Socio-economic Background, Senior Secondary Mathematics, and Post-secondary Pathways.

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The relationship between socio-economic background and completion of senior secondary mathematics study leading to various post-schooling pathways has been an area of keen interest to researchers, school systems and policy makers for some time. This paper briefly considers some aspects of this relationship using recent Victorian data relating to the index of relative socio-economic disadvantage (IRSD), enrolments and study scores for Victorian senior secondary mathematics students and *On Track* destination data.

Background

A distinctive feature of senior secondary mathematics curricula in countries around the world and also in Australia is the common use of a hierarchy of three to four distinctive mathematics subjects typically characterised in terms of a combination of: depth, breadth and directness of application to practical problem solving in real life; the level and scope of complexity and demand in 'pure' and 'applied' mathematical concepts, skills and processes; expectations for mental, by hand and technology assisted approaches to working mathematically and pathways to post-secondary study, training or work (see, for example, Tout & Motteram, 2006). The development of a 'national' or Australian curriculum from school entrance to the end of secondary school is now well underway in the first four subjects of English, Mathematics, Science and History, with drafts scheduled to be available for consultation throughout 2010.

The Australian Curriculum and Assessment Authority (ACARA) mathematics framing paper *The Shape of the Australian Curriculum: Mathematics* (National Curriculum Board, 2009) referred to four types of senior secondary mathematics courses that can be characterised as everyday mathematics vocational (Course A), general mathematics including data analysis, business and discrete mathematics leading to further training, employment or tertiary study that does not require a calculus background (Course B), a mainstream calculus based mathematics leading to tertiary study in sciences, economics, medicine and the like (Course C) and an advanced pure and applied calculus based mathematics leading to study that requires a substantial mathematical background such as engineering and actuarial work (Course D). It also noted the current imbalance in access to these types of courses with respect to socio-economic background. Curriculum benchmarking research typically carried out by state and territory curriculum and assessment authorities, board and councils as part of normal review processes (see also, for example, Masters & Matters, 2007) indicated a high level of commonality in the nature and purpose of different versions of such courses around the Australian states and territories.

In Victoria the corresponding courses are the Victorian Certificate of Applied Learning (VCAL) Senior Numeracy and the Victorian Certificate of Education (VCE) Unit 3 and 4 studies Further Mathematics, Mathematical Methods/Mathematical/Methods (CAS) and Specialist Mathematics. For 2006–2009 Mathematical Methods/Mathematical and Methods (CAS) were alternative and equivalent parallel implementations of the same type of course with different assumed enabling technology – an approved graphics calculator or CAS. Mathematical and Methods (CAS) replaced Mathematical Methods from 2010

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(inclusive). In the rest of this paper only these three VCE studies are considered and are referred to as 'Further', 'Methods' and 'Specialist' mathematics subjects respectively. At the Unit 3 and 4 level in 2009 around 48 000 students were enrolled in one of the VCE English group of studies (English, English as a Second Language, English language or Literature), hereafter similarly referred to as just 'English' (study of English is a compulsory requirement of the VCE).

In 2009, around 28 000 students were enrolled in Further; around 16 - 17 000 students were enrolled in Methods, and just under 5 000 students were enrolled in Specialist. Almost all of the Specialist students were concurrently enrolled in Methods (Specialist assumes previous completion of, or concurrent enrolment in, Methods), while around 3 500 students were concurrently enrolled in Further and Methods and around 300 students were concurrently enrolled in all three subjects. Over the last decade or so there has been a definite trend of increasing overall enrolments in Unit 3 and 4 level mathematics subjects - this has been through a significant increase in Further enrolments, with steady Methods enrolments and a decrease in Specialist enrolments. The number of students enrolling in two mathematics, Further and Methods or Methods and Specialist has also increased over this period.

This paper looks briefly at the socio-economic backgrounds of students undertaking Further Maths, Methods and/or Specialist subjects and links these to study scores and destinations of students who satisfactorily completed units 3 and 4 of these subjects six months after completing their senior secondary programs, and makes some preliminary observations and comments. Socio-economic background of students in this paper is used to examine how aspects of the profile of students undertaking mathematics subjects compare with those of VCE student population in general. It is not the intention to use this data to explore explanatory factors for student performance or likely destinations.

Key research has been done in the area in Australia, in particular with respect to Victorian and Queensland contexts, but also international contexts by Teese and colleagues (see, for example, Teese & Polesel, 2003; Teese, Lamb & Duru-Bellat, 2007). It has also been a key consideration of recent government inquiries such as the *National Numeracy Review Report* for the Human capital working group of the Council of Australian Governments (Council of Australian Governments, 2008). Some of the data presented here have only become recently available, and consideration of related matters could be enhanced by inclusion of NAPLAN data (the first available would be Year 9 data from 2008) along with VCE enrolment, study score and *On Track* destination data.

Data: Indices, Study Scores and Destinations

Data used in the first part of the study include student enrolments in Units 3 and 4 English, Further, Methods and Specialist in a given year between 2006 and 2009. Students enrolled in English are used as a proxy for the VCE population base and the socio-economic backgrounds of English students are used as a benchmark for VCE students. This is because English is a requirement both for award of the VCE and for an ATAR (formerly ENTER) score to be compiled. Thus, in Figure 1 the distribution for English would be a constant 10%. The Index of Relative Socio-Economic Disadvantage (IRSD) for areas published by the Australian Bureau of Statistics (ABS) is used as a proxy measure of student socio-economic status (SES). This index is derived from a wide range of population census data relating to measures of relative disadvantage in economic and social resources of people and households within the area, such as low income, low education, high unemployment and unskilled occupations.

Student residential postcodes are matched to the IRSD postal area codes. An ABS Postal Areas is an approximation of the Australia Post Postcode with the same four digit code. For a given year, about one per cent of student postcodes cannot be matched to the ABS postal area codes, mainly due to use of post office box postcodes by students.

The *On Track* results are used to look at the destinations and pathways of respondents who satisfactorily completed their Maths subject(s) in their final year of senior secondary programs. *On Track* is an annual survey conducted by the Victorian Department of Education and Early Childhood Development (DEECD) to gather information on the destinations of students six months after they completed senior secondary school. The survey is conducted in May each year. The *On Track* data included in this analysis are for those respondents who satisfactorily completed maths subject(s) in their final year of schooling and attained Year 12 or equivalent certificate in 2006, 2007 and 2008. For students who completed Year 12 or equivalent in 2009 and gave consent to participate in the *On Track*, destination data will not be available until mid 2010. This paper will only consider data for the 2008 VCE Unit 3 and 4 student cohort, that is, those students who undertook mathematics subject(s) in 2008 and had their pathways/destinations surveyed mid 2009.

The Further Cohort

Further is undertaken by students from a wide range of socio-economic backgrounds. In a given year, about 12% of students enrolled in Further are also enrolled in Methods. The proportion of students from each SES group (in deciles) is fairly evenly distributed from the *most* disadvantaged (lowest = 1st decile) to the *least* disadvantaged (highest = 10th decile) backgrounds as shown in Figure 1. Relative to English, there are slightly more students from the most disadvantaged backgrounds and moderately disadvantaged backgrounds, and fewer students from the least disadvantaged backgrounds enrolled in Further. This pattern has been consistently observed 2006 to 2009. The overall profile of socio-economic backgrounds of students studying Further is very similar to that of English students, and thus all VCE students.

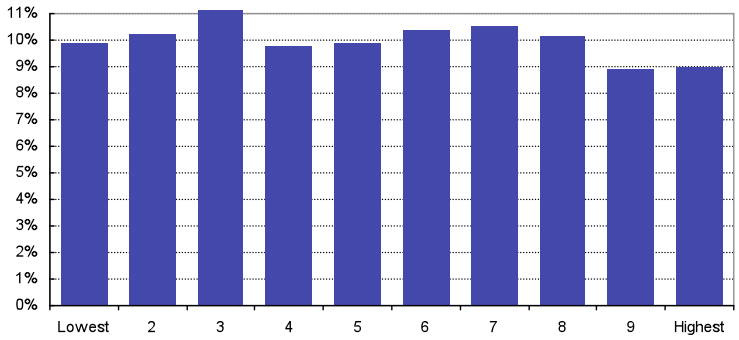

Figure 1: Students enrolled in Further in 2008 by SES

The overall distribution of study scores (which combines examination and school-based assessment components) for a VCE subject is modelled by a truncated normal distribution on a scale of 0 – 50 with a mean of 30 and a standard deviation of 7. When the corresponding distributions of study scores for Further students are considered by quartile as shown in Figure 2 the lowest and lower-mid socio-economic SES quartiles are fairly

similar, and students from the highest SES quartile (least disadvantaged) seem to achieve slightly higher results than students from the lowest SES quartile (most disadvantaged).

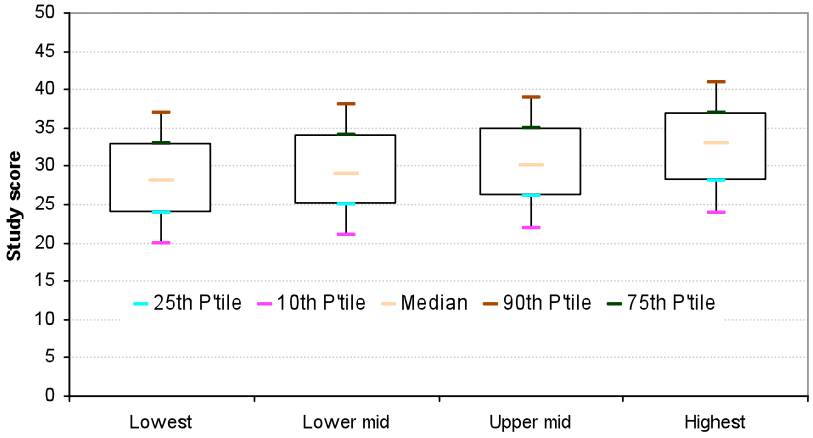

Figure 2: Further Maths, Distribution of study scores by SES quartile, 2008

Figure 3 shows the corresponding cumulative distribution of study scores for the lowest and highest SES quartiles.

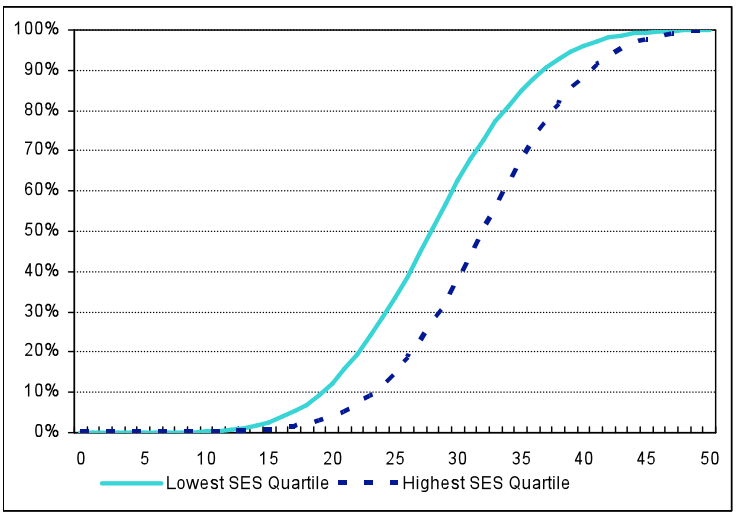

Figure 3: Cumulative distribution of 2008 study scores for lowest and highest SES quartiles

The Methods cohort

The Methods cohort of around 17 000 students effectively subsumes the Specialist cohort, where a bit less than one in three Methods students is also a Specialist student. These two studies also attract students from a wide range of socio-economic backgrounds; however, it is evident that there are a higher proportion of students from less disadvantaged backgrounds (= 8, 9 or 10th deciles) doing these studies compared to students from more disadvantaged backgrounds as shown in Figure 4. Thus, there are fewer students from low and low to mid SES backgrounds (although less pronounced for the lowest SES background) and more students from mid-high and high SES backgrounds in this cohort.

This profile, which may be likened to a flat '*J* curve' has also been consistently observed from 2006 to 2009, and is distinctive to those for English and Further.

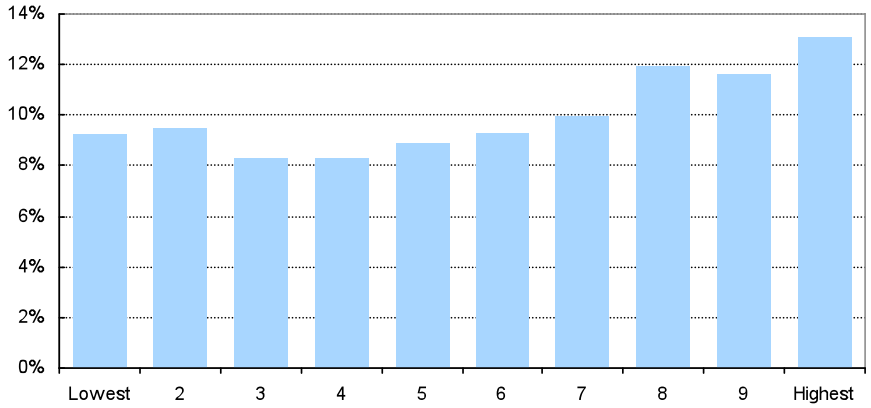

Figure 4: Students enrolled in Methods and possibly Specialist but not Further in 2008 by SES

When the corresponding distributions of study scores for Methods students are considered by quartile as shown in Figure 5 the lowest and lower-mid socio-economic SES quartiles are again fairly similar to those for Further, and again students from the highest SES quartile (least disadvantaged) seem to achieve higher results than students from the lowest SES quartile (most disadvantaged).

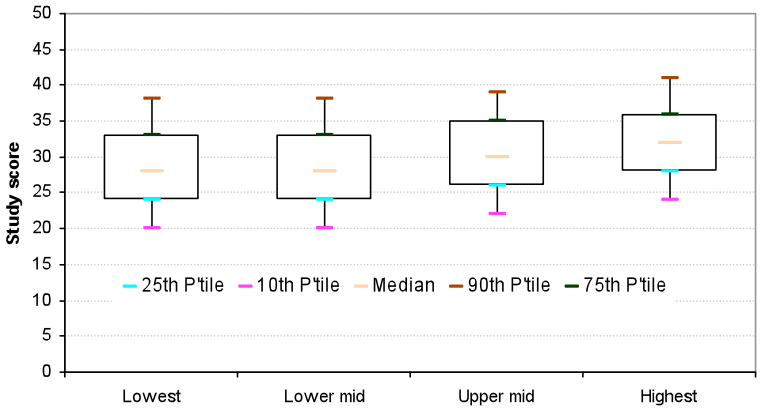

Figure 5: Students doing Methods (no Further): distribution of study scores in 2008 by SES quartiles

Figure 6 shows the corresponding cumulative distribution of study scores for the lowest and highest SES quartiles.

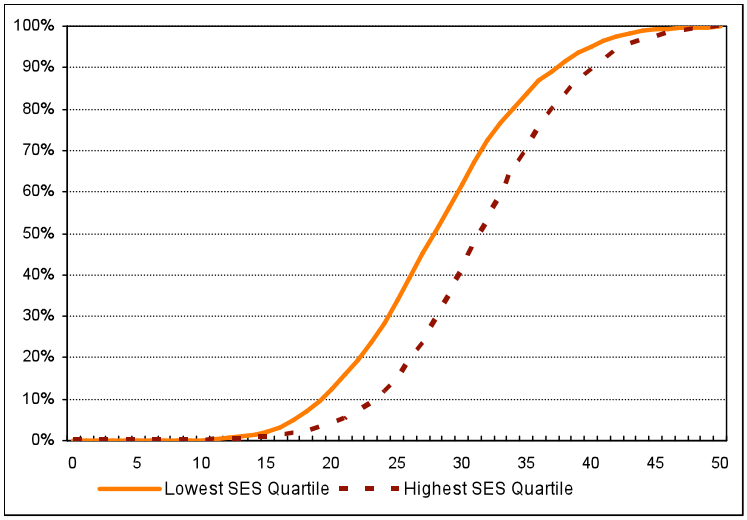

Figure 6: Cumulative distribution of 2008 study scores for lowest and highest SES quartiles

Pathways and Destinations

Table 1 shown pathways of young people who satisfactorily completed VCE Mathematics subject(s) in their final year of schooling, and were surveyed in 2009 in terms of various 'destinations' such as university, TAFE and so on. *On Track* 2009 surveyed the students who completed Year 12 or equivalent in 2008.

Table 1: *Post-school destinations for students completing various combinations of Unit 3 and 4 mathematics studies in 2008*

	Further only	**Further and Methods**	**Methods and Specialist**	**All *On Track* respondents**
University	38.7%	72.9%	72.7%	45.6%
VET Certificate IV and above	17.4%	9.0%	6.5%	14.3%
VET entry-level (Certificates I–III)	4.2%	2.7%	1.2%	3.8%
Apprentice/Trainee	8.7%	2.2%	2.7%	8.0%
Employed	13.9%	2.7%	2.9%	21.4%
Looking for work	3.5%	1.1%	0.7%	3.8%
Deferred	13.4%	9.4%	12.2%	12.1%
Total	100%	100%	100%	100%

The data show that respondents who satisfactorily completed only Further were much less likely to continue with education and training at University than respondents who successfully completed two mathematics studies, and slightly less likely to do so than all respondents. However, they were also much more likely to continue their further education and training in VET Certificate IV and above studies, via apprentice/trainee arrangements or is in employment than those respondents who successfully completed two mathematics studies. While a similar proportion of respondents who successfully completed Further and Methods and Methods and Specialist continued to university, a higher proportion of Further and Methods respondents undertook VET Certificate IV and above studies than Methods and Specialist respondents. Similar observations can be made with respect to *On Track* data from earlier years.

Concluding Remarks

The question as to whether a credentialing end of schooling certificate and/or various studies within that certificate are sufficiently robust with respect to ensuring broadly accessible and equitable opportunities for learning; suitably recognising demonstration of achievement of learning; and providing genuine opportunity for construction of meaningful and flexible pathways from entry to the senior secondary years and subsequent post-schooling destinations; is a perennial one. Recent discourse on this matter, in particular from national perspectives on the education agenda has brought such matters into increasingly sharp focus through the notion of educational entitlement for all, as expressed most recently in the Melbourne Declaration which is being used as the basis for the development of an Australian Curriculum. Various views on these matters have been argued over the years and systems have moved to progressively develop more detailed data collection to inform related debates. This paper briefly draws together some of the data aspects that are relevant to informing these debates in Victoria, and notes the opportunities for further refinement and development when data from the compulsory years of schooling can also be brought into consideration, and the possibility of an emerging national perspective.

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