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Access to senior secondary science and mathematics: examining the evidence for stratification in an Australian school system

Jenny Dean[1] · Philip Roberts[1] · Steve Murphy[2]

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Abstract
This research investigates access to senior school science and mathematics subjects offered in the final year of secondary schooling. Using data from the most populous Australian state of New South Wales, we examine whether stratification occurs in access to science and mathematics curricula. We find that the opportunity to study these subjects differs by key school characteristics, including location, socioeconomic composition and school sector. We find that while some science subjects and entry level mathematics are offered in most schools, substantial inequalities exist in access to the most advanced level of mathematics and chemistry. School location, socioeconomic composition, enrolment size and the availability of teachers predict the probability of whether a school offers the least and most advanced science and mathematics subjects. The findings highlight that stratification in curricula offerings occurs systemically and may intensify educational inequalities.

Keywords Secondary education · Curriculum · Educational equity · School stratification · STEM education · Australia

Introduction

Internationally, considerable importance over the last decades has been attached to science, technology, engineering and mathematics (STEM) education at all levels. STEM is seen to be critical to economic productivity and innovation (Freeman et al., 2019; Goodrum et al., 2012; Office of the Chief Scientist, 2012, 2013) and there is a "sense of urgency" (Office of the Chief Scientist, 2013, p. 9) to increase STEM employment levels and technological competitiveness (Australian Industry Group [AIG], 2013; Organisation for Economic Co-operation and Development [OECD], 2017; Morgan & Kirby, 2016; Pettigrew, 2012; Quintini, 2011). Many national governments have noted with concern declining achievement and student participation in STEM subjects, including the United Kingdom (House of Commons Science & Technology Committee, 2017); the United States of America (Committee on STEM Education, 2018), and Australia (Education Council, 2018). Research has documented this declining interest and participation in the study of STEM subjects, particularly science and mathematics, in Australian schools (Kennedy et al., 2014; Lyons & Quinn, 2010; Murphy, 2019, 2020) and in higher education (AIG, 2013). The reasons posed for these issues in Australia include low levels of student interest and motivation to study senior science (Lyons & Quinn, 2010) and advanced mathematics (McPhan, 2008), a lack of qualified teachers and support for science and mathematics professional development and teaching (Australasian Science Education Research Association, 2021; Office of the Chief Scientist, 2013), and the need for improved systems to encourage teacher and student engagement in science and mathematics subjects at school (Dekkers & De Laeter, 2001; Wilson & Mack, 2014).

Patterns of participation in science and mathematics have mostly been examined as specific to the science and mathematics disciplines themselves, and the motivations of students to study these subjects (Wang & Degol, 2013; Wang et al., 2017). However, there is evidence of a strong relationship between differences in many areas of the curriculum available to students at secondary school and the choices that students make to study a range of disciplines (Lamb et al., 2001; Perry & Lubienski, 2020). Indeed, participation in most core subject streams including English, mathematics, the sciences, economics, and vocational education, are

✉ Jenny Dean
Jenny.Dean@canberra.edu.au

1 Faculty of Education, University of Canberra, 11 Kirinari Street, Bruce ACT 2617, Canberra, Australia

2 School of Education, La Trobe University, Albury-Wodonga, Australia

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related to structural characteristics such as location and levels of school advantage or disadvantage (Dean et al., 2023b; Roberts et al., 2019) as well as to student characteristics such as socioeconomic status (SES) and gender. The senior secondary curriculum acts as a sorting mechanism differentiating more privileged students from those of low SES backgrounds and is reflected in the subjects that students are more likely to study as well as the subjects that schools are more likely to offer (Bleazby, 2015; Teese & Polesel, 2013; Tranter, 2012).

In this study, we examine the number and type of science and mathematics subjects offered across schools in New South Wales (NSW), Australia, and the evidence for stratification in the schooling system manifest through the number and nature of the curricula offered (Han, 2015; Perry & Lubienski, 2020). Along with Teese and others (Dean et al., 2023b; Murphy, 2019, 2020; Perry & Lubienski, 2020; Teese, 2013; Teese & Polesel, 2013), we believe that it is critical to identify what barriers might exist in access to these subjects at the systemic level. It is our contention that access to the science and mathematics curriculum varies by a range of school factors including the socioeconomic composition of the school and also, fundamentally, a school's location.

Literature review

Student participation in science and mathematics, particularly at the senior levels of schooling, have been examined in a range of international and Australian contexts. Comparable data on senior science and/or mathematics participation over time are not generally available, but there is an indication that student participation levels have increased in Singapore, Finland, China, Hong Kong and Korea, with achievement and policy initiatives reflecting an emphasis on high levels of investment in STEM (Freeman et al., 2019; Goodrum et al., 2012; Hodgen et al., 2010). In contrast, there are concerns that students in other nations such as the UK, USA, and Australia are both under-participating and underperforming in science and mathematics (AIG, 2015; Committee on STEM Education, 2018; Education Council, 2018; House of Commons Science & Technology Committee, 2017; Marginson et al., 2013). Between 1992 and 2012, school participation rates in science and mathematics subjects in all Australian states and territories declined except in Earth Sciences and general level science and mathematics (Jaremus et al., 2019; Kennedy et al., 2014). While there is some evidence that trends have slowed in some Australian states (Jaremus et al., 2019), there have been continuing decreases in student enrolment in intermediate and higher-level mathematics subjects in recent times (Wienk, 2022). Further, there has been a decrease in the proportion of Australian students graduating at tertiary level in the natural sciences, engineering, and information and communication technologies (OECD, 2017). These issues are seen as evidence of a "leak from the education pipeline" (Cooper et al., 2020, p. 362), where falling numbers of school science and mathematics enrolments are seen to affect the number of people studying the sciences at tertiary level and entering careers in these fields (Bergeron & Gordon, 2017; AIG, 2015).

Many parts of Asia including China, Japan, Singapore, South Korea have nationally integrated systems, with strong alignment to standards in science and mathematics curriculum and pedagogy (Marginson et al., 2013). On the other hand, along with the "Anglosphere" (Freeman et al., 2019, n.p.) countries of Canada, New Zealand, the United Kingdom and the United States, Australia is characterised as a decentralized country, with greater autonomy and choice given to individual schools for decisions and allocation of resources, staffing and curriculum (Asia Society, 2006; Freeman et al., 2019; Perry & Lubienski, 2020). In the latter systems, decentralisation in schooling is also seen to shape student decisions about, and participation in, certain subjects (Smyth & Hannan, 2006). In turn, much of the research literature exploring patterns of participation and subject choice in mathematics and the sciences in these countries has focussed on individual characteristics, including gender and SES, as well as students' personal motivations, attitudes and aspirations (Perry & Lubienski, 2020; Smyth & Hannan, 2006). Studies at the turn of the century by the Australian Council of Educational Research on Year 12 subject choice (Ainley et al., 1994; Fullarton & Ainley, 2000; Fullarton et al., 2003) for example, have consistently documented the influence of SES on students' participation in mathematics and the physical sciences. They have found that higher proportions of students whose parents are in professional occupations study physics and chemistry compared with those whose parents are in unskilled or semi-skilled jobs. Similarly, gender differences are striking, with males predominating in more advanced levels of mathematics, physics and chemistry, and females generally less likely to study all science and mathematics subjects except biology (Fullarton et al., 2003). More recent research has confirmed these findings in relation to both SES (Cooper et al., 2020; Gorard & See, 2009) and gender (Jaremus et al., 2019; Watt et al., 2006). Further, subject choices in later years of schooling are found to reflect prior achievement levels, particularly in mathematics and science (Gill & Bell, 2013; Jeffries et al., 2020; Smyth & Hannan, 2006; Tripney et al., 2010). Such factors are shown to interact with student attitudes to affect later subject choices and achievement in both mathematics and science (Jeffries et al., 2020). School organisation at lower secondary levels also structures initial subject choices which, in turn, shape the opportunities open to students at a later stage. These issues and the overall declines in science and mathematics subjects have shaped the kinds of research that many researchers have pursued in terms of student attitudes about, and motivations to study, mathematics and the sciences. For example, several studies have identified the influence of family background in the development of higher or lower "ability self-concept" (Wang et al., 2017, p. 1822) and its consequent influence on motivation, confidence levels and ultimately, senior subject choices (Gorard & See, 2009; Watt et al., 2006). In another study, it was found that girls had similar achievement levels to boys in Years 9 and 11 mathematics Watt et al. (2006), yet boys had significantly higher self-perceptions of their mathematics abilities than girls and indicated that they liked maths more than girls. A further study showed that students' take-up of science subjects was influenced by their motivations, enjoyment, perceptions and self-confidence in their abilities (Hassan, 2008).

Far less attention in the research literature has been given to structural factors that influence access and opportunities to learn science and mathematics subjects. Some exceptions to this are studies by Smyth and Hannan (2006), Perry and Lubienski (2020), and Perry et al. (2021). The researchers in these studies argue that differences in curricula and learning opportunities are influenced by school socioeconomic composition and the sector of schools, with non-government, higher SES schools generally offering a greater range of science and mathematics subjects. Studies with an emphasis on structural factors posit that even after controlling for family background and other individual factors, there is a strong relationship between subject availability in the final year of school, and post-school study choices and achievement levels (Dean et al., 2023b). Further, as school leaders respond to school resourcing and other constraints, they develop strategies for maintaining their competitiveness in the local education market in terms of the curricula they offer, such as different provisioning of a range of science or mathematics subjects (Perry & Lubienski, 2020).

In the United States (US), researchers have examined the links between setting academic standards for certain subject streams including mathematics, and the consequences of this for school students (Attewell & Domina, 2008; Domina & Saldana, 2012). They argue that while the expansion of mathematics courses in American high schools has encouraged the broader offering of more demanding curricula as required in US standards-based school reforms, practices within schools still mean that low SES students are less likely to be taking advanced courses in subjects such as calculus in their later years of schooling even after controlling for prior achievement levels. These and other empirical studies have confirmed that selectivity and subject streaming practices[1] effectively retain inequalities in school mathematics course placements (Adelman, 2006; Attewell & Domina, 2008; Long et al., 2009; Sandholtz et al., 2004). In Australia, streaming of students occurs at a relatively high rate compared to other OECD countries (OECD, 2012). Mathematics and the sciences are particularly subject to streaming in high school (Perry & Lamb, 2016), and these practices have been acknowledged to induce stratification by SES, gender, and cultural background (Brunello & Checchi, 2007; Connolly et al., 2019; Hornby & Witte, 2014). Moreover, streaming practices used within schools may lead to differential opportunities students have to access more advanced course content (Chmielewski, 2014; Dupriez & Dumay, 2006; Levin, 2007).

Between-school inequalities have also been examined. Compared to other OECD countries, Australian schools are highly segregated by location, their socioeconomic composition, and differences in the resources allocated to schools (OECD, 2019; Perry et al., 2021). Segregation in Australia has been fuelled by policies of school choice and the allocation of public funds to expand choice into the private sector (Campbell et al, 2009; Dean et al., 2023b; Lamb, 2007). These aspects define the Australian schooling system in terms of levels of equity, resources and other factors including diversification of the curriculum. In short, inequality may be perpetuated simply because certain subjects, and/or more advanced course content, are not offered in and across schools.

Underlying many of these issues is a strong association between access to school subjects, the characteristics of the students taking them and the structural factors that give rise to patterns of access, participation and achievement. Termed a "curriculum hierarchy" by Richard Teese (2013, p. 229), this hierarchy is related to the different valuing of subjects in the school curriculum based on socially constructed perspectives about certain knowledge, and how and which students are privy to this knowledge (Bleazby, 2015; Teese, 2013; Teese & Polesel, 2013). In the hierarchy, higher-status subjects are generally more abstract and theoretical while lower-status subjects are more concrete and practical (Bleazby, 2015). Researchers argue that certain subjects such as the more advanced streams of mathematics and the physical sciences are in the former category because of their abstractness and requirement for "higher-order thinking" (Bleazby, 2015, p. 677). The relative lower status of other subjects, including other mathematics and science subjects such as biology and general mathematics, reflects their connection to more concrete problems and experience

[1] Placing students into classes or learning groups based on an assessment of their ability levels, also known as tracking in the United Kingdom and the United States.

(Bleazby, 2015; Lynch & Baker, 2005; Teese & Polesel, 2013). The valuing of knowledge in this way recognises the long history between institutions and social status, and the fact that participation and achievement in certain subjects are dominated by students from certain social backgrounds. These concepts draw on the sociology of knowledge and power (Apple, 2004; Kenway et al., 2017), but also speak to the in-school processes that facilitate the dominance of powerful subjects in bringing about school and post-school outcomes, in particular university entry (Kenway et al., 2017; Ryan & Watson, 2009). Later research has established that the hierarchy continues to be socially constructed through the value that is placed on subjects and is strongly influenced by socioeconomic status (Dean et al., 2023b; Roberts et al., 2019). Researchers (e.g. Lamb et al., 2001; Perry & Southwell, 2014; Perry et al., 2021) have confirmed that access to, and achievement in, the curriculum hierarchy vary by a range of other factors including school sector, gender and location.

Another aspect that has received significant attention in the literature is teacher resourcing and quality in relation to mathematics and science subjects (Schleicher, 2012). In Australia, resource disparities are manifest across school sectors as well as by levels of school advantage and location (Levin, 2007; Perry et al., 2021). A 2003 report noted teacher shortages in specialist mathematics and science subjects as well as the difficulty in attracting mathematics and science teachers to remote locations, and the importance of recruiting and retaining the most qualified and experienced teachers (Committee for the Review of Teaching & Teacher Education, 2003). A decade or more later, there is evidence that these issues remain (Bonnor et al., 2021; Lloyd, 2013; Productivity Commission, 2012; Timms et al., 2018). A particular concern in disadvantaged and regional schools is the proportion of teachers who are teaching out of their field of qualification, that is, they are teaching subjects other than those they were trained for (Marginson et al., 2013). Out-of-field teaching is known to have effects on the availability of, and achievement in, science and mathematics subjects (Shah et al., 2020) and is more frequent in government and Catholic schools (McKenzie et al., 2014) and in non-metropolitan locations (Weldon, 2016). Using 2015 Programme for International Student Assessment data, Shah et al. (2020), for example, found that the predicted probabilities for teaching out-of-field mathematics and science were considerably higher for smaller schools and those in remote locations. In addition, smaller schools are generally less able to offer a wide range and diversity of curricular offerings compared to larger schools (Dean et al., 2023b; Lee et al., 2000; Perry & Southwell, 2014), and are also likely to be more poorly resourced and staffed than larger schools (Alegre & Ferrer, 2010; Lamb, 2007). Further, in schools with lower enrolment levels, school leaders' perceptions of student abilities and expected pathways are more likely to influence the offering of less diverse pedagogies and curriculum (Perry & Lubienski, 2020). In regard to location, research by Murphy (2019, 2020) looked at the effects of SES and location on senior science and mathematics participation and achievement in Victoria, using a two-way distinction between metropolitan and non-metropolitan schools. He found in both studies that low SES and non-metropolitan schools were less likely to offer as wide a range of these subjects, and further, that students performed less well, on average, than students in other schools. Several studies in the United States have found that the gap in rural and low SES students' mathematics achievement levels may be integral in perpetuating inequality in these environments (Reeves, 2012; Schmidt et al., 2015). Teacher availability, retention and training are also differentially impacted by locational issues in Australia (Downes & Roberts, 2018; OECD, 2010).

Building on structural perspectives around the concept of the curriculum hierarchy, this study examines the extent to which inequalities exist in access to science and mathematics subjects as selective influences on students' patterns of course taking, and differential opportunities to access various subjects. To consider these issues, we pose the following research questions:

1. Is there a science and mathematics curriculum hierarchy in New South Wales?
2. What proportion of schools offer science and mathematics subjects in Year 12?
3. Do the number and proportion of science and mathematics offerings, and the number of advanced science and mathematics offerings, vary by school socio-educational advantage, sector, location, year enrolment size and the number of teachers per student?
4. What is the probability of advanced or non-advanced science and mathematics subjects being offered in schools of different levels of socio-educational advantage, location and number of teachers per student?

Method

We investigate the extent to which science and mathematics subjects are offered by schools in the last year of secondary school in NSW. Table 1 lists the Science and Mathematics subjects examinable in the NSW Higher School Certificate (HSC) (Universities Admissions Centre, 2018) and that are contained in this analysis. These subjects have the potential to provide pathways

Table 1 Higher School Certificate subjects included in this study

Name	Brief overview[a]	2017 scaled mean[b]
Biology	Students learn about variations in the structures and functions of organisms and provides an understanding of the effects of the environment on living things. Students investigate reproduction, inheritance patterns and the causes of genetic variation	26.2
Chemistry	Students develop their knowledge, understanding and skills in relation to properties and structures of matter and a variety of chemical reactions incorporating organic compounds and acid/base equilibrium reactions	31.4
Earth/Environmental Science	Students learn about the compositional layers of the Earth and investigate how processes of plate tectonics, the formation of water and the introduction of life interact with different spheres and climate	23.4
Physics	Students develop their knowledge, understanding and skills relevant to the study of motion. Students examine energy in its different forms, and how we describe and measure electricity and magnetism and their interrelated effects	30.5
Senior Science	Students develop an understanding of the ethical, social, economic and political influences on science and scientific research in the modern world	18.5
Mathematics General 2	Students develop their knowledge, understanding and skills in working mathematically, improve their skills to solve problems relating to their present and future needs, and improve their understanding of how to communicate in a concise and systematic manner	21.7
Mathematics	Students develop their knowledge, understanding and skills in mathematics and working mathematically. Students have the opportunity to develop ways of thinking and use mathematics as a powerful way of viewing and modelling the world to investigate patterns, order, generality and uncertainty	31.2
Mathematics Extension 1	Students have the opportunity to develop rigorous mathematical arguments and proofs and use mathematical models extensively. Students develop their awareness of the interconnected nature of mathematics, its beauty and its functionality	39.3
Mathematics Extension 2	Students have the opportunity to develop strong mathematical manipulation skills and a deep understanding of the fundamental ideas of algebra and calculus, as well as an appreciation of mathematics as an activity with its own intrinsic value involving invention, intuition and exploration	43.2

[a]Brief overview drawn from NESA syllabus descriptions at https://educationstandards.nsw.edu.au/wps/portal/nesa/11-12/stage-6-learning-areas/. Subject names are those used in 2017

[b]Scaled means are taken from https://www.uac.edu.au/assets/documents/scaling-reports/Scaling-Report-2017-NSW-HSC.pdf. Scaled means are calculated out of a maximum of 50 to ensure comparability across extension subjects (1 unit, or maximum 50) and other subjects (2 unit, or maximum of 100)

to STEM professions to varying extents, however, it is worth noting that while many university courses recommend the study of senior mathematics or science, only Chemistry, Physics, and Mathematics Extensions 1 or 2, are listed as pre-requisites for access to STEM tertiary courses in NSW (Universities Admissions Centre, 2022). Some mathematics subjects must be taken concurrently: Mathematics Advanced is a corequisite to study Mathematics Extension 1; and Mathematics Extension 1 is a corequisite to study Mathematics Extension 2. Consequently, a student studying Mathematics Extension 2 must commit to studying both Mathematics Extension 1 and Mathematics.

Data

The NSW Education Standards Authority is the agency responsible for developing the final two years of curriculum in NSW and it is also responsible for student assessment. The dataset in our research covers students, schools and courses and was developed using data provided by the NSW Education Standards Authority, with university ethics approval.[2] We have drawn information on science and mathematics subjects and school characteristics from this dataset, which includes all schools in NSW that enrolled any Year 12 student engaging in at least one examinable subject in 2017—a total of 770 schools.[3] All data in the following analysis are the authors' calculations.

[2] Data are examined under University of Canberra Human Ethics approval number 20170077 and are used with permission from the NSW Education Standards Authority.

[3] This includes thirteen specialist schools aimed to provide a targeted technology education in NSW. These schools cover a variety of technology across all Key Learning Areas (Timms et al., 2018; School Choice, 2023).

Analytical strategy

Our analysis consists of descriptive statistics, a series of linear regressions examining the number of science and mathematics subjects per school and finally, logistic regressions from which probabilities have been calculated to predict the offerings of specific higher and lower status science and mathematics subjects in schools. Coefficients and/or probabilities are reported, measuring the degree of association between the outcome variables and predictors, interpreted as net effects on the outcome variables. Our aim is to test the association between the number and type of science and mathematics subjects offered in the final year of school (known in Australia as Year 12) and levels of school socio-educational advantage, school location, number of teaching staff and the number of Year 12 enrolments. The variable of school sector is not included in regressions because of issues of multicollinearity. This occurs, among other reasons, when there are relatively high correlations between two or more predictor variables, creating skewed and unstable modelled results (Mela & Kopalle, 2002). In this case, there is a correlation between high levels of socioeconomic composition and schools in the Catholic and independent sectors, while schools in the government sector, particularly those in outer regional and remote areas, are correlated with lower levels of socioeconomic composition (see Table 2).

Variables

The outcome variables in this study are the number of science and mathematics subject offerings per school,

Table 2 Distribution and characteristics of NSW schools

School sector	ICSEA quintile (%)					Total number of schools	%
	1st (lowest)	2nd	3rd	4th	5th (highest)		
Metropolitan schools							
Government	96.0	88.0	49.5	37.1	28.5	247	51.0
Catholic	0.0	6.7	29.3	32.8	20.8	102	21.1
Independent	4.0	5.3	21.2	30.2	50.7	135	27.9
Total (%)	100.0	100.0	100.0	100.0	100.0		100.0
Mean year 12 enrolments	80	112	103	115	128	113	
All metropolitan schools (n)	50	75	99	116	144	484	
Inner regional schools							
Government	97.0	86.4	25.5	3.0	0.0	96	52.2
Catholic	0.0	3.4	42.6	27.3	0.0	31	16.8
Independent	3.0	10.2	31.9	69.7	100.0	57	31.0
Total (%)	100.0	100.0	100.0	100.0	100.0		100.0
Mean year 12 enrolments	63	70	72	65	64	68	
All inner regional schools (n)	33	59	47	33	12	184	
Outer regional/remote/very remote schools							
Government	100.0	91.7	50.0	0.0	0.0	93	91.2
Catholic	0.0	8.3	25.0	33.3	0.0	5	4.9
Independent	0.0	0.0	25.0	66.7	0.0	4	3.9
Total (%)	100.0	100.0	100.0	100.0	0.0		100.0
Mean year 12 enrolments	22	36	52	40	nd	28	
All outer regional, remote and very remote schools (n)	67	24	8	3	0	102	
All schools							
Government	98.0	88.0	42.2	28.9	26.3	436	56.6
Catholic	0.0	5.7	33.1	31.6	19.2	138	17.9
Independent	2.0	6.3	24.7	39.5	54.5	196	25.5
Total (%)	100.0	100.0	100.0	100.0	100.0		100.0
Mean year 12 enrolments	50	85	91	103	124	91	
All schools (n)	150	158	154	152	156	770	

nd no data

comprising some or all of the subjects listed in Table 1. The number of science and mathematics offerings considered to be more advanced are also included to assess the effects of predictor variables on the offering of these subjects. The subjects included in this latter count of subjects are Physics, Chemistry, Mathematics, Mathematics Extension 1, and Mathematics Extension 2 and, for calculating probabilities, the individual subjects of Chemistry, Senior Science, Mathematics Extension 2 and Mathematics General 2. The scaled means of these subjects (see Table 1 and Fig. 1) signal their social status and level of complexity.

Predictor variables are those which operationalise the characteristics of SES, school socio-educational advantage, sector, location, number of teachers per student and the mean number of Year 12 enrolments. The measure of SES used in the construction of the curriculum hierarchy is measured through an index based on information provided by parents on their occupation and education and provided to each school. To create a continuous variable for each student, joint parental values are standardized, and the mean calculated, allowing each student to be placed on a normal distribution relative to other students. Data examining the socio-educational advantage of schools have been based on the Index of Community Socio-Educational Advantage (ICSEA), derived from parental occupation and education data for each student as well as Indigenous enrolments and the remoteness of the school. The Australian Curriculum, Assessment and Reporting Authority (ACARA) combines this information into a score for each school, with a median of 1000 and a standard deviation of 100, and values from low to high representing disadvantaged to advantaged educational backgrounds of students in each school (ACARA, 2015). In this study, school ICSEA scores are divided into quintiles ranging from lowest to highest (with the highest values in each quintile being 609–930, 931–982, 983–1035, 1036–1089 and 1090–1286, respectively). In addition to school ICSEA, the distribution of socio-educational advantage can be divided into four socio-educational advantage quarters representing a scale of relative disadvantage to relative advantage based solely on parental levels of occupation and education. In logistic regressions, schools are classified as 'advantaged' or 'less advantaged' based on whether the percentage of students in the bottom quarter of student socio-educational advantage in each school is less than or greater than 25% (ACARA, 2015). School location is based on the ABS remoteness structure (Australian Bureau of Statistics, 2018). Remoteness areas are based on the Accessibility Remoteness Index of Australia, a geographic accessibility index which measures the remoteness of a point to the nearest urban centre in each of five classes (see Australian Bureau of Statistics, 2018),[4] but in this study these categories have been collapsed to three: major cities, inner regional areas, and outer regional, remote and very remote areas. The data include 484 schools in major cities, 184 schools in inner regional locations and 102 schools in outer regional, remote and very remote locations (see Table 2). School sector is made up of government and non-government schools, with the government sector comprising 436 schools, and the non-government sector comprising 138 Catholic and 196 independent schools (see also Table 2). The number of teachers per student is presented as an estimate of the resource capacity of schools. It is calculated as the number of full-time enrolments divided by the number of full-time equivalent teaching staff and is included in linear regression models as a three-way cut (low, medium and high teachers per student, with the lowest and highest values in each group of 3.38–11.05, 11.06–13.13 and 13.14–23.05), and in logistic regressions as a two-way cut (low and high numbers of teachers per student, with the lowest and highest values in each group being 3.38–12.09 and 12.10–23.05). As the mean number of teaching staff is correlated with school size, the number of enrolments in the final year of school is an additional predictor variable, included in linear regression models as a three-way cut (small, medium and large number of Year 12 enrolments, with the lowest and highest values in each of these groups being 1–55, 56–108 and 109–466). Year 12 enrolment size is a more accurate measure of school enrolment size than total school size, as it reflects the year of schooling for which data on science and mathematics subjects are relevant.

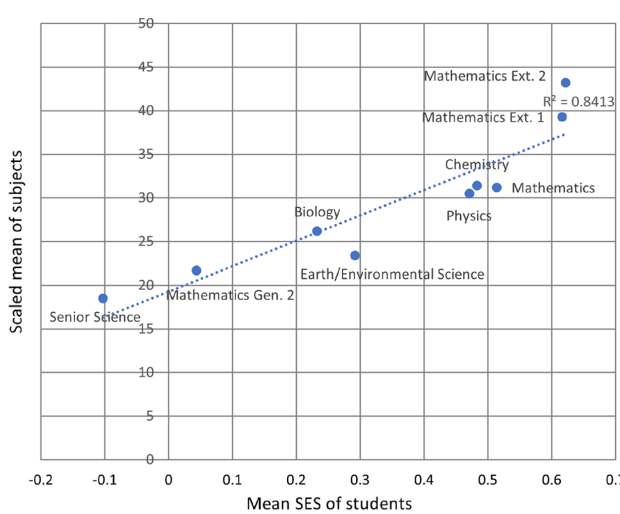

Fig. 1 Science and mathematics curriculum hierarchy

Findings

Table 2 summarises the distribution of schools in NSW according to ICSEA quintile, sector, location and mean size of enrolments in Year 12. There are substantial differences

[4] The five classes are major cities of Australia; inner regional Australia; outer regional Australia; remote Australia and very remote Australia.

across these key variables. Government schools comprise just over half (51%) of metropolitan schools, 52% of inner regional schools, and 91% of outer regional, remote and very remote schools. In addition, government schools comprise most of the schools in the two lowest ICSEA quintiles (98% and 88% respectively) while Catholic and independent schools together comprise most of the schools in the highest two quintiles (71% and 74% respectively). Finally, across metropolitan locations, just over half of schools are from the highest two ICSEA quintiles (54%) while across both inner regional locations and outer regional, remote and very remote locations, there are far lower proportions of schools in these quintiles (24% and 3% respectively). Table 1 also shows that mean enrolments in the final year of school increase by ICSEA quintile from an average of 50 in the lowest quintile to 124 in the highest quintile. Schools in outer regional, remote and very remote areas are also considerably smaller, on average (a mean of 28 students) than schools in both inner regional areas (68 students) and major cities (113 students). Similar patterns by ICSEA quintiles in which enrolments are generally smaller in lower quintiles occur across all locations confirming that there is a correlation between smaller enrolments and both socio-educational advantage and location. In Australia, socio-educationally disadvantaged schools are on average smaller because they tend to be marginalised (Lamb, 2007), a converse effect of the selectivity processes, in particular those in metropolitan areas, allowing more socially advantaged schools to sustain higher enrolment levels (Bonnor et al., 2021; Dean et al., 2023b; Lamb, 2007).

To answer the first research question, we investigate the hierarchy of science and mathematics subjects which reflects the differential valuing of school subjects and the disparity between low and high SES students taking up these subjects. The hierarchy is represented on the x-axis by the average SES of the students participating in science and mathematics subjects and on the y-axis by each subject's scaled mean, measuring the average level of academic achievement for each of these subjects (Universities Admission Centre, 2018). The Universities Admissions Centre independently determines the scaling for subjects and their contribution to a student's tertiary entrance rank—a score that is used to determine entry to university courses (Universities Admission Centre, 2018). This hierarchy is shown in Fig. 1.

The figure shows that there is a correlation between the study of higher-status science and mathematics subjects (that is, subjects with higher scaled means)—including Mathematics, Mathematics Extension 1 and 2, Chemistry and Physics—by students of higher average SES, and likewise, a correlation between the study of subjects that have lower scaled means—including Mathematics General 2 and Senior Science—by students of lower average SES.

To answer research question 2, Table 3 shows the proportion of schools across the three location categories that offer each science and mathematics subject as well as the mean number of these subjects offered per school. The table shows that access to science and mathematics subjects is patterned by the location of the schools that students attend. Among science fields, the subjects of Biology, Chemistry and Physics are almost universally offered in metropolitan

Table 3 Schools that offer science and mathematics subjects, by location and subject field

	Metropolitan schools $n=484$	Inner regional schools $n=184$	Outer regional/remote/very remote schools $n=102$	All schools $n=770$
Science subjects offered in schools	Percent			
Senior science	60.3	63.6	50.0	59.7
Biology	96.5	97.8	80.4	94.7
Chemistry	95.3	94.0	58.8	90.1
Physics	93.6	92.4	48.0	87.3
Earth/environmental science	22.3	25.0	4.9	20.6
	Number			
Mean science subjects offered per school	3.7	3.7	2.4	3.5
Mathematics subjects offered in schools	Percent			
Mathematics general 2	96.9	99.5	93.1	97.0
Mathematics	97.9	96.2	73.5	94.3
Mathematics extension 1	91.7	87.0	40.2	83.8
Mathematics extension 2	66.1	44.6	10.8	53.6
	Number			
Mean mathematics subjects offered per school	3.5	3.3	2.2	3.3

and inner regional schools, but these subjects are much more variably offered across outer regional, remote, and very remote schools. Biology remains relatively accessible in outer regional, remote, and very remote areas, with 80% of schools offering this subject, however Chemistry and Physics are only available in 59% and 48% of schools respectively. Earth/Environmental Science is only available in 22% and 25% of metropolitan schools and inner regional schools respectively, but even more rarely offered—less than 5%—in outer regional, remote and very remote areas. The generic subject of Senior Science is offered in half of schools in outer regional, remote, and very remote areas, approximately 10% less than other schools.

Among mathematics fields, Mathematics Extension 2, the most advanced mathematics subject in the HSC, has quite limited provision across all school location categories; it is offered in 66% of metropolitan schools, 45% of inner regional schools, and 11% of outer regional schools. Overall, only slightly more than half of schools in NSW offer Mathematics Extension 2 (54%). While the two other subjects viewed as advanced—Mathematics and Mathematics Extension 1—are widely offered in both metropolitan and inner regional schools, they are again more variably offered in outer regional, remote, and very remote locations (74% and 40%, respectively). In contrast, the generalist subject of Mathematics General 2 is offered in 97% of all schools in NSW and in more than 90% of schools across all location categories.

In summary, with the exceptions of Mathematics Extension 2, Senior Science, and Earth/Environmental Science, all science and mathematics subject fields are widely offered across schools in metropolitan and inner regional locations. However, all science and mathematics subjects are far less accessible across outer regional, remote, and very remote locations, particularly those regarded as advanced and that serve as preparation for tertiary STEM pathways, including Chemistry, Physics, Mathematics Extension 1, and Mathematics Extension 2. These statistics are reflected in the mean numbers of science and mathematics subjects offered across schools in these locations, where schools in outer regional, remote, and very remote locations offer, on average, almost 1½ fewer subjects across each of these subject streams than schools in other locations.

In Table 4, we examine the average number of all science and mathematics subjects offered by schools according to location, sector and ICSEA quintile. While the analysis of

Table 4 Mean number of all science and mathematics subjects offered, by location, sector and ICSEA quintile

	School sector			
	Government	Catholic	Independent	All schools
	n = 436	*n* = 138	*n* = 196	*n* = 770
School ICSEA quintile	Mean number of science/mathematics subjects offered per school			
Metropolitan schools				
1 (lowest)	6.4	nd	3.0	6.3
2	7.3	7.0	4.5	7.1
3	7.7	7.6	5.1	7.1
4	8.1	7.6	6.3	7.4
5 (highest)	7.5	7.9	7.3	7.5
All metropolitan schools	7.4	7.7	6.6	7.2
Inner regional schools				
1 (lowest)	6.6	nd	7.0	6.6
2	7.2	3.5	6.1	7.0
3	8.0	7.6	5.3	7.0
4	9.0	8.1	6.8	7.2
5 (highest)	nd	nd	7.6	7.6
All inner regional schools	7.1	7.5	6.5	7.0
Outer regional, remote and very remote schools				
1 (lowest)	4.2	nd	nd	4.2
2	5.0	7.0	na	5.2
3	6.0	7.5	1.5	6.2
4	nd	7.0	7.0	7.0
5 (highest)	nd	nd	nd	nd
All outer regional, remote and very remote schools	4.5	7.2	4.3	4.6

nd no data

averages gives less information on the nature of individual subjects (e.g., whether schools are offering greater or fewer numbers of advanced subjects), it nevertheless gives an indication of access to these disciplines. Metropolitan schools across the three sectors offer an average of 7.2 subjects, but those in the lower ICSEA quintiles, particularly government and independent schools, offer fewer subjects on average than schools in higher ICSEA quintiles. Across all sectors, metropolitan schools offer one less science and mathematics subject, on average, in schools in the lowest ICSEA quintile compared with schools in the highest quintile. The mean number of subject offerings in inner regional schools is similar, with an average of 7.0 subjects offered.

Fewer subjects are again offered across schools in lower ICSEA quintiles than schools in higher quintiles, particularly those in the government and independent sectors. Finally, schools in outer regional, remote and very remote locations offer an average of only 4.6 subjects and the number of subjects is almost 3 subjects lower, for schools in the lower ICSEA quintiles than those in the highest quintile, with the greatest variability among those in the government and independent sectors. Of the three sectors, Catholic schools are the most likely to offer consistently high numbers of subjects, with schools generally offering seven or more subjects in all locations and across almost all ICSEA quintiles.

An important additional factor that shapes school offerings of science and mathematics curricula is the number of teachers per student. Comparing the teacher to student ratio to the mathematics and science subjects offered provides an indirect measure reflecting the priorities driving the decisions made by school leaders. Science and mathematics subjects may have small or specialised enrolments, and whether to offer them depends on perceptions of student needs and post-school study and career aspirations, school size, as well as the availability of teachers to teach certain subjects (Dean et al., 2023b; Perry & Lubienski, 2020). Figure 2 shows that the number of science and mathematics

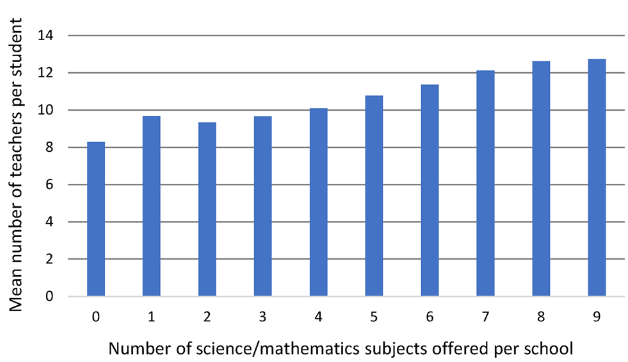

Fig. 2 Number of science and mathematics subjects offered by number of teachers per student

subjects offered does indeed vary by the mean number of teachers per student. Schools offering no science or mathematics subjects have an average of 8.3 teachers per student while those offering nine science and mathematics subjects (the maximum possible number of these subjects) have an average of 12.7 teachers per student.

Linear regression analysis

To answer research question 3, in Table 5, three models are constructed to examine the separate effects of the predictor variables on the number of science and mathematics offerings in schools. The analysis includes all schools with Year 12 students in NSW. While levels of statistical significance are not needed because it is a census of schools, they are included to give an indication of the dispersion and variation in the reported numbers.

Looking first at Model 1, the data show that there are few differences in the number of science subject offerings between ICSEA quintiles and the reference group of the lowest quintile, and for schools with high numbers of teaching staff per student compared with the reference group of schools with low numbers of teaching staff per student, after controlling for all other factors. However, in schools with both medium and large year enrolments, the number of these subjects *increases* by more than half a subject and over one subject respectively (0.76 and 1.22) compared with the reference group of small year enrolments. For schools in outer regional, remote and very remote areas, the number of science subjects also decreases by half a subject.

(-0.51) compared with those in major cities.

In Model 2, which shows superior explanatory power (adjusted $R^2 = 43.0\%$), the data again show minimal differences in the number of mathematics subjects for schools with high numbers of teaching staff per student, as well as those in inner regional areas, after controlling for all other factors. Like Model 1, the number of mathematics subjects *increases* by more than half a subject each (0.57 and 0.75 respectively) for schools with medium and large year enrolments compared with those with small year enrolments. Conversely, the number of mathematics subjects *decreases* by half a subject (-0.45) for schools in outer regional, remote and very remote areas compared with those in major cities. In addition, with each ICSEA quintile, the number of mathematics subjects increases by between a third of a subject and almost one subject each (0.32, 0.47, 0.70 and 0.78 respectively).

The third model in Table 5 examines the effects of the same group of predictor variables on the number of advanced maths & science offerings. The model confirms that even when only considering the most advanced subjects in the science/mathematics hierarchy, schools with both medium and high year enrolments are more likely to offer greater numbers of these subjects (0.86 and 1.09 respectively) than those with low

Table 5 Linear regression models estimating coefficients for effect on number of science and mathematics subject offerings

	Model 1 Number of science offerings *n* = 770 Coefficients	Model 2 Number of mathematics offerings *n* = 770	Model 3 Number of advanced science and mathematics offerings *n* = 770
ICSEA quintile (ref = 1 [lowest])			
2	0.14	0.32***	0.44***
3	0.01	0.47***	0.58***
4	0.09	0.70***	0.83***
5 (highest)	0.02	0.78***	1.02***
Number of teachers per student (ref = low)			
Medium	0.17*	0.14*	0.22*
High	0.04	0.05	0.11
Year size (ref = small)			
Medium	0.76***	0.57***	0.86***
Large	1.22***	0.75***	1.09***
Remoteness (ref = metropolitan schools)			
Inner regional schools	0.33***	0.08	0.15
Outer regional/Remote/Very remote schools	− 0.51***	− 0.45***	− 0.88***
Constant	2.73***	2.37***	2.84***
Adjusted *R* squared (expressed as %)	33.25%	43.01%	44.61%

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

year enrolments. The number of advanced subjects decreases by almost one subject (− 0.88) for schools in outer regional, remote and very remote areas compared with those in major cities and net of other factors. In addition, with each ICSEA quintile, the number of advanced subjects offered increases by half a subject and about one subject (0.44, 0.58, 0.83 and 1.02 respectively). This model again has superior explanatory power (adjusted $R^2 = 44.61\%$) and is an indication of a high strength of association between the number of advanced subject offerings and the identified predictor variables.

In summary, when holding other factors constant, the numbers of science and mathematics subjects are lower, on average in outer regional, remote and very remote schools and in schools with fewer year enrolments. School socio-educational advantage has only a small impact on the number of science subjects offered, but far greater impact on the number of mathematics subjects and also on the total number of advanced science and mathematics subjects offered. The effects of the number of teachers per student appear to be mediated by school size, which provides the broader context for the offering of small or specialised science and mathematics subjects and the availability of staff to teach these subjects.

Logistic regression analysis

To answer research question 4, we examine the effects of school predictors on selected individual science and mathematics subjects by conducting logistic regressions and interpreting these as predicted probabilities, holding all covariates at their means. Logistic regression is a model which predicts effects on a binary outcome variable (in this case whether the subject of interest is respectively offered or not offered in each school) in relation to a series of predictor variables. In logistic regression, point estimates are produced as coefficients or odds ratios, but the output can be difficult to interpret and present. Therefore, in this study, the value of the outcome variables of interest at given values of the predictor variables are expressed as predicted probabilities, using the margins command in Stata (see Williams, 2012). In these models, the probabilities are predicted with the values of other variables held at their means and calculated as values between 0 and 1.

In the following analysis, the predicted probabilities are shown in Table 6 as Models 1, 2, 3 and 4. They are visualised through a series of graphs (the odds ratios for each model are also given in Appendix 1, Table 1). The predictor variable of location is modelled together with school socio-educational advantage, and number of teachers per student included as binary alternatives in the models (see *Variables* section for further explanation of how these variables are constructed). Schools with 25% or fewer students in the bottom quarter of socio-educational advantage are termed 'advantaged' in the following analysis, and schools with greater than 25% or more students in the bottom quarter of socio-educational

Table 6 Predicted probabilities of schools offering selected subjects

	Metropolitan schools	Inner regional schools	Outer regional/ remote/very remote schools
	Predicted probabilities[c]		
Model 1			
Chemistry			
Advantaged schools, high teacher numbers by student	0.96	0.96	0.70
Advantaged schools, low teacher numbers by student	0.93	0.92	0.55
Less advantaged schools, high teacher numbers by student	0.97	0.96	0.72
Less advantaged schools, low teacher numbers by student	0.94	0.93	0.58
Model 2			
Mathematics Extension 2			
Advantaged schools, high teacher numbers by student	0.80	0.69	0.36
Advantaged schools, low teacher numbers by student	0.72	0.58	0.26
Less advantaged schools, high teacher numbers by student	0.52	0.37	0.13
Less advantaged schools, low teacher numbers by student	0.40	0.27	0.09
Model 3			
Senior Science			
Advantaged schools, high teacher numbers by student	0.59	0.61	0.45
Advantaged schools, low teacher numbers by student	0.45	0.48	0.32
Less advantaged schools, high teacher numbers by student	0.76	0.78	0.65
Less advantaged schools, low teacher numbers by student	0.65	0.67	0.51
Model 4			
Mathematics General 2			
Advantaged schools, high teacher numbers by student	0.96	0.99	0.84
Advantaged schools, low teacher numbers by student	0.96	0.99	0.83
Less advantaged schools, high teacher numbers by student	0.99	1.00	0.95
Less advantaged schools, low teacher numbers by student	0.99	1.00	0.94

[c]Derived from logistic regression estimates (see Appendix 1 and text for details)

advantage are termed 'less advantaged'. Teacher numbers per student are divided into two categories—low and high. Four subjects have been selected for analysis: the subjects in the science and mathematics streams that are, respectively, highest in the curriculum hierarchy (Chemistry and Mathematics Extension 2) and those which are lowest (Senior Science and Mathematics General 2).

Looking first at Model 1 for the subject of Chemistry in Fig. 3, the graph shows that metropolitan and inner regional schools have a 90% or higher probability of offering Chemistry, and these probabilities are almost the same for both advantaged and less advantaged schools with higher and lower numbers of teachers per student. In contrast, schools in outer regional, remote and very remote locations have a much lower probability of offering Chemistry, with those schools with higher numbers of teachers per student more likely to offer Chemistry (70% and 72% probabilities respectively) than those with lower numbers of teachers (55% and 58% probabilities respectively).

Figure 4, examining Model 2 for Mathematics Extension 2, shows that advantaged schools in metropolitan schools have the highest probability of offering this subject, with schools with a higher numbers of teachers per student (80%) slightly more likely to offer this subject than schools with lower numbers of teachers per student (72%). This pattern is consistent across all locations, with lessening chances of offering Mathematics Extension 2 by levels of school advantage and number of teachers per student. Indeed, less advantaged schools in outer regional, remote and very remote locations are over six times less likely to offer Mathematics Extension 2 than advantaged schools in metropolitan schools, and are four times less likely to offer this subject than their counterpart (i.e. less advantaged) schools in metropolitan areas.

Figures 5 and 6 model the probabilities of offering those subjects which are lowest in the curriculum hierarchy: Senior Science and Mathematics General 2. The patterns for these two subjects vary somewhat. However, in general, the chances of offering these subjects are higher for less advantaged schools and those in metropolitan or inner regional locations. In addition, while there are almost universally high probabilities of offering Mathematics General 2 across all locations, the chances of offering this subject are still slightly lower in outer regional, remote and very remote schools than

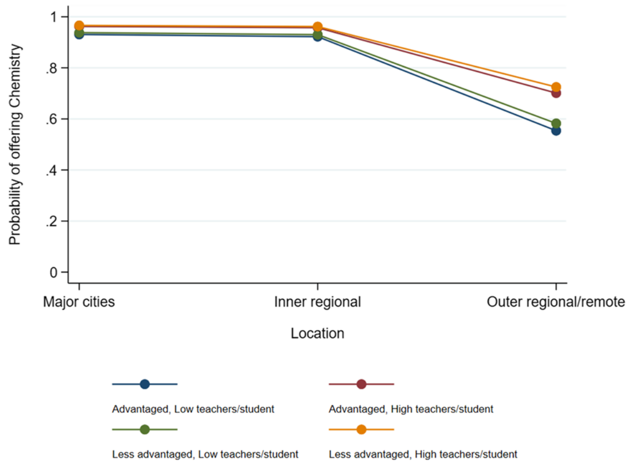

Fig. 3 Predicted probabilities of schools offering Chemistry, by levels of school socio-educational advantage, number of teachers per student and location

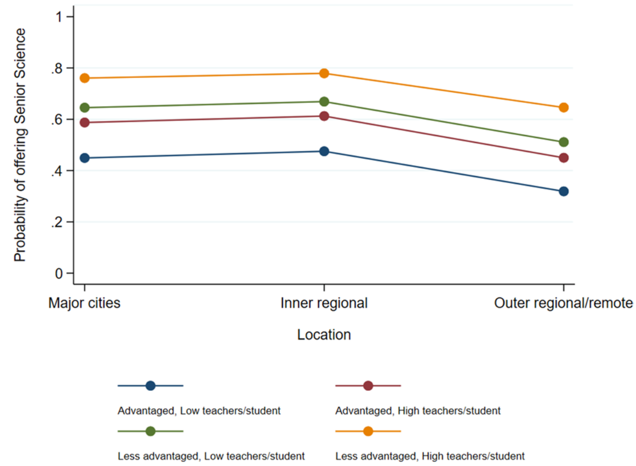

Fig. 5 Predicted probabilities of schools offering Senior Science, by levels of school socio-educational advantage, number of teachers per student and location

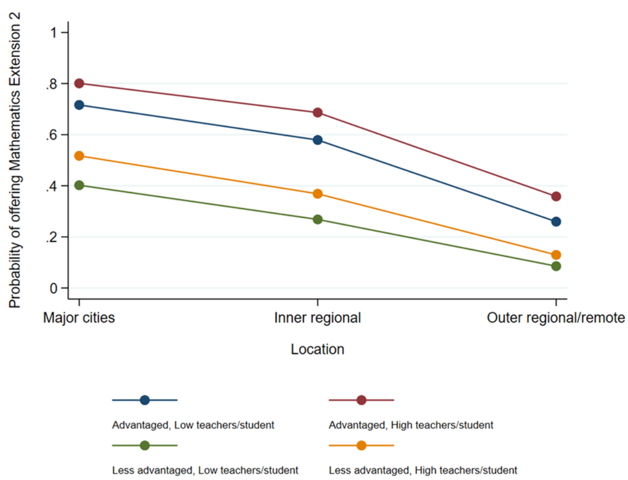

Fig. 4 Predicted probabilities of schools offering Mathematics Extension 2, by levels of school socio-educational advantage, number of teachers per student and location

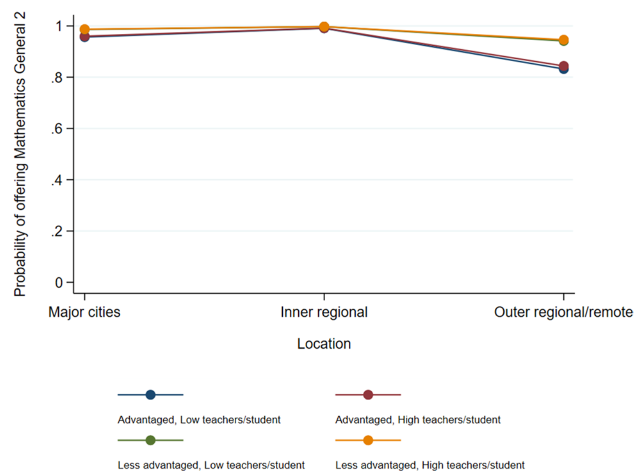

Fig. 6 Predicted probabilities of schools offering Mathematics General 2, by levels of school socio-educational advantage, number of teachers per student and location

other schools. Again, these trends are likely to reflect the decisions made by school leaders on the resourcing and staffing of schools that affect the availability of curricular offerings.

Conclusion

This study adds to the body of research examining structural factors that contribute to the science and mathematics curriculum hierarchy. The research departs from the existing literature in that we attempt to relate the effects of structural factors to equity in the curriculum. Specifically, we have identified between-school inequalities in access to science and maths curricula and this adds to the current research literature which is mainly focussed on in-school differences and student motivations and characteristics in studying STEM subjects. The results presented here suggest that a school's location and size as well as its levels of socio-educational advantage or disadvantage, all have an influence on students' access to the science and mathematics curriculum. There is very little empirical evidence about equity effects relating to subject access, particularly in mathematics and science, and we hope to build the case for further research in these areas.

First, we have shown that school location significantly impacts the offering of science and mathematics subjects. The offering of Chemistry and Physics—subjects that provide access to tertiary STEM pathways (Universities Admissions Centre, 2022)—is almost universal in metropolitan and inner regional schools, but these subjects are only offered by about half of schools in outer regional, remote and very remote locations. Similarly, the most advanced mathematics subject is six times more likely to be offered in metropolitan locations than in outer regional, remote and very remote locations. Indeed, all mathematics subjects other than Mathematics General are significantly less likely to be offered in outer regional, remote and very remote locations than other locations. The impact of location on Science and Mathematics offerings is far larger than that noted by Murphy (2019, 2020) in studies of Victorian schools. Murphy's study included only government schools, whereas this study includes government, independent and Catholic schools. Further Murphy only included a two-way distinction between metropolitan and non-metropolitan schools, while we were able to have a separate distinction for outer regional, remote and very remote schools. We note that the variation between metropolitan and inner regional schools, and between sectors in these locations, are not as apparent as variation between outer regional and remote schools with other schools. A case in point is that our study was conducted in NSW which has a greater proportion of schools in remote and very remote locations than Victoria.

Second, while there are few variations in the number of science subjects offered between schools of different levels of socio-educational advantage, this is not the case for the number of mathematics subjects, where schools in the highest quintile offer an average of one mathematics subject more than schools in the lowest quintile. Highest quintile schools also offer an average of one more of the most advanced science and mathematics subjects. The study also reveals different patterns of subject access and take-up by school sector, with Government and Catholic schools on average providing greater access to science and mathematics than independent schools. In fact, Catholic schools provide higher average access to these subjects across all locations, with this difference being most pronounced for outer regional, rural and remote locations.

Third, it is evident from our findings that curricular offerings are shaped by the size and location of schools in conjunction with the choices made by school leaders about subject content based on the number and availability of teachers to teach certain subjects. The Centre for Education Statistics and Evaluation (2013) along with other research (Downes & Roberts, 2018) have identified difficulties in recruiting, retaining and developing teachers in rural and remote locations. These issues in turn have impacts on the offering of subjects that are more selective and it appears that science and mathematics subjects, particularly advanced mathematics, are casualties in this regard. Our analysis reveals that enrolment size mediates the number of teachers as well as the offering of more specialised science and mathematics subjects which also tend to be the more advanced-level subjects. The results of our study indeed confirm that schools with larger Year 12 enrolments are likely to offer more science and mathematics subjects than schools with smaller Year 12 enrolments. These effects are again most acute in non-metropolitan areas where, even after controlling for enrolment size, schools in these areas offer, on average, fewer subjects than schools in metropolitan areas. The results confirm other research indicating that many small, rural and disadvantaged schools are subject to marginalisation and, consequently, offer less curriculum diversity (Dean et al., 2023a, 2023b; Lamb, 2007; Perry & Lubienski, 2020).

A limitation of our research is that we have only examined a single jurisdiction in Australia. However, we note that the research builds on similar studies in the Australian context (e.g., Perry & Southwell, 2014; Perry et al., 2021) and that both NSW and Australian schools share many features of high performing education systems internationally, and many of the same challenges in regard to equity. Due to the lack of suitable data, we cannot assess patterns of mathematics and science subject-taking prior to the final year of school, and this is a further limitation of the current study. It is also not possible to identify the potential influence of student characteristics, such as the number of students from immigrant backgrounds in the data, and therefore to assess the influence of aspirational patterns and preferences for studying STEM subjects. Data in the study are at school level and it is noted that future studies will explore the implications of student characteristics, including prior achievement levels, on participation and later achievement in science and mathematics.

Previous research has highlighted the role of subject access in the formation of stratification in the types and location of schools that students attend and the subjects they take (Dean et al., 2023b; Lamb et al., 2001; Teese & Polesel, 2013). While these issues are often couched more in terms of students' preferences and aptitudes, it is clear that structural factors interact with individual factors to stratify curricular offerings as well as student choices. The results of this research support these findings. In short, the organisation and provision of the curriculum in the final year of schooling reinforces forms of advantage and disadvantage in the subjects that schools are more likely to offer. The consequence of this stratification is that students have differential access to learning opportunities. Compared to many other countries, Australian schools are highly segregated, accompanied by inequalities in human and instructional resources (OECD, 2019). These inequalities are associated with high levels of marketization, and are manifest in staff shortages, less curriculum diversity and low enrolments in schools that are already highly marginalised (Bonnor et al., 2021; OECD, 2012). In policy terms, "…choice-based systems [need to] have carefully designed checks and balances that prevent choice from leading to inequity and segregation" (OECD, 2019, p. 3). Our findings offer understandings on the dynamics of science and mathematics participation in the Australian context and provide a further window for tackling issues in the light of policy and practice in other countries.

Appendix

See Table 7.

Table 7 Odds ratios from logistic regressions for schools offering selected subjects

	Model 1 Chemistry	Model 2 Mathematics Extension 2	Model 3 Senior Science	Model 4 Mathematics General 2
	Odds ratios			
Teacher numbers (ref = low number of teachers per student)				
High number of teachers per student	1.12	1.59	2.23	3.25
Socio-educational advantage (ref = advantaged schools)				
Less advantaged schools	1.89	0.27	1.75	1.09
Remoteness (ref = metropolitan schools)				
Inner regional schools	0.88	0.55	1.11	4.86
Outer regional/remote/very remote schools	0.09	0.14	0.57	0.23
Prob > chi^2 = 0.0000				

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Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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