either the Year 4, Year 8, or both surveys. 2019, 58 countries participated in the TIMSS fourth grade assessment, and 39 countries participated in the eighth grade assessment.



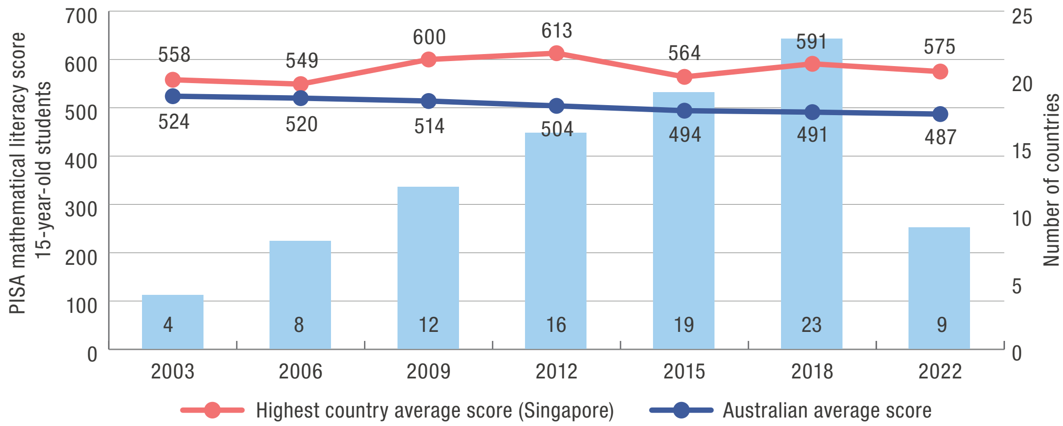
The OECD's 2022 PISA survey marks the first major international release of data on mathematical literacy following the COVID-19 pandemic. Between 2018 and 2022, mathematical performance of 15 year-old-students declined in 38 countries, with the OECD average dropping by 16 points during this period (De Bortoli et al., 2023). However, the average mathematical literacy score for Australian students in 2022 was 487 points, nearly identical to the 2018 score of 491 points (Figure 1.5).

Approximately 47 percent of Australian students reported that their school buildings were closed for more than three months as a result of the pandemic and school closures, slightly below the OECD average of 51 percent. Longer school closures were associated with lower student performance in mathematics. Despite these challenges, Australia appears to have weathered the pandemic's impact better than many countries. In 2022, only nine countries significantly outperformed Australia in mathematics, compared to 23 countries in 2018.

While the average mathematical achievement of Australian students has remained relatively stable over the past few decades, this stability conceals significant disparities in outcomes among different student groups. In a world increasingly dependent on digital and numeracy skills, a considerable portion of Australia's school population continues to lag, struggling to attain essential basic skills. Students from rural and remote areas, low-income families, and First Nations backgrounds are particularly vulnerable (Lamb et al., 2020).

Figure 1.5 PISA: comparative educational achievement of Australian students in mathematics in Year 8 (2003–2019)

Source: OECD (2023a).



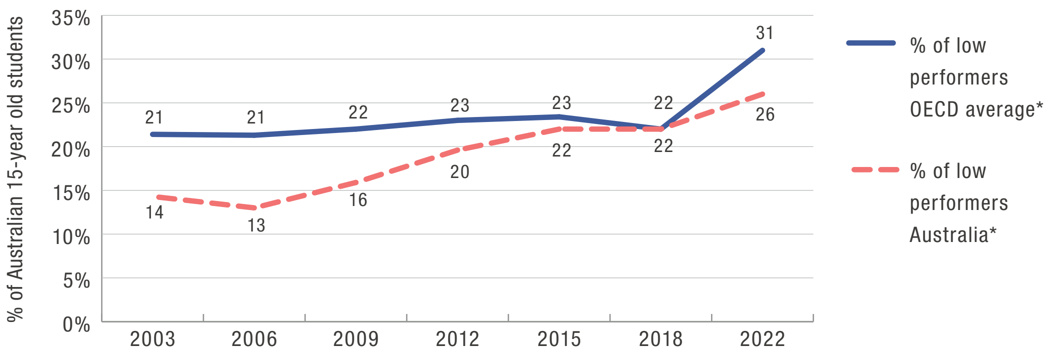
1.2 Distribution of mathematical achievement

From both social and economic perspectives, the persistent and, in some cases, deepening disparities in educational outcomes among Australian students are of significant concern. Compared to twenty years ago, fewer students excel in mathematics, and more are performing poorly, according to Australia's PISA results. In 2003, Australia outperformed the OECD average in both high and low achievement categories; however, by 2018, this advantage had diminished (Figures 1.6 and 1.7).

The pandemic seemingly had a negative effect on all OECD cohorts — overall, less students performed well, and more students performed poorly. Conversely, Australia saw an increase in high-achievers (from 10 percent in 2018 to 12 percent in 2022) and an increase in those considered low-achievers (from 22 percent in 2018 to 26 percent in 2022). This increase in both high- and low-achieving cohorts may reflect a differential impact of remote learning and inequities in education that the pandemic exposed (see Doucet et al., 2020).

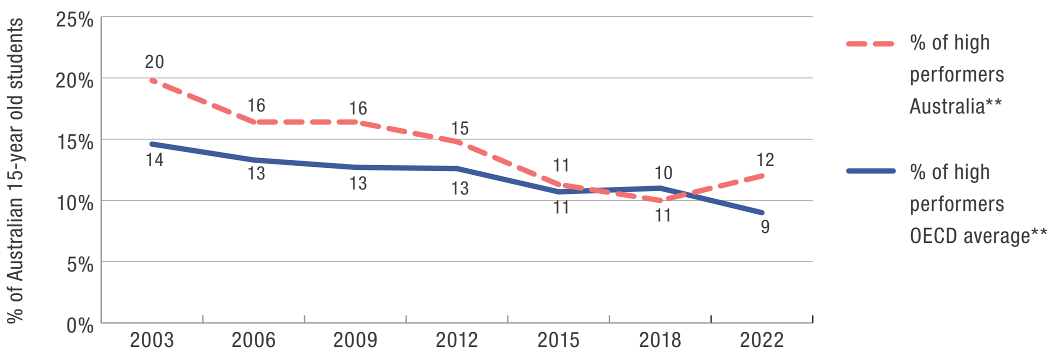
The reasons for this disparity might include access to devices, stable and reliable internet, and family support, which enabled high-achieving and motivated Australian students to thrive during remote learning (Pokhrel & Chhetri, 2021; Learning First, 2020). Conversely, the negative impacts were more pronounced for specific student groups. These groups include students from disadvantaged and low-income families, students whose parents have low literacy levels, First Nations students, students with disabilities, those from refugee backgrounds with existing trauma, and students whose families speak English as a second language (Learning First, 2020; Digital Nation Australia, 2021).

Figure 1.6 Percentage of Australian 15-year-olds performing poorly (at proficiency level 1 or below) in mathematics compared to OECD average (2003–2022)



***Source:** De Bortoli et al (2023).*

Figure 1.7 Percentage of Australian 15-year-olds performing very well (at proficiency level 5 or above) in mathematics compared to OECD average (2003–2022)



***Source:** De Bortoli et al (2023).*

The disparities in numeracy achievement reflect deeper societal gaps that Australia's education system has yet to close. While most young people acquire the skills needed to function effectively in today's economy and society, it is estimated that about one-fifth to one-third fall behind. As a result, Australia's educational goals for young Australians are not being fully met (see Commonwealth of Australia, 2024; COAG, 2023; Lamb et al., 2020; Productivity Commission, 2022). The disruptions caused by COVID-19 further exacerbated the situation, disproportionately affecting already vulnerable students (Brown et al., 2020).

Below is a brief overview of factors linked to students' performance in mathematics and numeracy. Certain circumstances, such as a student's socio-economic background or the location of their school in a remote or rural area, can place them at a clear disadvantage. Socio-economic and geographic disadvantages intersect with the ongoing effects of oppression and marginalisation, presenting significant and urgent challenges to improving numeracy achievement among First Nations students.

On the other hand, some factors, such as private school attendance (when adjusted for socio-economic background), do not seem to have a significant impact on numeracy outcomes. Gender is also not a barrier to excelling in mathematics, though differences exist in male and female attitudes and aspirations towards the subject. Similarly, coming from a migrant background is not necessarily a disadvantage, with many students from non-English speaking backgrounds performing particularly well in mathematics.

SOCIO-ECONOMIC FACTORS

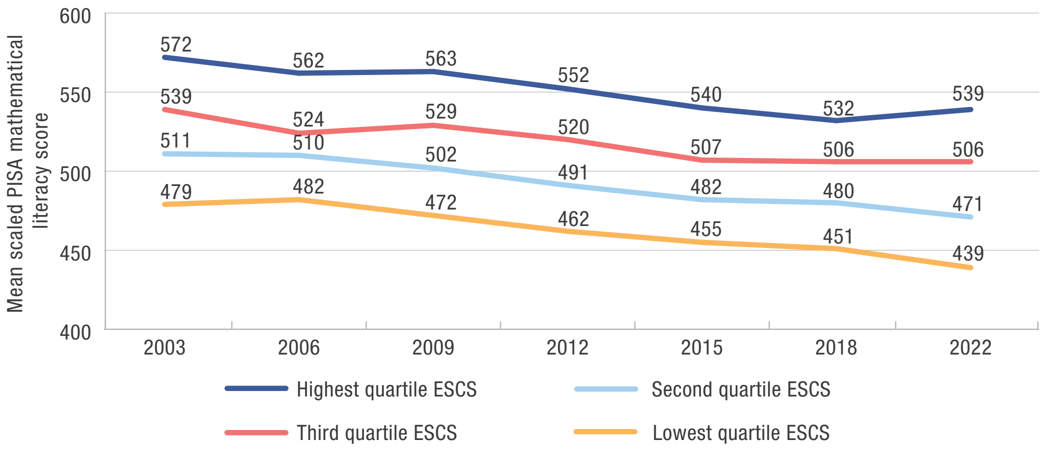
The NAPLAN, PISA, and TIMSS surveys indicate that socio-economic factors, such as parental education and occupation, as well as proxy indicators like the number of books in the home, are closely linked to mathematical performance.

Figure 1.8 below illustrates the correlation between socio-economic background and mathematical performance over time, according to the PISA survey. Students from higher socio-economic backgrounds consistently perform better than those from lower socio-economic backgrounds. In 2022, the performance gap between students from the highest and lowest ESCS (Economic, Social, and Cultural Status) quartiles was 101 points, roughly equivalent to five years of schooling - 20 PISA points representing approximately one year of schooling (De Bortoli et al., 2023). Over time, mathematical performance has declined more significantly for students in the lowest socio-economic quartile compared to those in the highest.

The COVID-19 pandemic underscored the impact of socio-economic status on student success. From 2018 to 2022, mathematical performance improved for students in the highest socio-economic quartile, while a decline was observed for those in the third and fourth quartiles. PISA scores for the highest quartile increased by 8 points in 2022, returning to levels seen in 2015. While scores for the second and third quartiles remained relatively steady during this time, the most concerning trend was a 16-point decline in scores for students in the lowest quartile. Further evidence that students with access to digital devices, the internet, a quiet place to study, and support from highly educated parents advanced academically, while those lacking resources fell further behind (Irwin, 2021; Shi et al., 2022).

Figure 1.8 Average student performance for mathematical literacy, by socio-economic background

Source: *De Bortoli et al (2023), extract Figure 3.38, page 81.*



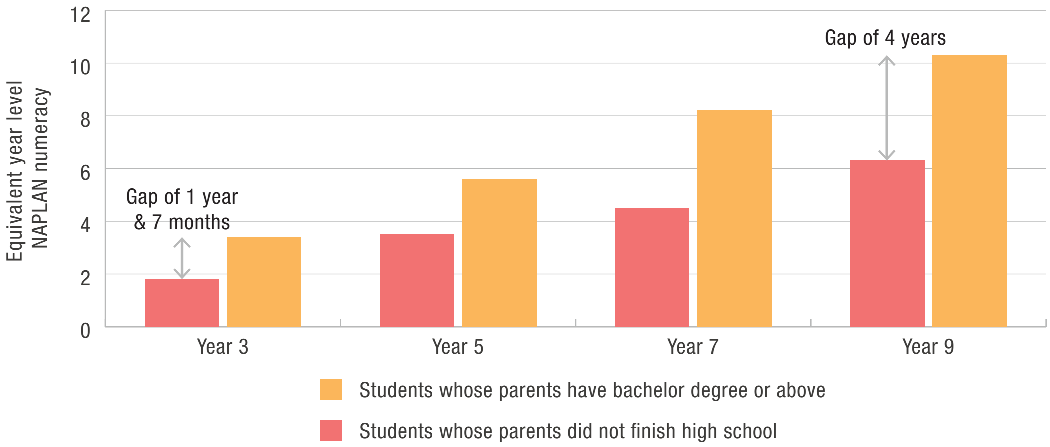
Books and other resources available to students at home also play a significant role in their mathematical achievement. For example, having an average number of books in the house, rather than just a few, is associated with higher performance in mathematics (Table 1.1).

Table 1.1 Mathematics achievement in Year 8 according to the number of books in the home

	Mean achievement score (TIMSS)	< Low achievement	Low achievement	Intermediate achievement	High achievement	Advanced achievement
Many books	559	3%	14%	27%	34%	22%
Average no. of books	529	6%	19%	36%	27%	12%
A few books	473	20%	32%	30%	14%	5%

***Source:** Mullis et al (2020); Thomson et al. (2020b), page 65.*

Figure 1.9 The learning gap in numeracy between advantaged and disadvantaged students doubles from Year 3 to year 9 (2022)

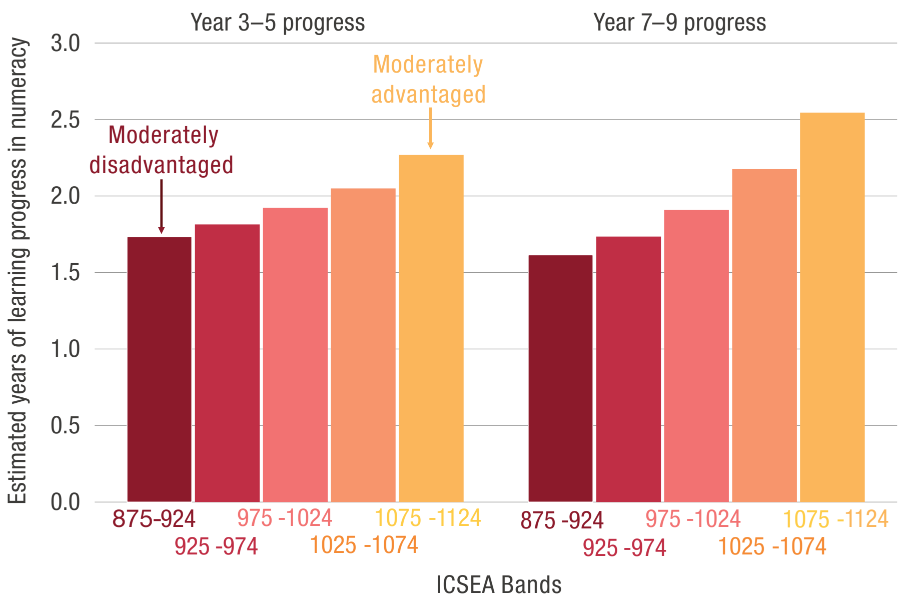


***Source:** Sonnemann & Hunter (2023).*

Socio-economic circumstances can profoundly affect children's learning outcomes, as analysis of NAPLAN data by the Grattan Institute has consistently shown. Independent of children's natural abilities when they start school, the learning gap between students from advantaged and disadvantaged backgrounds increases over time, doubling from 1 year and 7 months to 4 years between Year 3 and Year 9 (Figure 1.9).

Figure 1.10 sets out the learning progress (in years) in numeracy from Years 3 to 5 and Years 7 to 9 across schools in five bands ranging from moderately disadvantaged to moderately advantaged (using the Index of Community Socio-Economic Advantage or ICSEA). Students in moderately advantaged schools tend to make more than 2 years' worth of learning progress in the two-year period between NAPLAN tests, while students in moderately disadvantaged schools are likely to make far less. Students should be making one year's worth of learning progress every year, but only students in schools in the highest two ICSEA bands represented in this graph tend to reach that goal.

Figure 1.10 Numeracy progress in years by school ICSEA level



***Source:** Goss & Sonneman (2018), Figure 1.4, page 11.*

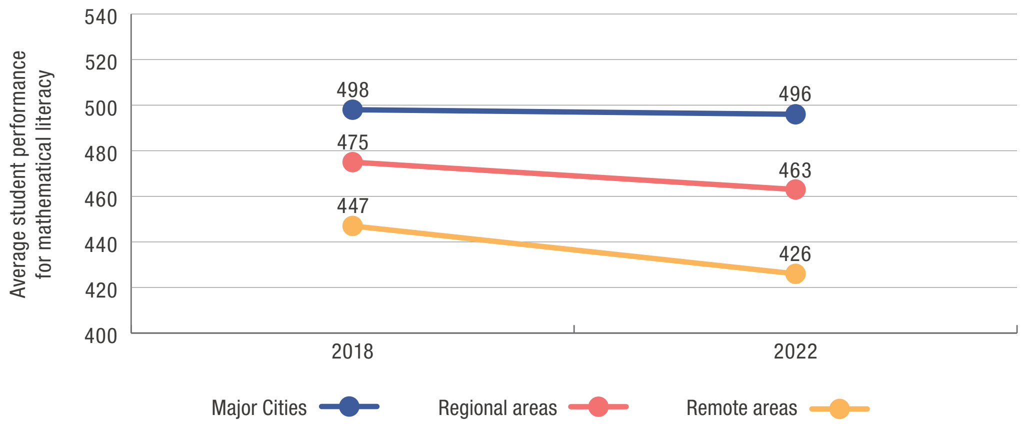
***Note:** ICSEA band 975–1024 is the average level of advantage. ICSEA band 1075–1124 is moderately advantaged; around one standard deviation above the mean. ICSEA band 875–924 is moderately disadvantaged; around one standard deviation below the mean.*

Geographic location

Figure 1.11 shows PISA outcomes by geographic location using the ASGS classification. In 2022, students in major cities achieved better results in mathematics compared to their counterparts in regional and remote areas. Specifically, students from regional areas scored on average 33 points lower than those in major cities, which equates to approximately 1.5 years of schooling. Students in remote areas scored 77 points lower, amounting to nearly four years of schooling. Between 2018 and 2022, there was a significant decline in performance among students from regional and remote areas, with declines of 13 and 21 points respectively. In contrast, performance among students in major cities remained steady.

Figure 1.11 Average performance of Australian 15-year-old students for mathematical literacy, by geographic location (ASGS) (2018–2022)

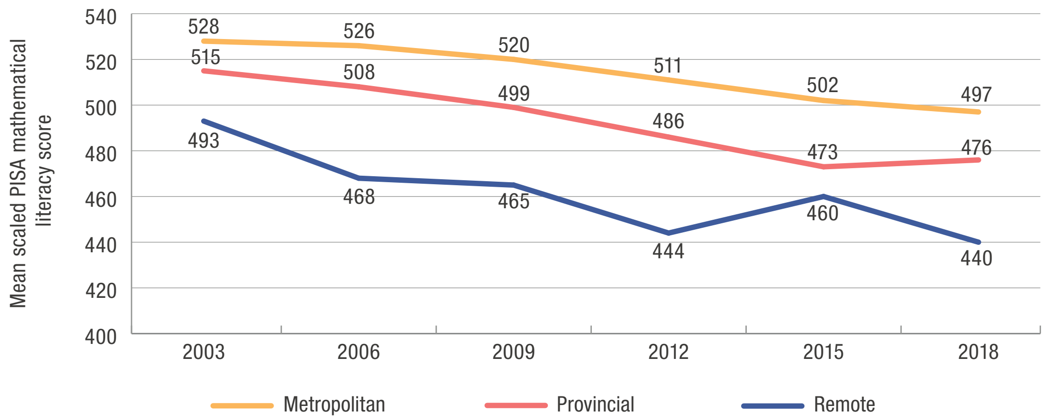
Source: De Bortoli et al. (2023), extract Figure 3.34, page 78.



Data prior to 2018, which used the MCEETYA classification, indicates metropolitan students consistently outperformed provincial and remote students at each PISA cycle. Between 2003 and 2018, average performance in mathematical literacy declined more in students from remote and provincial areas compared to students from metropolitan areas (Figure 1.12).

Figure 1.12 Average performance of Australian 15-year-old students for mathematical literacy, by geographic location (MCEETYA) (2003–2018)

Source: Thomson et al. (2019), extract Figure 5.30, page 160.



Using a more nuanced distinction—between major cities, inner regional, outer regional, remote, and very remote locations—the NAPLAN data reveal similar disparities in student performance across these areas (see Table 1.2). However, when comparing non-First Nations students across these locations, the differences in mathematical performance become smaller. Despite this, the proportions of students requiring additional support or categorised at "developing" levels are significantly larger outside major cities, while the percentage of students performing at "exceeding" expectations is notably lower in these more remote areas.

Table 1.2 Student performance in Year 9 Numeracy (NAPLAN) (2023)

ALL STUDENTS	Exempt	Needs additional support	Developing	Strong	Exceeding	Average NAPLAN score (confidence interval)
Major cities	1.8	8	21.8	56.3	12.2	578.2 (± 2.7)
Inner regional	1.7	14	30.3	49.8	4.3	544.5 (± 3.0)
Outer regional	1.8	17	30.7	46.7	3.8	537.8 (± 4.6)
Remote	3.2	26.1	30.1	38.5	2.1	513.9 (± 12.1)
Very remote	1.9	51.3	25.3	20.6	0.9	462.4 (± 14.6)
NON-FIRST NATIONS STUDENTS						
Non-First Nations major cities	1.7	7.2	21.2	57.3	12.6	581.1 (± 2.7)
Non-First Nations inner regional	1.6	11.8	29.4	52.5	4.7	550.2 (± 2.8)
Non-First Nations outer regional	1.5	12.6	29.5	51.9	4.5	548.8 (± 4.2)
Non-First Nations remote	1.8	11.3	31.4	52.6	2.9	546.1 (± 7.9)
Non-First Nations very remote	2.0	13.8	32.7	48.8	2.6	540.0 (± 10.8)

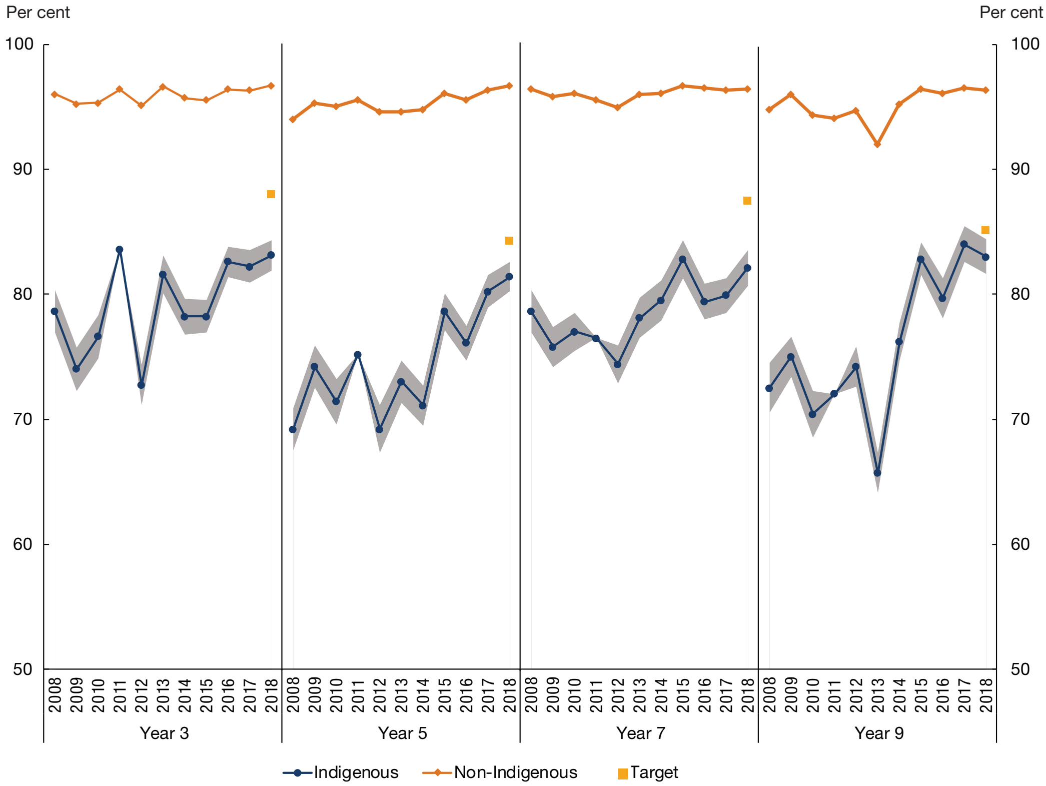
Source: *ACARA (2023a),*

In all likelihood, differences in student achievement between cities and more remote locations cannot be entirely separated from socio-economic factors. When measuring student *learning progress* rather than achievement, students in regional schools make similar progress to students in major cities schools if adjusted for school advantage (Goss & Sonnemann, 2018, page 17). Additionally, variation in student progress often depends more on the state than on geographical divide. When controlling for school advantage, some states perform better and some worse in advancing their students in specific subjects at various educational levels. No single state excels uniformly across all subjects and levels (Ibid, p. 18).

First Nations students

From 2008 to 2018, significant progress was made for First Nations students in Australia (Figure 1.13). The proportion of First Nations students reaching the NAPLAN minimum standard or above in numeracy increased by 4 to 12 percentage points, narrowing the gap with other student cohorts. The most notable achievement was a rise in Year 12 (or equivalent) attainment among First Nations students, from 52 percent in 2011 to 68 percent in 2021 (Productivity Commission, n.d.). This increase contrasts with a much smaller percentage rise in Year 12 attainment among non-First Nations students, effectively halving the remaining disparity. In 2021, 87 percent of First Nations students in the least disadvantaged socio-economic areas attained Year 12 or equivalent, compared to 58 percent in the most disadvantaged areas.

Figure 1.13 First Nations students at or above national standards for numeracy (2008–2018)



Note: (a) Shaded areas represent the 95 per cent confidence interval in school results for Indigenous.

Australians. Confidence intervals reflect the level of uncertainty associated with the measurement of results.

They define a range of values within which the actual result is likely to lie.

Source: *Department of Premier and Cabinet (2020), Figure 4.2, page 48.*

Many First Nations students face significant challenges in remaining engaged with the school system, particularly when disadvantage and geographic distance intersect with the impacts of historical displacement and oppression. The 2023 NAPLAN data highlights a notable achievement gap in Year 9 numeracy between First Nations students and their peers. Approximately 34.7 percent of First Nations students require additional support in numeracy, compared to 8.4 percent of non-First Nations students (Table 1.3). The gap is especially pronounced in outer regional and remote areas, where two-thirds of First Nations students in very remote locations need additional support. In contrast, the gap is smaller for First Nations students in major cities and inner regional areas.

Table 1.3 Student performance in Year 9 Numeracy by First Nations status (NAPLAN) (2023)

Source: ACARA (2023a).

	Exempt	Needs additional support	Developing	Strong	Exceeding	Average NAPLAN score (confidence interval)
First Nations	3.2	34.7	35.3	25.8	0.9	491.4 (± 2.5)
Non-First Nations	1.7	8.4	23.3	56.1		573.2 (± 2.2)
First Nations major cities	3.4	27.1	36.9	31.3	1.3	506.6 (± 3.0)
First Nations inner regional	2.7	32.2	37.9	26.4	0.7	495.2 (± 3.6)
First Nations outer regional	3.4	37.7	35.3	23	0.6	486.3 (± 4.8)
First Nations remote	5.6	52.5	27.7	13.8	0.4	454.7 (± 14.3)
First Nations very remote	1.9	66.6	22.1	9.2	0.2	430.7 (± 11.3)

According to OECD PISA data, First Nations students demonstrate lower proficiency in mathematics compared to their non-First Nations peers. In 2022, 20 percent of 15-year-old First Nations students met the National Proficient Standard in mathematical literacy, whereas 53 percent of non-First Nations students achieved this standard. Additionally, First Nations students are underrepresented at the higher end of the proficiency scale and overrepresented at the lower end. Specifically, just 2 percent of First Nations students were classified as high performers, compared to 13 percent of non-First Nations students. Over twice the proportion of First Nations students were classified as low performers (57 percent) compared to non-First Nations students (24 percent).

Gender

In Australia, males generally score higher than females in numeracy and mathematics, though this trend is not universally observed when compared to other countries. In Australia, the differences are often not statistically significant. The TIMSS surveys reveal a statistically significant achievement gap between Australian males and females only for Year 8 students in 2007, and for Year 4 students in 2015 and 2019. Similarly, PISA results show small, statistically significant differences in favour of males in several, but not all, years. NAPLAN results indicate a minor difference between female and male students. Male students are more frequently represented at levels exceeding expectations, while female students are more commonly found in the "middle of the range," achieving at a "strong" level and meeting cohort expectations (Table 1.4).

Table 1.4 Student performance in Year 9 Numeracy, by gender (NAPLAN) (2023)

Source: ACARA (2023a),

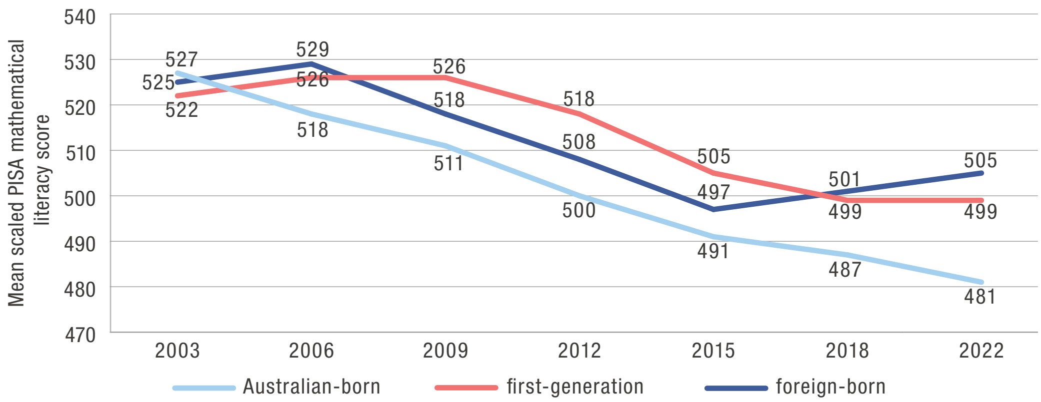
	Exempt	Needs additional support	Developing	Strong	Exceeding	Average NAPLAN score (confidence interval)
Male	2.3	10.4	22.3	53.1	11.9	572.3 (± 2.7)
Female	1.3	9.9	26.0	54.9	7.8	562.8 (± 2.3)

Immigrant and non-English-speaking background

Foreign-born and first-generation students tend to do well when it comes to mathematical literacy. According to the 2022 PISA survey, first-generation and foreign-born students were on average about a year ahead of Australian-born students (Figure 1.14). First-generation and foreign-born students have outperformed Australian-born students since 2006 and performed better or the same in 2022 compared to 2018. Conversely, Australian-born student performance has continued to decline since 2003.

Source: De Bortoli et al (2023) extract Figure 3.46, page 88.

Figure 1.14 Average performance of Australian 15-year-old students for mathematical literacy over time, by immigrant background (2003–2022)



Given the diversity in language skills, socio-economic situation and cultural backgrounds between different migrant groups, the spread of achievement, from low to advanced, is larger than for students from English-speaking backgrounds. In the 2019 TIMSS survey, Year 8 students from a non-English-speaking background achieved at advanced levels much more often than English-speaking students (26 per cent, versus 10 per cent) (Table 1.5). However, the difference between those with the lowest and highest achievement scores was 362 points, compared to 287 points for students with an English-speaking background.

Source: Mullis et al (2020); Thomson et al (2020b) page 70.

Table 1.5 Mathematics achievement in Year 8 according to whether a language other than English is spoken at home (2019)

	Mean	< Low	Low	Intermediate	High	Advanced
English	516	9	22	34	24	10
Other	542	12	17	18	26	26

Research into young people's attitudes toward STEM, commissioned by the Department of Industry, Innovation and Science, found that students born overseas or from culturally and linguistically diverse backgrounds show greater interest and involvement in STEM subjects compared to their peers. This indicates that socio-cultural heritage influences students' attitudes toward STEM fields, including mathematics (YouthInsight, 2021). Additionally, Australia's current mathematical workforce relies heavily on migration, a topic that is further explored in Chapter 3 of this report.

School sector

On the surface, the average mathematical literacy performance varies significantly across government, independent, and Catholic school sectors. The 2022 PISA results indicate that the performance gap between independent schools (with the highest average scores) and government schools (with the lowest average scores) is equivalent to just over two years of schooling. However, when these scores are adjusted for socio-economic background of students and schools, the difference between independent and government schools becomes statistically insignificant (see Table 1.6). This suggests that, after accounting for socio-economic factors, students from independent and government schools perform similarly, both outperforming students from Catholic schools.

Table 1.6 Average mathematical literacy performance by school sector (2022)

	Average mathematical literacy performance 2022 (PISA)		Difference in raw score	Difference in scores after student and school level socio-economic background is accounted for
Independent	519	Independent-Catholic	29	14
Catholic	490	Independent-government	44	-7*
Government	475	Catholic-government	15	-17

Source: *De Bortoli et al. (2023), extract Figure 3.24, page 69 and extract Table 3.3, page 70.*

Note: ** difference not statistically significant.*

Culture and attitudes to learning mathematics

The TIMSS survey traditionally includes questions directed at teachers, principals, and students in Year 8 about the school environment and student attitudes toward learning mathematics. It illustrates the significant role of school environment in student outcomes: schools that place a high or very high emphasis on academic success typically see higher average mathematical achievement.

Table 1.7 shows that the difference in average achievement between students from schools with a medium emphasis and those with a high emphasis on academic success is 45 points. In Australia, 63 percent of schools emphasise academic success at a high or very high level, compared to 57 percent internationally.

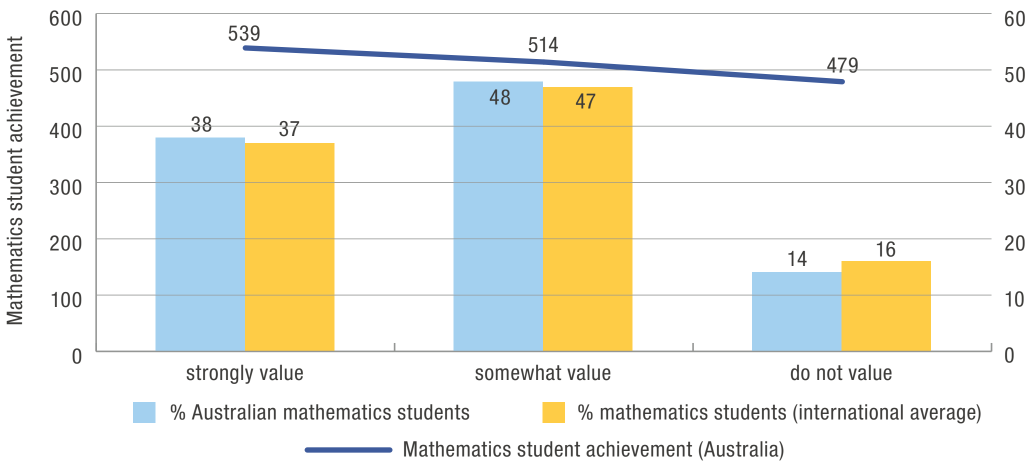
Table 1.7 Mathematics achievement in Year 8 according to school emphasis on academic success (according to Principals) (2019)

	Average mathematical achievement (Australia)	Proportion of students	International average mathematical achievement	Proportion of students
Very high emphasis	587	17%	538	8%
High emphasis	525	46%	500	49%
Medium emphasis	480	37%	469	43%

Source: *Mullis et al (2020), Exhibit 7.4.*

The TIMSS survey also provides valuable insights into student attitudes toward mathematics. Enjoyment and engagement with the subject are crucial, as mathematical achievement tends to improve with students' satisfaction with mathematics. The 2019 results indicate that Australian students value mathematics similarly to the international average (see Figure 1.15). There is a small but statistically significant positive correlation between student satisfaction and average mathematical achievement.

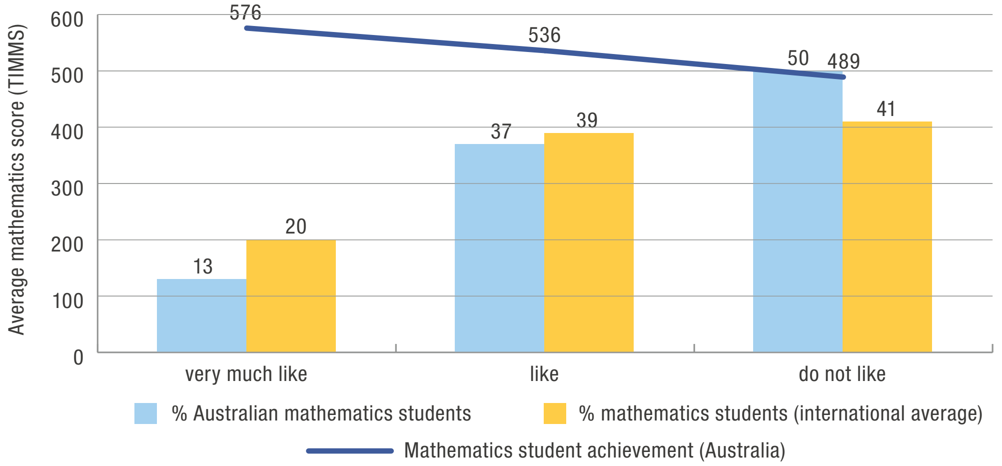
Figure 1.15 Value placed on mathematics in Year 8 compared to international average (2019)



Source: *Thomson et al (2021), extract from Figure 8.13 page 109.*

Figure 1.16 Enjoyment of mathematics in Year 8 compared to international average (2019)

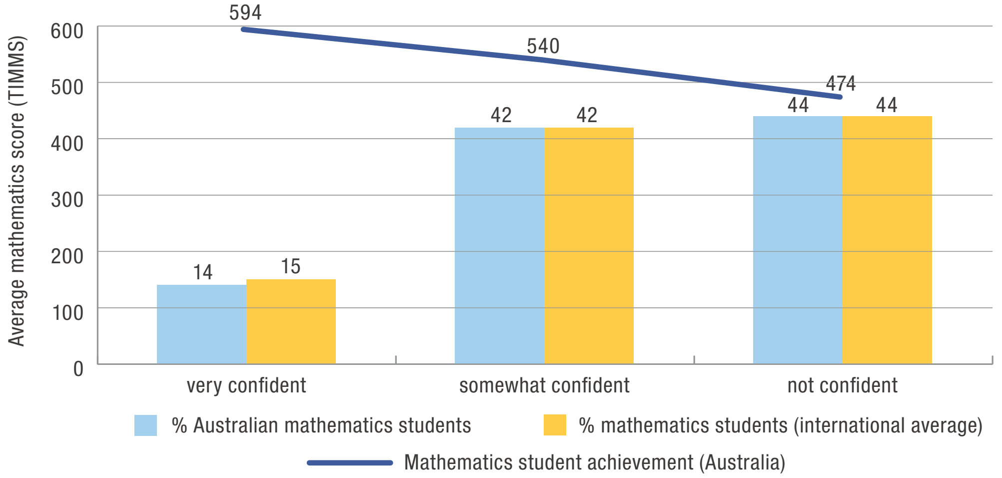
Source: *Thomson et al (2021), extract from Figure 8.1, page 98.*



In contrast, Australian students report lower enjoyment of mathematics compared to their peers in other countries, with half of Year 8 students indicating they do not like the subject (see Figure 1.16). Despite this, there is a positive correlation between enjoyment and achievement in mathematics—students who enjoy the subject tend to perform slightly better. On average, Australian students' confidence in their mathematical abilities is comparable to that of students in other countries. However, a lack of self-confidence has a moderate to large correlation with lower mathematical achievement (see Figure 1.17). Students who are less confident in their abilities are more likely to score lower on the TIMSS survey.

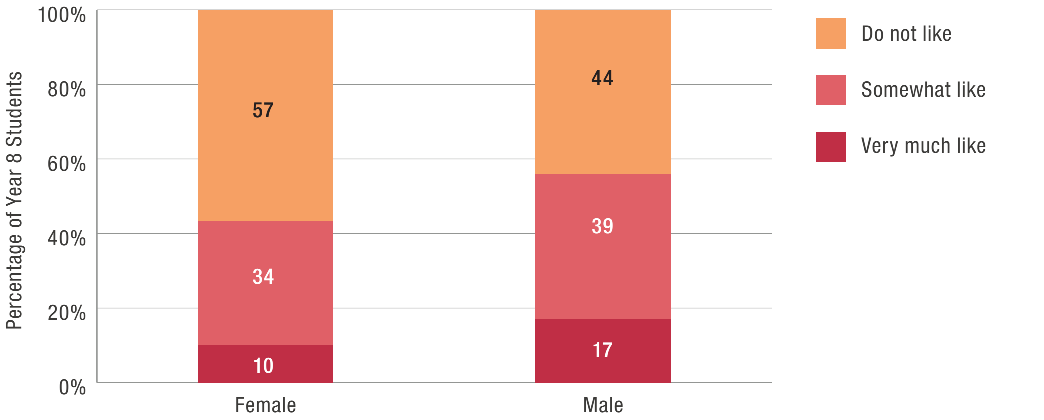
Figure 1.17 Student confidence in mathematics in Year 8 compared to international average (2019)

Source: *Thomson et al (2021), extract from Figure 8.7, page 104.*



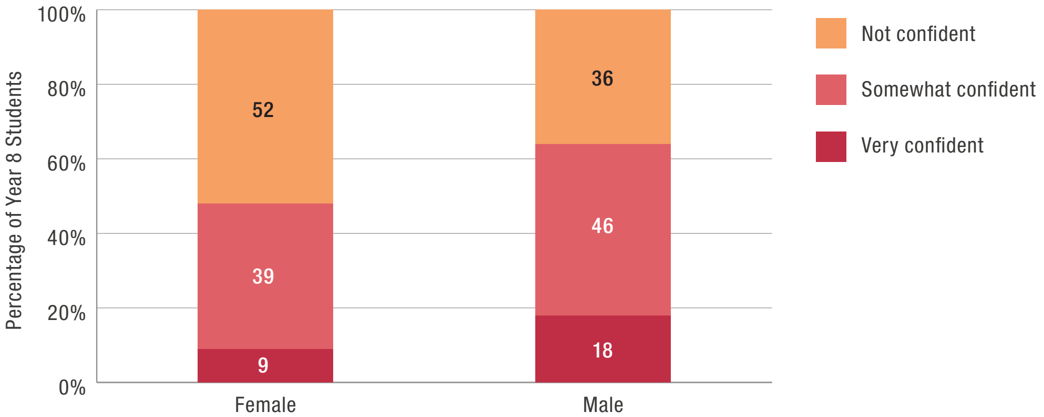
Unfortunately, lack of self-confidence and dislike of mathematics disproportionately affect female and disadvantaged students. By Year 8, 57 percent of female students have developed a dislike for mathematics. Only 10 percent of females, compared to 17 percent of males, report that they enjoy mathematics very much (see Figure 1.18). Additionally, more than half of female students lack confidence in their mathematical abilities, whereas 36 percent of male students report the same (see Figure 1.19).

Figure 1.18 Year 8 students like learning mathematics scale, by gender (2019)



Source: *Thomas et al. (2021), extract from Figure 8.2 page 99.*

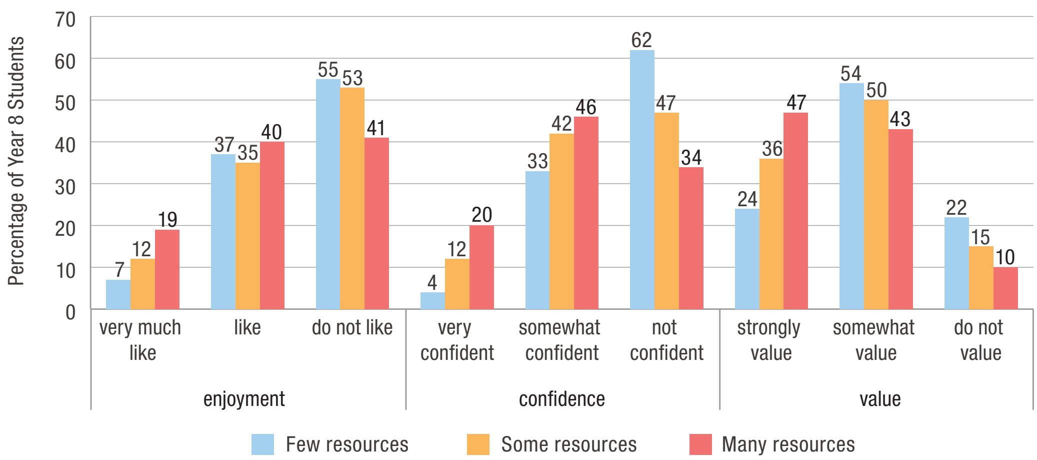
Figure 1.19 Year 8 students confidence in mathematics scale, by gender (2019)



Source: *Thomson et al (2021), extract from Figure 8.8, page 104.*

A similar pattern is observed among students in disadvantaged circumstances. Those with fewer resources at home—indicative of a lower socio-economic background—tend to place less value on mathematics, are more likely to dislike it, and generally have lower confidence in their mathematical abilities (see Figure 1.20).

Figure 1.20 Year 8 student's enjoyment, confidence and value of mathematics and resources in the home (2019)



Source: *Thomson et al (2021), extract from Figures 8.3, 8.9, 8.14, pages 100, 105, 110.*

1.3 Student numbers and participation rates

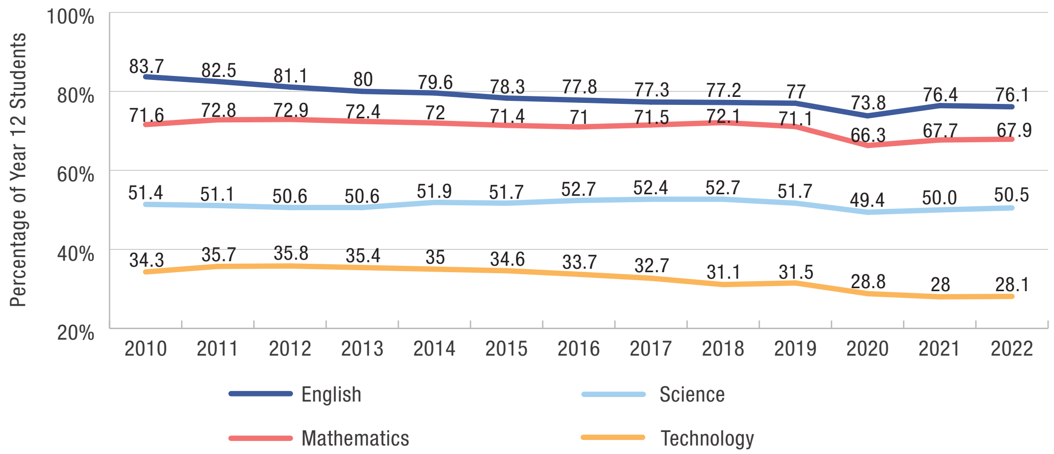
In the senior years of secondary schooling, participation in mathematics subjects that prepare students for tertiary study has been declining. Over the past decade, approximately 71–73 percent of Year 12 students were enrolled in one or more mathematics subjects that count towards university or other tertiary admissions. However, in 2020, this figure dropped to 66 percent. Although there has been a slight increase since then, with around 68 percent of students enrolled in at least one mathematics subject in 2021 and 2022 (Figure 1.21), the trend remains concerning. A similar trend is observed in science and English subjects, while participation in technology has continued to decline.

These participation rates must be viewed in the context of a growing Australian school population, with more students staying in school until Year 12. The number of students completing Year 12 with a secondary school certificate (such as the HSC in New South Wales or the VCE in Victoria) grew throughout the decade up to 2017 and has plateaued since then. In 2008, approximately 181,000 Year 12 students completed school with a qualification. Since 2012, this number has consistently exceeded 200,000 annually, peaking at 219,000 in 2017 before slightly decreasing to 210,000 in 2022 (AMSI, 2024).

Figure 1.21 Year 12 participation in the science, mathematics, ICT technology and English learning areas 2010–2022 (2022)

Source: *ACARA (2023b).*

Note: *The graph represents the proportion of students taking at least one subject in the learning areas of Science, Mathematics and Information and Communication Technology and English. It does not specify enrolments in individual subjects in each learning area.*

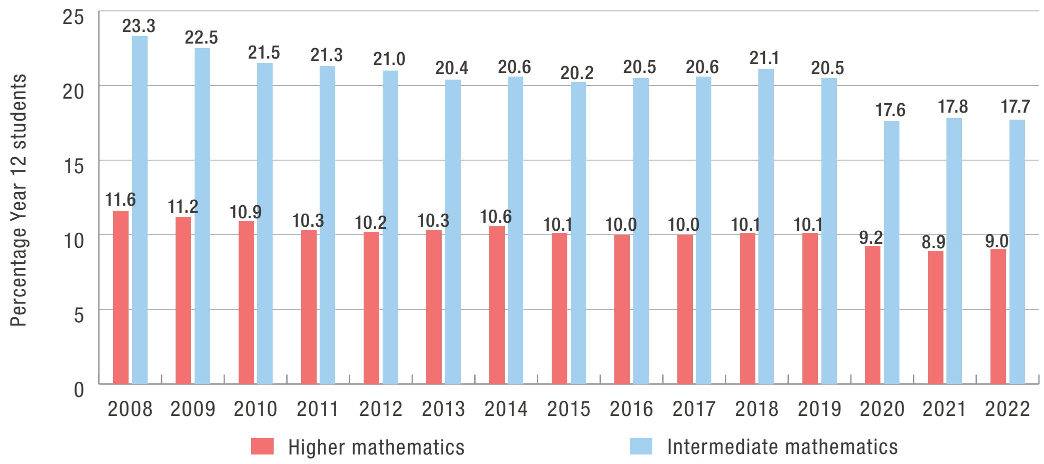


While participation in elementary mathematics subjects in Year 12 remained relatively steady before a decline in 2018, the proportion of students choosing more advanced, calculus-based mathematics subjects as their highest level of study has been decreasing over the past two decades. The most significant drop in Year 12 participation in intermediate or higher mathematics subjects occurred before 2010. In 1997, over 40 percent of Year 12 students selected intermediate or higher mathematics as their most advanced subject. This percentage declined gradually each year, settling between 29 percent and 30 percent in 2010.

From 2010 to 2019, the participation rate in intermediate mathematics subjects stabilised at around 20 percent of all Year 12 students, while participation in higher mathematics subjects was about 10 percent. Unfortunately, both rates dropped further from 2020 onwards, with a notable decrease in 2020 (see Figure 1.22).

Participation in higher mathematics fell below 10 percent for the first time in 2020 and has since remained between 8.9 and 9.2 percent. The number of students enrolled in higher mathematics dropped to fewer than 19,000 in 2022, down from an average of around 21,000 per year in the preceding decade. Similarly, participation in intermediate mathematics decreased to 17.6 percent in 2020, where it has largely remained, well below its previous rate of over 20 percent. The number of students in intermediate mathematics fell to between 37,000 and 38,000 from 2020 to 2022, compared to an average of nearly 43,000 students per year from 2008 to 2019.

Figure 1.22 Year 12 participation rates in higher and intermediate mathematics in Australia (2008–2022)

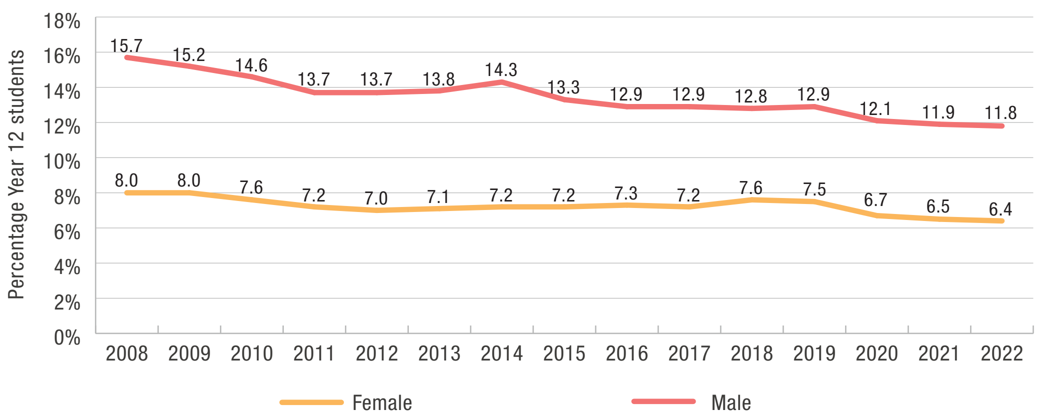


***Source:** Marchant & Kennedy (2024), AMSI collection of State Government data (2008–2022).*

***Note:** The following (non-exhaustive) key for basic, intermediate and advanced level mathematics applies:*
Elementary - VIC Further Maths, NSW Mathematics Standard 1 & 2, SA/NT General Maths, ACT Further Maths, TAS General Maths, QLD General Maths (Maths A), WA Maths Applications
Intermediate - VIC/TAS/ACT/WA/SA/NT Math Methods, NSW Mathematics Advanced, QLD Maths Methods (Maths B)
Advanced - VIC/ACT/SA/NT/WA Specialist maths, NSW Extension 1+2, TAS Specialised maths, QLD Specialist Maths (Maths C).

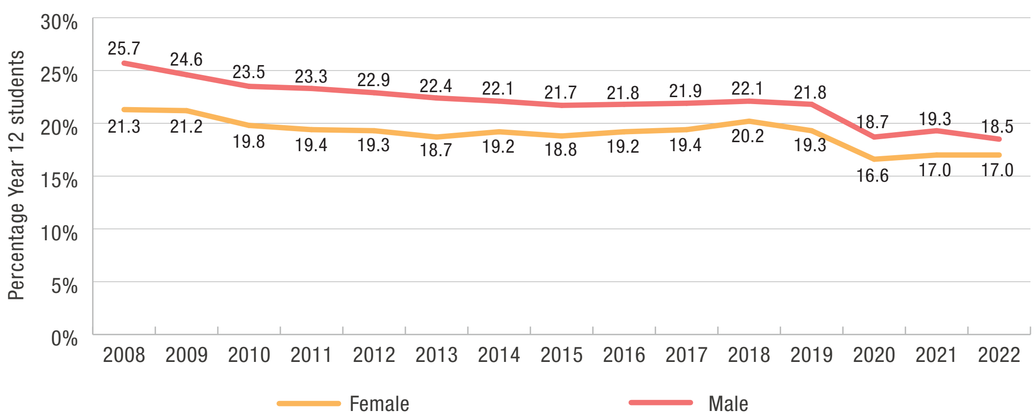
Over the years, the gender gap in Year 12 participation in higher mathematics has narrowed slightly. In 2022, 6.4 percent of females took higher mathematics compared to 11.8 percent of males (Figure 1.23). However, this reduction in the gap is not due to an increase in female participation. From 2008 to 2016, the decline in male participation in higher mathematics was more pronounced than that of female students. Since 2016, the difference in participation levels between genders has remained relatively constant. Meanwhile, the disparity in intermediate mathematics participation between males and females (Figure 1.24) has nearly disappeared.

Figure 1.23 Year 12 participation rate in higher mathematics in Australia, by gender (2008–2022)



***Source:** Marchant & Kennedy (2024), AMSI collection of State Government data (2008–2022).*

Figure 1.24 Year 12 participation rate in intermediate mathematics in Australia, by gender (2008–2022)



***Source:** Marchant & Kennedy (2024), AMSI collection of State Government data (2008–2022).*

Only a small percentage of senior secondary students express an interest in pursuing mathematical sciences at the university level. Gender differences persist, with 7 percent of males and 4 percent of females considering studying mathematics after high school (Figure 1.25).

Figure 1.25 Future study intentions for STEM at higher education among Year 11 and 12 students, by gender (%) (2021)

Source: *YouthInsight (2021), Figure 30, page 63.*

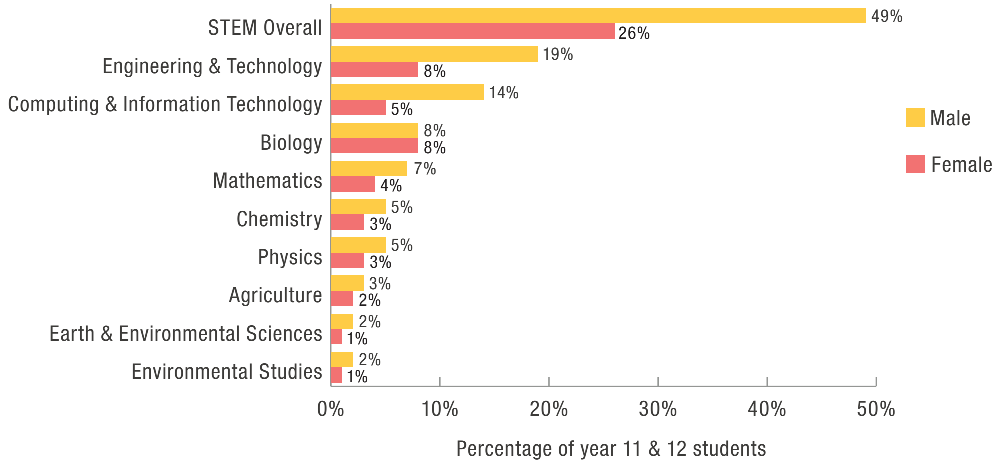
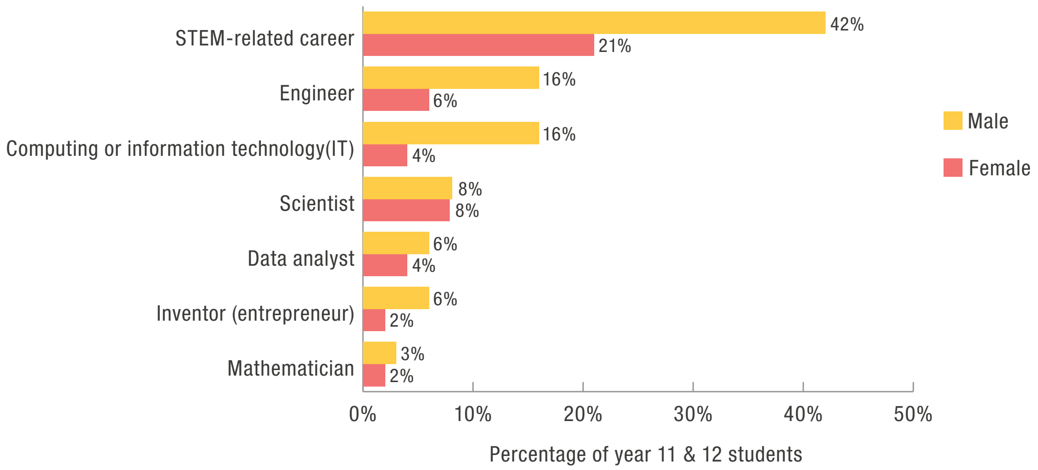


Figure 1.26 STEM career intentions among Year 11 and 12 students, by gender (%) (2021)

Source: *YouthInsight (2021), Figure 32, page 65.*



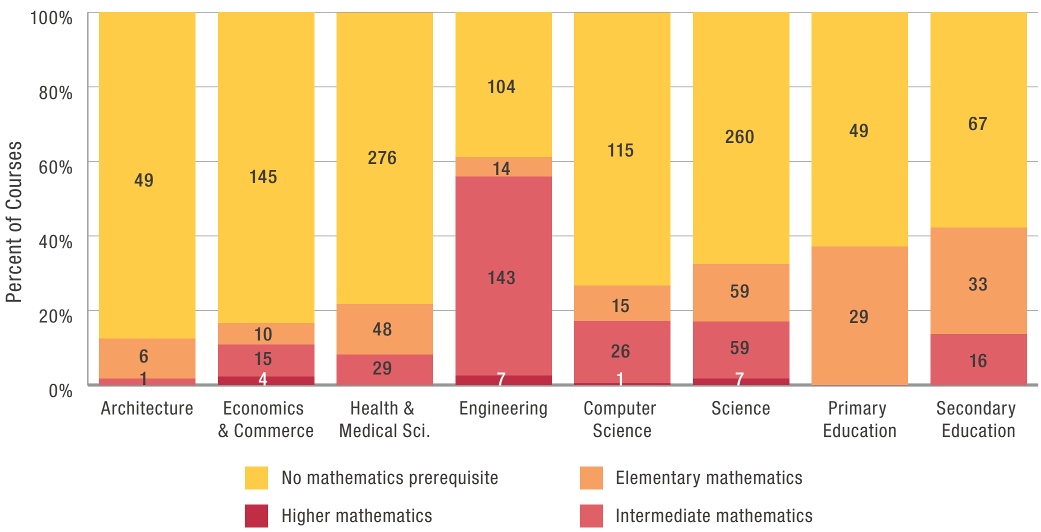
Even fewer Year 11 and 12 students consider mathematics as a career choice. Only 3 percent of males and 2 percent of females aspired to become a mathematician in 2021, while 6 percent of males and 4 percent of females were interested in a career as a data analyst (Figure 1.26).

The decline in engagement with advanced mathematics subjects and the low interest in pursuing mathematical sciences as a career are likely due to a variety of complex factors. These may include dissatisfaction with how mathematics is taught in schools, a lack of external incentives for undertaking intermediate and higher mathematics, and perceptions about the best strategies for maximising ATAR scores — whether these perceptions are correct or not since ATAR is based on scaled results (Murray, 2011; Pitt, 2015; CESE, 2017; Hine, 2018; Hine, 2019). Many students may focus on short-term goals, such as university entry, where mathematics is not always a requirement, without fully appreciating its importance for university success.

Previous studies have shown that studying higher-level mathematics in secondary school can positively impact performance in several university science subjects (Sadler & Tai, 2007; Poladian & Nicholas, 2013; Nicholas et al., 2015; Joyce et al., 2017). According to the most comprehensive Australian analysis to date (McMillan & Edwards, 2019), both the level and performance in Year 12 mathematics are linked to pass rates in science and mathematics subjects in the first year of university. Students who completed Mathematical Methods or Specialist Mathematics generally had higher pass rates in their first-year subjects compared to those who took General Mathematics. However, students with strong results in General Mathematics often achieved similar or higher pass rates than those who performed poorly in more advanced mathematics subjects.

Mathematics and statistics are core subjects for university studies in science, engineering, computer science, commerce, education, and health sciences. However, universities may not always provide clear guidance to secondary school students about the necessary prior knowledge for success in these degrees (King & Cattlin, 2015). As shown in Figure 1.27, intermediate or higher mathematics is a prerequisite for only a minority of degree programs. Most universities do not require Year 12 mathematics for entry into programs in science, computer science, health and medical sciences, architecture, economics, and commerce. Entry into primary or secondary education may require elementary mathematics, while engineering programs generally require at least intermediate mathematics.

Figure 1.27 Percentage of undergraduate courses with mathematics prerequisites, by level in 2019 for 2020 entry (data labels show number of courses)



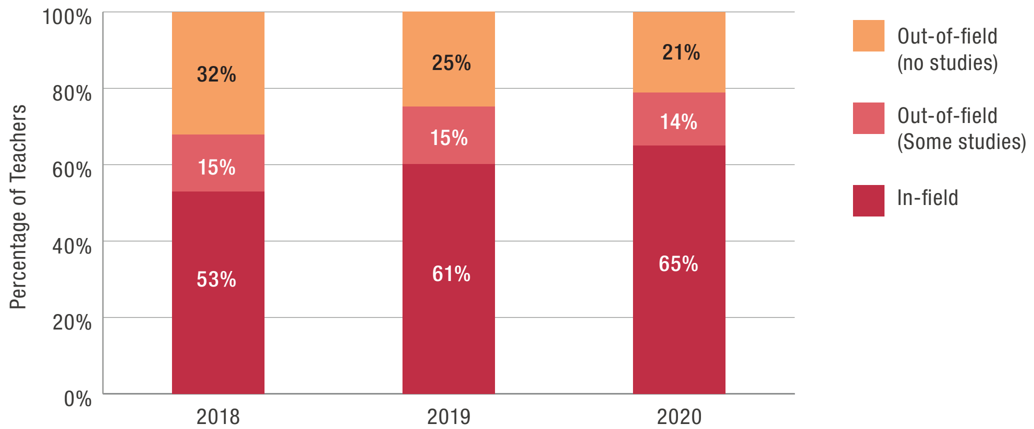
Source: *Office of the Chief Scientist & AMSI (2020), page 12.*

1.4. Teacher profiles and qualifications

Research consistently highlights a shortage of mathematically qualified teachers in Australian secondary schools. This means that large numbers of students are being taught by teachers who do not have necessary skills, knowledge, skills, and confidence to teach mathematics (Goos et al., 2024). Given that mathematics is taught in all secondary schools up to and including Year 10, and studied by most students up to Year 12, there is a pressing need for a large number of qualified teachers who can effectively teach this subject. According to AMSI, being qualified in a discipline means having completed both content and methodology training, as effective math teaching requires both deep mathematical knowledge and pedagogical expertise (Hinz, Walker & Witter, 2019, p. 3). However, due to shortages, many schools assign teachers specialised in other subjects to teach mathematics "out-of-field."

Surveys conducted as part of the AMSI Choose Maths program reveal that teachers who consider themselves to be teaching mathematics out-of-field—due to perceived gaps in content knowledge or methodology training—report feeling significantly less confident and competent in many aspects of mathematics teaching, especially in the senior years, compared to their in-field colleagues (Li & Sprakel, 2020). Teachers with a major in mathematics are far more likely to believe they are teaching mathematics effectively compared to those without a major or minor in the subject. In-field teachers also show greater confidence in preparing students for tertiary study in mathematics, motivating female students' interest in the subject, and encouraging females to consider mathematics-related careers (Ibid, p. 23). Empowering teachers with strong pedagogical and disciplinary expertise is therefore crucial for reversing the decline in student interest in mathematics and promoting inclusivity in the field.

Figure 1.28 Out-of-field teaching in mathematics in all participating States and Territories 2018–2020 (%)



Source: *AITSL (2023).*

Estimates of the number of teachers instructing mathematics without full content or methodology training vary significantly, influenced by data collection methods and definitions of "out-of-field" teaching (Barker, Goos & Couplan, 2024). One challenge in defining the extent of this issue is the lack of a uniform register that links disciplinary training to teacher accreditation. Consequently, the best available data relies on teacher surveys.

Data from AITSL (see Figure 1.28) suggest that out-of-field teaching rates in mathematics have declined over the past three years. However, it is important to note that the 2018 data came from a preliminary survey, which was expanded in 2019 and 2020 to include all states and territories and a larger number of respondents. By 2020, an estimated 21 percent of teachers were teaching mathematics out-of-field without having completed formal studies in the subject.

International TIMSS survey data from 2011, 2015, and 2019 estimate that the percentage of students taught mathematics by teachers without any formal qualifications in the subject ("all other majors") ranged from 34 percent in 2011 to 23 percent in 2019 (see Table 1.8). More recent data indicates that 40 percent of those teaching secondary school mathematics are teaching out-of-field (AITSL, 2021).

Table 1.8 Percentage of Year 8 students by mathematics teachers' formal education and student achievement, Australia and international averages (2011–2019)

	Major in Mathematics and Mathematics Education		Major in Mathematics but No Major in Mathematics Education		Major in Mathematics Education but No Major in Mathematics		All Other Majors	
	Proportion of students	Average achievement	Proportion of students	Average achievement	Proportion of students	Average achievement	Proportion of students	Average achievement
2011 Australia	37%	505	21%	519	9%	522	34%	500
2011 int. avg.	32%	471	41%	468	12%	470	12%	462
2015 Australia	46%	513	18%	507	14%	498	22%	503
2015 int. avg.	36%	483	36%	482	13%	481	13%	477
2019 Australia	46%	531	14%	523	17%	511	23%	501
2019 int. avg.	39%	492	39%	488	11%	494	10%	484

Source: *Mullis et al (2020), Exhibit 9.7; Thomson et al (2021), extract from Figure 4.1, page 49.*

More affluent schools in metropolitan areas generally face fewer challenges in attracting teachers with strong qualifications. TIMSS data confirm (see Table 1.9) that out-of-field teaching is more prevalent in disadvantaged schools. These schools often struggle to employ teachers with qualifications in both mathematics and mathematics education.

Table 1.9 Percentage of Year 8 students by mathematics teachers' formal education and student achievement, Australia and international averages (2011–2019)

More affluent	Neither more affluent nor more disadvantaged	More disadvantaged	Advanced
Major in Mathematics and Mathematics Education	54%	51%	31%
Major in Mathematics Education but no Major in Mathematics	16%	13%	23%
Major in Mathematics but no Major in Mathematics Education	14%	9%	18%
All Other Majors	16%	26%	28%

Source: *Mullis et al (2020); Thomson et al. (2021), extract from Figure 4.2, page 50.*

Enrolment Trends

Enrolments in mathematical sciences degrees are on the rise, particularly in coursework masters programs, which have **increased by 223%** since 2015

See page 35

Pandemic Impact

The mathematical sciences student — and teaching — load was impacted by the pandemic, **particularly among the international student cohort**. While there are signs of recovery post-pandemic, **visa restrictions** and **student caps** introduced in 2024 will further impact mathematical sciences departments.

See page 33–34

Data Science Growth

There has been **significant growth in data science degrees**, many of which combine computer science and mathematical sciences, co-taught across various faculties. Nearly **100** coursework masters degrees in data science, analytics, or artificial intelligence are available across **35** universities.

Student Satisfaction

Mathematical sciences students report **high satisfaction levels** regarding teaching quality and learning resources, however learner engagement and skills development is consistently rated lower than other students.

Female Representation in Mathematical Sciences Departments

There has been an **improvement in female representation** at senior academic levels, specifically among Associate Professors and Professors.

2 HIGHER EDUCATION

Over the past decade, the use of mathematical sciences has expanded rapidly, driven in part by advancements in artificial intelligence, machine learning, and data science fields that are deeply rooted in mathematical principles. This growth has increased the demand for mathematical concepts and skills across various research areas and industries, creating new career paths for which graduates in mathematical sciences are highly sought after. Studies in mathematical sciences, which include mathematics and statistics, provide individuals with in-demand and transferable skills applicable to nearly every industry.

The teaching load for mathematical sciences at Australian universities has risen significantly over the past decade, paralleling increases in student numbers at all degree levels, including both domestic and international students. The popularity of coursework-based masters degrees in mathematical sciences has surged, as well as data science programs that integrate computer science with mathematical sciences and are often taught across multiple faculties. Despite this growth, diversity remains a critical issue. There is a need to enhance participation among female students, those from low socio-economic backgrounds, and First Nations students. Additionally, student satisfaction concerning skills development and learner engagement requires ongoing attention.

The pandemic has had a profound impact on the higher education sector, particularly affecting international students who were unable to start their studies. Many mathematical sciences departments faced redundancies and restructurings, with smaller universities being especially vulnerable. While signs of recovery were observed in 2022, ongoing and planned restrictions on international student arrivals are likely to continue affecting student numbers and the teaching workforce.

2.1 Mathematics and statistics teaching at universities

The mathematical sciences are a group of study areas including mathematics, statistics and data science. They are foundational to a range of university degrees, including the natural and physical sciences, engineering, business, information technology, social sciences, education, and health. Beyond students enrolled in mathematical sciences degrees, mathematics and statistics departments also provide cross-disciplinary teaching to students across a variety of programs. As a result, these departments often carry a substantial teaching load.

The following paragraphs provide an overview of the general teaching load in mathematical sciences across all degree programs. Section 2.2 will further explore mathematical sciences degrees specifically.

Note: Teaching load is measured in Equivalent Full Time Student Load (EFTSL).

Source: Department of Education Higher Education Statistics, provided to AMSI.

Figure 2.1 Student load in mathematical sciences subjects, all degrees, all universities (2012–2022)

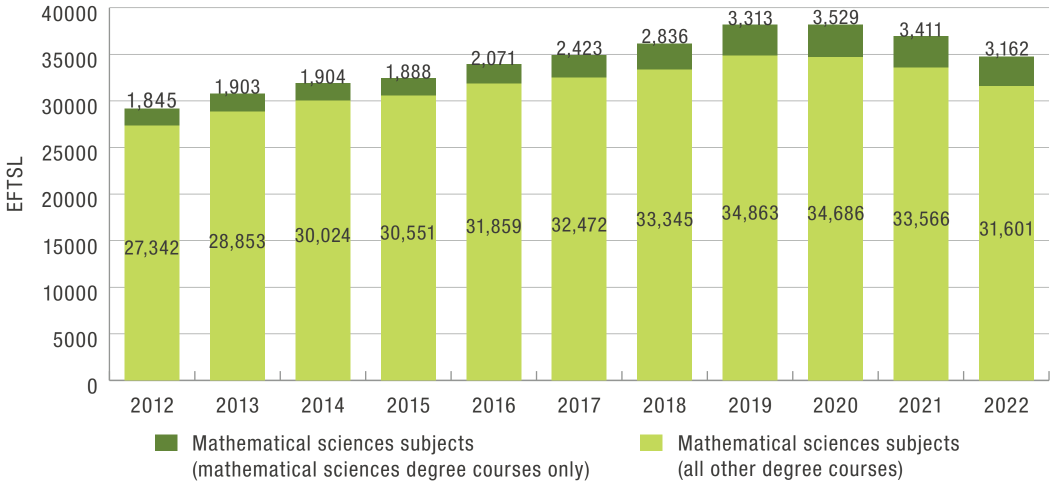


Figure 2.1 illustrates the overall teaching load in mathematical sciences subjects at Australian universities, distinguishing between students enrolled in mathematical sciences degrees and those taking mathematics subjects as part of other degrees. During the pandemic years (2019–2022), the student load in mathematical sciences degrees declined by 9 percent, while the total student load across all disciplines decreased by 8 percent. Despite this decline, the student load in mathematical sciences degrees increased by 19 percent from 2012 to 2022, outpacing the overall growth in the higher education sector, which saw a 17 percent increase over the same period (Department of Education, 2023a).

The graph clearly shows that mathematical sciences degree students constitute a minority among all mathematical sciences students—over 90 percent of teaching in the discipline at universities is directed towards students enrolled in other degrees. Nonetheless, the proportion of teaching dedicated to mathematical sciences degrees has risen over the past decade, increasing from approximately 6 percent of the student load in 2012 to about 9 percent in 2022.

Note: This graph includes teaching load of mathematical sciences subjects in bachelor and bachelor with honours degrees.

Source: Department of Education Higher Education Statistics, provided to AMSI.

Figure 2.2 Teaching in mathematical sciences subjects - undergraduate degree course level (2022)

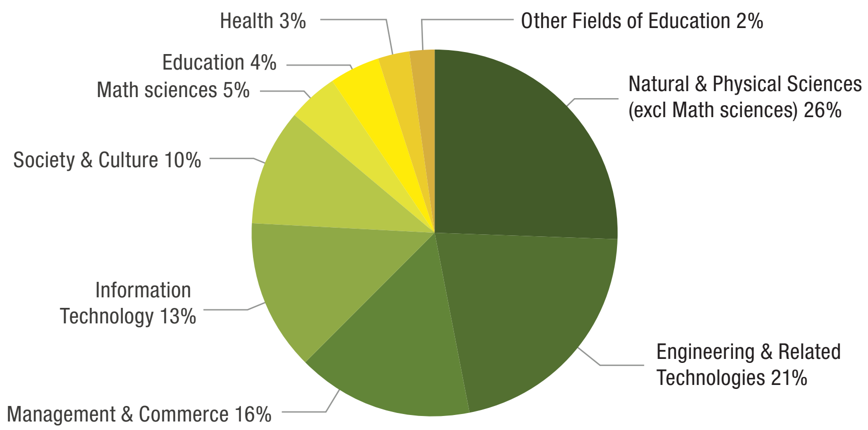
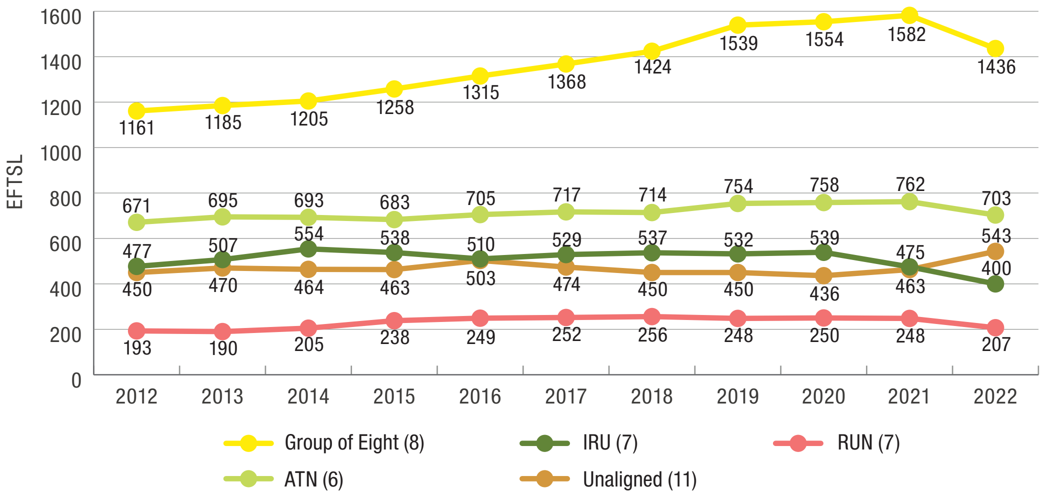


Figure 2.2 displays the distribution of mathematical sciences teaching across various undergraduate disciplines. In 2022, approximately 26 percent of mathematical sciences teaching was directed towards natural and physical sciences students, followed by 21 percent for engineering students. Teaching in management and commerce degrees, which previously constituted over 20 percent, decreased to 16 percent in 2022. Conversely, the share of mathematical sciences teaching in information technology degrees has risen to 13 percent of the total student load, more than double the 6 percent recorded in 2016.

It is important to note that the increase in mathematical sciences teaching load is not uniformly distributed across all Australian universities. Trends suggest that mathematical sciences teaching is becoming more concentrated at Australia's larger universities (see Figure 2.3). Between 2012 and 2021, undergraduate student load in mathematical sciences subjects grew by 36 percent at Group of Eight (GO8) universities, compared to an 8 percent increase at all other universities combined. In 2022, GO8 universities accounted for 44 percent of the undergraduate mathematical sciences student load, up from 40 percent in 2012.

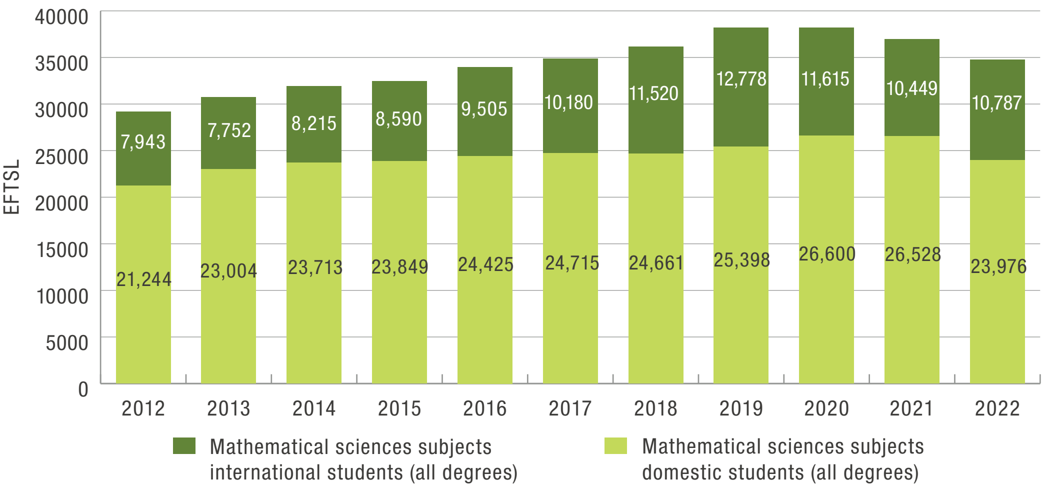
Figure 2.3 Average undergraduate student load per university in mathematical sciences subjects, by university network (2012–2022)



__Note:__ This graph includes teaching load of mathematical sciences subjects in bachelor and honours degrees.

__Source:__ Department of Education Higher Education Statistics, provided to AMSI.

Figure 2.4 Student load in mathematical sciences subjects, by international and domestic students (all degrees, all universities) (2012–2022)



__Note:__ Teaching load is measured in Equivalent Full Time Student Load (EFTSL).

__Source:__ Department of Education Higher Education Statistics, provided to AMSI.

Figure 2.4 displays the total student load in mathematical sciences subjects shown in Figure 2.1 but divided between international and domestic students. The domestic student load in mathematical sciences increased by 25 percent from 2012 to 2021, before declining by 10 percent in 2022. In contrast, the international student load in mathematical sciences subjects increased by 61 percent between 2012 and 2019, driven by significant growth in the number of international students at Australian universities. However, this load decreased by 16 percent between 2020 and 2022, primarily due to difficulties faced by international students in starting their degrees during the pandemic. Figure 2.5, shown below, illustrates the illustrates a decline of 21% for commencing international students between 2019 and 2021 and a stable load for non-commencing international students. The domestic commencing and non-commencing student load declined slightly during this period, by 6 and 4 percent respectively'. and continuing international students during the same period.

Note: Teaching load is measured in Equivalent Full Time Student Load (EFTSL).

Source: Department of Education Higher Education Statistics, provided to AMSI.

Figure 2.5 Impact of pandemic on undergraduate student load in mathematical sciences subjects (2015–2022)

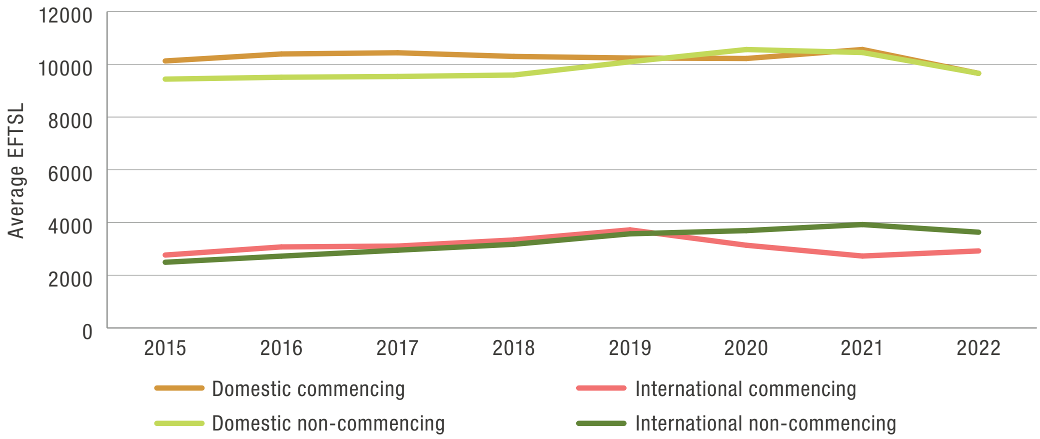
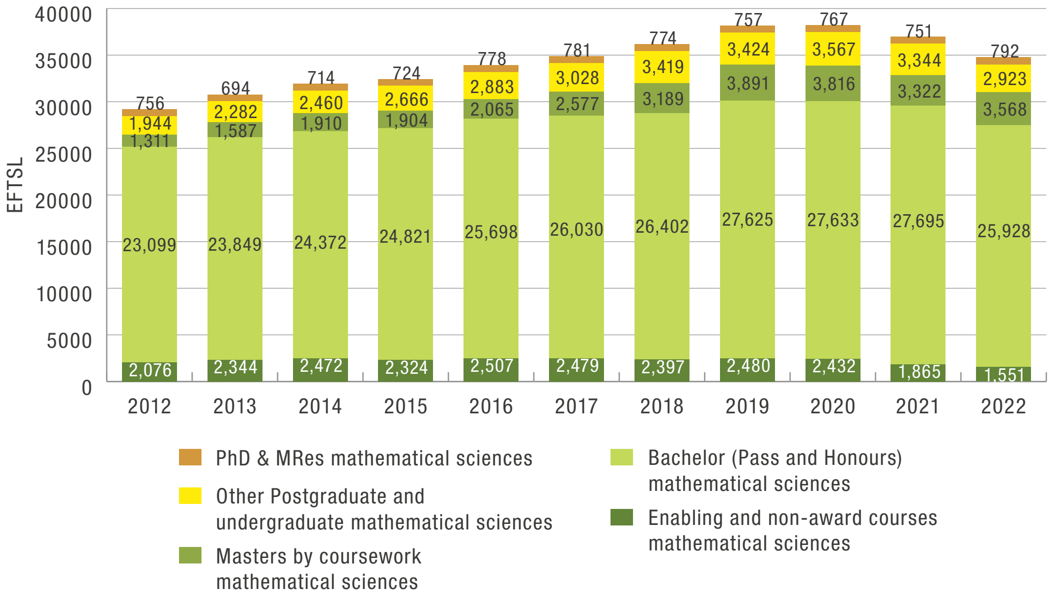


Figure 2.6 illustrates the mathematical sciences student load, as shown in Figures 2.1 and 2.4, categorised by broad degree types. Despite a decline in 2022, the student load in bachelors and Honours courses grew by a notable 12 percent between 2012 and 2022. The most significant growth, however, occurred in masters by coursework degrees, which saw a 172 percent increase since 2012. The load for 'Other' undergraduate and postgraduate degrees (including graduate certificates, diplomas, and associate degrees) rose by 50 percent over the same period. Although undergraduate teaching still constitutes the majority of the discipline's student load, there is a growing emphasis on masters and other postgraduate degrees, particularly among international students and professionals seeking to upskill. The student load in these courses has increased year-on-year since 2015, peaking in the 2019–20 academic year before experiencing a slight decline during the pandemic years.

Note: Teaching load is measured in Equivalent Full Time Student Load (EFTSL).

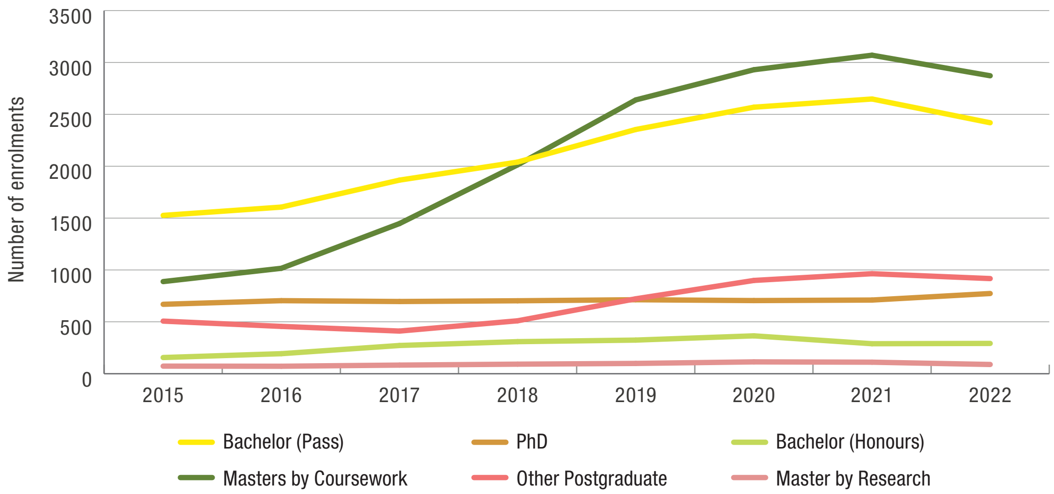
Source: Department of Education Higher Education Statistics, provided to AMSI.

Figure 2.6 Student load in mathematical sciences subjects, undergraduate and postgraduate degrees (all degrees, all universities) (2012–2022)



2.2 Mathematical sciences degrees

Figure 2.7 Enrolments in mathematical sciences degrees (all universities) (2015–2022)



Source: *Department of Education Higher Education Statistics, provided to AMSI.*

For students who pursue mathematics or statistics as their primary degree, most universities offer either a specialist degree in the mathematical sciences (potentially with a choice of various majors) or a Bachelor of Science degree with mathematical sciences-related majors.

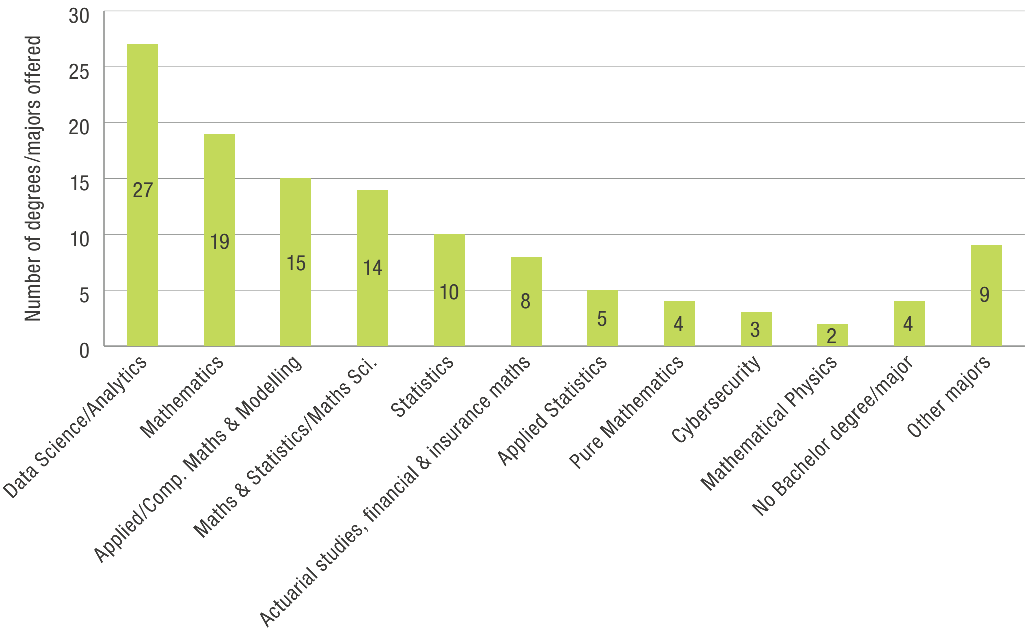
Since 2015, the total number of enrolments in mathematical sciences degrees has nearly doubled (see Figure 2.7). Enrolments in bachelor and Honours degrees increased by 59 percent and 87 percent, respectively, while research degree enrolments (PhD and research masters) grew by 16 percent and 22 percent. In contrast, enrolments in coursework masters degrees surged by a substantial 223 percent, and other postgraduate enrolments (such as graduate certificates and diplomas) rose by 81 percent. The rapid growth in coursework masters degrees has introduced a new pathway in the study pattern, complementing the traditional bachelor-to-honours-to-PhD sequence. In 2022, bachelor enrolments accounted for 33 percent of all mathematical sciences degree enrolments, down from 40 percent in 2015. Meanwhile, coursework masters enrolments increased from 23 percent of enrolments in 2015 to 39 percent in 2022.

2.2.1 BACHELOR DEGREES

Figure 2.8 provides a summary of the undergraduate offerings at Australian universities, including all degrees and majors in mathematics, statistics, and data science available in 2022. Only a few universities do not offer any mathematical sciences degree or major. At all other institutions, students can complete a degree or major in some aspect of mathematical sciences, including data science. Most universities provide combined degrees or major streams in mathematics and statistics. The opportunities to study data science at the undergraduate level have expanded significantly in recent years. In 2022, data science was included in bachelor degree offerings at 25 universities (across 27 separate degrees or majors), and this number is expected to continue growing.

Source: Desktop analysis of undergraduate degree offerings in 2022 at 39 Australian universities.

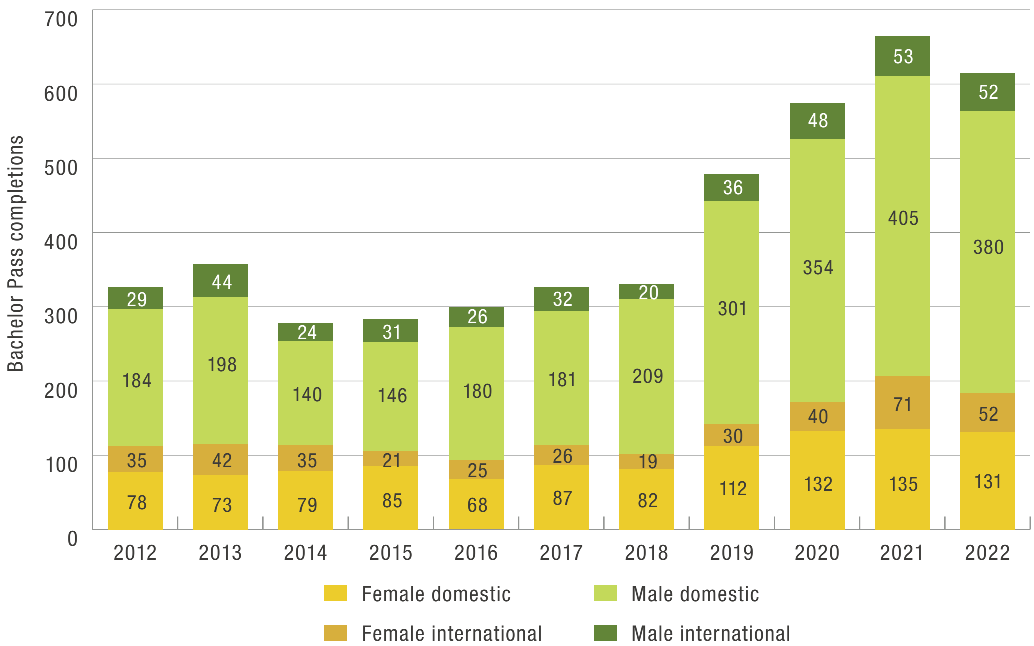
Figure 2.8 Undergraduate degrees/Majors offered in the mathematical and statistical sciences at Australian universities (2022)



Note: Students of unspecified/other gender make up less than 1 per cent of all mathematical sciences graduates — given their very small number they have not been included here.

Source: Department of Education Higher Education Statistics, provided to AMSI.

Figure 2.9 Bachelor Pass completions in the mathematical sciences by international and domestic students and gender (2012–2022)

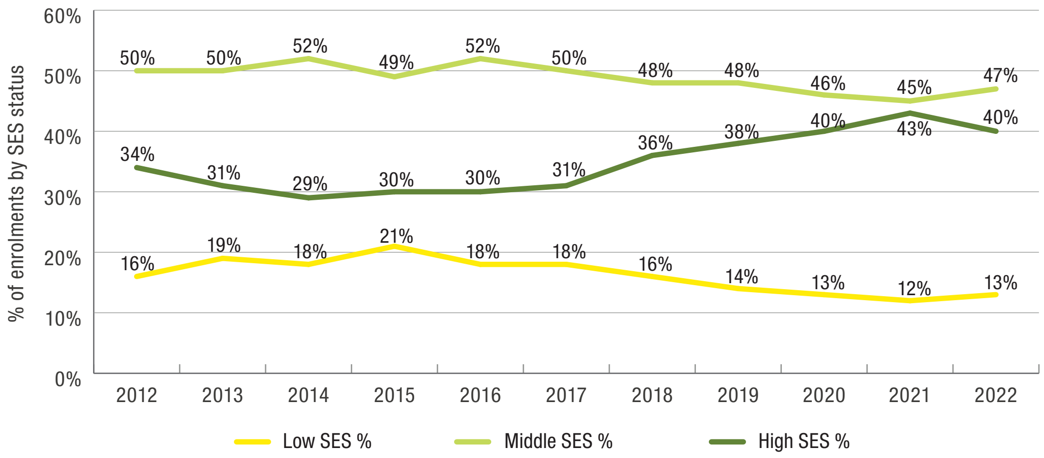


The total number of bachelor degree completions has more than doubled over the last decade, with most of the growth occurring among male domestic students. Completions by this group increased by 107 percent between 2012 and 2021, before declining in 2022 for the first time since 2014. Completions by domestic female students have risen by 68 percent since 2012, though they remain significantly lower than those by male domestic students. On average, females accounted for 29 percent of domestic completions, down from 35 percent in the decade preceding 2012.

International student bachelor degree completions nearly doubled between 2012 and 2022. However, bachelor degrees attract significantly fewer international students compared to masters degrees (as detailed below).

Yearly enrolments in bachelors degrees in mathematical sciences for First Nations students have fluctuated between 15 and 22 students nationally over the past decade—a very small proportion of domestic enrolments. This is well below the First Nations participation rate in overall domestic enrolments, which increased from 1.6 percent in 2012 to 2.4 percent in 2022, according to analysis of Department of Education student enrolment data.

Figure 2.10 Bachelor degrees - domestic enrolments in mathematical sciences degrees, by socio-economic background (SEIFA) (2012–2022)



Source: Department of Education Higher Education Statistics, provided to AMSI.

Recent growth in domestic student enrolments has been primarily driven by those from high socio-economic status (SES) backgrounds. Enrolments in this group increased from 31 percent in 2017 to 43 percent in 2021, before a slight decline to 40 percent in 2022 (see Figure 2.10). While the number of students from a middle SES background remained relatively stable, their relative participation decreased within the growing cohort.

Enrolments of students from low SES backgrounds increased between 2012 and 2015, reaching 21 percent, but then declined to 13 percent in 2022. A similar trend was observed across all fields of education, where enrolments rose to 19.5 percent in 2017 before decreasing to 17.4 percent in 2022 (Department of Education, 2023c).

Figure 2.11 Bachelor Honours completions in the mathematical sciences by international and domestic students, and gender (2012–2022)

Notes: Students of unspecified/other gender make up less than 1 per cent of all mathematical sciences graduates - given their very small number they have not been included here. From 2022 cell size suppression rules apply — counts of <5 are suppressed. The University of Melbourne, Western Sydney University and Macquarie University have replaced honours in mathematical science with coursework masters degrees.

Source: Department of Education Higher Education Statistics, provided to AMSI.

From 2012 to 2021, the number of students continuing to an honours degree in mathematical sciences increased by 151 percent. Most of this growth, similar to bachelor degrees, occurred among male domestic students, reflecting a broader trend in honours completions across the higher education sector. However, in 2022, there was a decrease of 35 honours completions in mathematical sciences, representing a 19 percent decline, compared to a 1.4 percent decline across all fields of education (Department of Education, 2023b).

While the number of females completing honours degrees in mathematical sciences has increased, their relative proportion has declined to an average of 20 percent of the total cohort, down from 30 percent in the decade prior. Regarding socio-economic background, the composition of the honours population—predominantly high and middle SES students—has remained relatively stable over the past decade. However, the proportion of students from high socio-economic backgrounds could rise as the current undergraduate cohort progresses into honours.

Note: The University of Melbourne, Western Sydney University and Macquarie University have replaced honours in mathematical science with coursework masters or research degrees and are not included in this table. Department of Home Affairs (2024) regional area classification used.

Source: Johnston (2022).

Table 2.1 Honours completions in mathematical sciences, by university geographical area (2012–2021)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Category 1: Major cities (see note)	101	91	107	117	76	61	77	89	119	141
average category 1 (2022)	9	8	10	11	7	6	7	8	11	13
Category 2: Cities & Major Regional Centres	46	46	54	48	50	58	57	52	72	75
average category 2 (2022)	3	3	4	3	3	4	4	3	5	5
Category 3: Regional Centres & Other Regional Areas	1	3	4	2	1	7	3	2	1	3
average category 3 (2022)	0.13	0.38	0.50	0.25	0.13	0.88	0.38	0.25	0.13	0.38
All universities (see note)	148	140	165	167	127	126	137	143	192	219
average all universities	4	4	5	5	4	4	4	4	6	6

Table 2.1 demonstrates that honours teaching continues to be a significant component of many mathematical sciences departments and schools, including those at regional universities, even if student numbers at individual institutions are relatively small. In 2021, 64 percent of honours teaching occurred at universities located in major cities such as Melbourne, Sydney, and Brisbane. During the 2020–2021 period, the number of honours completions increased in both major cities and major regional areas.

2.2.2 CONTINUED STUDY IN MATHEMATICAL SCIENCES

Before discussing postgraduate degrees, it is important to note that mathematical sciences graduates are more likely to pursue further full-time study compared to many other fields of education. In 2023, 23 percent of mathematical sciences graduates continued with further study, compared to 18 percent across all fields of education (see Table 2.2). In that year, the majority of mathematics undergraduates who pursued further study did so in the natural and physical sciences (50.8 percent), which includes mathematical sciences. This was followed by studies in information technology (13 percent).

Historically, male mathematical sciences graduates have been more inclined to pursue studies in information technology and engineering. However, this trend reversed in 2023, with 20 percent of female graduates pursuing further study in IT compared to 9.1 percent of males, and 8 percent of females continuing to study engineering compared to 4 percent of males. In 2023, more female mathematical sciences graduates also chose to study education, society and culture, and management and commerce, while male graduates predominantly continued their studies in natural and physical sciences.

Source: Social Research Centre (2024a) data provided to AMSI.

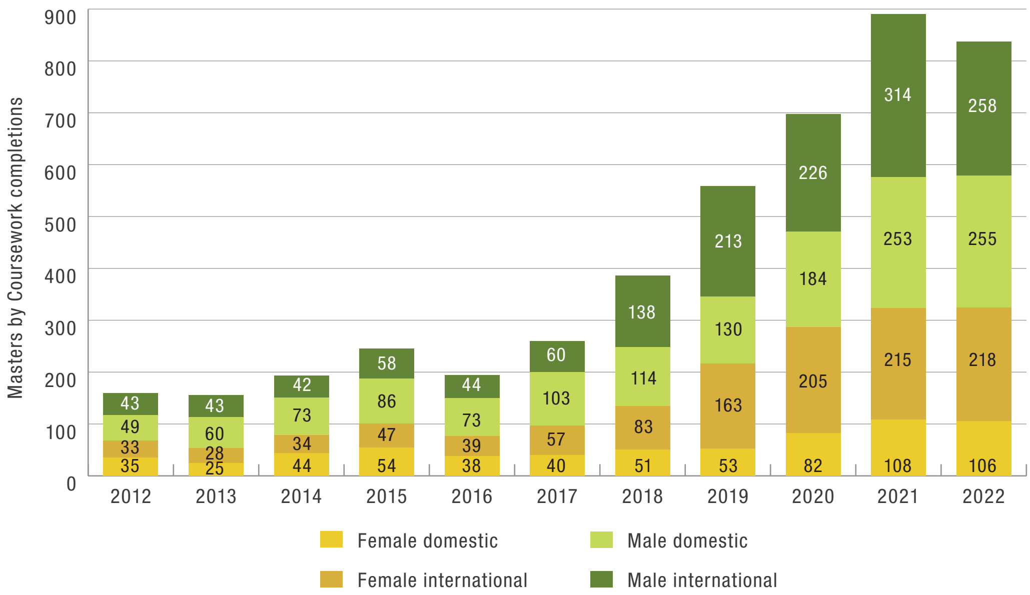
Table 2.2 Mathematics undergraduates and continued study in 2023 (change from 2022)

In further full-time study	2023 (change from 2022)		
	M	F	Total
In full time study: mathematics (%)	21.3 (-0.7)	27.3 (6.1)	23 (1.2)
In full time study: science & mathematics (%)	34.3 (0.8)	36.5 (-1.0)	35.7 (-0.2)
In full time study: all fields of education (%)	18.2 (-0.6)	17.9 (-0.6)	18 (-0.6)

Study area of undergraduates in further full-time study	2023 (change from 2022)			
	Mathematics graduates n=347 (n=480)			All fields of education
	M	F	Total	
Natural & physical sciences (%)	68.2 (14.6)	40 (-20.0)	50.8 (17.3)	15 (-0.4)
Information technology (%)	9.1 (-9.7)	20 (4.0)	13 (-5.1)	3.4 (0.3)
Education (%)	6.8 (-3.3)	16 (12.0)	10.1 (1.6)	8.7 (0.2)
Engineering & related technologies (%)	4.5 (-2.7)	8 (4.0)	5.8 (-0.6)	4.4 (-0.4)
Health (%)	2.3 (0.9)	0 (-4.0)	1.4 (-0.7)	24.4 (0.6)
Society & culture (%)	2.3 (-0.6)	12 (4.0)	5.8 (1.5)	28.2 (1.4)
Management & commerce (%)	2.3 (-3.5)	4 (0.0)	2.9 (-2.4)	5.3 (-0.2)

2.2.3 COURSEWORK MASTERS

Figure 2.12 Masters by Coursework completions in the mathematical sciences by domestic and international students and gender (2012–2022)



Note: Students of unspecified/other gender make up less than 1 per cent of all mathematical sciences graduates - given their very small number they have not been included here.

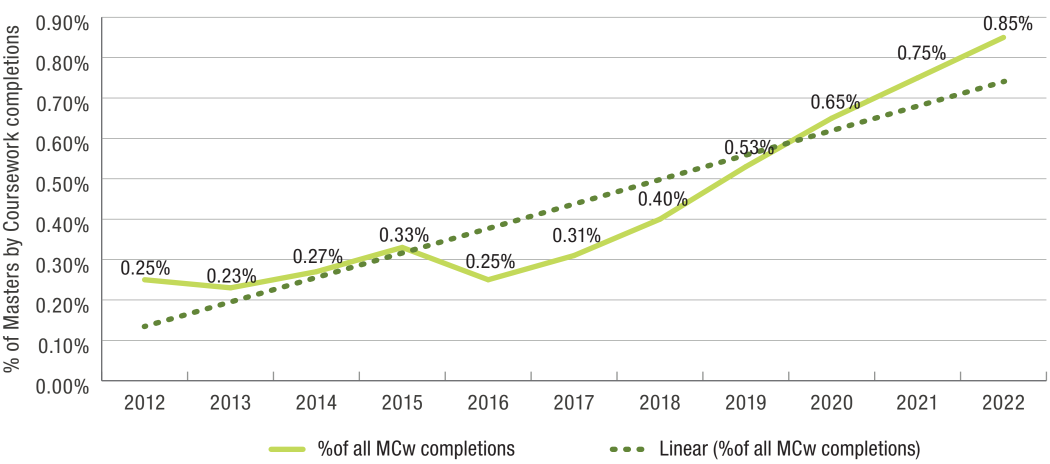
Source: Department of Education Higher Education Statistics, provided to AMSI.

The growth in mathematical sciences coursework masters degrees in recent years has been remarkable. Degree completions surged by 450 percent between 2012 and 2021, with a significant increase starting in 2018. International student numbers saw the largest growth, with completions by female international students rising by 500 percent and male international students by 600 percent by 2021. Domestic female completions grew the least, though still increased by about 200 percent. Following this period of rapid growth, completions declined by 6 percent in 2022, which is much less than the 17 percent decline in masters completions across all fields of education (Department of Education, 2023b).

Despite this decline, the total growth in coursework masters completions in mathematical sciences has surpassed the overall growth in masters degrees within the university sector. Mathematical sciences increased its share from a modest 0.25 percent in 2012 to a still small 0.85 percent of all masters completions in 2022 (see Figure 2.13). The increase in market share is notable, given that the expansion in coursework masters degrees in mathematical sciences is concentrated in only 13 out of 39 public universities. Most universities have few or no enrolments in masters by coursework degrees in mathematical sciences.

It is also important to note the significant growth in masters degrees in data science offered by Australian universities. In 2022, nearly 100 coursework masters degrees in data science, analytics, or artificial intelligence were available across 35 universities. Most data science programs are a blend of computer science and mathematical sciences (including mathematics and statistics) and are taught or co-taught across various faculties. Many of these degrees are classified outside of mathematical sciences, despite their mathematical sciences content.

Figure 2.13 Masters by Coursework completions in mathematical sciences as a proportion of completions in all fields of education (2012–2022)



Source: Department of Education Higher Education Statistics, provided to AMSI.

2.2.4 HIGHER DEGREE BY RESEARCH DEGREES

Higher degrees by research include Masters by Research and Doctor of Philosophy (PhD) degrees. Research masters degrees in mathematical sciences typically attract a small number of students, with average annual completions not exceeding 20 to 30 across Australia. However, PhD degrees have experienced some growth over the past decade.

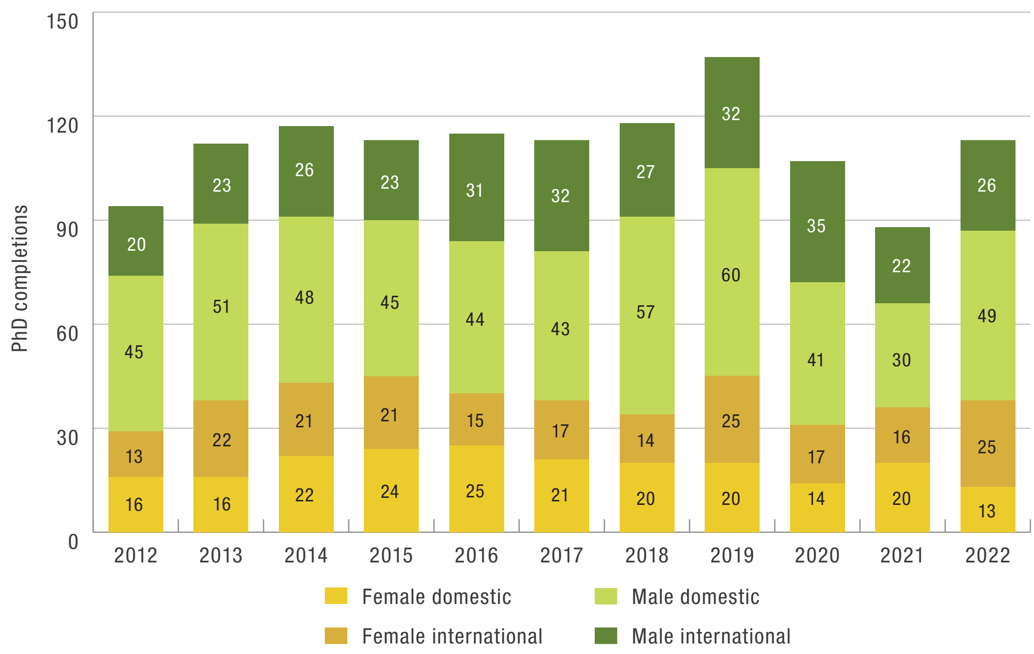
In the first decade of this century, an average of 75 to 80 students completed a PhD in mathematical sciences each year. In the past decade, this number increased to over 100 per year, excluding 2021, which was at the peak of the pandemic. The growth in PhD completions is largely attributed to an increase in international students pursuing PhDs in Australia.

This trend mirrors the pattern observed in PhD completions across all fields of education, which saw a decline in 2020 and 2021 before rising again in 2022. Conversely, the number of *enrolments* in mathematical sciences PhDs remained relatively stable in 2020 and 2021, suggesting that PhD completions may have been delayed due to the effects of the pandemic.

Figure 2.14 PhD completions in the mathematical sciences by domestic and international status and gender (2012–2022)

Note: *Students of unspecified/other gender make up less than 1 per cent of all mathematical sciences graduates - given their very small number they have not been included here.*

Source: *Department of Education Higher Education Statistics, provided to AMSI.*



2.3 student experience and course satisfaction

The annual Quality Indicators for Learning and Teaching (QILT) Student Experience Survey gathers current students' impressions of the quality of their courses. It includes questions on skills development, learner engagement, teaching quality, student support, learning resources, and overall assessment of their educational experience.

The 2022 survey results indicate that undergraduate mathematics students generally rated student support and learning resources positively (see Table 2.3). They also expressed relatively high satisfaction with teaching quality, although this rating was slightly lower compared to students from related disciplines and the average across all fields of education.

The most significant gaps in experience between undergraduate mathematics students and those in other disciplines were in skills development and learner engagement. Skills development encompasses critical and analytical thinking, complex problem-solving, effective teamwork, written and spoken communication skills, and work-related knowledge. Learner engagement includes aspects such as a sense of belonging to the institution and opportunities for interaction with other students both inside and outside study requirements. Mathematics students rated their overall educational experience slightly lower than students from cognate disciplines and the average across all fields of education.

Table 2.3 The undergraduate student experience, by study area (% positive rating) (2022)

	Skills Development	Learner Engagement	Teaching Quality	Student Support	Learning Resources	Quality of Entire Educational Experience
Science & mathematics	79	56	82	72	87	77
* Natural & Physical Sciences	77	53	81	70	86	76
* Mathematics	**76**	**48**	**79**	**75**	**84**	**74**
* Biological Sciences	80	59	83	74	89	79
* Medical Science & Technology	82	61	84	76	89	80
All fields of education	80	55	80	73	84	76

Source: *Social Research Centre (2023a).*

Postgraduate students studying mathematics reported lower satisfaction with their educational experience compared to the average, scoring below others on every measure except for student support and learning resources (see Table 2.4). Similar to undergraduates, the largest gaps in experience between postgraduate mathematics students and those in other disciplines were in learner engagement and skills development. Postgraduate mathematics students rated their overall educational experience lower than those in cognate disciplines and below the average across all fields of education.

Table 2.4 The postgraduate student experience, by study area (% positive rating) (2022)

	Skills Development	Learner Engagement	Teaching Quality	Student Support	Learning Resources	Quality of Entire Educational Experience
Science & mathematics	82	50	85	77	88	79
* Natural & Physical Sciences	82	49	85	74	86	82
* Mathematics	**74**	**33**	**79**	**77**	**86**	**69**
* Biological Sciences	89	61	89	75	89	83
* Medical Science & Technology	87	61	88	81	91	83
All fields of education	81	49	82	75	84	77

Source: *Social Research Centre (2023a).*

For both undergraduate and postgraduate students, assessments of skills development and learner engagement have consistently been lower compared to students across all fields of education (see Figures 2.15 and 2.16). However, these lower ratings for learner engagement and skills development have not necessarily resulted in consistently lower ratings for the overall quality of the student experience, particularly for undergraduate students. The relative importance that students place on various elements of their experience is not well understood, and comparisons of results between institutions, cohorts, and disciplines should be approached with caution.

Figure 2.15 Experience of undergraduate mathematical sciences students compared to students in all of fields of education (difference in % positive rating) (2012–2022)

Source: Social Research Centre (2018, 2019a, 2020a, 2021, 2022a, 2023a).

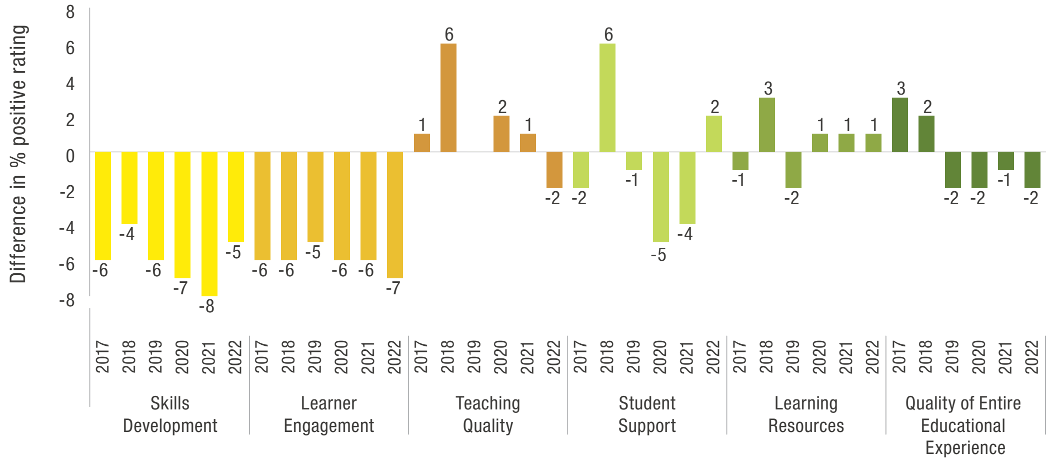
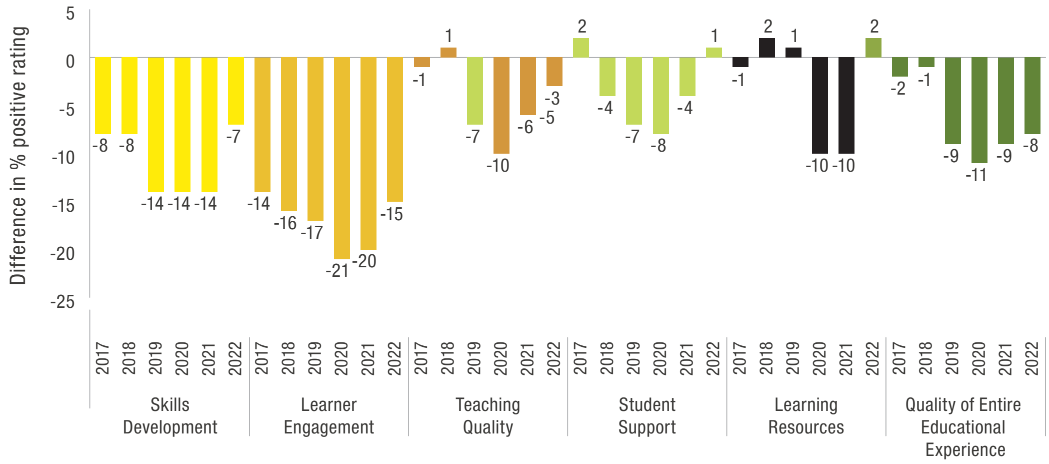


Figure 2.16 Experience of postgraduate mathematical sciences students compared to students in all fields of education (difference in % positive rating) (2012–2022)

Source: Social Research Centre (2018, 2019a, 2020a, 2021, 2022a, 2023a).



2.4 Staffing at mathematical sciences departments

In 2023, Australian universities employed approximately 950 academic staff in mathematical sciences departments, schools, or discipline units for teaching and/or research. About 10 percent of these staff were in teaching-only positions, while another 20 percent were in research-only roles. The remaining staff combined both teaching and research responsibilities.

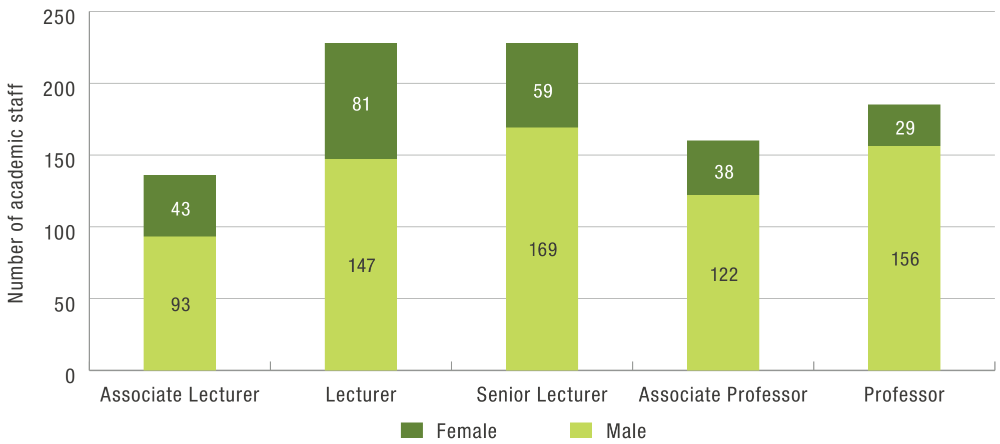
Of all academic mathematicians and statisticians, 57 percent worked at the research and teaching-intensive Group of Eight (Go8) universities. The average number of 67 staff members per Go8 university is significantly higher than at other universities, which employ an average of 14 academic staff. There are about seven universities with fewer than five academic staff, often embedded in multidisciplinary teaching units; these are mostly universities in regional and outer-suburban areas.

The academic mathematical sciences workforce is relatively small compared to other STEM disciplines, and female participation has historically been low, particularly at higher levels of seniority (as illustrated by Figure 2.17). In 2023, only 27 percent of the academic workforce in mathematics and statistics was female, which is about the same as it was in 2018. The gender composition is slightly better at smaller universities, with 31 percent females compared to 23 percent at Go8 universities.

On a positive note, female representation at senior levels of Associate Professor and Professor has improved in recent years. At Australian universities, 16 percent of mathematical sciences professors and 24 percent of associate professors are now female, compared to an estimated 10 percent and 18 percent in 2018. At Go8 universities, the number of female professors has increased to 20, representing 18 percent.

During the pandemic years, many mathematical sciences departments faced redundancies and restructurings, with smaller universities being particularly affected. The international student visa restrictions for 2024 and the planned international student caps for 2025 are likely to have a significant negative impact on the future workforce in mathematical sciences departments.

Figure 2.17 Academic staff in the mathematical sciences at Australian universities, by gender (2023)



Note; *Staff of unspecified/other gender currently make up about 0.5 per cent of all mathematical academic staff - given their very small number they have not been included here.*

Source: *AMSI Survey complemented by desktop analysis of academic staff at 37 universities, excluding casual staff (completed in 2023). The resulting estimate also excludes staff employed in Education faculties to teach maths education to teachers in training.*

Occupational Growth

The category 'Other Information and Organisational Professionals', which includes data science roles, **has surged by nearly 1300%** in the past five years, and is now ranked as the top occupation for mathematical scientists.

See page 47

Salary Trends

Median starting salaries for mathematical sciences graduates have **increased substantially in recent years**, especially for those holding masters degrees.

See page 48

Workforce Demographics

The ageing mathematical sciences workforce is being revitalised by a growing influx of young professionals, particularly recent immigrants who came to study at Australian universities as international students.

See page 49

Gender Disparity

While gender parity was nearly achieved among older cohorts of mathematical science degree holders, **the gap has widened in younger age groups**, resulting in fewer females represented.

See page 51

Numeracy Skills and Outcomes

Strong numeracy skills contribute to better employment, higher wages, and improved health outcomes. Although most Australian adults possess basic numeracy skills, **a significant gap exists between those with low and advanced skills**.

See page 53

3 MATHEMATICAL SCIENCES IN THE WORKFORCE

The mathematical sciences encompass a range of study areas, including mathematics, statistics, and data science. In recent years, the value of these disciplines has gained significant recognition in both business and government sectors. Their application in data-driven decision-making has fuelled a growing demand for mathematicians, statisticians, and data scientists. These experts possess crucial skills in problem-solving and analytical thinking, making them valuable assets across various industries, including finance, technology, and healthcare.

The scope of employment opportunities for mathematical scientists has expanded considerably, with many new roles emerging. This demand is expected to continue its upward trajectory, with high employment growth anticipated well into the future. The employment prospects for recent graduates in mathematical sciences are particularly strong, with full-time employment rates notably higher than those for graduates in general science and mathematics fields. Additionally, median starting salaries for new graduates have shown consistent growth, especially for those holding postgraduate degrees. The majority of these graduates find professional roles in the private sector and the education industry.

The workforce is becoming more diverse, with a significant proportion of professionals from migrant backgrounds and an increase in female representation—although a gender imbalance persists, particularly among the youngest cohorts entering the field. Overall, the rising demand for mathematical scientists has driven positive changes in both the size and demographic makeup of the workforce, signalling a bright future for those with expertise in this area.

3.1 Increased demand for mathematicians, statisticians and data scientists

In recent years, businesses and governments have been transforming the way they operate. Increasingly, organisations and government agencies recognise the critical importance of data in making informed decisions. The surge in online activity across virtually every aspect of life, coupled with the explosion of available information that needs protection, analysis, and conversion into valuable insights, has made the skills and expertise of mathematicians, statisticians, and data scientists highly sought after.

Individuals with a degree in mathematical sciences, including the many new university degrees in data science discussed in Chapter 2, bring essential skills and knowledge to a variety of industries. With their strong foundation in problem-solving and analytical thinking, these professionals are equipped to tackle complex challenges in fields such as finance, technology, and engineering. They also play a crucial role in science, research, and data analysis, helping organisations make sense of large volumes of information. Data scientists, in particular, are in high demand in industries like finance, healthcare, retail, and technology, where many organisations are investing heavily in digital projects that require their expertise.

This significant shift has expanded the range of jobs available to mathematical scientists. Traditional occupations, such as secondary school teacher, university academic, or actuary, while still important, have been overshadowed by the emergence of new employment opportunities that demand advanced quantitative and analytical skills. Notably, new occupation codes for Data Scientist and Data Analyst have recently been added to the Australian and New Zealand Standard Classification of Occupations (ANZSCO) under the Mathematical Science Professionals unit group (ABS, 2022).

As illustrated in Table 3.1, between 2016 and 2021, employment in traditional roles for mathematical scientists grew modestly or even declined, as seen in the 7 percent decrease in Secondary School Teaching. Conversely, there has been substantial growth in occupations such as Software Applications Programmer, Management and Organisation Analyst, ICT Business and System Analyst, and Advertising and Marketing Professional. The occupational category of Other Information and Organisation Professional, which includes various roles related to data science, grew by nearly 1300 percent, making it the top occupation for mathematical scientists in 2021. Furthermore, the proportion of mathematical scientists working in the private sector increased to 74 percent in 2021, up from 71 percent in 2016 (ABS, 2021).

Table 3.1 Top 20 occupations of persons with a mathematical sciences qualification in 2021, change since 2016 and outlook to 2026

	Top 20 occupations of persons with a qualification in the mathematical sciences in 2021	Number of mathematicians/ statisticians in these occupations	% change since 2016	Projected employment growth for these occupations 2018–2023 (%)
1	Other Information and Organisation Professionals*	3004	1284%	26.2%
2	Software and Applications Programmers*	2443	50%	27.0%
3	Secondary School Teachers**	1601	-7%	3.7%
4	University Lecturers and Tutors	1444	7%	16.6%
5	Actuaries, Mathematicians and Statisticians	1297	5%	11.0%
6	Management and Organisation Analysts*	903	30%	32.2%
7	ICT Managers	800	19%	17.7%
8	Professionals, nfd***	650	-28%	6.9%
9	ICT Business and Systems Analysts*	562	32%	12.9%
10	Sales Assistants (General)	406	22%	1.7%
11	Accountants	400	10%	9.2%
12	Database & Systems Admins, and ICT Security Specialists*	360	28%	38.9%
13	Contract, Program and Project Administrators	357	11%	9.3%
14	General Clerks	350	15%	12.9%
15	ICT Support Technicians	326	34%	17.4%
16	Financial Dealers	324	31%	1.7%
17	Advertising and Marketing Professionals	324	33%	11.4%
18	Advertising, Public Relations and Sales Managers	315	38%	4.4%
19	Retail Managers	287	13%	0.3%
20	Private Tutors and Teachers	287	14%	13.6%
	Total	**16440**		
	Average projected growth top 20 occupations of mathematicians and statisticians			13.8%

Notes:

** The occupational classification in use up to and including 2021 did not include the relatively new occupations of "data analyst", "data scientist" and related. These new occupations are likely to have been classified in the various categories "Other Information and Organisation Professionals", "Software and Applications Programmers", "Management and Organisation Analysts", ICT Business and Systems Analysts", "Database and Systems Administrators and ICT Security Specialists" and "Professionals, nfd", some of which have experienced explosive growth in the past five years.*

*** Secondary school teachers with a mathematical sciences qualification are only a small subset of all mathematics teachers in Australia — the vast majority of whom are likely to have indicated they have an Education qualification. Also note that the projected employment growth 2021–2026 covers all secondary school teachers — there will likely be differences between teachers in different subject specialisations.*

**** nfd: Not further defined*

Source: *ABS (2021); National Skills Commission (2021).*

The average projected growth rate for the top 20 jobs for mathematicians by 2026 is 13.8 percent, significantly outpacing the 9.1 percent growth forecast for all Australian jobs. This upward trend is expected to continue well into the foreseeable future. The National Skills Commission anticipates strong employment growth across many of the top 20 jobs for mathematical scientists (NSC 2021). Notably, roles such as Database and Systems Administrators, ICT Security Specialists, Information and Organisation Professionals, and Software and Applications Programmers rank among the top 10 percent of Australian jobs with the highest expected growth.

This increasing demand translates into favourable employment prospects and competitive salary levels for new university graduates with degrees in mathematical sciences, particularly those with a masters degree. According to the 2023 QILT Graduate Outcomes Survey, 73.5 percent of students graduating with a bachelor degree in mathematics secured full-time employment within four months of graduation (Table 3.2). This rate is higher than that of graduates from science and mathematics disciplines combined, though slightly lower than the average across all fields of education.

Graduates who complete postgraduate coursework in mathematics enjoy even better employment prospects. In 2023, nearly 89 percent of masters degree holders in mathematics found full-time employment within four months of graduation, outperforming their peers from science and mathematics disciplines, though slightly below the average for all fields of education. However, employment outcomes for mathematics graduates with research degrees declined by 6.9 percent between 2020 and 2023 and were lower than those for graduates from related disciplines.

Source: Social Research Centre (2022b, 2023b, 2024).

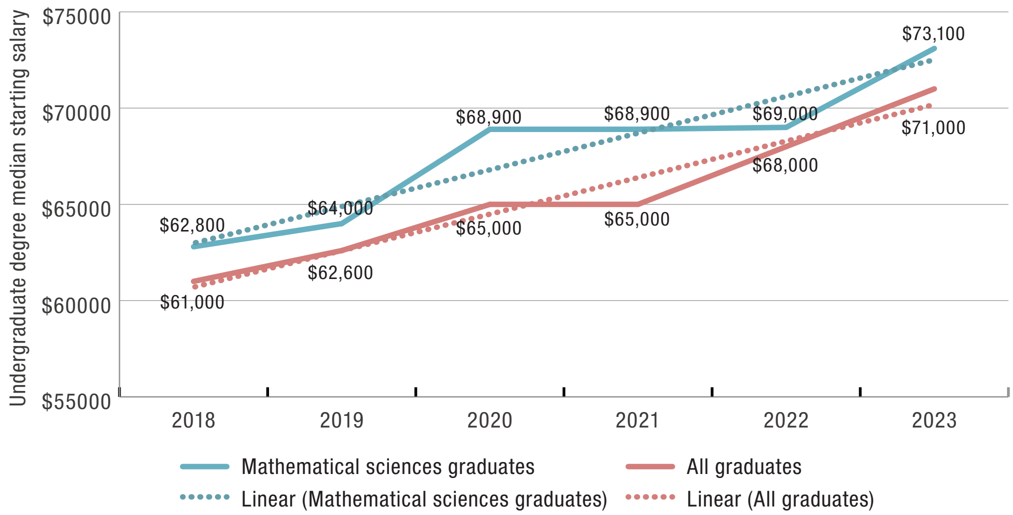
Table 3.2 Graduates in mathematical sciences: employment outcomes in 2023 (change from 2020)

Full time employment 4 months after graduation	Undergraduate	Postgraduate by Coursework	Postgraduate by Research
in full time work: mathematics (%)	73.5 (+0.5)	88.4 (+8.4)	78.1 (**-6.9**)
in full time work: science & mathematics (%)	69.8 (+10.8)	83 (+11)	83.9 (+3.9)
in full time work: computing & information systems (%)	74.4 (+2.4)	88 (+4.0)	86.3 (+5.3)
in full time work: engineering (%)	89.2 (+6.2)	90.9 (+4.9)	85.5 (+4.5)
in full time work: teacher education (%)	89.6 (+8.6)	90.9 (+4.9)	87.4 (**-1.6**)
in full time work: all fields of education (%)	79 (+10.3)	90.3 (+4.7)	85.3 (+5.2)

In line with the growing demand for mathematical scientists, median starting salaries for new graduates in this field have seen significant growth since 2016, particularly for those with postgraduate degrees. Figure 3.1 illustrates the median starting salary for bachelor degree graduates, while Figure 3.2 presents the corresponding data for graduates with a masters degree. The starting salaries for masters graduates have shown the most substantial increase, approaching the earnings typically seen by newly graduated dentists and business and management professionals, who have traditionally been among the highest earners.

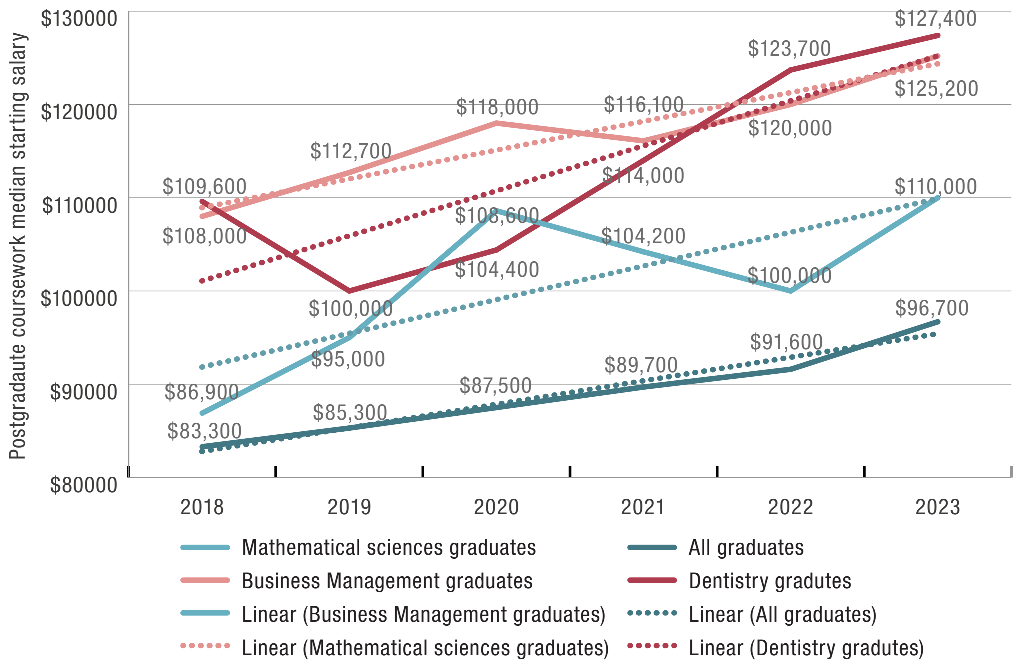
Source: Social Research Centre (2019b, 2020b, 2022b, 2023b, 2024a).

Figure 3.1 Undergraduate degree - median starting salaries (2018–2023)



Source: Social Research Centre (2019b, 2021b, 2023b, 2024a).

Figure 3.2 Postgraduate Coursework - median starting salaries (2018–2023)



Consistent with the most popular job destinations listed in Table 3.1, the vast majority of new mathematics graduates secure professional-level employment. In 2023, 77.9 percent of undergraduates found work at the professional level, while 83.6 percent of coursework graduates and 97.1 percent of research graduates also attained professional roles (Table 3.3).

Table 3.3 Occupation of mathematical science graduates (% of total employed) in 2023 (change from 2020)

Source: Social Research Centre (2023b, 2024a, 2024b).

note: np - not provided.

Occupation level	Undergraduate		Postgraduate by Coursework		Postgraduate by Research	
	Mathematics	All fields of education	Mathematics	All fields of education	Mathematics	All fields of education
Managers	np	5.7 (+0.9)	7.3 (**-0.8**)	14.1 (+1.1)	2.9 (+2.9)	6.4 (**-0.6**)
Professionals	77.9 (+0.9)	53.7 (+1.3)	83.6 (+4.2)	69.7 (**-0.3**)	97.1 (-2.9)	83.1 (**-1.9**)
Technicians & trade workers	np	4.4 (+0.5)	1.8 (**-0.9**)	1.8 (**-0.2**)	0	2.1 (+0.1)
Community & personal services workers	np	13.2 (+0.3)	1.1 (**-0.7**)	4.6 (**-0.4**)	0	1.6 (-0.4)
Clerical & administrative workers	np	12.3 (+0.3)	4 (0)	7.9 (**-0.1**)	0	5.5 (+2.5)
All other occupations	9.3 (**-1.7**)	10.7 (**-3.4**)	2.2 (**-1.8**)	1.9 (1.1)	0	1.3 (+0.3)

3.2 Mathematics, statistics and data science workforce characteristics

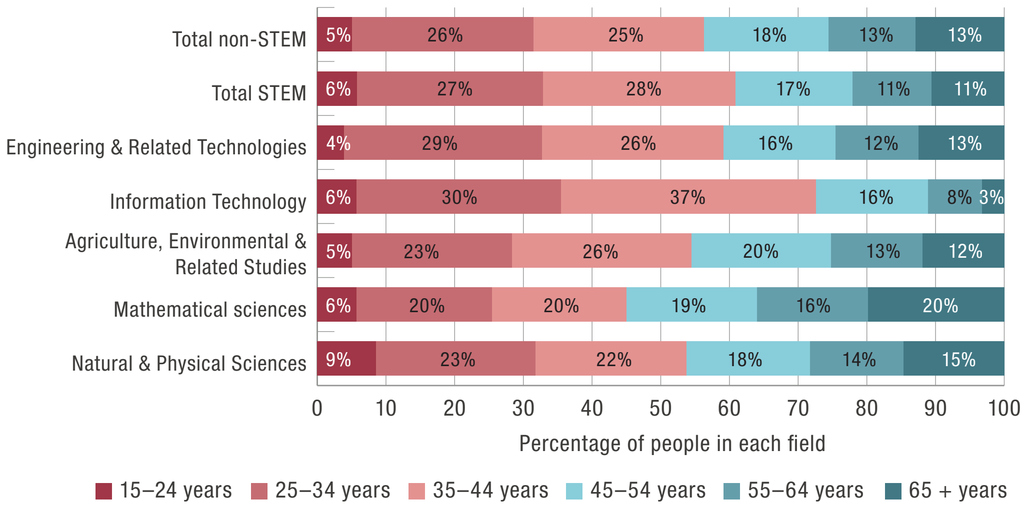
The increased demand for mathematical scientists has brought about significant changes in the size and demographic makeup of the workforce. The 2021 ABS Census revealed that over 44,000 individuals reported having a qualification in mathematical sciences, marking an increase of 11,000 (more than 30 percent) compared to the 2016 Census.

The majority of these qualifications are university degrees, with 95 percent of the workforce holding such credentials. Among them, 57 percent have a bachelors degree as their highest qualification, and 10 percent hold a PhD. Notably, since 2016, the number of individuals with a masters degree in mathematical sciences has grown by 4,000, raising their representation to 22 percent of the workforce, up from 17 percent in 2016.

However, the mathematical sciences workforce has been aging rapidly. As illustrated in Figure 3.3, compared to other STEM and non-STEM disciplines, the mathematical sciences workforce is the oldest, with 55 percent of professionals aged 45 years or older. Furthermore, in 2021, 20 percent of mathematical scientists were 65 years or older, an increase from 16 percent in 2016.

Figure 3.3 Proportion of university qualified people in each age group in different fields (2021)

Source: ABS (2021).

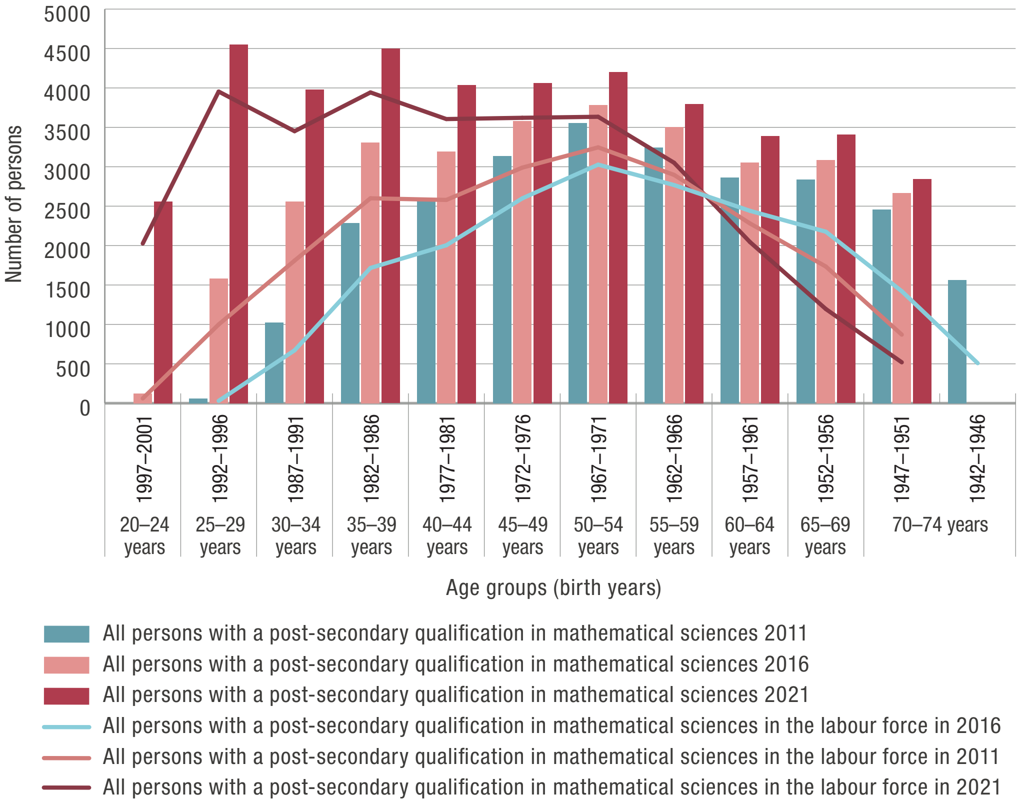


In the past five years, there has been a notable increase in the number of younger individuals entering the mathematical sciences workforce, helping to offset retirements and contribute to the overall growth of the active workforce, as shown in Figure 3.4. While the 2011 and 2016 censuses indicated a relatively low influx of younger professionals, recent years have seen a significant rise. The most substantial growth is among individuals born between 1992 and 1996, who are now in their late twenties.

Despite the retirement or departure of 3,000 mathematical scientists since 2016, the total number of employees with a mathematical sciences degree has still increased by 7,500, reflecting a positive trend in workforce expansion.

Figure 3.4 Mathematical sciences workforce qualifications and labour force rate by birth cohort (AGE5P) (2011–2021)

Source: *ABS (2021).*



A significant proportion of younger professionals in the mathematical sciences workforce are recent immigrants. Many of these individuals arrived in Australia as teenagers or young adults and pursued their studies at Australian universities as international students. Among mathematical scientists in Australia aged 25 to 34 years, 47 percent arrived between 2011 and 2020, while 39 percent were born in Australia (ABS, 2021). The remaining 14 percent arrived before 2011.

Figure 3.5 illustrates the gender distribution among individuals with a mathematical sciences degree. In 2021, 42 percent of adults aged 20–64 with a mathematics degree were female, a slight decrease from 43 percent in 2016. Over time, the gender ratio among those with a mathematical sciences degree has become more balanced. For individuals born between 1982 and 1986, the numbers are nearly equal. However, the gender gap has widened again among younger mathematical scientists. For example, in the 35–39 age group, 48 percent of math graduates were female, whereas this figure drops to 44 percent among those aged 30–34, moving the goal of gender parity further away.

Figure 3.5 Proportion of females with mathematical science degrees and in the labour force by birth cohort (AGE5P) (2011–2021)

Source: ABS (2021).

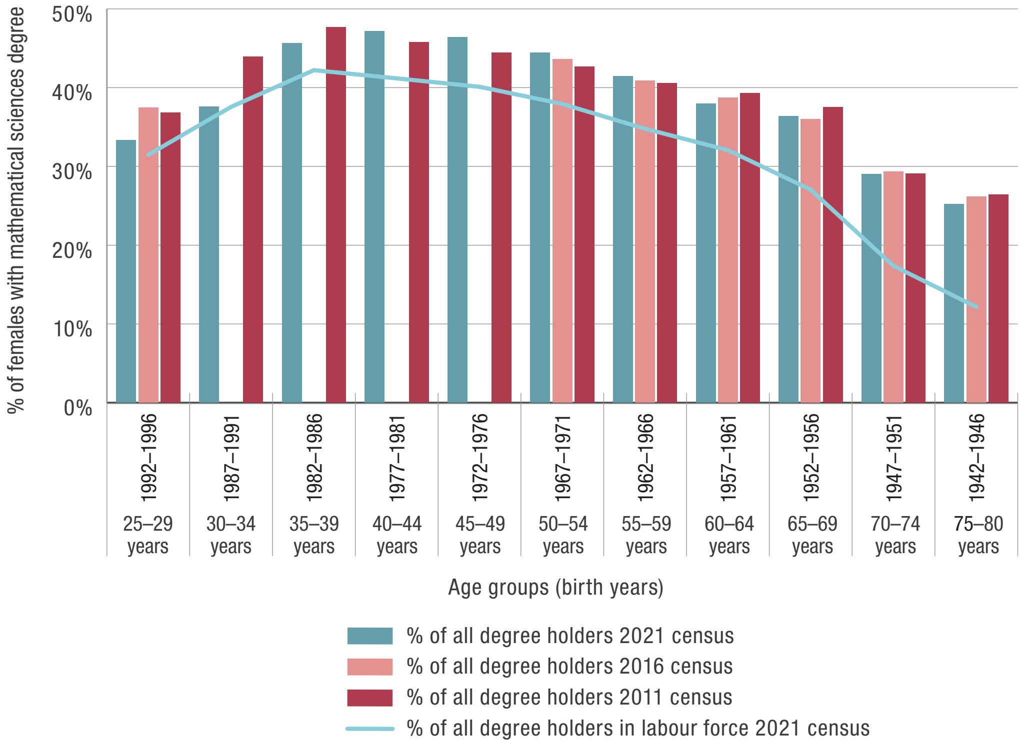
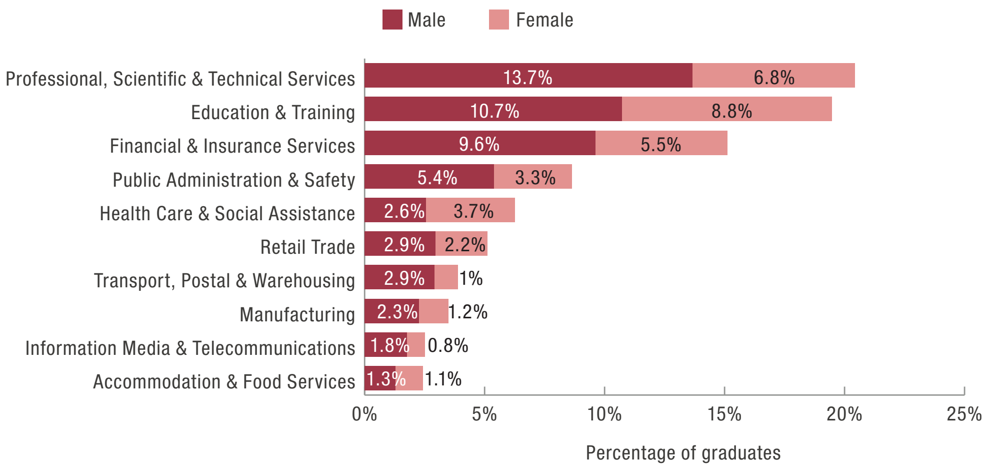


Figure 3.6 displays the top 10 industries employing mathematicians and statisticians. The sectors of professional, scientific, and technical services (21 percent), education and training (20 percent), and financial and insurance services (16 percent) collectively employ more than half of all mathematical scientists. Notably, education and training is no longer the largest employment sector for mathematical scientists, a shift from five years ago.

Gender imbalance remains prevalent across different industries. Most sectors employ more male mathematical scientists, with the exception of healthcare and social assistance, where 59 percent of employees are female. In education and training, the gender balance is relatively even, with 45 percent female mathematical scientists. However, in the financial and insurance services (36 percent female) and professional, scientific, and technical services (33 percent female), female mathematical scientists are still in the minority.

Figure 3.6 Top ten industry divisions of employment for persons with a post-secondary qualification in mathematical sciences, by gender (2021)

Source: ABS (2021).



The gender imbalance is even more pronounced among the top 10 mathematical science occupations. Figure 3.7 provides detailed insights into the gender distribution within these roles. Accountants and secondary school teachers exhibit a balanced gender ratio. However, only 30 percent of university lecturers and tutors in mathematical sciences are female. Among mathematicians working as software and applications programmers, just 22 percent are female. In most other occupations, the proportion of female mathematical scientists ranges between 30 percent and 40 per cent.

Figure 3.7 Top ten unit group level occupations of persons with a post-secondary qualification in mathematical sciences, by gender (2021)

Source: *ABS (2021).*

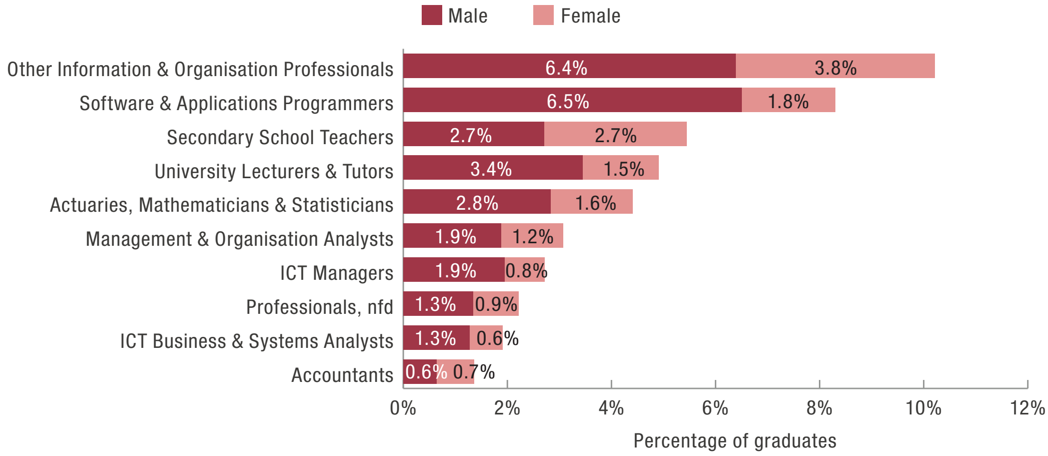
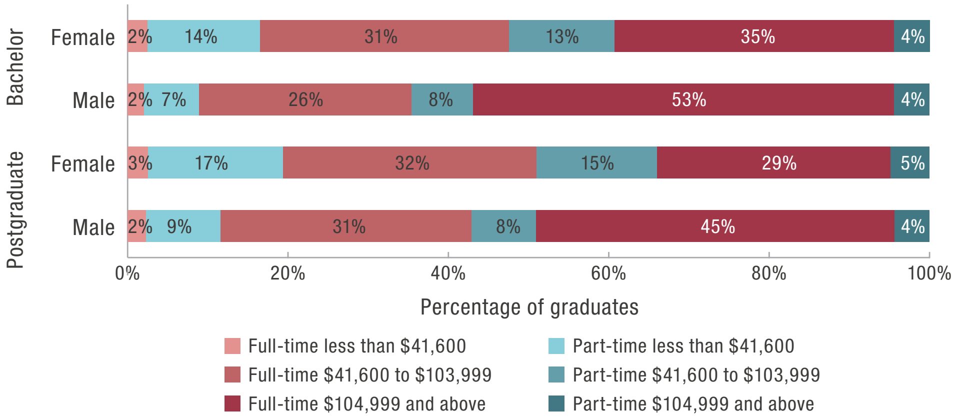


Figure 3.8 illustrates the effect of degree type on income levels among mathematical scientists. Among those holding a doctorate, 62 percent of men and 43 percent of women are in the highest income bracket. Income levels are also influenced by gender and employment status, with a higher proportion of females working part-time compared to males. Most part-time workers fall into the lower- and middle-income brackets.

Figure 3.8 Personal annual income of mathematical sciences graduates working full-time and part-time, by gender and level of qualification (2021)

Source: *ABS (2021).*



Numeracy skill levels in the Australian adult population

As we've seen, many of the fastest-growing careers demand a strong foundation in mathematics and statistics. However, having a certain level of numeracy benefits individuals in much broader ways, even if it is not directly related to their job. Modern life requires more sophisticated literacy and numeracy skills than ever before, and lacking the basic skills needed to navigate current society poses a real risk of being left behind.

Decent numeracy skills are essential for performing mathematical tasks and making informed decisions in various aspects of life. They enable individuals to manage their finances effectively, solve everyday problems such as measuring, calculating distances, and determining probabilities, and contribute to job efficiency and safety. Numeracy skills also aid in understanding and interpreting numerical information and statistics, fostering critical thinking and problem-solving skills that are transferable to other areas of life.

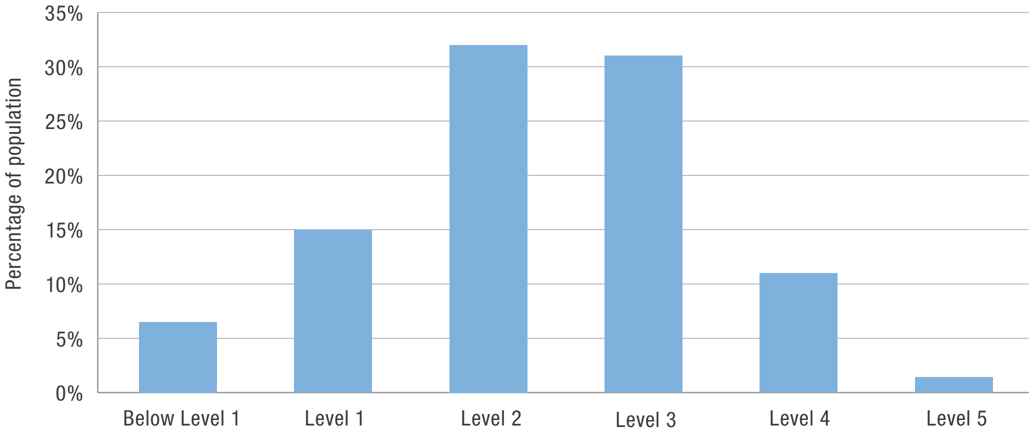
Evidence indicates that strong numeracy skills are linked to better outcomes in employment, wages, and health. Research by Jonas (2018) indicated that individuals with high numeracy skills are more likely to be employed compared to those with lower skills. They also tend to earn higher incomes and report better health, with adults possessing advanced numeracy skills more likely to report good to excellent health.

Adult numeracy is assessed through the Programme for the International Assessment of Adult Competencies (PIAAC), a study conducted by the Organisation for Economic Co-operation and Development (OECD) to evaluate the skills and knowledge of adults in participating countries (OECD, 2022). This study measures literacy, numeracy, and problem-solving skills through standardised testing. Australia participated in PIAAC's first cycle, and data on adult numeracy in Australia dates back to 2011–12. Data collection for the second cycle is currently underway, with results expected to be published in December 2024.

The Australian PIAAC results from 2011–12 (see Figure 3.9) revealed that while the majority of adults (53.5 percent) have basic numeracy skills (up to and including level 2), a significant portion of the population still exhibits low proficiency levels (level 1 or below). Level 2 is considered the minimum necessary to meet basic modern work and life demands. The results also highlighted disparities in skill attainment, with disadvantaged groups, such as those from lower socio-economic backgrounds, showing lower levels of proficiency (House of Reps., 2022).

Figure 3.9. Proportion of Australian adult population at each numeracy level (2011–2012)

Source: ABS (2013).

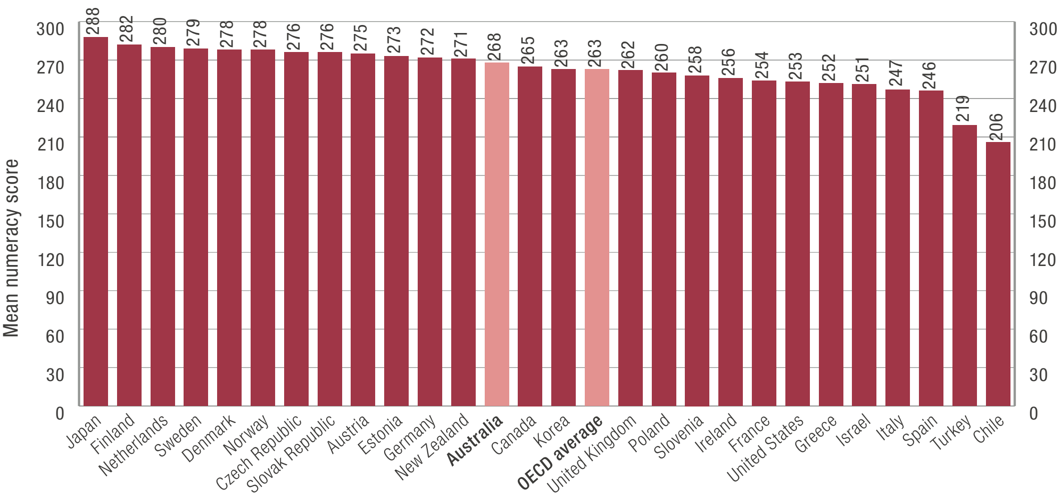


In the 2011–12 PIAAC survey, Australia's numeracy levels were average compared to other participating countries, ranking in the middle of the pack with scores similar to the OECD average. Countries such as Japan, the Netherlands, and Finland demonstrated higher levels of numeracy proficiency, while Italy and Spain had lower levels (see Figure 3.10).

The survey also highlighted a significant gap between those with low and advanced numeracy skills. The OECD noted, "Although Australia's average results are not poor, the challenges presented by adults with low basic skills may lead to Australia being left behind by countries that have been more successfully investing in the skills of all their people (emphasis added by AMSI)" (OECD 2017, p. 9).

Figure 3.10 Mean numeracy score in the Survey of Adult Skills (PIAAC)

Source: OECD (2017).



The 2021 Parliamentary Inquiry into adult literacy and numeracy made several key recommendations, including the joint development of a national strategy for language, literacy, numeracy, and digital literacy (LLND) by the Australian, state, and territory governments (House of Reps., 2022).
As part of the 2023–24 Budget, the Australian Government is investing $436.4 million over four years to enhance adult education in these areas through a revamped Skills for Education and Employment (SEE) Program (Dep. of Employment and Workplace Relations, 2024).

Funding Sources

Higher Education Research and Development (HERD) funding for mathematical sciences has declined, representing just **1.26%** of total funding in 2022—the lowest since 2008. Despite increasing industry demand, the business sector contributes less than 1% of its total funding to the mathematical sciences.

See page 57–58

ARC Funded Projects

The number of Australian Research Council (ARC) funded projects in the mathematical sciences has decreased to less than half of what it was in 2012, with the most significant declines in funding for pure and applied mathematics research.

See page 61

Research Ratings

Most Australian universities are rated above or well above world standards for research in mathematical sciences. All assessed institutions maintained or improved their ratings over the past decade.

See pages 65–66

Top Institutions

The University of New South Wales, Australian National University, The University of Melbourne, and Monash University rank as the top universities for mathematics and statistics in 2024. Monash University has been ranked the top university for statistics for three consecutive years.

See page 67

4 RESEARCH

Mathematical research is crucial to many industries, including finance, transport, computing, mining, insurance, and telecommunications. Despite its importance, financial investment in this area is modest, with businesses contributing only a small fraction of their Research and Development (R&D) expenditure to mathematical or statistical research. Over the past decade, the primary sources of funding for mathematical sciences research have been Higher Education funding and Commonwealth support through the Australian Research Council (ARC). However, recent years have seen a sharp decline in R&D funding.

The mathematical sciences have been relatively successful in securing ARC funding, particularly through Discovery Projects. Although the mathematical sciences represent a small discipline in Australia—producing just 2 to 3 percent of the country's total scientific publications—they have consistently achieved high standards. In the 2018 Excellence in Research Australia (ERA) evaluation, all universities received a ranking of at or above world standard in mathematical sciences.

The role of mathematical sciences is expanding across various research areas, including medicine, biology, social sciences, business, climate, finance, and advanced materials. The growing reliance on complex computing simulations and large-scale data analysis underscores the need for advanced mathematical science research. Given the increasingly interdisciplinary nature of mathematical sciences, sustained investment across the entire spectrum of this field is essential. This investment will allow mathematical sciences to continue strengthening their foundational role in 21st-century research and technology while preserving the core strengths necessary for the future of the discipline.

4.1 The importance of mathematical sciences research for the Australian economy

While mathematical science research significantly contributes to the Australian economy, there is limited recent economic analysis on its impact. The last substantial assessment was a 2015 report by the Australian Academy of Science (AAS), which attempted to quantify the influence of advanced physical and mathematical sciences. More recently, a 2023 report commissioned by the Australian Research Council (ACIL Allen) emphasised the impact of research in general but did not specifically address the economic effects of any particular scientific discipline.

Despite the lack of recent economic analysis specific to mathematical research in Australia, there is ample evidence of technological advances deeply rooted in mathematical sciences. Many industrial innovations originate from scientific research and development, with mathematical sciences often playing a foundational role. Although the practical application of new mathematical research may take decades, insights from basic research can eventually lead to significant progress in other fields and drive technological breakthroughs.

This reliance on mathematical and statistical research is evident across various sectors, including finance, transport, and computing. Industries like mining, insurance, and telecommunications, which draw on multiple advanced physical and mathematical sciences, also depend on these research advances. Furthermore, mathematical sciences are crucial in the development of artificial intelligence systems, underpinning machine learning and providing essential tools for data analysis.

With the explosion of data collection across all areas of life, the demand for data handling, analysis, and application has surged in the past decade. This has fuelled the growth of the data science field, which encompasses efforts to extract meaningful insights from data. Data science activities include managing data infrastructure, developing and applying models and algorithms, and visualising and communicating quantitative information. The expertise driving these activities is drawn from core academic disciplines such as mathematics, statistics, information science, computer science, and artificial intelligence, as well as various applied fields.

4.2 Research funding

Despite its wide-ranging impact, monetary investment in mathematical sciences research in Australia remains modest. There are three main sources of funding:

Higher Education Expenditure on Research and Development (HERD) covers the costs of human resources and expenditures by Australian higher education institutions, primarily universities, for research and experimental development.

Government Expenditure on Research and Development (GOVERD) includes human resources and expenditures by Commonwealth, state, and territory governments, as well as research funding provided through the Australian Research Council (ARC).

Business Expenditure on Research and Development (BERD) represents the human resources and expenditures by businesses in Australia.

In addition to these primary sources, funding for mathematical sciences research is supplemented by initiatives that provide national support and infrastructure for workshops, conferences, and international collaboration. These initiatives are typically supported by a combination of university and philanthropic funds (AMSI 2022; MATRIX 2022; SMRI 2022).

Compared to other STEM fields and Medical and Health Sciences (STEMM), the mathematical sciences receive a relatively small share of research and development expenditure from these three main funding sources (Table 4.1). In recent funding rounds, government funding (GOVERD) contributed the largest amount and proportion to the mathematical sciences—nearly $188 million. This was followed by Higher Education expenditure on Research and Development (HERD), which provided $176 million. The business sector invested approximately $32 million in the mathematical sciences.

Table 4.1 Australian research and development expenditure by sector

	HERD (2022)		BERD (2021–22 financial year)		GOVERD (2022–23 financial year)	
Field	$ '000	%	$ '000	%	$ '000	%
Total	13,990,418		20,641,516		4,344,376	
STEMM	10,629,819	75.98%	19,408,049	94.02%	4,081,288	93.94%
Breakdown of STEMM	$ '000	%	$ '000	%	$ '000	%
Agricultural & Veterinary Sciences	647,952	4.63%	1,533,930	7.43%	635,516	14.63%
Biological Sciences	1,087,808	7.78%	344,734	1.67%	432,713	9.96%
Chemical Sciences	351,958	2.52%	393,013	1.90%	181,440	4.18%
Earth Sciences	349,667	2.50%	150,669	0.73%	283,082	6.52%
Engineering	1,650,471	11.80%	5,399,774	26.16%	484,506	11.15%
Environmental Sciences	530,621	3.79%	288,475	1.40%	409,514	9.43%
Information & Computing Sciences	630,626	4.51%	7,927,016	38.40%	442,332	10.18%
Mathematical Sciences	**176,608**	**1.26%**	**32,008**	**0.16%**	**187,632**	**4.32%**
Biomedical & Clinical Sciences	3,223,010	23.04%	2,949,225	14.29%	551,183	12.69%
Health Sciences	1,539,778	11.01%	250,724	1.21%	191,421	4.41%
Technology	441,320	3.15%	138,481	0.67%	281,949	6.49%

Source: *ABS (2023), (2024a), (2024b).*

An analysis of Research and Development (R&D) expenditure over time by the business, government, and higher education sectors (see Figure 4.1) shows that business allocates well below 1 percent of its funding to the mathematical sciences, with only a temporary increase in investment during 2017/18. Government funding for the mathematical sciences, on the other hand, has steadily increased since 2014/15, receiving additional boosts during the 2020/21 and 2022/23 periods.

In contrast, HERD funding for the mathematical sciences has declined in recent years. Between 2018 and 2022, this funding dropped by nearly $50 million, reaching just 1.26 percent of total funding—the lowest percentage since 2008. Furthermore, over the last decade, the proportion of HERD expenditure directed toward applied research has increased, while funding for pure basic and strategic research has decreased across all scientific disciplines (de Gier et al., 2024).

Figure 4.1 Research and development expenditure in the mathematical sciences

Source: *Australian Bureau of Statistics (2009–2023), (2010–2024a), (2010–2024b).*

AUSTRALIAN RESEARCH COUNCIL FUNDING

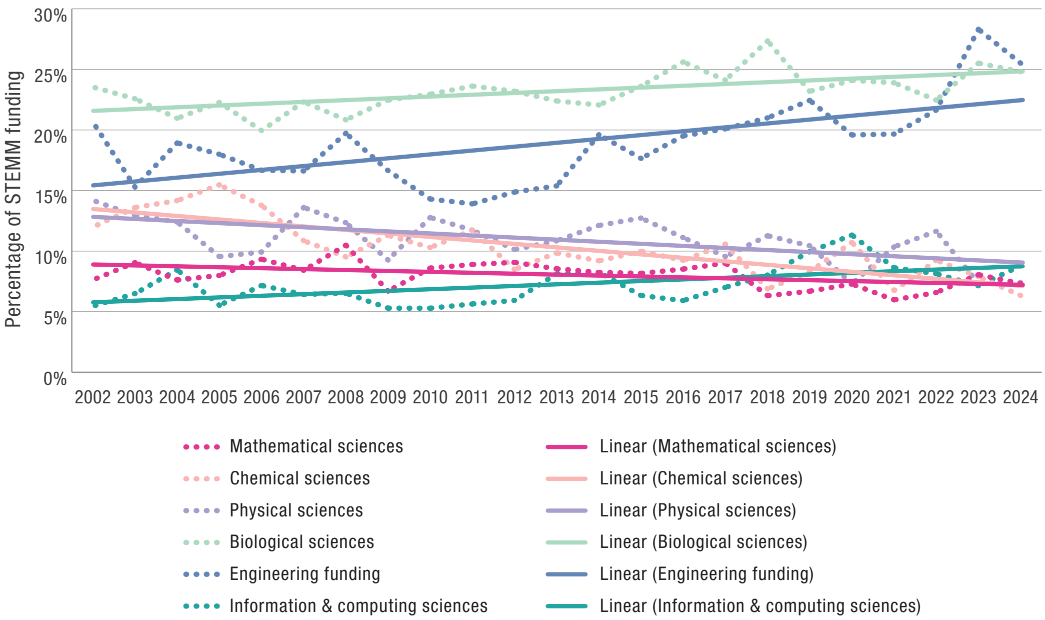
Funding through the Australian Research Council (ARC) is a key component of the Commonwealth Government's research spending. The ARC administers competitive grant funding schemes and programs that are crucial for sustaining a healthy mathematical sciences research workforce. These grants provide essential opportunities for early career postdoctoral researchers, enabling them to gain experience either as part of senior researchers' projects or by securing their own grants. The figures in this section reflect announced grant funding as of August 2024, with total funding for the year expected to increase.

Of particular importance to mathematical sciences research is the ARC Discovery Program (see also Figure 4.6), which funds individual researchers and research teams, with a focus on fundamental or basic research. This program includes Discovery Projects, Fellowships, and Awards for early career researchers. However, the available funding for the Discovery Program has not increased over the past decade. In fact, it has decreased from $542 million in 2012 (not adjusted for inflation) to $466 million in 2023.

Figure 4.2 illustrates the long-term trend in Discovery Program funding for the mathematical sciences and related disciplines. Amid the overall decline in funding, there has also been a decrease in the proportion of STEMM (Science, Technology, Engineering, Mathematics, and Medical) funding allocated to the mathematical sciences. Similar declines have occurred in the chemical and physical sciences, while disciplines like engineering, biological sciences, and information and computing sciences have seen gradual increases in their share of STEMM funding.

A closer look reveals that the decline in funding for the mathematical sciences began in recent years. From 2018 onwards, the percentage of STEMM funding allocated to the mathematical sciences has been markedly lower than in almost every year since 2002. Between 2002 and 2018, the mathematical sciences received an average of 8.4 percent of STEMM funding annually. Since 2019, this average has dropped to 7.2 percent.

Figure 4.2 Discovery Program funding allocation — Percentage of STEMM funding allocated to the mathematical sciences and cognate disciplines (2002–2024)



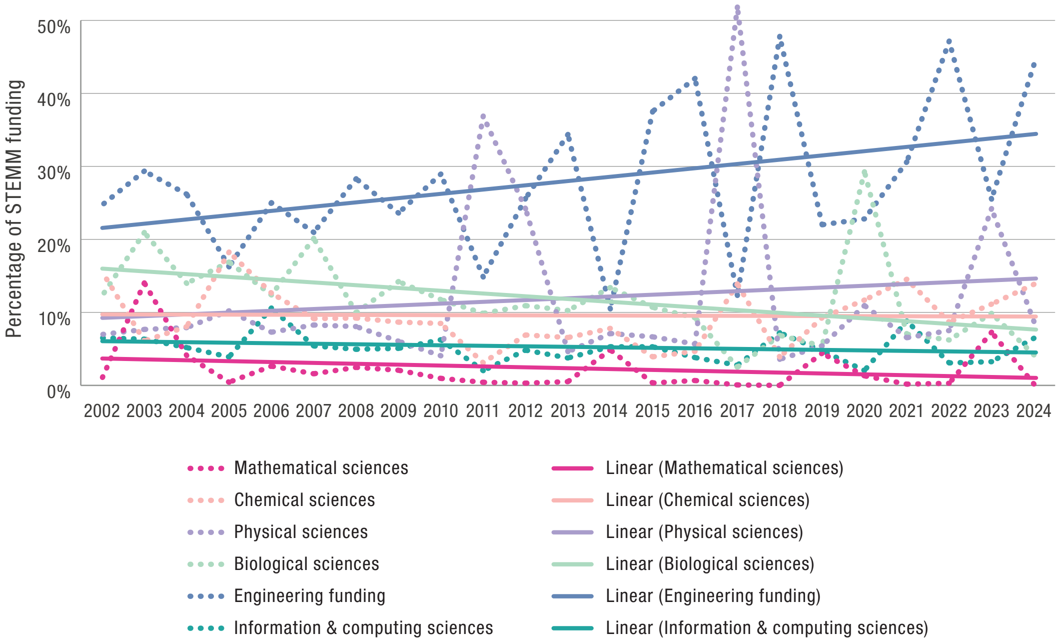
Note: *In 2020 the ANZSRC Field of Research Classification was revised. Under the 2008 FoR classification, STEMM disciplines were classified under the 2-digit levels 01-11; under the 2020 FoR classification, STEMM codes are classified at the 2-digit level under 30, 31,32,34,37,40,41,42,46,49, and 51.*

Source: *Australian Research Council (2024a).*

The ARC Linkage Program fosters cooperative research between universities and partnerships with businesses, industries, and other organisations. Within this program, the mathematical sciences typically receive a small number of Linkage Projects each year and a modest share of other multi-year research infrastructure grants, such as Industrial Transformation Training Centres and Linkage Infrastructure, Equipment, and Facilities grants (see also Figure 4.7).

The spikes in funding proportions in 2014 and 2023 are due to the awarding of multi-year ARC Centres of Excellence, of which there have been three since 2002. The most recent Centre, starting in 2023, has a primary focus on mathematical sciences (Figure 4.3).

Figure 4.3 Linkage Program funding allocation — Percentage of STEMM funding allocated to the mathematical sciences and cognate disciplines (2002–2024)



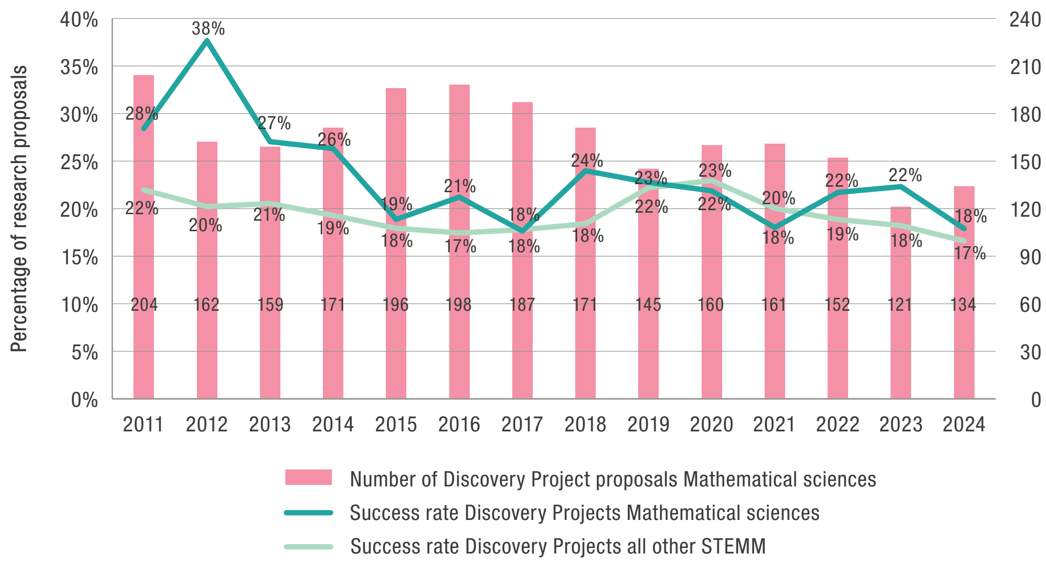
Note: *In 2020 the ANZSRC Field of Research Classification was revised. Under the 2008 FoR classification, STEMM disciplines were classified under the 2-digit levels 01-11; under the 2020 FoR classification, STEMM codes are classified at the 2-digit level under 30, 31,32,34,37,40,41,42,46,49, and 51.*

Source: *Australian Research Council (2024a).*

Since 2002, the percentage of Discovery and Linkage program funding allocated to mathematical sciences research within STEMM has declined. This decline has occurred despite the periodic boost from the awarding of an ARC Centre of Excellence in the Linkage Program, which happens roughly once every decade. Mathematical sciences research has lost ground in most other schemes within the Linkage Program, as well as in the Discovery Program.

Regarding competitive grant proposal success rates, ARC data shows that from 2011 to 2014, Discovery Project proposals in the mathematical sciences had significantly higher success rates than those in other disciplines. However, after 2014, these rates began to converge with those in other STEMM areas (Figure 4.4). Although the success rate for mathematical sciences dropped below other STEMM areas in 2020 and 2021, it rebounded after 2022. Despite this recovery, the number of funding proposals has been gradually declining, with 2023 and 2024 seeing the lowest number of proposals in at least 13 years.

Figure 4.4 ARC success rate of Discovery Project proposals in the mathematical Sciences (2011–2024)



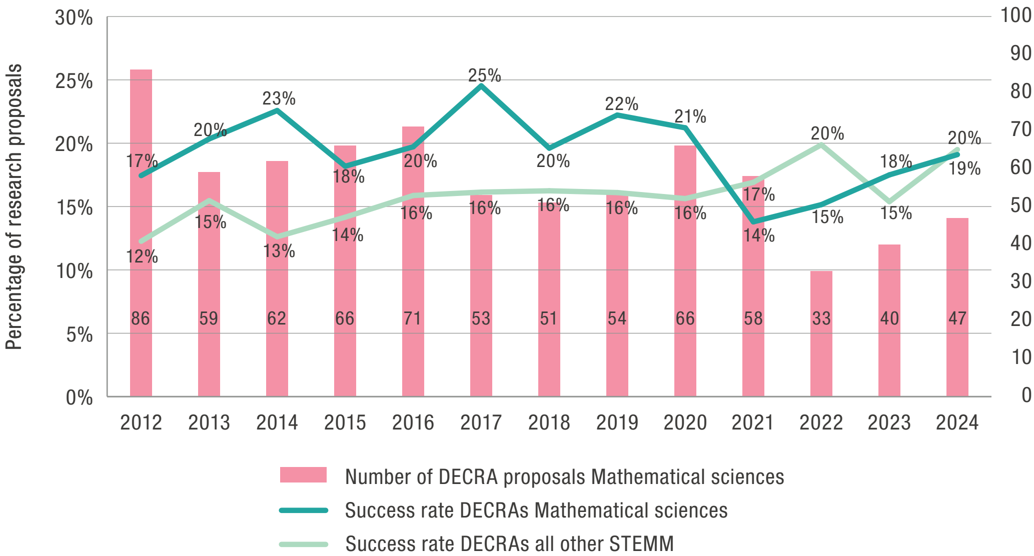
Note: *In 2020 the ANZSRC Field of Research Classification was revised. Under the 2008 FoR classification, STEMM disciplines were classified under the 2-digit levels 01-11; under the 2020 FoR classification, STEMM codes are classified at the 2-digit level under 30, 31,32,34,37,40,41,42,46,49, and 51.*

Source: *Australian Research Council (2024a), (2024b).*

Support for early career researchers through ARC grants has notably declined. Success rates, which were previously healthy, fell sharply in 2021 and 2022. In 2021, only eight projects were funded out of 58 proposals, and in 2022, just five projects were funded out of 33 proposals (see Figure 4.5).

However, there is a positive trend as the success rate and number of project proposals have started to increase again in 2023–24.

Figure 4.5 ARC success rates of Discovery Early Career Researcher Award (DECRA) proposals in the mathematical sciences (2012–2024)

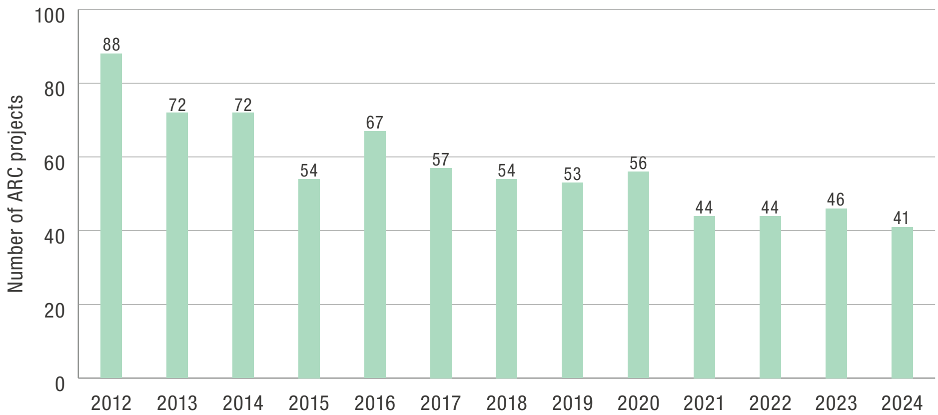


Note: *In 2020 the ANZSRC Field of Research Classification was revised. Under the 2008 FoR classification, STEMM disciplines were classified under the 2-digit levels 01-11; under the 2020 FoR classification, STEMM codes are classified at the 2-digit level under 30, 31,32,34,37,40,41,42,46,49, and 51.*

Source: *Australian Research Council (2024a), (2024b).*

Figure 4.6 shows a gradual decline in the total number of ARC projects attributed to the mathematical sciences since 2012. By 2024, the number of funded projects was less than half of what it was in 2012.

Figure 4.6 Number of ARC projects in the mathematical sciences by year funding commenced (2012–2024)



Source: *Australian Research Council (2024a).*

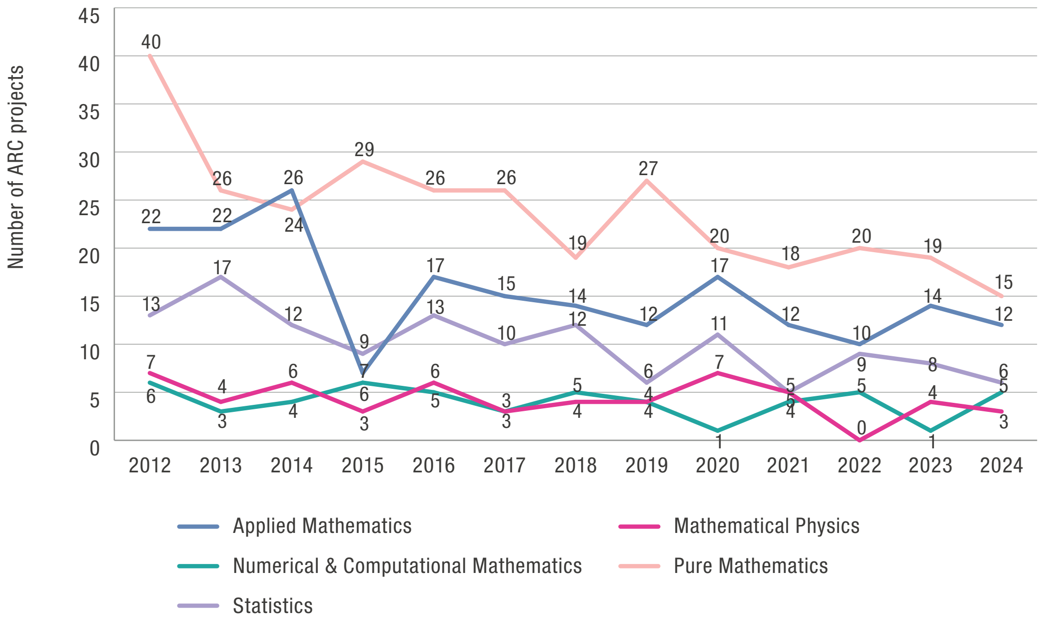
Figure 4.7 illustrates the relative contribution of ARC funding to the main five subdisciplines of mathematical sciences—pure mathematics, applied mathematics, statistics, mathematical physics, and numerical and computational mathematics—since 2012. The data reveals that pure and applied mathematics, followed by statistics, are the most common fields for ARC-funded projects. Since 2012, funding for pure and applied mathematics has declined the most, while funding for mathematical physics, and numerical and computational mathematics has remained relatively steady.

The mathematical sciences are increasingly interdisciplinary. Applied mathematics and statistics projects, in particular, exhibit significant interaction with other research fields. It is important to note that many projects with a minor mathematical component are primarily categorised under other disciplines. Areas with the most interdisciplinary interactions include biological mathematics, applied statistics, stochastic analysis and modelling, and calculus of variations, systems theory, and control theory.

Note: *This graph displays these projects by the four-digit FoR 2008 Groups within Division 01: 0101, 0102, 0103, 0104 and 0105, and FoR 2020 Division 49I 4901, 4902, 4903, 4904 and 4905.*

Source: *Australian Research Council (2022), (2024a).*

Figure 4.7 ARC funded research projects in the mathematical sciences by subdiscipline and year funding commenced (2012–2024)

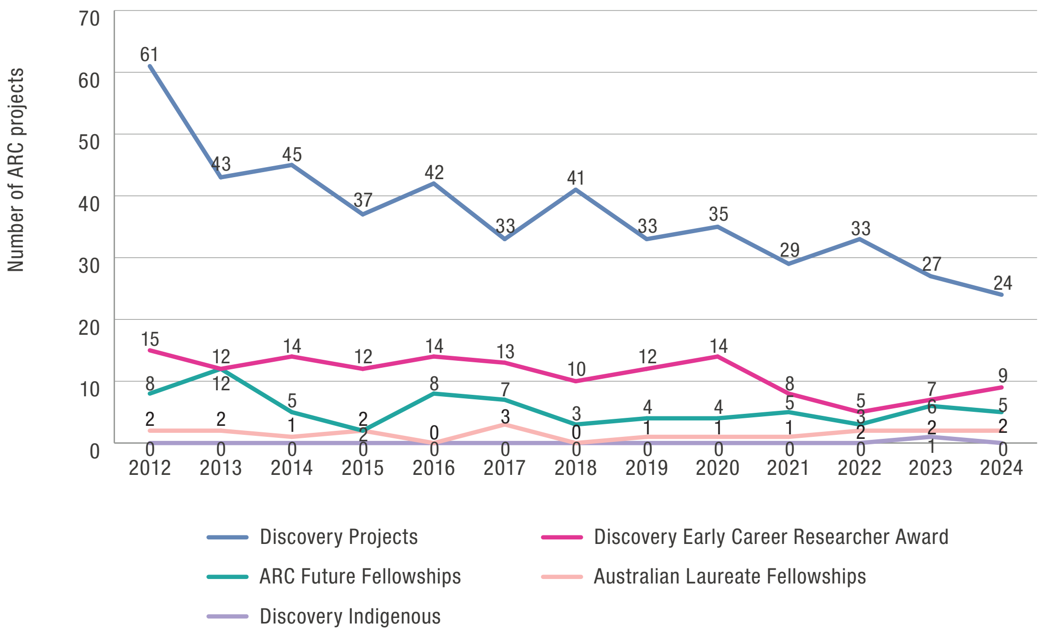


Figures 4.8 and 4.9 show the distribution of ARC projects by type. In the mathematical sciences, the majority of Discovery Program projects are Discovery Projects (67 percent), followed by Discovery Early Career Researcher Award (DECRA) projects (20 percent).

Since 2012, Discovery Projects have experienced the greatest decline in funding, while other Discovery Program projects have remained low but stable. Notably, there was only one Discovery Indigenous project in the mathematical sciences, funded in 2023.

Source: *Australian Research Council (2024a), (2024c).*

Figure 4.8 ARC research projects in the Discovery Program in mathematical sciences by project type and year funding commenced (2012–2024)



Funding for mathematical sciences research under the Linkage program has historically been much lower compared to the Discovery program. Since 2012, only 26 Linkage projects have been funded, compared to 720 Discovery projects. The Linkage program has primarily awarded funding to Linkage Projects, with additional grants including two ARC Centres of Excellence (in 2014 and 2023), two Industrial Transformation Training Centres (in 2019 and 2020), and one Linkage Infrastructure, Equipment, and Facilities project (in 2022).

The Linkage program is not well-suited to support mathematical sciences research - although applications under this scheme have a higher success rate than those under the Discovery program, the number of applications is much lower. This results in a very limited number of projects and only occasional grants awarded (de Gier et al., 2024).

Figure 4.9 ARC research projects in the Linkage Program in the mathematical sciences by project type (2012–2024)

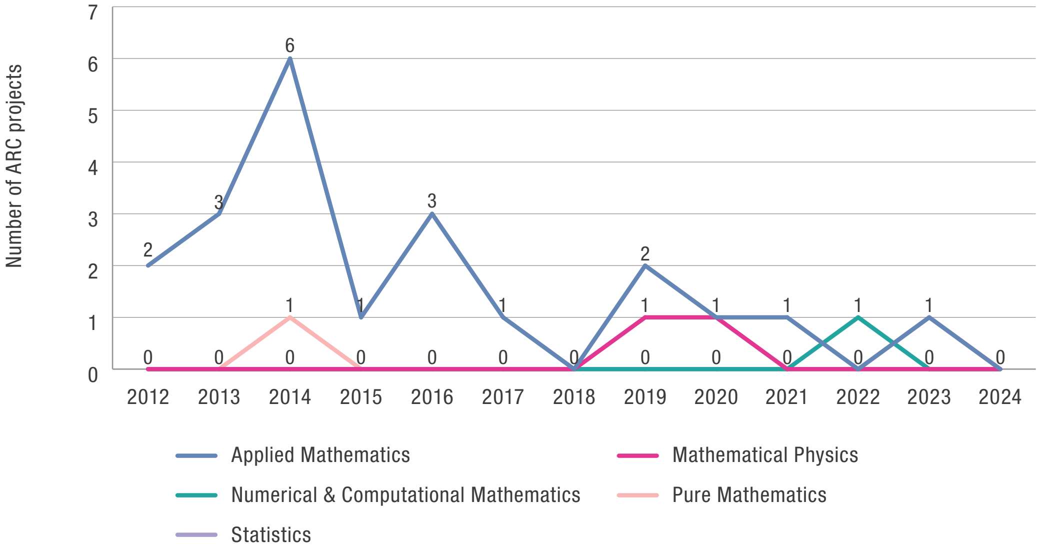


Table 4.2 shows the distribution of ARC Discovery and Linkage Projects among universities. The awarding of these projects is highly concentrated among the Group of Eight (Go8) universities, with regional universities being the most underrepresented. Since 2012, Go8 universities have received 77 percent of mathematical sciences projects under the Discovery Program and 54 percent under the Linkage Program. Unaligned universities have received nearly 15 percent of Discovery projects and 25 percent of Linkage projects in mathematical sciences. In contrast, regional universities have been awarded less than 2 percent of Discovery Projects and no Linkage Projects.

Table 4.2 Number of ARC Discovery and Linkage Projects awarded to university groupings (2012–2024)

Discovery Projects														
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
Group of Eight Universities	67	57	45	37	49	45	43	37	42	37	32	33	32	556
Not Aligned Universities	10	7	13	12	8	8	9	9	8	2	8	6	5	105
Australian Technology Network of Universities	6	1	5	2	4	1	1	1	3	2	1	3	2	32
Innovative Research Universities	2	2	1	1	2			1	1	2	1	1		14
Regional Universities Network	1	2	1	1	1	2	1	2			1		1	13
Non-university Organisations														0
Total	**86**	**69**	**65**	**53**	**64**	**56**	**54**	**50**	**54**	**43**	**43**	**43**	**40**	**720**
Linkage projects														
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
Group of Eight Universities	2	2	4		1	1		1	1		1	2		15
Not Aligned Universities			3		1			2	1					7
Australian Technology Network of Universities				1	1					1				3
Innovative Research Universities		1										1	1	3
Regional Universities Network														0
Total	**2**	**3**	**7**	**1**	**3**	**1**	**0**	**3**	**2**	**1**	**1**	**3**	**1**	**28**

Note: *The table includes projects with a primary FoR 2008 code in Division 01 Mathematical Sciences and FoR 2020 49-Mathematical Sciences.*

Source: *Australian Research Council (2024a).*

4.3 Research output and quality

Australian mathematical sciences represent a small area of research on the global stage. Table 4.3 shows that from 2002 to 2019, mathematical sciences produced approximately 38,199 publications, accounting for 2.5 percent of the world total. This proportion is similar to that of chemical and physical sciences.

According to publication outputs reported to the ARC for the Excellence in Research evaluation, the number of publications in the mathematical sciences has steadily increased from 1,250 in 2003 to over 2,000 in 2016 (see Figure 4.10).

Despite the rising number of publications, mathematical sciences research accounts for only 2 to 3 percent of all research publications produced in Australia (see Figure 4.12)

Table 4.3 Scopus (Elsevier) publications in ICT, Mathematics and Statistics by year (2011–2019)

Source: *UNESCO (2021).*

	Australia		World total
Year	Total	% World	
2011	3962	2.4%	165060
2012	4250	2.5%	172387
2013	4502	2.6%	174822
2014	4612	2.6%	175879
2015	4636	2.6%	177790
2016	4683	2.6%	187821
2017	4825	2.6%	197625
2018	5069	2.6%	207406
2019	5622	2.7%	221763
Total	**38199**	**2.5%**	**1515493**

Figure 4.10 Number of mathematical sciences publications submitted to ERA (2003–2016)

Source*: Australian Research Council(2010), (2012), (2016), (2019).*

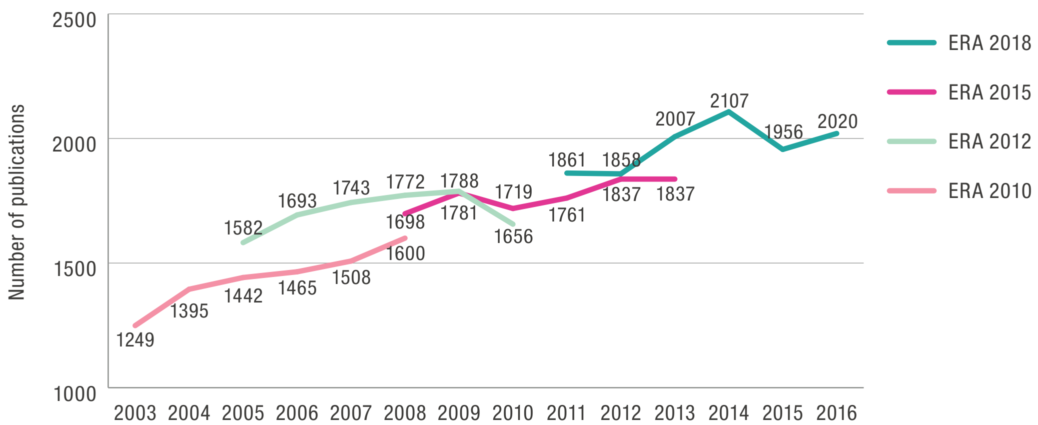
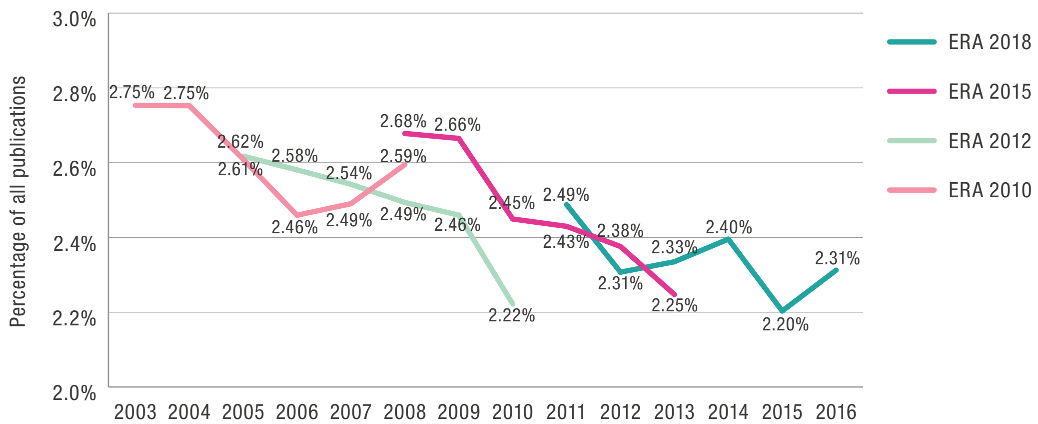


Figure 4.11 Mathematical sciences publications submitted to ERA as a proportion of all publications (2003–2016)

Source: *Australian Research Council (2010), (2012), (2016), (2019).*



The Excellence in Research for Australia (ERA) framework evaluates the strength and quality of Australian research. Evaluations were conducted in 2010, 2012, 2015, and 2018, with the process now on hold while a new framework is being developed. Despite this, ERA provides valuable data on the quality of research in Australia's higher education sector.

The ERA assesses research performance within disciplines (Units of Evaluation, or UoEs) that have a significant volume of research output (more than 50 publications). Research output is evaluated either through peer review (for pure mathematics) or citation scores (for other mathematical sciences subdisciplines). Each UoE receives a rating from one (low) to five (high), with a rating of three indicating "at world standard."

Compared to earlier evaluations (see Table 4.4), the 2018 ERA results show a steady increase in the ratings for mathematical sciences research since 2010. In 2018, mathematical sciences disciplines (at the two-digit level 01-mathematical sciences) were assessed at 27 out of 42 universities. The majority of these universities received ratings of five (well above world standard) or four (above world standard), indicating performance at or above world standard. Additionally, all assessed universities either maintained or improved their ratings compared to 2015.

ANALYSIS OF SUBDISCIPLINES AT THE FOUR-DIGIT LEVEL

Table 4.4 Summary of ERA ratings by discipline and subdiscipline in the mathematical sciences (2010–2018)

	ERA 2010						ERA 2012						ERA 2015						ERA 2018					
Number of ratings	01 Mathematical Sciences	0101 Pure Mathematics	0102 Applied Mathematics	0103 Numerical & Computational Mathematics	0104 Statistics	0105 Mathematical Physics	01 Mathematical Sciences	0101 Pure Mathematics	0102 Applied Mathematics	0103 Numerical & Computational Mathematics	0104 Statistics	0105 Mathematical Physics	01 Mathematical Sciences	0101 Pure Mathematics	0102 Applied Mathematics	0103 Numerical & Computational Mathematics	0104 Statistics	0105 Mathematical Physics	01 Mathematical Sciences	0101 Pure Mathematics	0102 Applied Mathematics	0103 Numerical & Computational Mathematics	0104 Statistics	0105 Mathematical Physics
Not rated																1								
1-Well below world standard		1						1																
2-Below world standard	6	3			4		5	2	2		1												1	
3-At world standard	10	8	8	3	6		11	6	7	3	2	3	8	2	3			6	2	1	4		3	1
4-Above world standard	6	4	8		1	3	8	6	11	1	6	3	11	7	15	2	1		13	4	8	1	5	3
5-Well above world standard	2	2	1	2	1	3	3	2	2	1	1		7	6	5	1	11		12	10	13	3	8	
Total UoEs evaluated	**24**	**18**	**17**	**5**	**12**	**6**	**27**	**17**	**22**	**5**	**10**	**6**	**26**	**15**	**23**	**4**	**12**	**6**	**27**	**15**	**25**	**4**	**17**	**4**

Note: *the classification 0199 - Other Mathematical Sciences has been left out as no Units of Evaluation were assessed in this subdiscipline.*

Source: *Australian Research Council (2010), (2012), (2016), (2019).*

Analysis of the four-digit subdisciplines illustrated in Table 4.4 reveals the following trends:

The number of universities evaluated for pure mathematics research has steadily decreased since 2010, from 18 universities to 17 in 2012, and 15 in both 2015 and 2018. In contrast, the number of evaluations for applied mathematics increased significantly, from 17 in 2010 to 25 in 2018. While mathematical physics and numerical and computational mathematics saw a decline in assessed units, statistics increased to 17 evaluations in 2018.

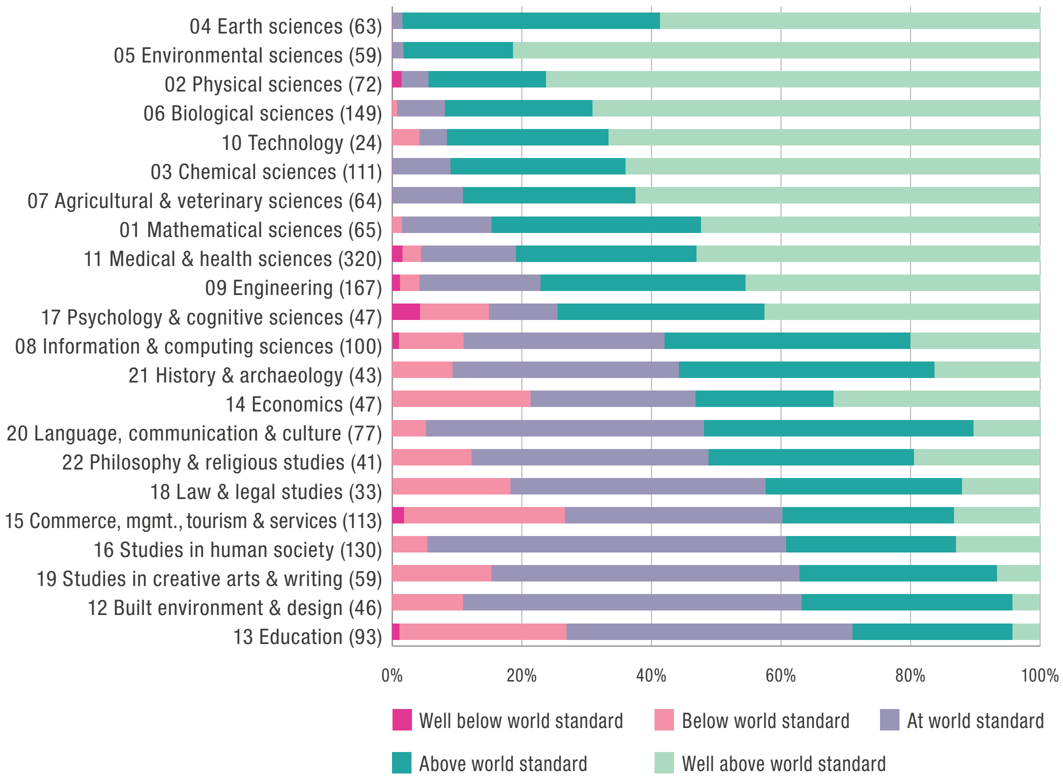
In 2018, pure and applied mathematics received the highest ratings, with numerical and computational mathematics also showing improvement. The ratings for mathematical physics were more variable, with higher ratings but fewer evaluated units compared to 2015. Statistics had fewer top ratings than in 2015.

Nearly all subdisciplines at the four-digit level received ratings at or above world standard, with 98 percent achieving this level compared to 92 percent across all research disciplines. Additionally, 52 percent of the evaluated units received the highest rating of five, compared to 40 percent of units in all research disciplines.

For a comparison with other disciplines, see the aggregated sub-discipline level ratings for all 22 research disciplines in Figure 4.12.

Figure 4.12 Distribution of UoE ratings for four-digit UoEs (grouped into two-digit FoR code level)

Source: *Quacquarelli Symonds Limited (2024).*



TOP AUSTRALIAN UNIVERSITIES IN MATHEMATICS AND STATISTICS

Table 4.5 QS world university rankings — Top 10 Australian universities for mathematics, and statistics and operational research (2024)

Source: *Quacquarelli Symonds Limited (2024).*

Mathematics	University	2024	2023	2022	2021
	The University of New South Wales	1	3	3	1
	Australian National University	2	2	2	3
	The University of Melbourne	3	1	1	4
	The University of Sydney	4	4	4	2
	Monash University	5	5	5	5
	The University of Queensland	6	6	6	6
	The University of Adelaide	7	7	7	7
	Queensland University of Technology	8	10	8	8
	The University of Western Australia	9	8	12	9
	University of Technology Sydney	10	13	9	11
Statistics & operational research	**University**	**2024**	**2023**	**2022**	**2021**
	Monash University	1	1	1	3
	Australian National University	2	2	2	2
	The University of Melbourne	3	3	3	1
	The University of New South Wales	4	4	4	5
	The University of Sydney	5	6	6	7
	Queensland University of Technology	6	7	7	4
	The University of Queensland	7	5	5	6
	University of Technology Sydney	8	8	8	8
	The University of Adelaide	9	9	10	11
	RMIT University	10	10	11	10

The following table shows the top ten Australian universities for mathematics and statistics according to the QS World University Rankings. In 2024, The University of New South Wales (UNSW) was ranked the top university in Australia for mathematics, followed by Australian National University (ANU) and The University of Melbourne (UoM). For Statistics and Operational Research, Monash University was ranked the top Australian university in 2024 for the third consecutive year, followed by ANU and UoM. Notably, ANU has been ranked in the top three for both mathematics and statistics since 2021, while UoM, Monash University, and UNSW have consistently ranked in the top five.

References

Australian Bureau of Statistics (ABS) (2021). ABS Census TableBuilder data from the 2011, 2016 and 2021 Census. Released 8/11/2021. https://www.abs.gov.au/statistics/microdata-tablebuilder/tablebuilder

Australian Bureau of Statistics (ABS) (2022a). ANZSCO - Australian and New Zealand Standard Classification of Occupations. Released 22/11/2022. https://www.abs.gov.au/statistics/classifications/anzsco-australian-and-new-zealand-standard-classification-occupations/2022/browse-classification/2/22/224/2241

Australian Bureau of Statistics (ABS). (2009 –2023). *Business expenditure in R&D, by fields of research, 2007/08-2021/2022.* https://www.abs.gov.au/statistics/industry/technology-and-innovation/research-and-experimental-development-businesses-australia

Australian Bureau of Statistics (ABS). (2010 –2024a). *Higher education expenditure on R&D, by location – by fields of research, 2008 –2022.* https://www.abs.gov.au/statistics/industry/technology-and-innovation/research-and-experimental-development-higher-education-organisations-australia

Australian Bureau of Statistics (ABS). (2010 –2024b). *Government expenditure on R&D, by fields of research, 2008/09 – 2022/23*. https://www.abs.gov.au/statistics/industry/technology-and-innovation/research-and-experimental-development-government-and-private-non-profit-organisations-australia

Australian Bureau of Statistics (ABS). (2023). *Business expenditure in R&D, by fields of research, 2021-22.* https://www.abs.gov.au/statistics/industry/technology-and-innovation/research-and-experimental-development-businesses-australia

Australian Bureau of Statistics (ABS). (2024a). *Higher education expenditure on R&D, by location – by fields of research, 2022*. https://www.abs.gov.au/statistics/industry/technology-and-innovation/research-and-experimental-development-higher-education-organisations-australia/latest-release

Australian Bureau of Statistics (ABS). (2024b). *Government expenditure on R&D, by fields of research, 2022-23*. https://www.abs.gov.au/statistics/industry/technology-and-innovation/research-and-experimental-development-government-and-private-non-profit-organisations-australia

Australian Curriculum, Assessment and Reporting Authority (ACARA). (2022). *2022 National Assessment Program— Literacy and Numeracy: National Report for 2022.* https://www.nap.edu.au/docs/default-source/default-document-library/2022-naplan-national-report.pdf

Australian Curriculum, Assessment and Reporting Authority (ACARA). (2023a). *NAPLAN Achievement in reading, writing and numeracy: National report for 2023*. https://www.acara.edu.au/reporting/national-report-on-schooling-in-australia/naplan-national-results

Australian Curriculum, Assessment and Reporting Authority (ACARA). (2023b). *Year 12 subject enrolments dataset*. https://www.acara.edu.au/reporting/national-report-on-schooling-in-australia/year-12-subject-enrolments

Australian Institute for Teaching and School Leadership (AITSL) (2021). *Australian Teacher Workforce Data: National Teacher Workforce Characteristics Report.* https://www.aitsl.edu.au/research/australian-teacher-workforce-data/atwdreports

Australian Institute for Teaching and School Leadership (AITSL) (2023). *Teacher workforce characteristics, Data release 29 March 2023*. Retrieved from https://www.aitsl.edu.au/docs/default-source/atwd-js/march29-2023/atwd-key-metrics-dashboard---march-2023.pdf

Australian Mathematical Sciences Institute (AMSI). (2022). *AMSI and AustMS/ANZIAM Workshop funding.* https://rhed.amsi.org.au/workshop-funding/.

Australian Research Council (ARC). (2010). *Excellence in Research for Australia 2010, National Report*. Retrieved from https://www.arc.gov.au/excellence-research-australia/archived-era-reports.

Australian Research Council (ARC). (2012). *Excellence in Research for Australia 2012, National Report*. Retrieved from https://www.arc.gov.au/excellence-research-australia/archived-era-reports.

Australian Research Council (ARC). (2016). *State of Australian University Research 2015-2016, ERA National Report*. Retrieved from https://www.arc.gov.au/excellence-research-australia/archived-era-reports.

Australian Research Council (ARC). (2019). *State of Australian University Research 2018-2019, ERA National Report*. Retrieved from www.arc.gov.au/excellence-research-australia.

Australian Research Council (ARC). (2024a). *ARC NCGP Trends: Areas of Research.* https://www.arc.gov.au/funding-research/funding-outcome/grants-dataset/trend-visualisation/ncgp-trends-areas-research

Australian Research Council (ARC). (2024b). *ARC NCGP Trends: Success Rates.* https://www.arc.gov.au/funding-research/funding-outcome/grants-dataset/trend-visualisation/ncgp-trends-success-rates

Australian Research Council (ARC). (2024c). *ARC Data Portal: Grants Search.* https://dataportal.arc.gov.au/NCGP/Web/Grant/Grants

Barker, M., Goos., M & Coupland, M. (2024). *Relieving Out of Field Teaching in Australian Secondary Mathematics.* https://amsi.org.au/?publications=relieving-out-of-field-teaching-in-australian-secondary-mathematics

Brown, N., Te Riele, K., Shelley, B. & Woodroffe, J. (2020). *Learning at home during COVID-19: Effects on vulnerable young Australians.* Independent Rapid Response Report. Peter Underwood Centre for Educational Attainment. University of Tasmania. https://www.utas.edu.au/__data/assets/pdf_file/0008/1324268/Learning-at-home-during-COVID-19-updated.pdf

Centre for Education Statistics and Evaluation (CESE) (2017). *Why aren't students studying higher level maths? How ATAR scaling may affect maths uptake.* Sydney: Centre for Education Statistics and Evaluation. https://education.nsw.gov.au/content/dam/main-education/about-us/educational-data/cese/2017-why-arent-students-studying-higher-level-maths.pdf

Council of Australian Governments (COAG). (2023). *National School Reform Agreement Extended Agreement.* https://www.education.gov.au/recurrent-funding-schools/resources/national-school-reform-agreement-0

Commonwealth of Australia. (2024). *Commonwealth Closing the Gap 2023 Annual Report and Commonwealth Closing the Gap 2024 Implementation Plan.* National Indigenous Australians Agency (NIAA). https://www.niaa.gov.au/resource-centre/indigenous-affairs/commonwealth-closing-gap-2023-annual-report-and-2024-implementation-plan

De Bortoli, L., Underwood, C., & Thomson, S. (2023). *PISA 2022. Reporting Australia's results. Volume I: Student performance and equity in education.* Australian Council for Educational Research. https://doi.org/10.37517/978-1-74286-725-0

De Gier, J., Keegan, T., Kennedy, S., & Wienk, M. (2024). Research Investment and Expenditure into the Mathematical Sciences, AMSI-MATRIX Report, May 2024. https://amsi.org.au/wp-content/uploads/2024/05/amsi-matrix-research-funding-report-may-2024.pdf

De Gier, J., Keegan, T., & Wienk, M. (2022). *Research Investment and Expenditure into the Mathematical Sciences*, AMSI-MATRIX Report, May 2022. https://amsi.org.au/wp-content/uploads/2022/03/amsi-matrix-research-funding-report.pdf

Department of Education. (2023a). Higher Education Statistics. *Student Load Pivot Table 2022: D23/4870160.* Commonwealth of Australia. https://www.education.gov.au/higher-education-statistics/resources/student-load-pivot-table-2022

Department of Education. (2023b). Higher Education Statistics. *Section 14 Award course completions 2022: D23/4870150*. https://www.education.gov.au/higher-education-statistics/resources/2022-section-11-equity-groups

Department of Education. (2023c). Higher Education Statistics. *Section 11 Equity groups 2022: D23/4870144*. https://www.education.gov.au/higher-education-statistics/resources/2022-section-14-award-course-completions

Department of Education (2024). *Higher Education Statistics – data provided to AMSI.*

Department of Employment and Workplace Relations. (2024). *Foundation Skills.* https://www.dewr.gov.au/foundation-skills

Department of Premier and Cabinet (2020). *Closing the Gap Report 2020.* Commonwealth of Australia. https://ctgreport.niaa.gov.au/content/closing-gap-2020

Department of Home Affairs (2024). *Regional migration: Designated regional areas.* https://immi.homeaffairs.gov.au/visas/working-in-australia/regional-migration/eligible-regional-areas

Doucet A., Netolicky D., Timmers K., Tuscano F. J. (2020). *Thinking about pedagogy in an unfolding pandemic (An Independent Report on Approaches to Distance Learning during COVID-19 School Closure*). Work of Education International and UNESCO. https://issuu.com/educationinternational/docs/2020_research_covid-19_eng

Goos, M. Grace. E., Marchant, T., Purcell, J., Makar, K. & Gordon, I. (2024). Relieveing out of field teaching in Australian secondary schools: Position Paper. https://amsi.org.au/wp-content/uploads/2024/03/ooft-position-paper-2024.pdf

Goss, P. & Sonnemann, J. (2018). Measuring student progress – a state-by-state report card. Melbourne: Grattan Institute. https://grattan.edu.au/report/measuring-student-progress/

Hine, G. (2019). Reasons why I didn't enroll in a higher-level mathematics course: Listening to the voice of Australian senior secondary students. *Research in Mathematics Education* 21(3), 295 –313. https://doi.org/10.1080/14794802.2019.1599998

Hine, G. (2018). Teachers' perceptions on declining student enrolments in Australian senior secondary mathematics courses. *Issues in Educational Research 28* (3), 635 –654. https://iier.org.au/iier28/hine.pdf

Hinz, B., Walker, L. & Witter, M. (2019). *Learning from the best: What makes an excellent teacher of mathematics?* Australian Association of Mathematics Teachers/PIVOT Professional Learning. https://www.pivotpl.com/paper-launch-new-research-identifies-key-characteristics-of-great-maths-teachers/.

House of Representatives Standing Committee on Employment, Education and Training (House of Reps.). (2022). *Don't take it as read – Inquiry into adult literacy and its importance*. Canberra: Commonwealth of Australia. https://parlinfo.aph.gov.au/parlInfo/download/committees/reportrep/024806/toc_pdf/Don'ttakeitasread.pdf;fileType=application%2Fpdf

International Mathematical Research Institute MATRIX. (2022). https://www.matrix-inst.org.au/

Irwin, V. (2021). *Student's Internet Access Before and During the Coronavirus Pandemic by Household Socioeconomic Status.* National Centre for Education Statistics (NCES). https://nces.ed.gov/blogs/nces/post/students-internet-access-before-and-during-the-coronavirus-pandemic-by-household-socioeconomic-status

Johnston, P. (2022). Higher Degrees and Honours Bachelor Degrees in Mathematics and Statistics Completed in Australia in 2021. *AustMS Gazette 49* (5), 212 –219. (Longitudinal data collection provided to AMSI.)

Jonas, N. (2018), *Numeracy practices and numeracy skills among adults*, OECD Education Working Papers, no. 177, Paris: OECD Publishing.

Joyce, C., Hine, G., & Anderton, R. (2017). The association between secondary mathematics and first year performance in health sciences. *Issues in Educational Research 27*(4), 770 –783. https://eric.ed.gov/?redir=http%3a%2f%2fwww.iier.org.au%2fiier27%2fjoyce.pdf

King, D. & Cattlin, J. (2015). The impact of assumed knowledge entry standards on undergraduate mathematics teaching in Australia. *International Journal of Mathematical Education in Science and Technology 46* (7), 1032 –1045. https://doi.org/10.1080/0020739X.2015.1070440

Lamb, S., Huo, S., Walstab, A., Wade, A., Maire, Q., Doecke, E., Jackson, J. & Endekov, Z.(2020). *Educational opportunity in Australia 2020: Who succeeds and who misses out.* Centre for International Research on Education Systems, Victoria University, for the Mitchell Institute: Melbourne.

Learning First. (2020). *The Experience of remote and flexible learning in Victoria.* Department of Education and Training Victoria. https://www.education.vic.gov.au/Documents/about/department/COVID-19/experience-of-remote-and-flexible-learning-report.pdf

Li, N. & Sprakel, J. (2020). *CHOOSEMATHS School Survey and Teacher Survey (2016-2019) Key Findings*. Melbourne: Australian Mathematical Sciences Institute. https://amsi.org.au/wp-content/uploads/2020/06/teachersurveykeyfinding_withcover_questionnaires.pdf.

Marchant, T. & Kennedy, S. (2024). Year 12 Mathematics Participation Report Card: Mathematics Enrolments Remain at All-Time Lows. Australian Mathematical Sciences Institute (AMSI). https://amsi.org.au/?publications=year-12-mathematics-participation-report-card-mathematics-enrolments-remain-at-all-time-lows

McMillan, J. & Edwards, D. (2019). *Performance in first year mathematics and science subjects in Australian universities: Does senior secondary mathematics background matter? – Final report*, Melbourne: Australian Council for Educational Research/Australian Council of Deans of Science. https://research.acer.edu.au/higher_education/62

Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D. L., & Fishbein, B. (2020). TIMSS 2019 International Results in Mathematics and Science. Boston College, TIMSS & PIRLS International Study Center. https://timssandpirls.bc.edu/timss2019/international-results/

Murray, S. (2011). Declining participation in post-compulsory secondary school mathematics: Students' views of and solutions to the problem. *Research in Mathematics Education 13* (3), 269 –285. https://doi.org/10.1080/14794802.2011.624731

National Skills Commission (NSC). (2021). *2021 NSC Employment projections – for the five years to November 2026*. https://www.nationalskillscommission.gov.au/topics/employment-projections#Projectionsbyoccupationalgroup

Nicholas, N., Poladian, L., & Wilson, R. (2015). Mathematics preparation for university: entry, pathways and impact on performance in first year science and mathematics subjects. *International Journal of Innovation in Science and Mathematics Education 23* (1), 37 –51. https://www.researchgate.net/publication/281667674_Mathematics_preparation_for_university_Entry_pathways_and_impact_on_performance_in_first_year_science_and_mathematics_subjects

Office of the Chief Scientist (OCS). (2014). *Benchmarking Australian Science, Technology, Engineering and Mathematics*. https://www.chiefscientist.gov.au/2014/12/benchmarking-australian-science-technology-engineering-mathematics.

Office of the Chief Scientist & Australian Mathematical Sciences Institute (OCS & AMSI). (2020). *Mapping University Prerequisites in Australia.* Melbourne/Canberra: AMSI/Office of the Chief Scientist. https://amsi.org.au/wp-content/uploads/2020/10/mapping_university_prerequisites_in_australia.pdf

. (2017). Building Skills for All in Australia: Policy Insights from the Survey of Adult Skills. https://read.oecd-ilibrary.org/education/building-skills-for-all-in-australia/

Organisation for Economic Co-operation and Development (OECD). (2019a). *PISA 2018 Results (Volume I): What Students Know and Can Do*. PISA, OECD Publishing, Paris, https://doi.org/10.1787/5f07c754-en

Organisation for Economic Co-operation and Development (OECD). (2019b). *PISA 2018 Results (Volume II): Where All Students Can Succeed*. PISA, OECD Publishing, Paris, https://doi.org/10.1787/b5fd1b8f-en

Organisation for Economic Co-operation and Development (OECD). (2022). *OECD Skills Surveys*. https://www.oecd.org/skills/piaac/

Organisation for Economic Co-operation and Development (OECD). (2023a). *PISA 2022 Results (Volume I): The State of Learning and Equity in Education*. PISA, OECD Publishing, Paris, https://doi.org/10.1787/53f23881-en.

Organisation for Economic Co-operation and Development (OECD). (2023b). *PISA 2022 Results (Volume II): Learning During – and From – Disruption.* PISA, OECD Publishing, Paris. https://doi.org/10.1787/a97db61c-en

Pokhrel, S., & Chhetri, R. (2021). A Literature Review on Impact of COVID-19 Pandemic on Teaching and Learning. *Higher Education for the Future*, 8 (1), 133 –141. https://doi.org/10.1177/2347631120983481

Productivity Commission (2022). *Review of the National School Reform Agreement*. Australian Government. https://www.pc.gov.au/inquiries/completed/school-agreement/report/school-agreement.pdf

Productivity Commission (n.d.). Closing the Gap dashboard: Table CtG5A.1and CtG5A.4. Australian Government. https://www.pc.gov.au/closing-the-gap-data/dashboard

Poladian, L. & Nicholas, N. (2013). Mathematics Bridging Courses and Success in First year Calculus. In: King, D., Loch, B. & Rylands, L. (Eds.). *Shining through the fog - Proceedings of Lighthouse Delta 2013: the 9th Delta Conference on teaching and learning of undergraduate mathematics and statistics* (150 –159). Sydney: University of Western Sydney.

Pitt, D. (2015). On the scaling of NSW HSC marks in mathematics and encouraging higher participation in calculus-based courses. *Australian Journal of Education 59* (1), 65 –81. https://doi.org/10.1177/0004944115571943

Quacquarelli Symonds (QS) Limited (2024). *QS World University Rankings by Subject – Mathematics.* https://www.topuniversities.com/university-subject-rankings/mathematics

Social Research Centre. (2018). *Quality Indicators in Learning and Teaching (QILT) - 2017 Student Experience Survey (SES)* [Report Tables]. Commonwealth of Australia: Canberra. https://www.qilt.edu.au/surveys/student-experience-survey-(ses)

Social Research Centre. (2019a). *Quality Indicators in Learning and Teaching (QILT) - 2018 Student Experience Survey (SES)* [Report Tables]. Commonwealth of Australia: Canberra. https://www.qilt.edu.au/surveys/student-experience-survey-(ses)

Social Research Centre. (2019b). *Quality Indicators in Learning and Teaching (QILT) - 2018 Graduate Outcomes Survey (GOS)* [Report Tables]. Commonwealth of Australia: Canberra. https://www.qilt.edu.au/qilt-surveys/graduate-employment.

Social Research Centre. (2020a). *Quality Indicators in Learning and Teaching (QILT) - 2019 Student Experience Survey (SES)* [Report Tables]. Commonwealth of Australia: Canberra. https://www.qilt.edu.au/surveys/student-experience-survey-(ses)

Social Research Centre. (2020b). *Quality Indicators in Learning and Teaching (QILT) - 2019 Graduate Outcomes Survey (GOS)* [Report Tables]. Commonwealth of Australia: Canberra. https://www.qilt.edu.au/qilt-surveys/graduate-employment.

Social Research Centre. (2021). *Quality Indicators in Learning and Teaching (QILT) - 2020 Student Experience Survey (SES).* [Report Tables]. Commonwealth of Australia: Canberra. https://www.qilt.edu.au/surveys/student-experience-survey-(ses)

Social Research Centre. (2022a). *Quality Indicators in Learning and Teaching (QILT) - 2021 Student Experience Survey (SES)* [Report Tables]. Commonwealth of Australia: Canberra. https://www.qilt.edu.au/surveys/student-experience-survey-(ses)

Social Research Centre. (2022b). *Quality Indicators in Learning and Teaching (QILT) - 2021 Graduate Outcomes Survey (GOS)* [Report Tables]. Commonwealth of Australia: Canberra. https://www.qilt.edu.au/qilt-surveys/graduate-employment.

Social Research Centre. (2023a). *Quality Indicators in Learning and Teaching (QILT) - 2022 Student Experience Survey (SES)* [Report Tables]. Commonwealth of Australia: Canberra. https://www.qilt.edu.au/surveys/student-experience-survey-(ses)

Social Research Centre. (2023b). *Quality Indicators in Learning and Teaching (QILT) - 2022 Graduate Outcomes Survey (GOS)* [Report Tables]. Commonwealth of Australia: Canberra. https://www.qilt.edu.au/qilt-surveys/graduate-employment.

Social Research Centre. (2024a). *Quality Indicators in Learning and Teaching (QILT) - 2023 Graduate Outcomes Survey (GOS).* [Report Tables]. Commonwealth of Australia: Canberra. Data provided to AMSI.

Social Research Centre. (2024b). *Quality Indicators in Learning and Teaching (QILT) - 2023 Graduate Outcomes Survey (GOS)* [Report Tables]. Commonwealth of Australia: Canberra. https://www.qilt.edu.au/qilt-surveys/graduate-employment.

Sadler, P. & Tai, R. (2007). The two high-school pillars supporting college science. *Science 317* (5837), 457 –458. DOI: 10.1126/science.1144214

Shi, Y. Pyne, K., Kulophas, D., & Bangpan, M. (2022). Exploring equity in educational policies and interventions in primary and secondary education in the context of public health emergencies: A systematic literature review. *International Journal of Educational Research,* Vol. 111, p. 101911, https://doi.org/10.1016/j.ijer.2021.101911.

Sonnemann, J. & Hunter, J. (2023). *Tackling under-achievement. Why Australia should embed high-quality small-group tuition in schools.* Melbourne: Grattan Institute. https://grattan.edu.au/wp-content/uploads/2023/01/Tackling-under-achievement-Grattan-report.pdf

Thomson, S., de Bortoli, L., Underwood, C., & Schmid, M. (2019). *PISA 2018: Reporting Australia's results, Volume I Student Performance*. Melbourne: Australian Council for Educational Research. https://research.acer.edu.au/ozpisa/35/

Thomson, S., De Bortoli, L., Underwood, C., & Schmid, M. (2020a). *PISA 2018: Reporting Australia's Results. Volume II Student and School Characteristics.* Australian Council for Educational Research. https://research.acer.edu.au/ozpisa/49

Thomson, S., Wernert, N., Rodrigues, S. & O'Grady, E. (2020b). *TIMSS 2019 Australia, Volume I: Student Performance* Melbourne: Australian Council for Educational Research. https://doi.org/10.37517/978-1-74286-614-7

Thomson, S., Wernert, N., Buckley, S., Rodrigues, S., O'Grady, E., Schmid, M. (2021). *TIMSS 2019 Australia. Volume II: School and Classroom Contexts for Learning.* Australian Council for Educational Research. https://doi.org/10.37517/978-1-74286-615-4

UNESCO. (2021). UNESCO *Science Report: The Race Against Time for Smarter Development.* S. Schneegans, T. Straza and J. Lewis (eds). UNESCO Publishing: Paris. https://www.unesco.org/reports/science/2021/en/statistics

University of Sydney Mathematical Research Institute (SMRI). (2022). https://sydney.edu.au/research/centres/mathematical-research-institute.html.

YouthInsight. (2021). *2021 Youth in STEM Report*, Canberra: Department of Industry, Innovation and Sciences. https://www.industry.gov.au/sites/default/files/2022-08/youth-in-stem-report-2021.pdf

Glossary

AAS: Australian Academy of Science

ABS: Australian Bureau of Statistics

ACARA: Australian Curriculum, Assessment and Reporting Authority

ACER: Australian Council for Educational Research

AEU: Australian Education Union

APM sciences: advanced physical and mathematical sciences encompassing the core physical sciences of physics, chemistry, the earth sciences and the mathematical sciences. 'Advanced' means science undertaken and applied in the past 20 years.

ARC: Australian Research Council

ASGS: ABS Australian statistical geography standard

ATN: Australian Technology Network, alignment of universities consisting of Curtin University, University of South Australia, RMIT University, and University of Technology Sydney

AustMS: Australian Mathematical Society

BERD: Business Expenditure Research & Development

CIE: Centre of International Economics

ESCS: Index of economic, social and cultural status

EFTSL: Equivalent Full Time Student Load

ERA: Excellence in Research for Australia

FTE: Full Time Equivalent

Go8: Group of Eight universities, alignment of universities consisting of University of Sydney, University of New South Wales, University of Adelaide, University of Melbourne, Monash University, Australian National University, University of Western Australia and University of Queensland

GOVERD: Government Expenditure Research & Development

GVA: Gross Value Added

HERD: Higher Education Expenditure Research & Development

ICSEA: Index of Community Socio-Educational Advantage

IRU: Innovative Research Universities, alignment of universities consisting of Charles Darwin University, Flinders University, Griffith University, James Cook University, La Trobe University, Murdoch University and Western Sydney University.

MANSW: Mathematical Association of New South Wales

MCEETYA: Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) Schools Geographic Location Classification.

NAPLAN: National Assessment Program- Literacy and Numeracy

NMS: National Minimum Standard (NAPLAN)

OCS: Office of the Chief Scientist

OECD: Organisation for Economic Co-operation and Development

QILT: Quality Indicators in Learning and Teaching

PISA: Programme for International Student Assessment

RUN: Regional Universities Network, alignment of universities consisting of Central Queensland University, Southern Cross University, Federation University Australia, University of New England, University of Southern Queensland, Charles Sturt University and University of the Sunshine Coast. Note that Charles Sturt newly joined RUN in 2019 and has been included with non-aligned universities in this publication.

STEM: Science, Technology, Engineering and Mathematics

TIMSS: Trends in International Mathematics and Science Study

UoE: Unit of Evaluation (ERA)

AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

AMSI.ORG.AU
BUILDING 161, C/- THE UNIVERSITY OF MELBOURNE, VICTORIA 3010 AUSTRALIA
T: +61 3 8344 1777 **E:** ENQUIRIES@AMSI.ORG.AU