Mathematics and Science enrolments

A research review and analysis of recent Queensland data

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Queensland Government | Queensland Curriculum & Assessment Authority

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1 Background

In 2014, the Queensland Curriculum and Assessment Authority's (QCAA) predecessor, the Queensland Studies Authority (QSA) published a commentary — Trends & issues in curriculum and assessment: Identifying enrolment trends in senior Mathematics and Science subjects in Queensland schools — that discussed Queensland's Mathematics and Science enrolment trends from 1992 to 2013. In 2019, a new QCE system was introduced for Year 11 students and in 2020, the Overall Position (OP) was replaced by the Australian Tertiary Admission Rank (ATAR). The introduction of this new system also included new senior secondary Mathematics and Science subjects that are based on their equivalent senior secondary Australian Curriculum subjects. External assessment contributing between 25% and 50% of the final subject result was also introduced for General subjects.

Given the significance of these changes, it is timely to provide an update to the 2014 commentary that includes a summary of Australian research into Mathematics and Science, enrolment trends, and an analysis of Queensland's recent senior secondary enrolment data.

1.1 QCAA working party

In 2021, the QCAA Board approved the establishment of a working party and research team to conduct further research into the enrolment trends in Mathematics and Science subjects. Specifically, the working party and research team was to:

- conduct jurisdictional scans and a literature review on trends in senior secondary Mathematics and Science enrolments
- collect and analyse data on Mathematics and Science enrolments in Queensland and other jurisdictions
- synthesise findings and propose possible reasons for identified trends.

This paper presents these findings and provides more recent (2022) data where available.

2 The new QCE system

The new QCE system for senior secondary students was introduced for Year 11 students in 2019. In 2020, the Overall Position (OP) was replaced by the Australian Tertiary Admission Rank (ATAR) as the primary means for selecting and offering Year 12 graduates places in university courses.

In Queensland, the ATAR is based on a student's best scaled results in either:

- five General subjects
- four General subjects plus one Applied subject
- four General subjects plus one VET qualification at Certificate III or above.

Only one Applied subject can be included in the ATAR calculation. For instance, if a student enrols in Essential Mathematics (Applied subject) and Science in Practice (Applied subject), only the higher scaled result is used in the calculation.

The new QCE system includes redeveloped senior subjects along with new ones. General subjects are designed for students who wish to pursue tertiary pathways, vocational education and training, or to commence employment. These subjects have four summative assessments — three internal, which are developed, administered and marked by schools, and one external examination at the end of Year 12, which is developed, administered and marked by the QCAA. Applied subjects are designed for post-school vocational education and training or employment pathways. They also have four summative assessments. However, they are all internally developed, administered and marked by the school.

2.1 Queensland senior secondary Mathematics and Science subjects

The 2019 Queensland senior Mathematics syllabuses are based on their equivalent senior secondary Australian Curriculum subjects, which contain nationally agreed content and standards, in accordance with the *Education (Queensland Curriculum and Assessment Authority) Act 2014*.

There are four Mathematics subjects based on Australian Curriculum subjects:

- Essential Mathematics (Applied)
- General Mathematics
- Mathematical Methods
- Specialist Mathematics.

Four of Queensland's 2019 Science syllabuses are also based on Australian Curriculum subjects:

- Biology
- Chemistry
- Earth & Environmental Science
- Physics.

Along with the syllabuses developed from the Australian Curriculum, Queensland includes several other subjects in Mathematics and Science, including the Numeracy Short Course, Agricultural Science, Marine Science, Psychology, Agricultural Practices (Applied), Aquatic Practices (Applied) and Science in Practice (Applied).

The 2019 Mathematics syllabuses are broadly equivalent to the Mathematics subjects of the previous system. The 2019 Science syllabuses are also consistent with previous QCE subjects, apart from Psychology (introduced as a new subject in 2019) and Science 21 (retired in 2019). However, the General subjects now include an external assessment and the Applied subjects such as Essential Mathematics can contribute to an ATAR (their predecessors, Authority Registered Subjects, could not contribute to an OP).

3 Literature review

3.1 Mathematics enrolments

As different jurisdictions have different Mathematics subjects in senior secondary, the literature on Mathematics enrolments tends to classify subjects as 'basic' or 'elementary', 'intermediate', and 'advanced' or 'higher', depending on the nature of the content and the likely post-schooling pathway (Chinofunga, Chigeza & Taylor 2022). For the purposes of this report, Essential Mathematics and General Mathematics are classified as 'elementary', Mathematical Methods as 'intermediate' and Specialist Mathematics as 'advanced'.

Wienk and O'Connor (2020) provide the most recent summary of national enrolments in Mathematics, which indicates that the proportion of students enrolling in Mathematics has remained stable over the past decade. In general, enrolment proportions are calculated by dividing the number of students enrolled in a Mathematics course by the total number of students in the cohort. The proportions of students enrolled in each level of Mathematics are calculated in the same way. However, the number of students studying advanced Mathematics is not included in the number of students studying intermediate Mathematics, because they are typically corequisite subjects (Barrington & Evans 2016; Wienk & O'Connor 2020). The same is true for students studying both intermediate and elementary Mathematics subjects, because reliable estimates of the number of these students are not available (Wienk & O'Connor 2020). Studies that delineate between states are few and dated. The last state-by-state analysis appears to have been conducted by Forgasz (2006b) for the period 2000–2004.

3.1.1 Advanced Mathematics enrolment

At the national level, the proportion of Year 12 students enrolling in advanced Mathematics has been in steady decline over the past decade (Barrington & Evans 2016; James 2019; Kennedy, Lyons & Quinn 2014; Wienk & O'Connor 2020). This decline is a continuation of the downward trend in national advanced Mathematics enrolments since the 1980s (Dekkers & Malone 2000; Malone, De Laeter & Dekkers 1993).

In general, substantially greater percentages of males enrol in Year 12 advanced Mathematics than females (James 2019; Kennedy, Lyons & Quinn 2014; Watt, Eccles & Durik 2006; Wienk & O'Connor 2020), and this trend has endured since at least the 1970s (Barrington & Brown 2014; Barrington & Evans 2016; Forgasz 2006b). A recent analysis of national enrolments in Mathematics by Wienk and O'Connor (2020) revealed that the percentage of Year 12 males enrolled in advanced Mathematics subjects was consistently higher than females over the past decade. In 2019, for example, there were 12,449 males enrolled compared to 7,816 females, meaning that 38.6% of Year 12 students enrolled in advanced Mathematics subjects were female.

At a state level, in New South Wales, the proportion of Year 12 students studying Mathematics Extension 2 has remained stable for the past decade, but the number of students enrolled in Mathematics Extension 1 has declined steadily (Jaremus et al. 2019). In 2017, the percentage of NSW males enrolled in Mathematics Extension 1 and 2 (15.5% and 6.1% respectively) exceeded the percentage of females (9.7% and 3.2% respectively). Murphy (2019), Sikora and Pitt (2019) and Yeoh and Leigh-Lancaster (2010) found that students from lower socioeconomic status (SES) backgrounds were less likely to enrol in advanced Mathematics subjects (this research was for Victoria and New South Wales).

In Queensland, the proportion of Year 12 students enrolled in advanced Mathematics declined through the 1990s but appeared to stabilise in 2000 (Queensland Studies Authority 2014).

Jennings (2014) argued that the number of Queensland Year 12 students enrolled in advanced Mathematics (Mathematics C) as a proportion of all students receiving an OP provided a more appropriate representation of the enrolments in advanced Mathematics in Queensland than the proportion of the entire cohort. Students who were not OP-eligible were not intending to apply for university entrance and would not be studying an advanced mathematics subject. Using this approach, in 2013, 15.2% of OP-eligible students were enrolled in advanced Mathematics, up from a low of 9.7% in 2003 (Jennings 2014). Jennings (2022) updated this analysis with more recent data, noting that from 2006 to 2018 the number of Queensland students studying advanced Mathematics increased by more than 63% in raw numbers and 1.4% as a percentage of the Year 12 cohort.

3.1.2 Intermediate Mathematics enrolment

Year 12 enrolments in intermediate Mathematics at the national level fell from 23.3% in 2008 to 20.5% in 2019 (Wienk & O'Connor 2020). As with enrolments in advanced Mathematics, the declining enrolments in intermediate Mathematics continued an ongoing decline since the 1980s (Barrington & Brown 2014; Barrington & Evans 2016; Forgasz 2006a, 2006b; Kennedy, Lyons & Quinn 2014).

The percentage of Year 12 males enrolled in intermediate Mathematics is consistently larger than the percentage of females but by a much smaller margin than for advanced Mathematics (Barrington & Evans 2016; James 2019; Wienk & O'Connor 2020). In 2019, 49.15% of students enrolled in intermediate Mathematics were female (Wienk & O'Connor 2020). This negligible difference in gender proportions has been relatively steady since the 1990s (Barrington & Brown 2014; Dekkers & Malone 2000; Forgasz 2006b; Kennedy, Lyons & Quinn 2014).

In state-based research, Jaremus et al. (2019) analysed New South Wales Year 12 enrolments from 1991 to 2017 and found a steady decline in intermediate Mathematics. Enrolments increased slightly for the first time in this period in 2017, to 48.8% (from more than 50% of students studying intermediate Mathematics in 1991).

In Queensland, the proportion of Year 12 students enrolled in intermediate Mathematics declined substantially through the 1990s and 2000s (Queensland Studies Authority 2014). However, Queensland had the highest average percentage of Year 12 students enrolled in intermediate Mathematics from 2000 to 2004, according to Forgasz (2006a). The proportion appears to increase again slightly from 2010 to 2013 (Queensland Studies Authority 2014).

Chinofunga, Chigeza and Taylor (2022) recently reviewed the data from 2010 to 2019 for senior Mathematics in Queensland, concluding that Queensland's enrolment trends are aligned with the broader national trends found in other research. With respect to gender, they found that 47.5% and 35.2% of the students studying the calculus-based courses Mathematics B and C (respectively) in Years 11 and 12 were female.

3.1.3 Elementary Mathematics enrolment

Nationally, the percentage of Year 12 students enrolling in elementary Mathematics increased steadily through the 1970s,1980s, and 1990s (Dekkers, De Laeter & Malone 1986; Dekkers & Malone 2000; Dekkers, Malone & De Laeter 1983). Kennedy, Lyons and Quinn (2014) found that this trend continued into the new century, from around 38% in 1994 to around 49% in 2012. However, a recent analysis by Wienk and O'Connor (2020) found that the proportion of Year 12 students enrolled in elementary Mathematics declined from 52% in 2008 to 48.7% in 2019. Barrington and Evans (2016) estimate that 52% of Year 12 students were enrolled in elementary Mathematics in 2015. While there are some discrepancies between enrolment percentages across different studies due to the way enrolment is defined, it can safely be assumed that around half of Year 12 students were enrolled in elementary Mathematics at the national level over the past decade.

Historically, the percentage of Year 12 females enrolled in elementary Mathematics has been higher than the percentage of males (Barrington & Brown 2014; Forgasz 2006b; Kennedy, Lyons & Quinn 2014). James (2019) estimated that 50.7% of the Year 12 students enrolled in elementary Mathematics in 2017 were female. Again, there are some discrepancies due to the different ways that this category is defined.

In state-based research, New South Wales enrolments in Year 12 elementary Mathematics increased up to 2000 as students opted out of intermediate Mathematics (Jaremus et al. 2019). However, since 2000, the percentage of students not enrolling in Mathematics at all has increased, as has the percentage of students enrolling in Mathematics subjects that do not count toward their ATAR calculation. Overall, gender differences in enrolments are consistent with those at the national level, i.e. the percentage of males exceeds the percentage of females for advanced and intermediate Mathematics, and the percentage of females is higher for elementary or no Mathematics (Jaremus et al. 2019). This is also the case in Victoria (Forgasz & Leder 2017). Furthermore, Year 12 students from lower SES backgrounds were more likely to enrol in elementary Mathematics subjects (Murphy 2019).

3.2 Reasons for enrolment in Mathematics subjects

Research suggests that there are many reasons why Year 12 students choose to enrol (or not) in Mathematics. These reasons have been combined into three broad groups — pragmatic reasons, individual beliefs and educational arrangements.

3.2.1 Pragmatic reasons

Students' choice of Mathematics is influenced by:

- future utility, such as the requirements for further study (Bøe et al. 2011; Brinkworth & Truran 1998; Hine 2016, 2018, 2019; Kirkham, Chapman & Wildy 2020)
- career aspirations (Jeffries, Curtis & Conner 2020; Prieto & Dugar 2017; Sikora & Pitt 2019),
- to keep their options open, particularly when their future study and work intentions are uncertain (Brinkworth & Truran 1998; Easey & Gleeson 2013; Palmer, Burke & Aubusson 2017).

Students might enrol in intermediate or advanced Mathematics because of a perceived scaling advantage in the ATAR calculations. They may also enrol in elementary Mathematics because it allows them to devote more time to their preferred subjects, thereby improving their ATAR (Bøe et al. 2011; Easey & Gleeson 2013; Gordon & Nicholas 2013; Hine 2016, 2018, 2019; Jennings 2014; Kirkham, Chapman & Wildy 2020; Pitt 2015; Queensland Studies Authority 2014).

Studies suggest that students' perceptions of the workload required to complete subjects influence their enrolment choices. Students who choose not to enrol in intermediate or advanced Mathematics likely do so because they believe that:

- these subjects take up too much time or the workload is too high (Bøe et al. 2011; Gordon & Nicholas 2013; Hine 2016, 2018, 2019; Jaremus et al. 2019; Kirkham, Chapman & Wildy 2020; McPhan et al. 2008; Oo 2017)
- the subject matter is difficult to learn and understand (Bøe et al. 2011; Hine 2016, 2019; McPhan et al. 2008; Murray 2011; Watt & Bornholt 2000)

- they require too much effort for the perceived reward (Hine 2016, 2019; Watt & Bornholt 2000).

Conversely, some students enrol in advanced Mathematics because the workload delivers a perceived payoff in the ATAR calculation and/or bonus points/adjustment factors (Hine 2019; Jennings 2014; Queensland Studies Authority 2014).

3.2.2 Individual beliefs

Enrolment choices are also affected by students' individual opinions and beliefs. These can include:

- self-efficacy in Mathematics (Brinkworth & Truran 1998; Hine 2019; Kirkham, Chapman & Wildy 2020; Li 2019; Martin et al. 2012; McPhan et al. 2008; Plenty & Heubeck 2011; Watt & Bornholt 2000; Watt, Eccles & Durik 2006)
- academic self-concept, i.e. their perception of their own academic ability (Kirkham, Chapman & Wildy 2020; Li 2019; Sikora & Pitt 2019)
- attainment value, i.e. the value of doing well on the task (Kirkham, Chapman & Wildy 2020; Watt et al. 2012)
- expectations of success (Bøe et al. 2011; Gordon & Nicholas 2013; Hine 2016, 2019; Watt & Bornholt 2000; Watt et al. 2012)
- previous success or otherwise in Mathematics (Brinkworth & Truran 1998; Easey & Gleeson 2013; Fullarton & Ainley 2000; Jeffries, Curtis & Conner 2020; McPhan et al. 2008; Sikora & Pitt 2019; Watt, Eccles & Durik 2006)
- having friends taking the subject (or not) (Brinkworth & Truran 1998; Kirkham, Chapman & Wildy 2020)
- anxiety (Kirkham, Chapman & Wildy 2020; Li 2019; Martin et al. 2012).

Student enrolment choices can be positively influenced by:

- their interest in and enjoyment of Mathematics (Bøe et al. 2011; Jeffries, Curtis & Conner 2020; Martin et al. 2012; McPhan et al. 2008; Watt & Bornholt 2000; Watt, Eccles & Durik 2006)
- a belief in the intrinsic value of Mathematics (Kirkham, Chapman & Wildy 2020; Li 2019; Martin et al. 2012; Murray 2011; Plenty & Heubeck 2011; Watt & Bornholt 2000; Watt et al. 2012)
- family encouragement or support (Kirkham, Chapman & Wildy 2020; Martin et al. 2012; McPhan et al. 2008).

Conversely, enrolment choices can be negatively influenced by:

- poor previous experiences of Mathematics (Cooper, Berry & Baglin 2020; Li 2019; Martin et al. 2012; McPhan et al. 2008)
- finding Mathematics boring (Bøe et al. 2011; Brinkworth & Truran 1998; Murray 2011)
- gender stereotypes (Jaremus et al. 2020)
- a lack of knowledge or awareness of the relevance of Mathematics for future study and careers (Chinnappan et al. 2008; Easey & Gleeson 2013; McPhan et al. 2008; Murray 2011).

Nonetheless, Kennedy, Quinn and Lyons (2020) surveyed a sample of 363 Year 7 students and found that they generally intended to enrol in Year 11 and 12 Mathematics, despite having low self-efficacy and finding the subject unenjoyable, difficult and not personally useful. These results suggest that beliefs and affect towards Mathematics are formed and sustained from very early experiences in secondary schooling (Kennedy, Quinn & Lyons 2020; Martin et al. 2012).

3.2.3 Educational arrangements

The resources and advice available at particular schools can also influence students' Mathematics enrolment choices. The lack of suitably qualified teachers (Chinnappan et al. 2008) and the ability to access advanced Mathematics courses (Bøe et al. 2011; Chinnappan et al. 2008; Murphy 2019) may limit students' enrolment options. Furthermore, curriculum authorities may not require students to enrol in a Mathematics subject in Year 12 (Jaremus et al. 2019; Murray 2011).

The advice received from school advisors, counsellors or teachers can also influence enrolment decisions (Brinkworth & Truran 1998; Easey & Gleeson 2013; Gordon & Nicholas 2013; Kirkham, Chapman & Wildy 2020; Queensland Studies Authority 2014).

There is some evidence that restricted educational arrangements might stop capable students from enrolling in intermediate and/or advanced Mathematics (Easey & Gleeson 2013; Hine 2018; Sikora & Pitt 2019). While students can enrol in intermediate/advanced Mathematics bridging courses to meet the need for university course entry or success (Gordon & Nicholas 2013; Hine 2019), Oo (2017) found that some students who completed elementary Mathematics and subsequently enrolled in STEM subjects at university regretted not taking intermediate or advanced Mathematics.

3.3 Science enrolments

While there are older reports that document the trends in national Year 12 Science enrolments throughout the 1970s, 1980s and 1990s, there are few recent reports into enrolment trends for Year 12 Science subjects in Australia. The most recent studies are by Kennedy, Lyons and Quinn (2014) at the national level and by Jaremus et al. (2019) for New South Wales.

At the national level, the proportion of Year 12 students enrolling in a science increased throughout the 1970s and 1980s and peaked in 1992, due to increasing Year 12 retention rates and broader alternative science subject offerings in this period. The percentage of Year 12 students enrolling in Science subjects has been declining since then (Kennedy, Lyons & Quinn 2014; Lyons & Quinn 2010, 2015; Dekkers & De Laeter 2001; Dekkers, De Laeter & Malone 1986, 1989; Hassan & Treagust 2003). There is evidence that roughly equal percentages of females and males enrol in senior Science subjects at an aggregate level (Falkiner 2012; Fullarton et al. 2003), though there is substantial difference in the gender ratios for each Science subject (Cooper, Berry & Baglin 2020; Fullarton & Ainley 2000; Fullarton et al. 2003; Jeffries, Curtis & Conner 2020; Kennedy, Lyons & Quinn 2014). Year 12 students from higher SES backgrounds are more likely to enrol in a Science subject (Cooper & Berry 2020; Cooper, Berry & Baglin 2020; Fullarton et al. 2003; Jeffries, Curtis & Conner 2020; Murphy 2020).

Indigenous Year 12 students are less likely to enrol in a senior Science subject (Cooper, Berry & Baglin 2020). Students who were born overseas or have at least one parent who was born overseas are more likely to enrol in a Year 12 Science subject (Cooper, Berry & Baglin 2020; Fullarton & Ainley 2000; Jeffries, Curtis & Conner 2020).

As for state-based research, in New South Wales, Year 12 enrolments in Science subjects have decreased in line with the national trend. However, the declines have slowed since 2001 and for some subjects have started to increase (Jaremus et al. 2019). In Western Australia, the percentage of Year 12 students enrolled in Science subjects decreased slightly between 2002 and 2007 (Venville 2008). However, there are no studies that have analysed recent trends.

3.3.1 Physics enrolments

The proportion of Year 12 students enrolling in Physics nationally increased throughout the 1970s and 1980s and peaked in 1992 (Dekkers & De Laeter 2001; Dekkers, De Laeter & Malone 1986, 1989; Malone, De Laeter & Dekkers 1993). Since then, it has been in steady decline, from 21% of Year 12 students enrolled in Physics in 1992, to 14% in 2012 (Kennedy, Lyons & Quinn 2014).

The percentage of Year 12 males enrolled in Physics nationally is consistently and substantially higher than females across all time periods (Ainley 1993; Dekkers, De Laeter & Malone 1986, 1989; Fullarton & Ainley 2000; Fullarton et al. 2003; Kennedy, Lyons & Quinn 2014; Malone, De Laeter & Dekkers 1993). Malone, De Laeter and Dekkers (1993) estimate that 29% of all Year 12 Physics enrolments in 1990 were female and Kennedy, Lyons and Quinn (2014) estimate that this fell to 25% by 2012.

In terms of state data, in New South Wales, enrolments in Year 12 Physics declined substantially between 1991 and 2001, and this decreasing trend continued until 2017 (Jaremus et al. 2019). In 2017, 21.8% of males were enrolled in Year 12 Physics compared with 6.0% of females (Jaremus et al. 2019).

In Western Australia, the percentage of Year 12 students enrolled in Physics decreased from 15.9% in 2002 to 14.98% in 2007 (Venville 2008). In Victoria, the proportion of Year 12 students enrolled in Physics is higher for students from high SES backgrounds (Murphy 2020). There is a slightly higher percentage of Year 12 females enrolled in Physics in Victorian single-sex schools than in co-educational schools (Forgasz & Leder 2020).

In Queensland, the proportion of students enrolling in Year 12 Physics has declined gradually since the peak in 1992 (Queensland Studies Authority 2014).

3.3.2 Chemistry enrolment

The national trend in Year 12 Chemistry enrolments is similar to Physics, although enrolments in Chemistry are consistently higher than Physics. The percentage of Year 12 students enrolling in Chemistry increased through the 1970s and 1980s and peaked in 1992 (Dekkers & De Laeter 2001; Dekkers, De Laeter & Malone 1986; Dekkers & De Laeter 1997; Dekkers, De Laeter & Malone 1989; Malone, De Laeter & Dekkers 1993). It then decreased from 23% in 1992 to 18% in 2012 (Kennedy, Lyons & Quinn 2014).

Historically, more males have enrolled in Year 12 Chemistry than females (Ainley 1993; Dekkers, De Laeter & Malone 1986, 1989; Malone, De Laeter & Dekkers 1993). Malone, De Laeter and Dekkers (1993) estimated that 43% of Chemistry enrolments in 1990 were female. However, Kennedy, Lyons and Quinn (2014) estimated that the gender ratio has been steady, at about 49% female since 1995.

In New South Wales, the percentage of Year 12 students enrolled in Chemistry decreased substantially between 1991 and 2001 but since then remained relatively stable until 2017 (Jaremus et al. 2019). The percentage of males enrolled in Year 12 Chemistry in NSW was 17%, compared with 13% of females (Jaremus et al. 2019).

In Victoria, a larger proportion of students from high SES backgrounds enrol in Year 12 Chemistry (Murphy 2020). The percentage of females enrolled in Chemistry is higher in single-sex schools, as it is for Physics (Forgasz & Leder 2020).

In Western Australia, the percentage of Year 12 students enrolled in Chemistry increased from 17.77% to 18.45% between 2002 and 2007 (Venville 2008).

In Queensland, the proportion of Year 12 students enrolled in Chemistry declined gradually from 1992 to 2010, at which point the proportion appeared to stabilise (Queensland Studies Authority 2014).

3.3.3 Biology enrolment

Nationally, the proportion of Year 12 students enrolled in Biology has been consistently greater than for Physics and Chemistry, with enrolments increasing throughout the 1970s and 1980s and peaking in 1992 (Dekkers & De Laeter 1997, 2001; Dekkers, De Laeter & Malone 1986, 1989; Malone, De Laeter & Dekkers 1993). The percentage of Year 12 students enrolled in Biology then decreased from 35% in 1992 to 25% in 2012 (Kennedy, Lyons & Quinn 2014).

The percentage of Year 12 females enrolled in Biology is consistently higher than the percentage of males (Dekkers, De Laeter & Malone 1986, 1989; Kennedy, Lyons & Quinn 2014; Malone, De Laeter & Dekkers 1993). Malone, De Laeter and Dekkers (1993) estimate that there were approximately two females for every one male enrolled in Biology between 1976 and 1990, and Kennedy, Lyons and Quinn (2014) estimate that there were about nine females for every five males in 2012.

State-based data shows that in New South Wales, the decrease in Year 12 Biology enrolments between 1991 and 2001 was consistent with the enrolment trends for Physics and Chemistry (Jaremus et al. 2019). However, there has since been an upward trend, with 31.1% of females and 20.2% of males enrolled in Year 12 Biology in 2017 (Jaremus et al. 2019). Biology is the most popular Science in New South Wales, particularly among females, which is consistent with the national trend (Jaremus et al. 2019).

In Western Australia, Human Biology is the most popular Science, though Biology is less popular than Chemistry and Physics (Venville 2008). There was a downward trend in enrolment in Human Biology from 23.07% in 2002 to 22.28% in 2007, and in Biology from 10.47% in 2002 to 8.26% in 2007 (Venville 2008).

In Victoria, there was a greater percentage of Year 12 females than males enrolled in Biology from 2001 to 2017. However, the percentage of males has increased over the same period (Forgasz & Leder 2020).

In Queensland, the proportion of Year 12 students enrolled in Biology declined substantially from 1992 to 2010, but appeared to increase slightly from 2010 to 2013 (Queensland Studies Authority 2014).

3.3.4 Earth & Environmental Sciences

Kennedy, Lyons and Quinn (2014) reported that national Year 12 enrolments in Earth & Environmental Science subjects declined from 1.3% in 1992 to 0.5% in 2000, but subsequently increased to 1.6% in 2012. They also estimated that there were about nine females for every 10 males enrolled. The trend in New South Wales Earth and Environmental Science enrolments is consistent with the national trend (Jaremus et al. 2019).

3.3.5 Alternative Science subjects

Year 12 enrolments in the range of alternative Science subjects offered in each jurisdiction in Australia increased at a greater rate in the 1980s than enrolments for Physics, Chemistry and Biology (Dekkers & De Laeter 2001; Dekkers, De Laeter & Malone 1989; Malone, De Laeter & Dekkers 1993). This trend coincided with significant increases in the number of students completing Year 12 and the introduction of more alternative Science subjects throughout Australia (Dekkers & De Laeter 2001; Dekkers, De Laeter & Malone 1989). The increasing trend in enrolments peaked in 1993 (Dekkers & De Laeter 2001) and then fell from about 9% in 1992 to 4.3% in 2012 (Kennedy, Lyons & Quinn 2014). The percentage of Year 12 males enrolled in alternative Science subjects is slightly more than the percentage of females, with Kennedy, Lyons and Quinn (2014) estimating 25 males for every 22 females.

The only state-based research is for New South Wales, in which enrolments in alternative Science courses have increased steadily since 2001. In 2017, 11% of males and 9.2% of females were enrolled in the multidisciplinary course Senior Science (Jaremus et al. 2019).

3.4 Reasons for enrolment in science subjects

Research suggests that there are many reasons why Year 12 students choose to enrol in a Year 12 Science subject. As with the above discussion of Mathematics enrolments, these reasons have been combined into three broad groups — pragmatic, individual beliefs and educational arrangements.

3.4.1 Pragmatic reasons

Students enrol in one or more Science subjects due to:

- requirements for entrance to tertiary study (Bøe et al. 2011; Cousins 2007; Dekkers & De Laeter 2001; Jeffries, Curtis & Conner 2020; Lyons & Quinn 2010; Murphy 2020; Palmer, Burke & Aubusson 2017)
- career aspirations and job prospects (Barnes, McInerney & Marsh 2005; Lyons & Quinn 2010; Palmer 2020; Palmer, Burke & Aubusson 2017; Venville 2008; Venville et al. 2010)
- the general utility value of learning a Science (Abraham & Barker 2014).

The perceived advantage for ATAR calculations may also influence a student's decision to enrol in a Year 12 Science subject (Bøe et al. 2011; Palmer 2020; Venville 2008; Venville et al. 2010). This perceived advantage was also evident in research about Mathematics enrolment choices.

3.4.2 Individual beliefs

Individual beliefs also affect students' choices. Enrolment decisions may be positively influenced by:

- student interest and engagement in Science subjects (Abraham & Barker 2014, 2015a; Barnes, McInerney & Marsh 2005; Jaremus et al. 2019; Oliver et al. 2017; Palmer 2020; Palmer, Burke & Aubusson 2017; Venville et al. 2010)
- enjoyment and/or previous achievement in junior Science (Cousins 2007; George & Taylor 2001; Jeffries, Curtis & Conner 2020; Oliver et al. 2017; Ainley 1993; Fullarton & Ainley 2000; Holmes et al. 2018; Jeffries, Curtis & Conner 2020)
- expectations of success (Abraham & Barker 2014, 2015a; Barnes, McInerney & Marsh 2005; Bøe et al. 2011; Palmer, Burke & Aubusson 2017; Venville et al. 2010)
- self-efficacy (Jeffries, Curtis & Conner 2020; Palmer 2020; Palmer, Burke & Aubusson 2017)
- perception of Science as intrinsically valuable (Jeffries, Curtis & Conner 2020; Lyons 2006; Lyons & Quinn 2010)
- family context (Cousins 2007; Jeffries, Curtis & Conner 2020; Lyons 2006; Oliver et al. 2017)
- school culture (Oliver et al. 2017).

Conversely, students' decisions to enrol in a senior Science subject may be negatively influenced by:

- a lack of interest in, excitement about, and engagement with Science (Cooper, Berry & Baglin 2020; Hassan & Treagust 2003; Lyons 2006; Lyons & Quinn 2010, 2015; Palmer 2020; Palmer, Burke & Aubusson 2017; Venville et al. 2010)

- low motivation (Hassan & Treagust 2003)
- the breadth of available subjects (Dekkers & De Laeter 2001; Kennedy, Lyons & Quinn 2014; Lyons & Quinn 2010, 2015; Murphy 2020; Queensland Studies Authority 2014)
- a lack of previous achievement in Science (Fullarton & Ainley 2000; Holmes et al. 2018; Jeffries, Curtis & Conner 2020)
- a perception that Science is irrelevant (Cooper, Berry & Baglin 2020; Lyons 2006; Lyons & Quinn 2015; Murphy 2020)
- a perception that Science has low intrinsic value (Jeffries, Curtis & Conner 2020; Lyons 2006), gender stereotypes, particularly in relation to Physics and Chemistry (Abraham & Barker 2014, 2015b; Cousins 2007; Jeffries, Curtis & Conner 2020; Palmer 2020)
- negative perceptions of scientists (Hassan & Treagust 2003; Lyons & Quinn 2010, 2015)
- the school context (Abraham & Barker 2014, 2015a; Jeffries, Curtis & Conner 2020)
- the family context (Abraham & Barker 2014, 2015a; Cousins 2007; Jeffries, Curtis & Conner 2020; Lyons 2006; Palmer 2020).

Students typically perceive Physics and Chemistry as more difficult and work intensive than Biology and alternative Science subjects (Bøe et al. 2011; Jaremus et al. 2019; Lyons 2006; Murphy 2020; Venville et al. 2010), and they may opt out of taking Science altogether because the perceived difficulty outweighs the potential benefits (Lyons & Quinn 2010; Palmer 2020; Venville et al. 2010). However, a survey of Year 7 students (Kennedy, Quinn & Lyons 2020) found that, while students felt Science was unenjoyable and difficult, they nevertheless expressed strong intentions to enrol in senior Science subjects and acknowledged the importance of Science for future careers.

3.4.3 Educational arrangements

The advice received from school advisors, counsellors or teachers can influence enrolment decisions (Brinkworth & Truran 1998; Easey & Gleeson 2013; Gordon & Nicholas 2013; Kirkham, Chapman & Wildy 2020; Queensland Studies Authority 2014). The breadth of available alternative subjects in other learning areas, such as IT/computer courses, has been linked to students not choosing a science subject (Dekkers & De Laeter 2001; Kennedy, Lyons & Quinn 2014; Lyons & Quinn 2010, 2015; Murphy 2020; Queensland Studies Authority 2014). Lyon and Quinn (2015) discussed the increased participation of VET in schools as a possible factor. However, they noted that typically these students may not have been inclined to enrol in a science subject in the first place.

4 Tertiary entrance requirements

4.1 Prerequisites, assumed knowledge and recommended study

For entry into many tertiary courses, students need to have achieved a certain level of performance in specific Year 12 subjects, which are prerequisites for a course.

Some courses that do not have prerequisites specify assumed knowledge and/or recommended study. In these cases, students can receive an offer for a course but might have difficulty with their studies. Subjects specified as assumed knowledge and/or recommended study for acceptance into a course are usually assessed by the institution when reviewing a student's enrolment, and where necessary, students may be offered bridging or introductory subjects to prepare them for discipline-specific study.

4.1.1 Fields of Education

The Queensland Tertiary Admissions Centre's (QTAC) institutional course offerings are grouped according to Fields of Education (FOE) (Queensland Tertiary Admissions Centre 2021b). Table 1 provides an overview of the number of tertiary course offerings in: Agriculture, Environmental and Related Studies; Architecture and Building; Creative Arts; Education; Engineering; Food, Hospitality and Personal Services; Health; Information Technology; Management and Commerce; and Natural and Physical Sciences, from 2017 to 2022. Table 2 shows which ones include a course with a Year 12 Mathematics and/or Science subject requirement. Figure 1 shows the total number of courses offered and those that have a Mathematics or Science prerequisite over the same period.

Table 1. Number of tertiary courses offered in each FOE (Queensland Tertiary Admissions Centre 2021c)

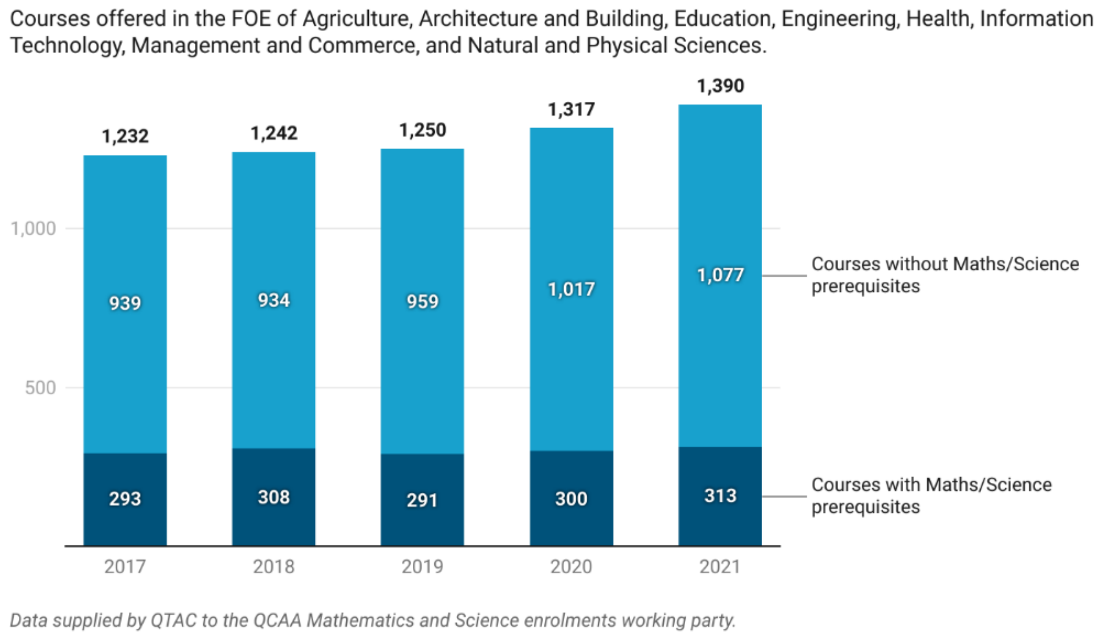
Broad FOE	2017	2018	2019	2020	2021*
Agriculture, Environmental and Related Studies	46	49	42	46	48
Architecture and Building	51	47	56	50	60
Education	138	160	159	157	156
Engineering	132	144	115	133	137
Health	275	298	309	318	314
Information Technology	86	95	104	111	130
Management and Commerce	373	314	308	338	370
Natural and Physical Sciences	131	135	157	164	175

*2021 data to date as at 22/5/21

Table 2. Broad FOE and courses that have a Mathematics or Science subject as a prerequisite (P) or assumed knowledge (A) (Queensland Tertiary Admissions Centre 2021b)

QCAA General subjects	Mathematical Methods (Maths B)	Specialist Maths (Maths C)	General Maths (Maths A)	Chemistry	Physics	Biology	Agricultural Science	Earth & Environmental Science	Marine Science
Broad Field of Education									
Agriculture, Environmental and Related Studies		P	P						
Architecture and Building	A	A	A						
Creative Arts									
Education	P	P	P	P	P	P	P	P	P
Engineering	P	P		P	P				
Food, Hospitality and Personal Services									
Health	P		P	P	P	P			
Information Technology	P								
Management and Commerce	P	P	P						
Natural and Physical Sciences	P	P		P	P	P	P	P	P

Figure 1. Number of courses with and without Maths/Science prerequisites (Queensland Tertiary Admissions Centre 2021b)



Traditionally, there is a perception that Mathematics and Science FOEs are those that directly relate to careers that are Mathematics and Science based, such as Engineering, Information Technology, and Natural and Physical Sciences (Queensland Tertiary Admissions Centre 2021b). As can be seen above, the FOEs of Education, and Management and Commerce, have at least one course that includes a Mathematics or Science subject as a prerequisite. Interestingly, Education courses stand out as having some of the most stringent prerequisite subject requirements across all institutions (Queensland Tertiary Admissions Centre 2021b).

Given the full range of Mathematics and Science subjects nominated as tertiary course entry requirements across all FOEs, it is clear that studying Mathematics and/or Science at school can lead to a career in more than just a scientific or engineering field.

4.1.2 Which Mathematics and Science subjects?

Mathematical Methods (formerly Mathematics B) is the most common Year 12 subject requirement where there is only a single maths subject as a prerequisite or recommended study. Many tertiary courses offer the entry option of having any one of the three Mathematics subjects — Mathematical Methods, Specialist Mathematics or General Mathematics — as a prerequisite.

Where there is a single prerequisite or recommended Science subject, Chemistry is the most commonly required subject, followed closely by Physics. Many courses ask for any one of Chemistry, Physics or Biology as a prerequisite. Some courses require only ‘a general Science subject’ which broadens the student’s options to subjects such as Agricultural Science, Earth & Environmental Science, Marine Science and Psychology.

Over the 2017 to 2021 period (i.e., the period that includes the change to the senior secondary and tertiary entrance systems), there has generally been little change in the subject prerequisite requirements (including assumed knowledge and recommended subjects) for Mathematics and Science subjects for most courses; there is no clear trend amongst Queensland institutions towards decreasing the prerequisite entry requirement for any specific courses. However, there are a few courses in some institutions where a prerequisite has been changed to assumed knowledge/recommended (Queensland Tertiary Admissions Centre 2021b).

4.2 Tertiary applicant data

4.2.1 First preferences

Table 3 shows the first preferences of applicants for relevant specific FOEs from 2017 to 2022. QTAC provided this data to the QCAA Mathematics and Science enrolments working party.

Table 3. First preferences in specific FOE (Queensland Tertiary Admissions Centre 2021c)

Broad FOE	2017	2018	2019	2020	2021*
Agriculture, Environmental and Related Studies	764	810	842	753	808
Architecture and Building	1,724	1,639	1,909	1,535	1,678
Education	7,058	5,692	6,422	6,148	7,164
Engineering	4,353	4,470	4,221	3,733	4,138
Health	22,316	22,360	21,674	21,663	24,364
Information Technology	1,921	2,060	2,236	1,933	2,360
Management and Commerce	9,111	8,697	7,703	6,852	6,799
Natural and Physical Sciences	5,870	6,033	6,251	6,172	6,882

*2021 data to date as at 22/5/21

4.2.2 Number of applicants

The data below shows the combined number of applicants (Figure 2), applicants with offers (Figure 3) and applicants with accepted offers (Figure 4) for the FOEs from 2017 to 2021.

Figure 2. Number of applicants (Queensland Tertiary Admissions Centre 2021b)

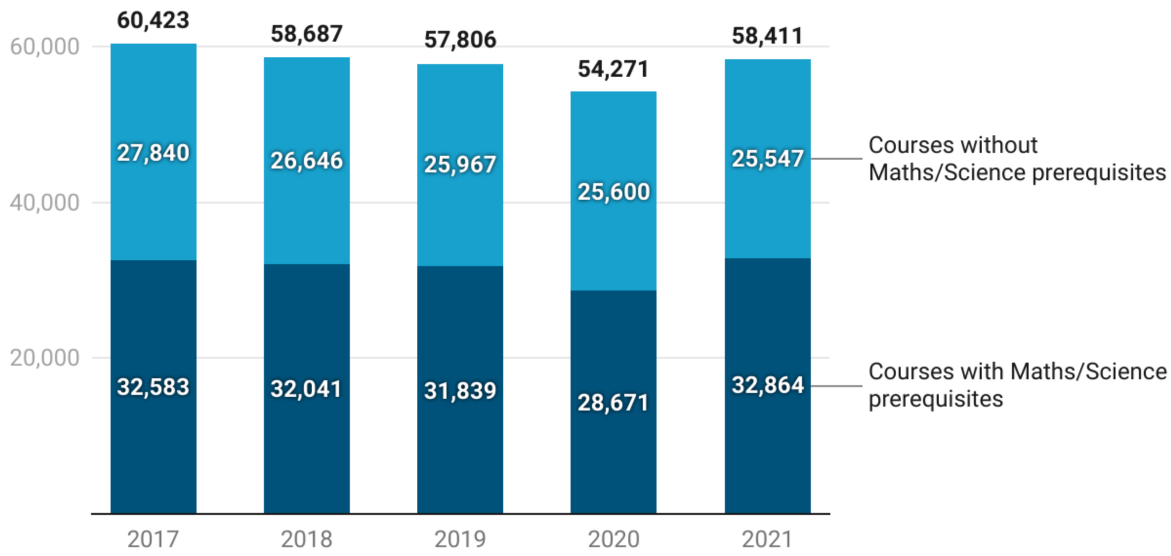


Figure 3. Number of applicants with offers (Queensland Tertiary Admissions Centre 2021b)

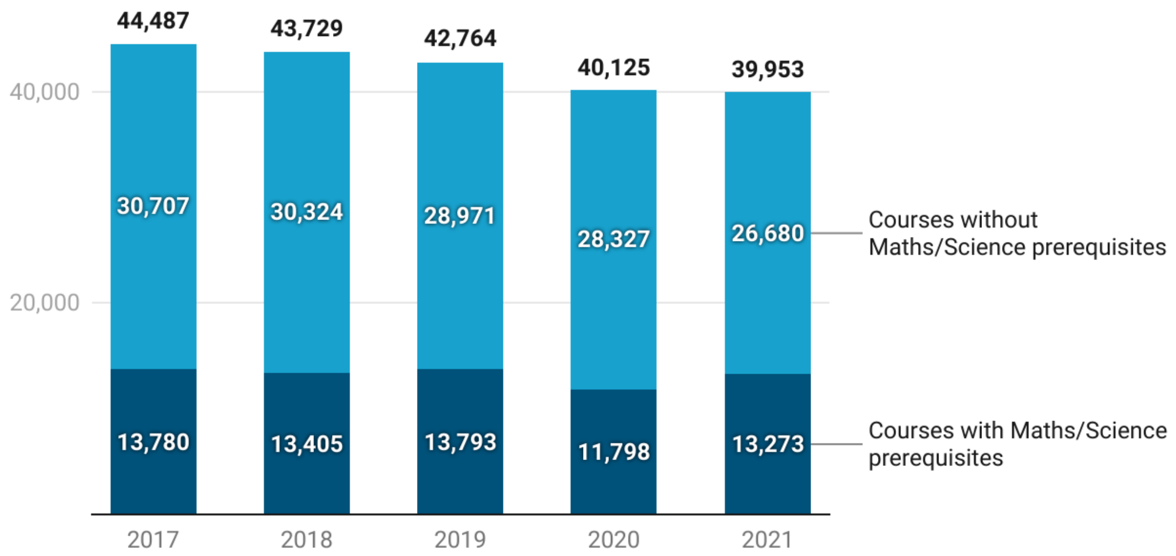
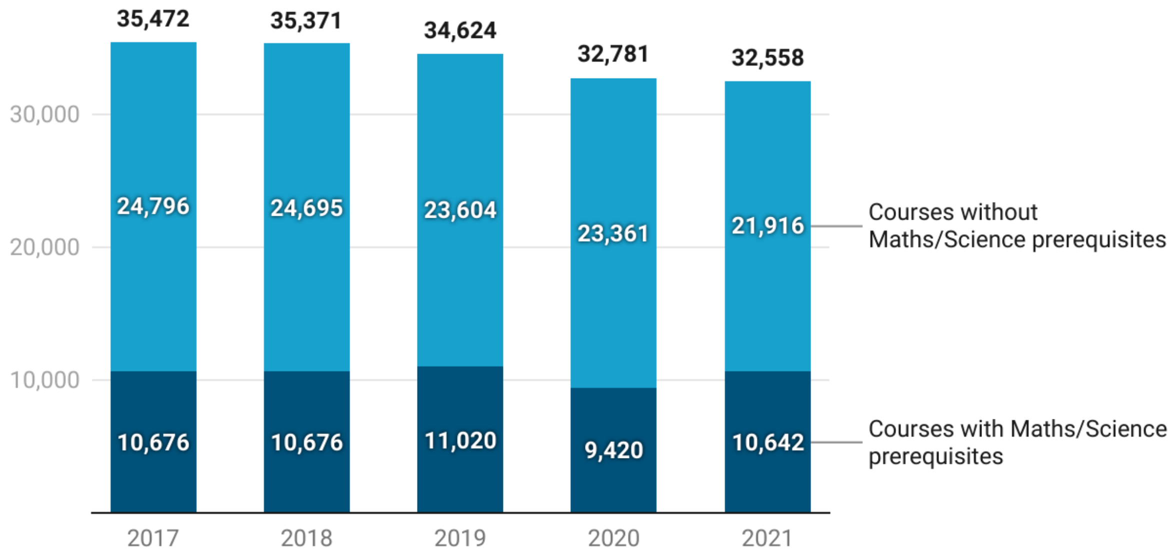


Figure 4. Number of applicants with accepted offers (Queensland Tertiary Admissions Centre 2021b)



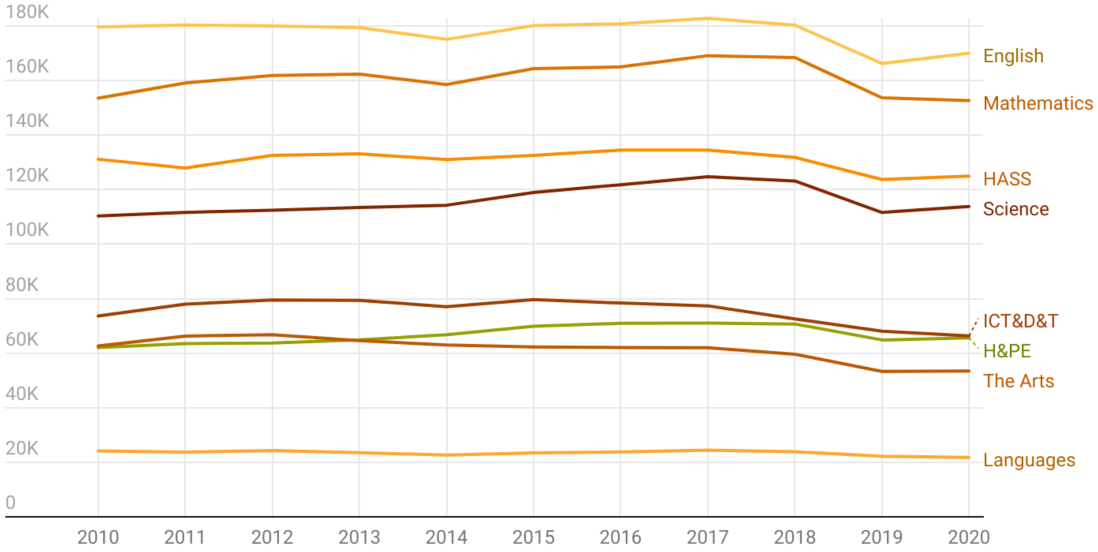
5 Year 12 enrolment data

5.1 National enrolment data

The national enrolment trends in the learning areas of English, Health and Physical Education (H&PE), Humanities and Social Sciences (HASS), Information and Communication Technology and Design and Technology (ICT and D&T), Languages, Mathematics, Sciences and The Arts, from the National Report on Schooling data portal are represented in Figure 5 and Figure 6. They show the total number of students studying a subject, and as a percentage of Year 12 students studying the subject.

Figure 5. National learning area enrolment trends 2010 to 2020 — number of Year 12 students

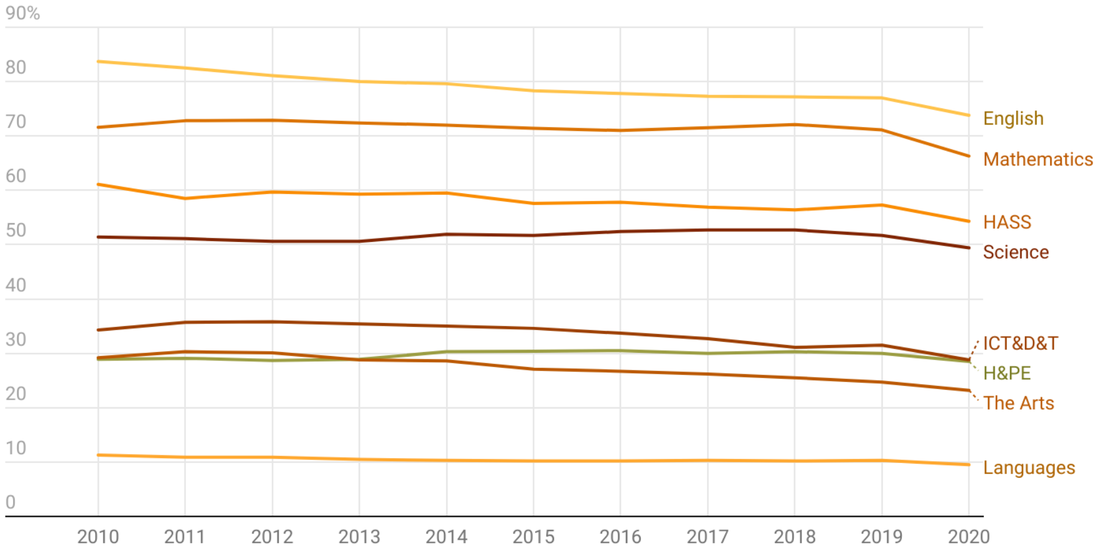
The number of Year 12 students enrolled in each learning area in Australia from 2010 to 2020.



Note that for this data, students may be enrolled in more than one subject within each learning area, e.g. a student may be enrolled in Chemistry and Physics, but is only counted as a single Science enrolment.

Figure 6. National learning area enrolment trends — percentage of Year 12 students

The percentage of Year 12 students enrolled in each learning area in Australia from 2010 to 2020.



Note that for this data, students may be enrolled in more than one subject within each learning area, e.g. a student may be enrolled in Chemistry and Physics, but is only counted as a single Science enrolment.

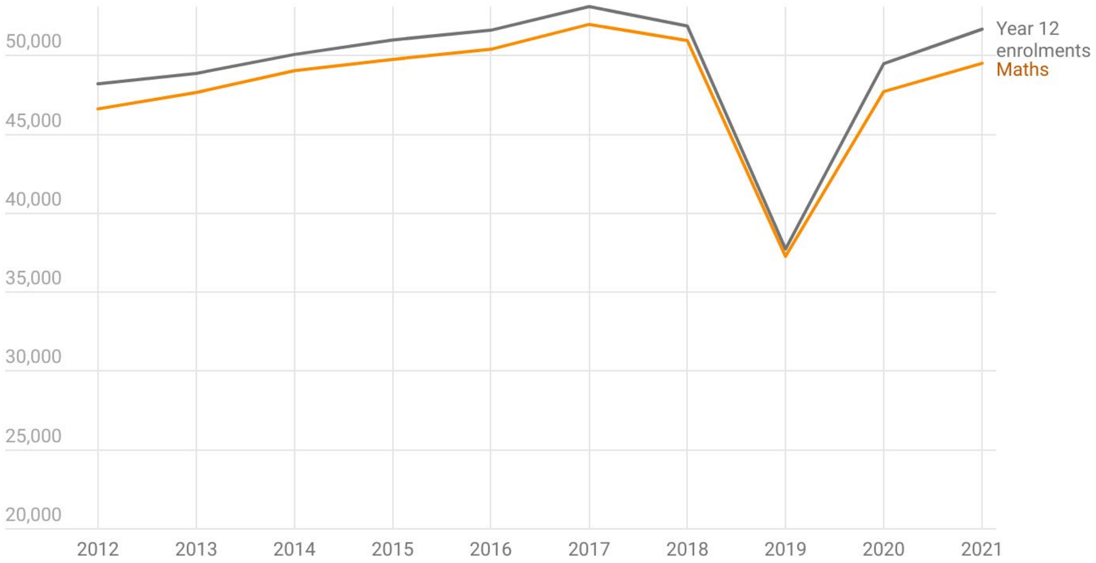
As can be seen, there has been a downward trend in a number of learning areas over this period without a comparable rise in others. When considering these enrolment trends, it is important to note that this data is for tertiary-recognised subjects in the learning areas. Enrolments in VET courses and Applied syllabuses (and their interstate counterparts) are not included. Along with the decline in English (which senior certificates and post-school tertiary entrance processes typically require to some extent); this data may be indicative of more Year 12 students opting for non-university post-school pathways in general, or using other pathway options to meet tertiary entry requirements.

5.2 Queensland's Mathematics enrolment data

Queensland's enrolment data from 2012 to 2021 for the Mathematics learning area as a whole is shown in Figure 7. Figure 8 and Figure 9 show the enrolment data for each Mathematics subject over this period.

Figure 7. Queensland Mathematics learning area enrolments

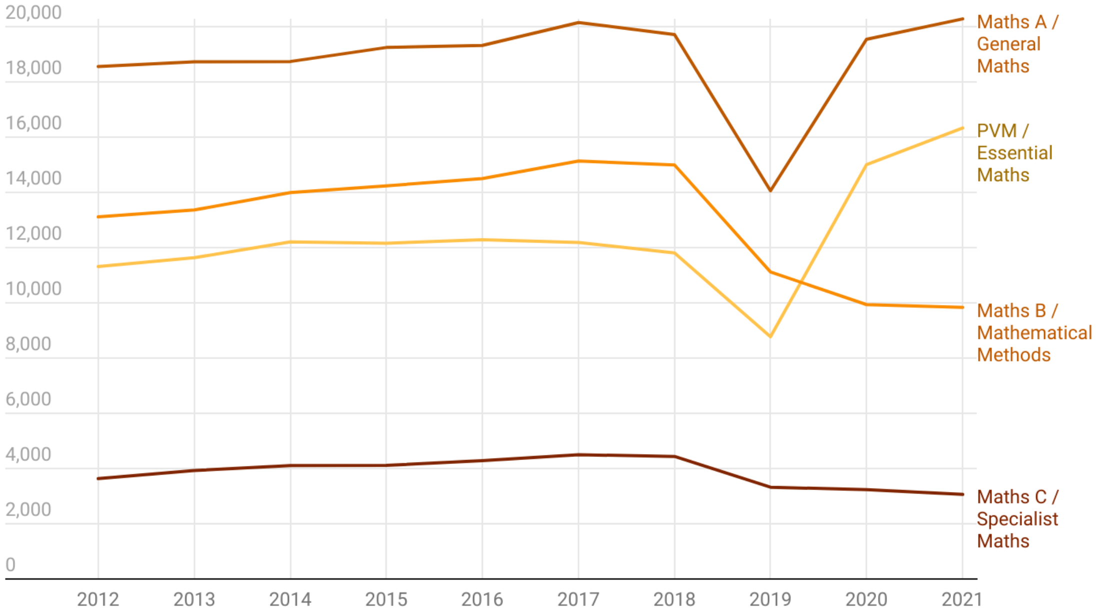
The total number of Year 12 students and total number of students enrolled in Mathematics subjects



Total Year 12 enrolments are the number of students who received a senior education profile (SEP). Mathematics enrolments are the sum of enrolments for each General and Applied Mathematics subject (and their predecessors), i.e. students studying more than one Mathematics subject are counted each time, not just once.

Figure 8. Queensland Mathematics enrolment trends — number of Year 12 students

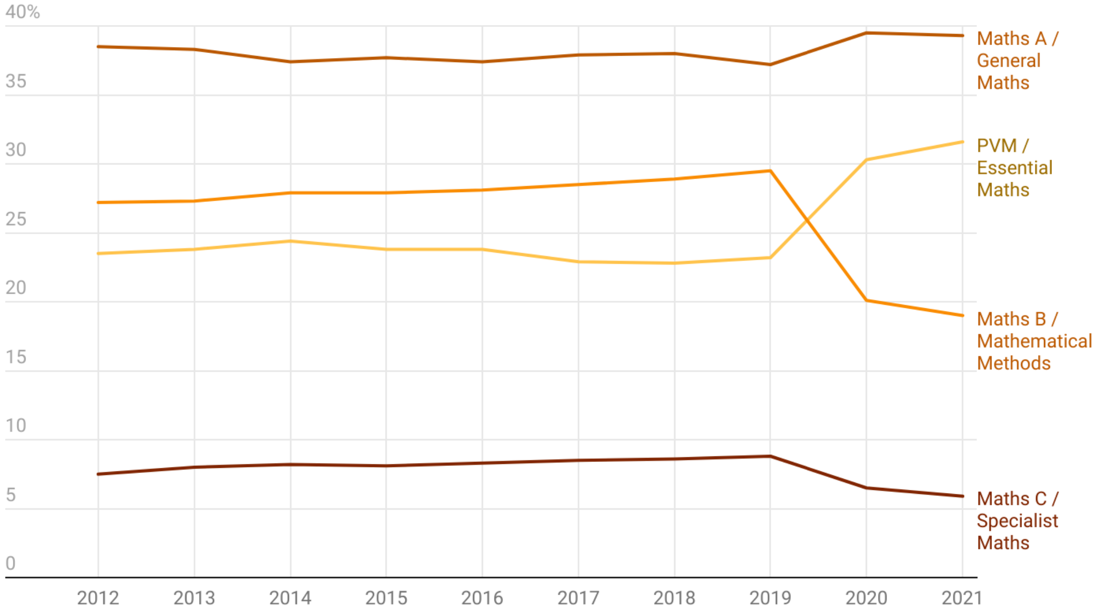
The number of Year 12 students enrolled in senior Mathematics subjects in Queensland from 2012 to 2021.



Enrolments in this data refer to completing four semesters (2012–2019) or completing Units 3 & 4 (2020–2021).

Figure 9. Queensland Mathematics enrolment trends — percentage of Year 12 students

The percentage of Year 12 students enrolled in senior Mathematics subjects in Queensland from 2012 to 2021.



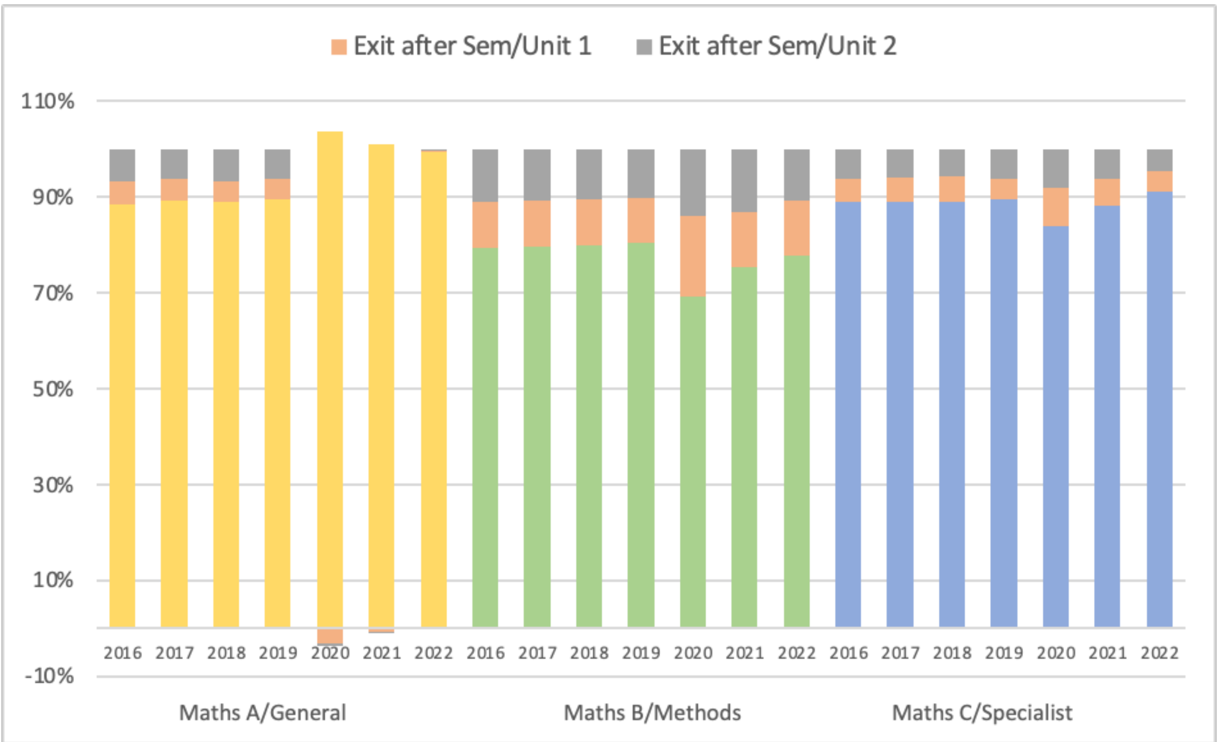
Enrolments in this data refer to completing four semesters (2012–2019) or completing Units 3 & 4 (2020–2021).

Figure 7 shows Mathematics enrolments are strongly correlated to the total enrolments. The significant dip in enrolments in 2019 was due to the smaller 'half cohort' of students who began in Prep in 2007. To meet the numeracy requirement of the QCE, students must complete at least one semester or unit of a Mathematics subject (or equivalent). The subject enrolment figures above count an enrolment as a student who has completed four semesters (2012–19) or Units 3 and 4 (2020–21) of the subject. Thus, over the 2012–2021 period, 96% to 99% of Year 12 students completed either four semesters or the final summative two units of a senior Mathematics subject.

Figure 8 and Figure 9 show there has been an increase in enrolments in General Mathematics (2020–21) and a decrease in enrolments in Mathematical Methods (2020–21) and Specialist Mathematics (2020–21), compared with their predecessors, respectively Mathematics A, B and C (2012–2019). At the same time, there has been a significant increase in enrolments in Essential Mathematics (2020–21) compared with its predecessor, Prevocational Mathematics (2012–19). Essential Mathematics can be used to contribute to an ATAR calculation and includes new quality assurance and assessment processes (endorsement and a Common Internal Assessment developed by the QCAA). It can therefore be viewed as a more rigorous and valued subject than its predecessor, which did not contribute towards the OP and did not have endorsed or QCAA developed assessment.

Figure 10 shows the percentage of students who exited the senior Mathematics subjects after completing one or two semesters/units. That is, students who selected this subject at the end of Year 10 but then moved out of the subject before beginning summative assessment in Year 12 or Units 3 and 4.

Figure 10. Percentage of Queensland students who exit Mathematics subjects after Semester 1 / Unit 1 or Semester 2 / Unit 2 — 2016 to 2022 cohorts



Note: The data shows that for the 2020 and 2021 cohort, there was a net gain of enrolments in Unit 2 and Unit 3 for General Mathematics.

The movement of students out of one Mathematics subject does not necessarily mean they moved into another Mathematics subject. However, the data in Figure 10 aligns with the data in Figure 8 and Figure 9. There are more students moving into General Mathematics compared with its predecessor Mathematics A, after Sem/Unit 1 and Sem/Unit 2. For Mathematical Methods and Specialist Mathematics, higher proportions of students are exiting after Sem/Unit 1 and Sem/Unit 2 than there were for their predecessors, Mathematics B and C. While this is a small sample, this difference was not so pronounced in 2021 and appears to be regressing to the mean.

The percentage of students in each senior Mathematics subject by the Year 9 NAPLAN numeracy band they achieved, for 2020 and 2021, is shown in Figure 11 and Figure 12 respectively.

Figure 11. Percentage of Queensland students in Mathematics subjects by 2017 Year 9 NAPLAN numeracy band, 2020

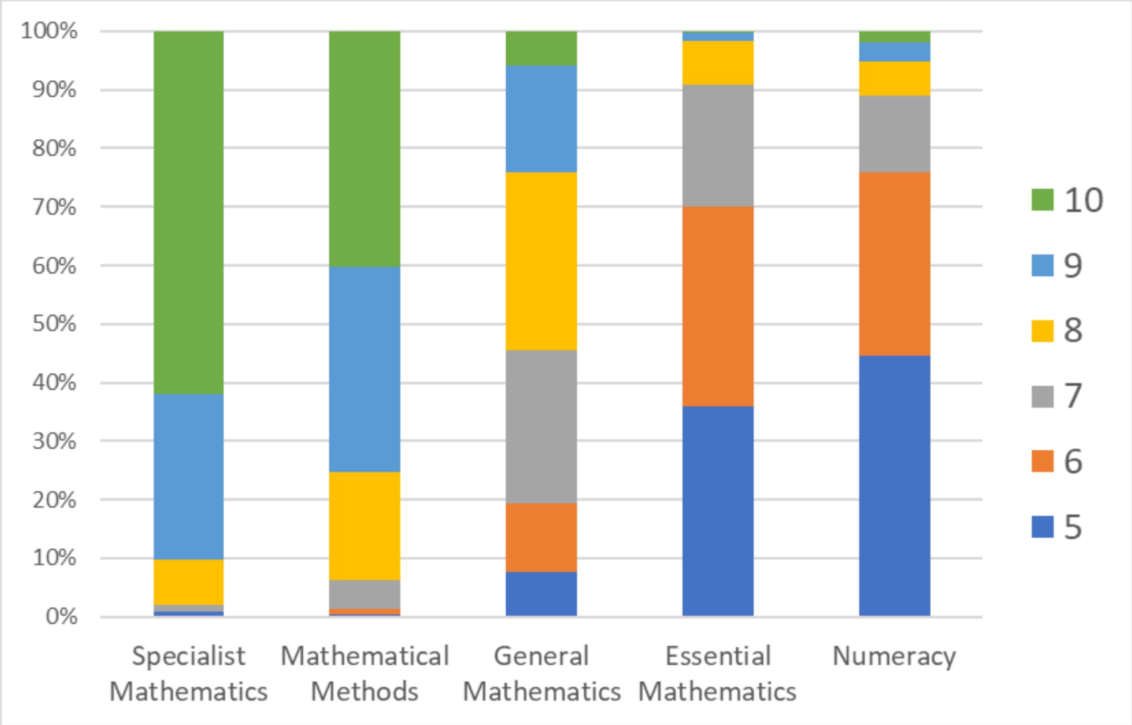
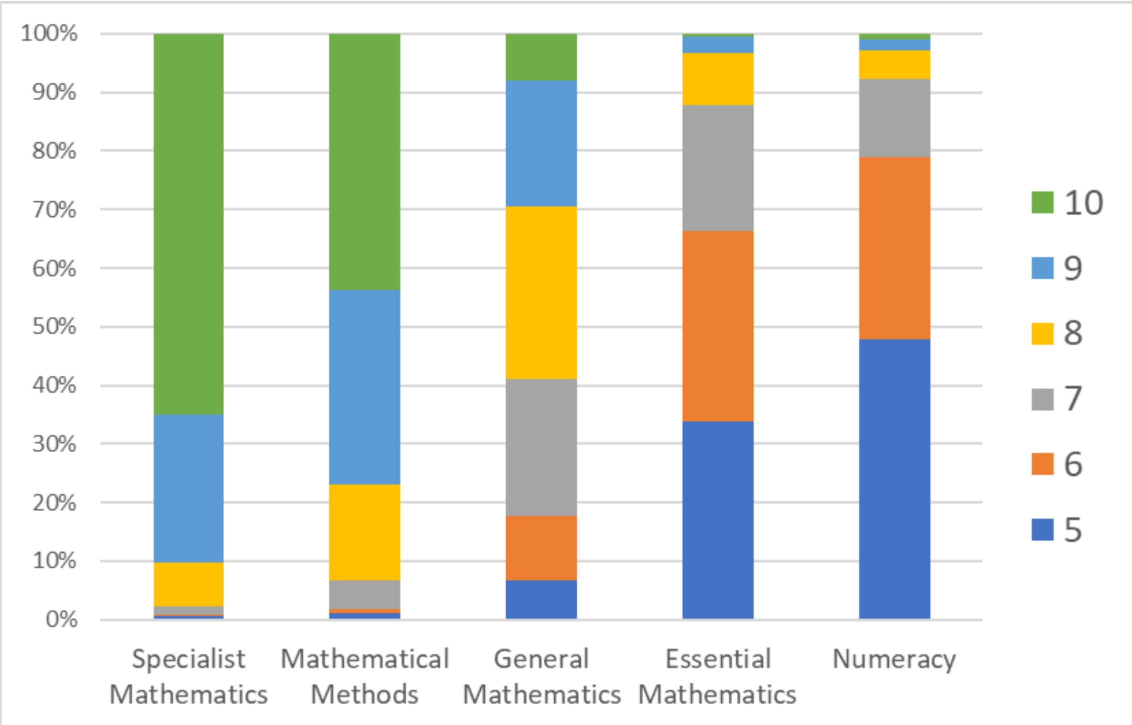


Figure 12. Percentage of Queensland students in Mathematics subjects by 2018 Year 9 NAPLAN numeracy band, 2021

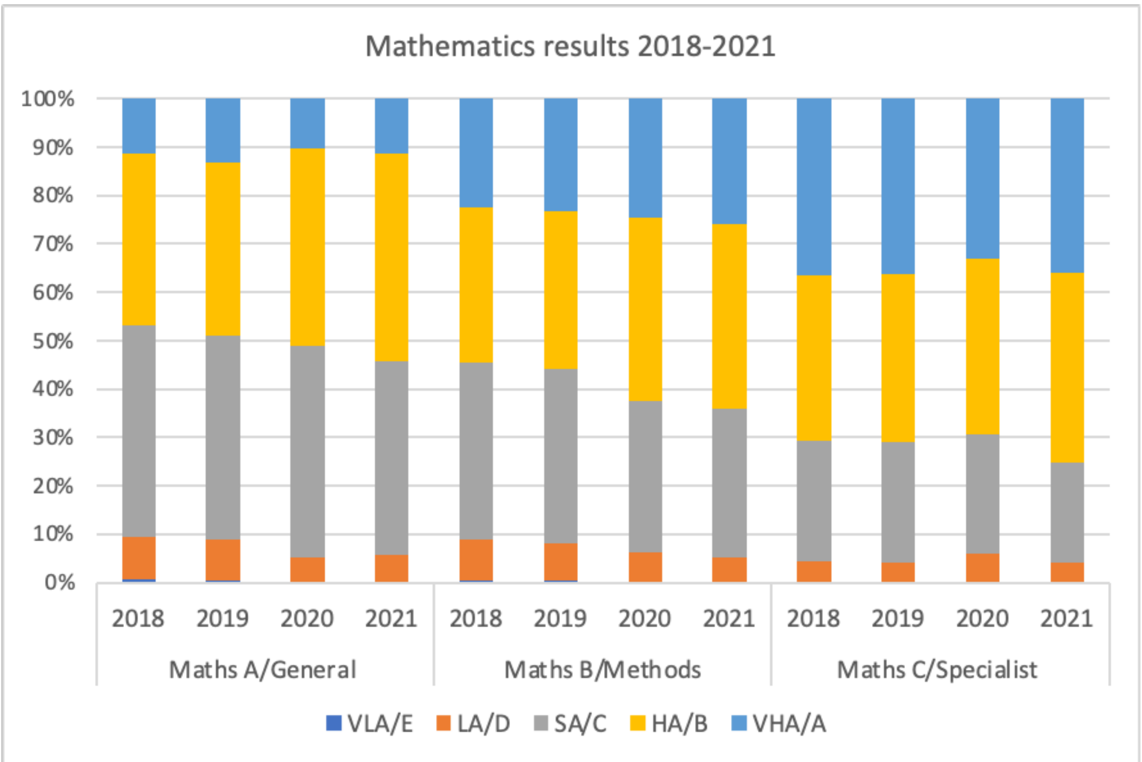


The data in Figure 11 and Figure 12 shows that students who went on to study the more advanced Mathematics subjects (Mathematical Methods and Specialist Mathematics) predominantly achieved a Band 9 or 10 for NAPLAN numeracy when they were in Year 9. This reinforces the finding outlined in the literature review regarding the influence of the previous level of success in Mathematics (Brinkworth & Truran 1998; Easey & Gleeson 2013; Fullarton & Ainley

2000; Jeffries, Curtis & Conner 2020; McPhan et al. 2008; Sikora & Pitt 2019; Watt, Eccles & Durik 2006).

Figure 13 provides the Mathematics results (in terms of the percentage of students who received each level of achievement or grade) between the last two years of the previous system and the first two years of the new system.

Figure 13. Comparison of Mathematics results in Queensland, 2018–2021



As previously noted, from 2020, the QCE introduced syllabuses based on the senior secondary Australian Curriculum that also included state-wide external examinations as a component of the assessment. As can be seen in Figure 13, the data shows that the performance of students has remained largely consistent. While this is a small sample, in the current system there was on average a higher percentage of students who attained an A, B or C compared with students attaining a VHA, HA or SA in the previous system.[1]

Table 4 shows a breakdown of the weighting of internal assessment (IA) and external assessment (EA) for senior Mathematics subjects in Queensland, New South Wales, Victoria, Western Australia and South Australia, as well as student enrolments in 2020 and 2021 as a percentage of the Year 12 cohort and as a percentage of those receiving an ATAR.

[1] From 2020, standards in the QCE system have been reported on a five-point scale, A–E. The previous system also reported on a five-point scale from Very High Achievement (VHA) through to Very Low Achievement (VLA).

Table 4. Jurisdictional IA/EA weighting and enrolments in Mathematics subjects[2]

				Percentage of Year 12		Percentage of ATAR	
		IA	**EA**	**2020**	**2021**	**2020**	**2021**
Essential Mathematics	QLD	100%	—	30.2%	31.3%	—	—
	WA	100%	—	39.3%	38.8%	—	—
	SA	70%	30%	7.0%	6.9%	—	—
General Mathematics	QLD	50%	50%	39.3%	38.9%	75.0%	74.3%
	NSW	50%	50%	45.3%	45.5%	56.0%	56.1%
	VIC	34%	66%	53.1%	52.0%	68.2%	69.3%
	WA	50%	50%	30.9%	30.5%	72.9%	73.6%
	SA	70%	30%	22.6%	22.3%	29.0%	—
Mathematical Methods	QLD	50%	50%	20.0%	18.9%	38.2%	36.1%
	NSW	50%	50%	25.0%	25.1%	30.9%	30.9%
	VIC	34%	66%	26.9%	26.4%	34.5%	35.1%
	WA	50%	50%	16.3%	16.1%	38.4%	38.8%
	SA	70%	30%	16.9%	16.7%	21.7%	—
Specialist Mathematics	QLD	50%	50%	6.5%	5.9%	12.4%	11.2%
	NSW	50%	50%	8.3%	7.7%	10.3%	9.5%
	VIC	34%	66%	7.0%	6.8%	9.0%	9.1%
	WA	50%	50%	6.1%	6.1%	14.5%	14.6%
	SA	70%	30%	5.7%	5.7%	7.3%	—

There are several similarities and differences between jurisdictions that are important to note. NSW includes a 50% external assessment in their Mathematics subjects, and South Australia a 30% external assessment. Victoria has a 66% external assessment for their Mathematics subjects. NSW and Victoria do not offer Essential Mathematics in Year 12, which would likely influence enrolments in the other subject offerings. In South Australia, Essential Mathematics includes an external examination, whereas in Queensland and Western Australia it does not. However, Western Australia includes an ‘Externally Set Task’ and Queensland a ‘Common Internal Assessment’ in Essential Mathematics. These assessments are externally developed by

[2] Data for this comparison was collated from the Australian Bureau of Statistics (2022), NSW Education Standards Authority (2021), Queensland Curriculum and Assessment Authority (2022), Queensland Tertiary Admissions Centre (2021a, 2022), South Australian Certificate of Education Board (2022), School Curriculum and Standards Authority (2022), South Australian Tertiary Admissions Centre (2022), Tertiary Institutions Service Centre (2022), Universities Admissions Centre (2021, 2022), Victorian Curriculum and Assessment Authority (2022), and Victorian Tertiary Admissions Centre (2022). 2021 South Australian ATAR data is not yet published at the time of writing.

the respective curriculum authorities but are administered and marked in schools as an internal assessment. NSW does not have Mathematical Methods and Specialist Mathematics, but rather, Mathematics Advanced, and Mathematics Extension 1 and 2 (approximately 40% of students who complete Extension 1 also complete Extension 2). The SACE Board of South Australia also assesses students in the Northern Territory.

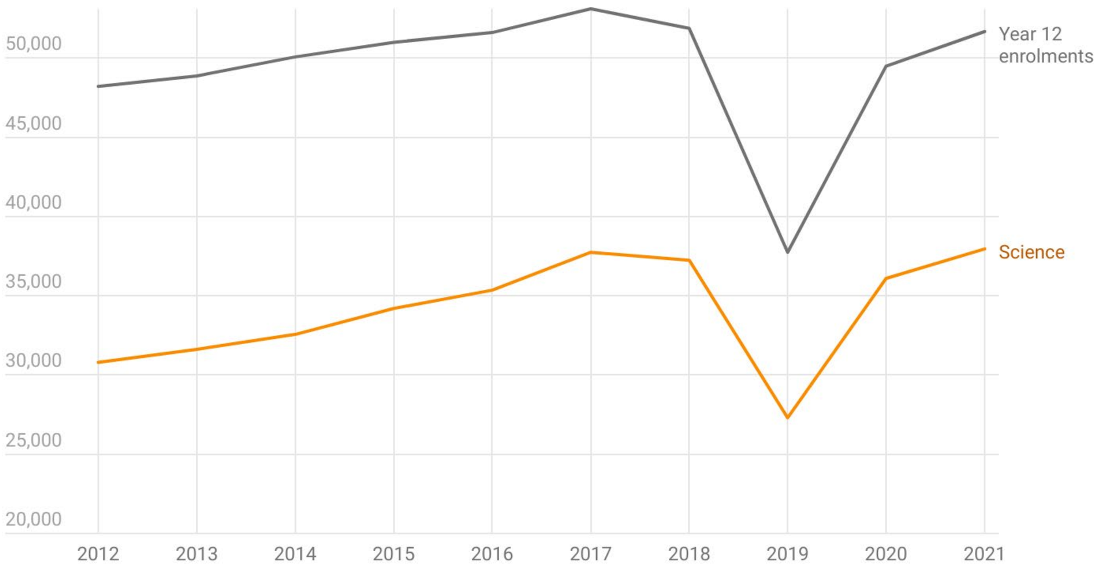
While a direct comparison may not be possible, from what we can see in Table 4, Queensland's enrolments appear to be in line with those of other states, as found by Chinofunga, Chigeza and Taylor (2022).

5.3 Queensland's Science enrolment data

Queensland's enrolment data from 2012 to 2021 for the Sciences learning area as a whole is shown in Figure 14. Figure 15 and Figure 16 show subject enrolment data.

Figure 14. Queensland Science learning area enrolments

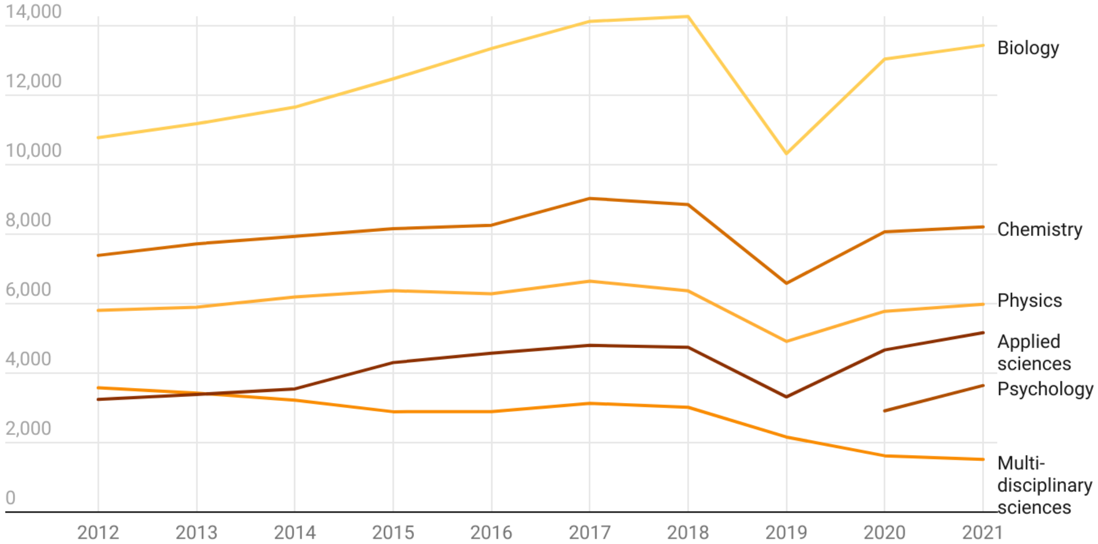
The total number of Year 12 students and total number of students enrolled in Science subjects



Total Year 12 enrolments are the number of students who received a senior education profile (SEP). Science enrolments are the sum of enrolments for each General and Applied Science subject (and their predecessors), i.e. students studying more than one Science subject are counted each time, not just once.

Figure 15. Science enrolment trends — number of Year 12 students

The number of Year 12 students enrolled in senior Science subjects in Queensland from 2012 to 2021.

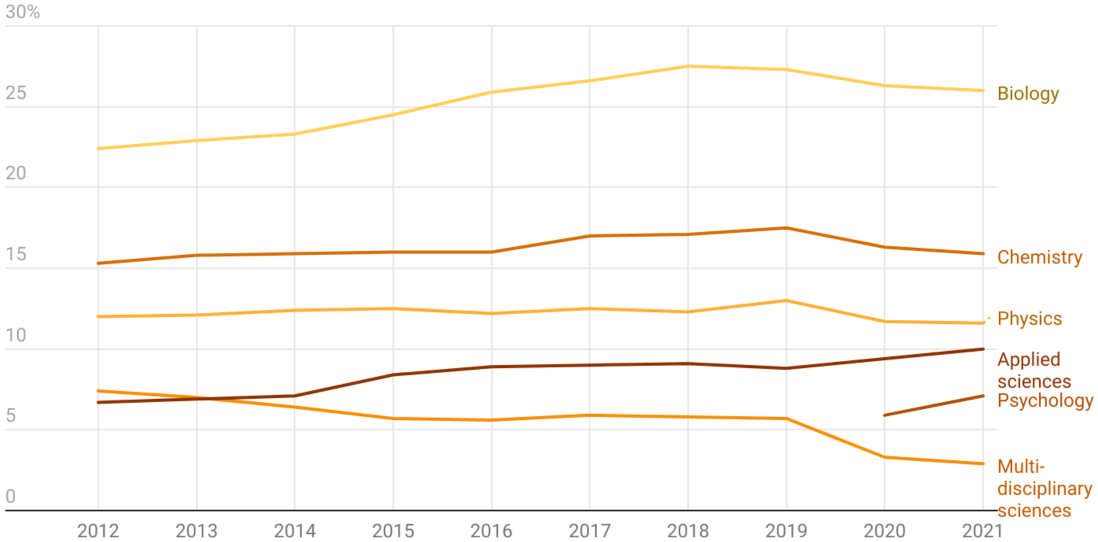


Enrolments in this data refer to completing four semesters (2012–2019) or completing Units 3 & 4 (2020–2021).

Applied sciences are Science in Practice, Agricultural Practices, Aquatic Practices, and their predecessors. Multi-disciplinary sciences are Agricultural Science, Earth & Environmental Science, Marine Science, Science21 and their predecessors.

Figure 16. Science enrolment trends — percentage of Year 12 students

The percentage of Year 12 students enrolled in senior Science subjects in Queensland from 2012 to 2021.



Enrolments in this data refer to completing four semesters (2012–2019) or completing Units 3 & 4 (2020–2021).

Applied sciences are Science in Practice, Agricultural Practices, Aquatic Practices, and their predecessors. Multi-disciplinary sciences are Agricultural Science, Earth & Environmental Science, Marine Science, Science21 and their predecessors.

As with the Mathematics enrolment data, the dip in 2019 is due to the smaller ‘half cohort’ of students who began Prep in 2007. Figure 14 shows Science enrolments are strongly correlated to total enrolments. However, over the last decade, overall science enrolments have increased at a greater rate than the cohort size increase. In 2012, the total Year 12 enrolments were 48,203, and in 2021 these had increased by 3,469 enrolments to 51,672. Total Science enrolments in 2012 were 30,792 (64% of the cohort), and in 2021 these had increased by 7,162 enrolments to 37,954 (73% of the cohort).

Figure 15 shows enrolments in Biology increased significantly from 2012 to 2018, and as can been seen in Figure 16, they have since stabilised, at approximately 26% of the cohort. Chemistry and Physics have remained relatively steady over the past decade in raw numbers and as a percentage of the cohort. Enrolments have gradually increased for the Applied science subjects (Science in Practice, Agricultural Practices and Aquatic Practices). The combined enrolments of the Multi-disciplinary sciences (Agricultural Science, Earth & Environmental Science, Marine Science and Science21) and their predecessors dropped in 2020. However, this is explained by the retirement of Science21 (final Year 12 cohort in 2019). For the Sciences learning area, this has been more than offset by the introduction of Psychology. At its peak in 2017, Science21 had an enrolment of 1,467 students. In its second year in 2021, Psychology had an enrolment of 3,644 students.

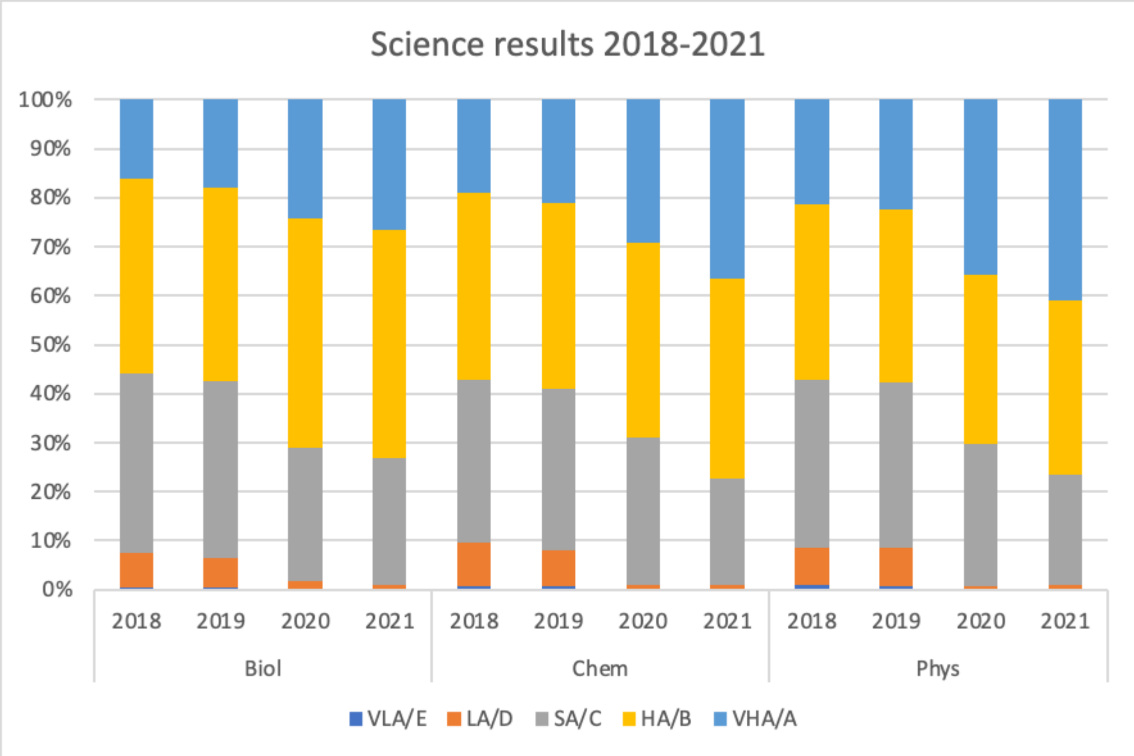
Figure 17 shows the percentage of students who exited senior Biology, Chemistry and Physics after completing one or two semesters/units — that is, students who selected this subject at the end of Year 10 but then moved out of the subject before beginning summative assessment in Year 12 / Units 3 and 4.

Figure 17. Percentage of Queensland students who exited Biology, Chemistry and Physics after Semester 1 / Unit 1 or Semester 2 / Unit 2 — 2016 to 2022 cohorts

As can be seen in Figure 17, a lower percentage of students exited Biology, Chemistry and Physics after Semester 1 / Unit 1 or Semester 2 / Unit 2 in the 2019–22 period than in the 2016–18 period. The data shows that in recent history, when students initially elected to study Biology, Chemistry or Physics in senior secondary, they were more likely to continue with their chosen subject in Year 12 than was previously the case.

Figure 18 provides the Biology, Chemistry and Physics results (in terms of the percentage of students who received each level of achievement or grade) between the last two years of the previous system and the first two years of the new system.

Figure 18. Comparison of Science results in Queensland, 2018–2021



As with Mathematics, from 2020, the QCE introduced syllabuses based on the senior secondary Australian Curriculum that include state-wide external examinations as a component of the assessment. The data shows a significantly higher percentage of students attaining an A, B or C in the current QCE system compared with students attaining a VHA, HA or SA in the previous system.[3]

Finally, Table 5 shows a breakdown of the weighting of internal assessment (IA) and external assessment (EA) for senior Biology, Chemistry and Physics in Queensland, New South Wales, Victoria, Western Australia and South Australia, as well as student enrolments in 2020 and 2021 as a percentage of the Year 12 cohort and as a percentage of those receiving an ATAR.

Table 5. Jurisdictional IA/EA weighting and enrolments in Science subjects[4]

				Percentage of Year 12		Percentage of ATAR	
		IA	**EA**	**2020**	**2021**	**2020**	**2021**
Biology	QLD	50%	50%	26.2%	26.3%	50.1%	47.8%
	NSW	50%	50%	27.9%	24.8%	34.4%	34.5%

[3] From 2020, standards in the QCE system have been reported on a five-point scale, A–E. The previous system also reported on a five-point scale, from Very High Achievement (VHA) through to Very Low Achievement (VLA).

[4] Data for this comparison was collated from the Australian Bureau of Statistics (2022), NSW Education Standards Authority (2021), Queensland Curriculum and Assessment Authority (2022), Queensland Tertiary Admissions Centre (2021a, 2022), South Australian Certificate of Education Board (2022), School Curriculum and Standards Authority (2022), South Australian Tertiary Admissions Centre (2022), Tertiary Institutions Service Centre (2022), Universities Admissions Centre (2021, 2022), Victorian Curriculum and Assessment Authority (2022), and Victorian Tertiary Admissions Centre (2022). 2021 South Australian ATAR data is not yet published at the time of writing.

	VIC	50%	50%	24.2%	28.0%	31.0%	31.6%
	WA	50%	50%	24.7%	25.5%	58.2%	58.7%
	SA	70%	30%	17.6%	16.8%	22.6%	—
Chemistry	QLD	50%	50%	16.2%	16.3%	31.0%	29.6%
	NSW	50%	50%	15.2%	13.5%	18.7%	18.8%
	VIC	40%	60%	17.5%	20.3%	22.5%	22.9%
	WA	50%	50%	17.9%	18.6%	42.3%	42.7%
	SA	70%	30%	10.9%	10.4%	14.0%	—
Physics	QLD	50%	50%	11.6%	11.7%	22.2%	21.2%
	NSW	50%	50%	12.0%	10.7%	14.8%	14.8%
	VIC	40%	60%	11.9%	13.8%	15.3%	15.5%
	WA	50%	50%	11.5%	11.9%	27.1%	27.4%
	SA	70%	30%	9.5%	9.1%	12.2%	—

As previously noted, there are similarities and differences between the states. As with Mathematics, NSW and Western Australia include a 50% external assessment and South Australia a 30% external assessment in their Science subjects. Victoria has a 50% external assessment in Biology, and a 60% external assessment in Chemistry and Physics. Western Australia offers both Biology and Human Biology in senior secondary. Noting these differences, Queensland’s Biology, Chemistry and Physics enrolments as a percentage of Year 12 and as a percentage of those receiving an ATAR are comparable with those of the other states.

6 Conclusion

Changes to enrolments in senior Mathematics and Science subjects should be viewed with an understanding of the complex broader factors that influence the reality of senior secondary schooling. Demographic factors, such as SES, expanded subject offerings, and senior secondary certification, and tertiary entrance requirements or incentives will all affect subject enrolments.

In 2020, Queensland introduced subject-based external assessment for the first time in nearly 50 years and tertiary entrance processes changed, enabling students to include one Applied subject or one VET subject in a tertiary entrance rank calculation. For this cohort of students, Queensland’s senior Mathematics syllabuses, along with the senior science subjects of Biology, Chemistry, Earth & Environmental Science, and Chemistry, were developed from their equivalent senior secondary Australian Curriculum subjects, with nationally agreed content and standards, in accordance with QCAA legislation. All other subjects were also revised to align with the design of the Australian Curriculum subject (where an equivalent existed) and external assessment requirements. While there are many more similarities than differences in the content of these syllabuses and previous ones, they are new subjects.

During any period of significant transition, fluctuations in subject enrolments are perhaps unsurprising. With the introduction of the new syllabuses, along with the changes to the QCE and tertiary entrance systems, there has been a significant increase in enrolments in Essential Mathematics when compared with its predecessor, Prevocational Mathematics. Essential

Mathematics can be used to contribute to tertiary entrance calculations whereas its predecessor could not. There has also been an increase in General Mathematics enrolments compared with its predecessor, Mathematics A. Conversely, there has been a decrease in the enrolments in Mathematical Methods and Specialist Mathematics, compared with their equivalent predecessors.

For Science overall, enrolments remain strong. Over the past decade, enrolments (as a percentage of the cohort) in the disciplinary Sciences (Biology, Chemistry, and Physics) have been stable or have increased. There was a slight decrease in 2020, but the 2020–21 enrolments are equivalent to the 2015–16 period. There has been significant interest in the new subject Psychology, and enrolments in the Multi-disciplinary sciences (Agricultural Science, Earth & Environmental Science, Marine Science) and Applied sciences (Agricultural Practices, Aquatic Practices and Science in Practice) continue to grow.

As with Essential Mathematics, the Applied sciences can be used to contribute to tertiary entrance calculations, whereas their corresponding authority-registered subjects could not. The 2019 syllabus revisions to the Multi-disciplinary and Applied sciences provided clear pathways from these courses into tertiary education or post-school employment. Many tertiary courses that require a senior Science as a prerequisite (e.g. Primary Education) treat all the General Science subjects equally for prerequisite purposes.

The data shows that Queensland’s Mathematics and Science enrolments are broadly aligned with national trends and other jurisdictions. Comparing the data from the previous system with data from the new system, it is clear that students are continuing to study and achieve good results in Mathematics and Science subjects.

The research into why students choose to study Mathematics and Science reveals a complex mixture of competing motivations. Students make varying decisions about their senior pathways based on pragmatism, individual beliefs and the wide variety of learning options available to them in senior secondary. Their choices are initially made in Year 10 and, for some, continue to be made in Year 11, where at the completion of Unit 1 or Unit 2, they may change their enrolment out of a Mathematics or Science subject to one more commensurate with their past performance or of greater interest to them. In all cases, students (in consultation with their teachers and parents/carers) are encouraged to select subjects that will help them achieve their post-schooling plans by giving them the best chance for success in senior secondary.

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