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The Determinants of Academic Achievement Among Primary School Students: A Case Study of the Australian Capital Territory

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Abstract

This paper uses a unique opportunity of access to unit record data held by the ACT Education and Training Directorate to estimate the determinants of outcomes for primary students in the NAPLAN reading and numeracy tests. The results show that individual characteristics such as gender, educational background of parents, Indigeneity and non-English speaking background have a significant influence on outcomes. The average level of socio-economic advantage of the school and the size of the school were also important. The results add to our existing knowledge of the determinants of academic achievement at the primary level in Australia.

Keywords: Educational achievement, Primary school, NAPLAN, Socio-economic status

JEL classification: I24, I21, I25

1. Introduction

Educational attainment has long been recognised as an important determinant of labour market outcomes. Australian figures show that there is a strong link between educational attainment and employment. Those with a low level of education are less likely to be participating in the labour force; almost 30 per cent of those with less than a Year 12 level of education did not participate in the labour force in 2014 compared to 19 per cent of those with a bachelor degree. Sixty per cent of those holding a Bachelor Degree were employed on a full-time basis compared to just 40 per cent of those with less than a Year 12 level of education (Australian Bureau of Statistics (ABS), 2014). The higher rates of participation in conjunction with higher hourly pay rates mean that people who have at least completed year 12 have higher incomes than those who have not.

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There is considerable evidence that poor performance by students in national and international tests in the high school years is associated with a lower propensity to complete secondary schooling (Curtis and McMillan, 2008; Mahuteau and Mavromaras, 2014; Marks, 2007 and Marks, 2014a) and to have problems gaining full-time employment (Carbonaro, 2006; Jensen and Seltzer, 2000 and Marks, 2006). Outcomes during secondary education are in turn strongly correlated with primary school performance (Marks, 2014b). Heckman (2002) emphasised the importance of early intervention strategies for promoting better outcomes for children from disadvantaged backgrounds in the US. Researchers in the UK (Anders *et al*., 2011) and Australia (Hilferty and Redmond, 2010) have also advocated for early intervention strategies for children at risk of low levels of academic achievement. The determinants of student performance at primary school are therefore important for their future engagement with the labour force.

The aim of this paper is to examine determinants of outcomes for primary school students in the National Assessment Program- Literacy and Numeracy (NAPLAN) tests for reading and numeracy, including the impact of the level of educational advantage/ disadvantage of the school and parental education. This study offers a unique opportunity to examine the relationship between parents' education, school-level variables and academic outcomes for primary school students in an Australian jurisdiction, the Australian Capital Territory (ACT), as the authors have been granted access to de-identified unit record data available at the ACT Education and Training Directorate. These data have been linked to data from the *MySchool* website to create a dataset with both individual and school-level variables relevant to academic achievement.

The Australian Capital Territory (ACT) is a small Australian jurisdiction with particular features arising from its role as the seat of the Government of Australia. It has the highest median income and educational attainment among Australian States and Territories. According to the 2011 Population Census conducted by the Australian Bureau of Statistics (ABS), almost three-quarters of the population aged 15 years and older had completed Year 12 or equivalent and over half of that population held a post school qualification (ABS, 2013). Almost 60 per cent of those with post school qualifications held a bachelor degree or higher. Given the association between parents' education and child's education (Alon, 2009; Chesters and Watson, 2013; Pfeffer, 2008 and Stadelmann-Steffen, 2012), it is not surprising to find that ACT students perform well in the NAPLAN tests.

The ACT has advantages as the focus of this study as it is a relatively small homogeneous jurisdiction, reducing the effects of confounding influences such as urban/rural location of schools on results. In addition, most Australian studies have focused on secondary school results while this one examines the results for students attending government primary schools. A third reason why these results are of wider interest is that they add to the accumulated knowledge on the determinants of test performance in Australia. Education is a State and Territory responsibility in Australia so each jurisdiction has its own particular characteristics. While analysis of Australia-wide data through testing under the OECD Programme for International Student Assessment (PISA) and surveys such as the Longitudinal Survey of Australian Youth

(LSAY) offer an aggregate picture, a detailed examination of outcomes at the State/Territory level require analysis of State/Territory level data. This study will contribute to the development of this evidence base.

2. Determinants of Test Performance

There are a number of variables which have been shown in the international and Australian contexts to have an important influence on the academic achievements of school-aged children. However, the choice of variables used in this analysis has been limited by the availability of data. The variables used in this study include characteristics of the individual student such as their parents' educational attainment, language background (NESB), Indigenous status and sex. Characteristics of the school have also been shown to have a significant impact on academic outcomes including the average socio-economic status (SES) of the school and its location. The following section presents the key findings of earlier studies of the determinants of student performance relevant for this study.

There is considerable evidence that the socio-economic background of fellow students has a significant influence on educational outcomes for students and may even be more important than an individual's background in determining outcomes (see for example, Buckingham *et al*., 2013; Lim *et al*., 2013; McConney and Perry, 2010; OECD, 2010; Perry and McConney, 2010; Rothman and McMillan, 2003 and Sirin, 2005). The interaction between students, the school environment and community support all contribute significantly to individual performance in academic tests.

Researchers examining the effects of parental education and socio-economic status on child's educational achievement and attainment largely agree that high SES parents are able to facilitate the development of their children's cognitive abilities and provide them with the necessary cultural capital required for success at school (Ball, 2010; Bourdieu, 1984; Breen *et al*., 2009; Roska and Potter, 2011; van de Werfhorst and Hofstede, 2007). Furthermore, they are able to provide a home environment conducive to intellectual development and encourage their children's participation in appropriate extracurricular activities (Lareau, 2011).

The OECD (2010) emphasised the importance of the SES of schools in their analysis of reading results for 15 year olds in 65 participating countries under the Programme for International Student Assessment (PISA). The study concluded that students attending schools with socio-economically advantaged peers tended to perform better on the tests regardless of their own SES. The results for Australia show that while the dispersion of reading results according to the socio-economic status of individual students was less than the average for OECD countries, the socio-economic gradient was steeper than the OECD average, that is, there was a significant increase in scores as SES rose.

In a more detailed examination of the 2012 PISA results for mathematical literacy Thomson, De Bortoli and Buckley (2013) show that the socioeconomic gradient was steeper in the ACT than for Australia as a whole. Students from low socioeconomic backgrounds in the ACT performed less well than their counterparts in all states except Tasmania and the Northern Territory whereas those from more advantaged socioeconomic backgrounds performed better than the Australian average.

This has implications for employability with the types of jobs available in the ACT typically requiring higher levels of education and skills. Of those employed in the ACT, 45 per cent held a bachelor degree or higher qualification compared 29 per cent nationally (Department of Education, 2015).

Gender, English speaking background and Indigenous status have also been found to have an effect on test scores. Girls tend to perform better than boys on reading tests while this is reversed for mathematical tests. The effect of migrant status on achievement is mixed with Marks (2014b) finding that students from language backgrounds other than English (LBOTE) scored lower, on average, on numeracy and reading in Year 3 than their English-speaking peers but higher, on average, on both domains in Year 5. By Year 7, LBOTE students achieved higher scores for numeracy and lower scores for reading. According to the OECD (2010) students in Canada and Australia who spoke a language other than the assessment language at home performed as well as the average.

The differences in educational outcomes for Indigenous Australians have been well documented. The results for NAPLAN tests provide evidence of the raw gap in performance between Indigenous and non-Indigenous students (ACARA, 2012; Marks, 2014b). The poorer academic outcomes of Indigenous students have been the focus of considerable policy concern. One of the Closing the Gap goals is to 'halve the gap for Indigenous children in reading, writing and numeracy within a decade (by 2018)' (CoAG, 2008: p. 6).

A final variable included in this study that has not appeared in many other Australian studies is the size of the school. The effect of school size on academic achievement has been contested in the literature. Economies of scale might be expected to improve the range and availability of resources for students in larger schools and therefore their academic outcomes while smaller schools might have the advantage of a less bureaucratic environment and reduced social stratification among students and teachers (Huang and Howley, 1993). A series of studies based on data from seven US states, referred to as the Matthew Project, found that the negative effect of social disadvantage on student academic performance was reduced in small schools compared to large schools (Howley and Bickel, 1999). However, Australian research on Higher School Certificate performance in Catholic schools in NSW from the same period found that after controlling for school and individual characteristics, students at larger schools outperformed those at smaller schools (Mok and Flynn, 1996).

In summary, previous research shows that individual measures of social background, gender, language background, Indigenous status and school-level measures such as school size have an effect on students' performance in academic tests. Levels of academic achievement at school are correlated with educational attainment which in turn is subsequently correlated with labour force status. Therefore, recognising the importance of the primary school years for employment outcomes over the life course, this paper examines the links between individual and school-level characteristics and levels of academic achievement in primary school. It adds to the existing literature on this topic by presenting results for one Australian jurisdiction, the ACT.

3. Method

We analyse data from two sources: the ACT ETD (Australian Capital Territory, Education and Training Directorate); and the *MySchool* website. The ACT ETD provided de-identified data from 45 primary schools and seven combined primary and secondary schools on NAPLAN scores for reading and numeracy in Years 3 and 5; parents' education; Indigenous (Aboriginal and/or Torres Strait Islander) status; NESB (language other than English spoken at home) status; and sex. We analyse data pertaining to one cohort of students who were in Year 3 in 2010 and Year 5 in 2012. Rather than focus on change in individual scores between Year 3 and Year 5, we conduct separate analysis of the two cohorts to examine whether school effects mediate family effects in Year 3 and 5.

NAPLAN is a national testing of achievement across five educational domains: reading; writing; spelling; grammar and numeracy at Year 3, 5, 7, and 9 levels which has been conducted annually since 2009. There is a common scale across all years ranging from 0 to 1000 in each domain so a score, for example, of 500 indicates the same level of achievement regardless of the year of study for the student but the average national score and minimum standards increases at higher levels of schooling.

In 2010, the national average reading score for Year 3 was 414.3 and the numeracy score, 395.4. The ACT averages were higher in each category, 439.1 for reading and 412.6 for numeracy (ACARA, 2010). The percentage of students tested who did not achieve the national minimum standard in reading and numeracy in the ACT was less than half for Australia as a whole, 2.1 per cent for reading compared to 4.0 per cent for Australia as a whole and 1.2 per cent compared to 3.7 per cent in the numeracy test. In 2012 the average reading score for Year 5 in the ACT was 519.0 compared to the national average of 493.0 and in numeracy, 504.4 compared to the national average of 488.7. Once again the percentage of students who did not achieve the national minimum standards in Year 5 in the ACT was less than half the Australian average (ACARA, 2012). These figures relate to all students in the ACT including both public and private schools.

We use the raw NAPLAN scores for each student attained in Year 3 (in 2010) and Year 5 (in 2012). Parents' education is an indicator of individual socio-economic status (Lim and Gemici, 2011; Pfeffer, 2008) and is derived from the highest level of school education of either parent. Unfortunately, a more refined categorisation of education level was not available, therefore, the parents' education variable has three categories: less than Year 12; Year 12; missing. Indigenous status is coded 1 = either Aboriginal or Torres Strait Islander. NESB status is coded 1 = language other than English spoken at home. The data also include information on whether the child is from a non-English-speaking background (LBOTE), however, we chose to use the information regarding the language spoken at home as this is a more precise measure of the first language spoken. Sex is coded 1= female.

The *MySchool* website data provide school level data on size of school and the school mean ICSEA (Index of Community Socio-Educational Advantage). The ICSEA mean variable has five categories: <1001; 1001 -1050; 1051- 1100; 1101 -1150 1151 -1200. To identify the schools with both primary and secondary school students, we include a dummy variable coded 1= combined school. When we allocated

combined schools into categories of the school size variable, we used the number of students enrolled from Preschool to Year 6. The school size variable has seven categories: <251; 251 -300; 301 - 350; 351- 400; 401 -450; 451- 500; 501+ students. The descriptive statistics of the sample are provided in table 1.

Table 1 also provides the mean scores and standard deviations for Year 3 and Year 5 reading and numeracy scores. The mean scores of students attending government schools are somewhat lower than those for the entire cohort of the ACT students. The mean score for reading in Year 3 of 435.6 is 3.5 points lower than the ACT mean (439.1) and the mean score for reading in Year 5 of 515.3 is 4.7 points lower than the ACT mean (519). The mean score for numeracy is just half a point lower in Year 3 (412.1 compared to 412.6) and 2.4 points lower in Year 5 (502 compared to 504.4). These differences are not surprising given that students with highly-educated parents are more likely to have higher levels of academic achievement (Jaeger, 2011; Roska and Potter, 2011); and that highly-educated parents tend to send their children to non-government schools (Chesters, 2015).

Table 1 - Characteristics of the Sample

	n=	*Per cent*
Male	927	49
Female	962	51
Parents' education		
<Year 12	236	12
Year 12	1265	67
Missing	388	21
Indigenous status		
non- Indigenous	1838	97
Indigenous	51	3
NESB Status		
Non NESB	1531	81
NESB	358	19
School ICSEA mean		
<1001 (10 schools)	283	15
1001 to 1050 (10 schools)	300	16
1051 to 1100 (8 schools)	386	20
1101 to 1150 (16 schools)	555	29
1151+ (8 schools)	365	19
School size		
<251 (9 schools)	148	8
251 to 300 (12 schools)	329	17
301 to 350 (4 schools)	147	8
351 to 400 (10 schools)	438	23
401 to 450 (5 schools)	233	12
451 to 500 (4 schools)	181	10
>500 (8 schools)	413	22
NAPLAN scores	**mean**	**Std dev.**
Year 3 reading	435.6	91.9
Year 5 reading	515.3	87.5
Year 3 numeracy	412.1	77.1
Year 5 numeracy	502.0	73.0

4. Analytical Strategy

To simultaneously analyse the effects of individual and school characteristics on NAPLAN scores, we estimate a series of nested multi-level models for each of the four outcome variables: reading score in Year 3, reading score in Year 5, numeracy score in Year 3 and numeracy score in Year 5. At this stage we do not have access to the unique student identifier which would enable an analysis of changes in performance between Years 3 and 5. Nevertheless, our results enable a comparison of the average effect of the independent variables on NAPLAN outcomes between Years 3 and 5. Our analyses are performed on data pertaining to an entire cohort of ACT students rather than a sample taken from the cohort, therefore, levels of statistical significance are not reported in this paper. Levels of statistical significance provide an indication of whether the results obtained from the analysis of a sample of the population reflect the results that would be obtained if data from the whole population were analysed.

5. Results

The analyses presented here are derived from a series of hierarchical linear models examining the effects of parents' education on NAPLAN reading and numeracy scores. In the first set of models, presented in table 2, the outcome variables are Year 3 reading scores and Year 5 reading scores. In Model 1, when only individual factors: parents' education; sex; Indigenous status; and NESB status; are included, between-school variance accounts for 10 per cent of the unexplained variation in Year 3 indicating that differences between students within schools were a far more important factor in overall variance than differences between students attending different schools. The coefficients for Model 1 indicate that even after controlling for the effects of sex, Indigenous status and NESB status, parents' education has a positive effect on Year 3 reading scores. Having at least one parent who completed Year 12 is associated with an increase of 48 points, on average. Indigenous students' scores were, on average, 43 points lower than those of non-Indigenous students and NESB students' scores were, on average, 10 points lower than those of non-NESB students, net of other factors.

When the school level effects are included in Model 2, the proportion of unexplained variance attributable to school factors not measured in the model, such as teacher quality and class size is just 0.01. School ICSEA mean has a positive association with Year 3 reading score, net of the effects of the other factors with students attending schools with higher ICSEA means recording higher, on average, reading scores than students attending schools with the lowest ICSEA means. Students attending schools with more than 250 students had, on average, lower reading scores in Year 3 compared to students in smaller schools. Parents' education has a strong positive effect on achievement, as measured by the NAPLAN reading test, in Year 3 even after controlling for school effects.

Table 2 - Effect of Parents' Education on Reading Score in Year 3

	Year 3		*Year 5*	
	Model 1 Coef.	*Model 2 Coef.*	*Model 3 Coef.*	*Model 4 Coef.*
Individual level characteristics				
Female =1	13.90	13.60	12.97	12.96
Parents' education				
<Year 12 (ref.)				
Year 12	48.11	46.10	50.20	48.65
Missing	32.08	29.33	39.46	37.22
Indigenous =1	-42.70	-38.55	-29.80	-26.45
NESB =1	-10.73	-11.70	-17.66	-17.26
School-level variables				
School ICSEA mean				
<1001 (ref.)				
1001 to 1050		25.59		15.48
1051 to 1100		34.98		30.75
1101 to 1150		55.69		60.77
1151+		77.67		81.02
School size				
<251 (ref.)				
251 to 300		-31.59		-12.44
301 to 350		-32.97		-22.41
351 to 400		-31.13		-14.38
401 to 450		-21.56		-19.18
451 to 500		-9.59		2.17
501+		-20.96		-17.64
Combined school =1		9.58		13.49
constant	390.54	374.30	468.17	440.96
Random effects				
Between school variance proportion	0.10	0.01	0.13	0.02
Within school variance proportion	0.90	0.99	0.87	0.98
Chibar2 a	103.35	10.29	165.38	11.60

level 1 n= 1870 Year 3 students; n= 1888 Year 5 students; level 2 n= 52 school. a. The Chi Bar squared test takes into account the restrictions imposed in estimating this multi-level model.

The results presented in Model 3 indicate that between-school variance accounts for 13 per cent of the unexplained variation in Year 5 reading scores. The coefficients indicate that even after controlling for the effects of sex, Indigenous status and NESB status, parents' education has a positive effect on Year 5 reading scores. Having at least one parent who completed Year 12 is associated with an increase of 50 points, on average. Indigenous students' scores were, on average, 30 points lower than those of non-Indigenous students and NESB students' scores were, on average, 18 points lower than those of non-NESB students, net of other factors.

When we include school level characteristics in Model 4, we find that between-school variance accounts for two percent of the unexplained variation in Year 5 reading scores. School ICSEA mean has a positive association with Year 5 reading score, net of the effects of the other factors. Students attending schools with more than 250

students have lower reading scores in Year 5 compared to students attending smaller schools. Parents' education has a strong positive effect on achievement, as measured by the NAPLAN reading test, in Year 5 even after controlling for school effects. The average negative effect associated with Indigenous status declined between Year 3 and Year 5 whereas the average negative effect associated with NESB status increased between Year 3 and Year 5.

Next we examine the association between Year 3 and Year 5 numeracy scores and parents' education and present the results in table 3. The results for Model 1 indicate that even after controlling for the effects of sex, Indigenous status and NESB status, parents' education has a positive effect on Year 3 numeracy scores. Having at least one parent who had completed Year 12 is associated with an increase of 42 points, on average. Indigenous students' scores were, on average, 46 points lower than those of non-Indigenous students, net of other factors. NESB status had a small negative effect on numeracy scores.

Table 3 - Effect of Parents' Education on Year 3 and Year 5 Numeracy Scores

	Year 3		*Year 5*	
	Model 1 Coef.	*Model 2 Coef.*	*Model 3 Coef.*	*Model 4 Coef.*
Individual characteristics				
Female =1	-7.55	-7.87	-11.23	-11.28
Parents' education				
<Year 12 (ref.)				
Year 12	42.20	40.20	45.25	44.30
Missing	34.02	30.18	37.88	36.64
Indigenous =1	-46.01	-41.40	-30.20	-27.77
NESB =1	-5.51	-6.23	-6.10	-6.11
School level characteristics				
School ICSEA mean				
<1001 (ref.)				
1001 to 1050		21.14		28.09
1051 to 1100		26.43		37.31
1101 to 1150		40.21		56.77
1151+		56.40		64.11
School size				
<251 (ref.)				
251 to 300		-12.21		-12.84
301 to 350		-12.36		-26.70
351 to 400		-15.57		-16.60
401 to 450		-12.83		-20.47
451 to 500		1.60		5.12
501+		-9.82		-17.26
Combined school =1		13.91		16.89
constant	381.64	361.77	468.72	441.79
Random effects				
Between school variance proportion	0.07	0.01	0.13	0.03
Within school variance proportion	0.93	0.99	0.87	0.97
Chibar2 a	61.94	2.51	136.84	14.86

level 1 n= 1838 Year 3 students; n= 1855 Year 5 students; level 2 n= 52 schools. a. The Chi Bar squared test takes into account the restrictions imposed in estimating this multi-level model.

When the school level variables are included in Model 2, school ICSEA mean has a positive effect on Year 3 numeracy score, net of the effects of the other factors. Students attending schools in the second ICSEA mean group scored, on average, 21 points higher than students attending schools in the lowest ICSEA mean group. The average increase for students attending schools in the third, fourth and fifth ICSEA mean group are 26 points, 40 points and 56 points, respectively.

Students attending schools with more than 250 students had lower, on average, numeracy scores in Year 3 than students attending smaller schools, net of the effects of the other factors. Parents' education continues to have a strong positive effect on achievement in Year 3 even after controlling for school effects.

The coefficients reported in Model 3 indicate that after controlling for the effects of sex, Indigenous status and NESB status, parents' education has a positive effect on Year 5 numeracy scores. Having at least one parent who had completed Year 12 is associated with an increase of 45 points, on average. Indigenous students' scores are, on average, 30 points lower than those of non-Indigenous students, net of other factors. NESB status has a small negative effect on numeracy scores.

When the school level variables are included in Model 4, we find that between-school variance now accounts for three per cent of the unexplained variance. School ICSEA mean has a positive association with Year 5 numeracy score, net of the effects of the other factors. Students attending schools in the highest ICSEA group score, on average, 64 points higher than students attending schools in the lowest ICSEA group, net of the effects of the other variables. School size has a negative effect on numeracy scores in Year 5, net of the other factors. Parents' education continues to have a strong positive effect on achievement, as measured by the NAPLAN numeracy test, in Year 5 even after controlling for school size and school ICSEA mean.

6. Discussion and Conclusion

The analyses presented in this paper show that both individual socio-economic status as measured by parents' education and average level of educational advantage of the school population have a positive effect on child's academic achievement, as measured by NAPLAN literacy and numeracy tests, thus confirming the findings of the majority of previous research. Perry and McConney (2010) found that academic achievement was positively correlated with socio-economic status at both an individual and school level. Their measure of socio-economic status was based on the economic, social and cultural status (ESCS) measure calculated by the PISA project team. After conducting a comprehensive meta-analysis of existing research, Buckingham *et al*. (2013) also concluded that individual and school socioeconomic status were positively correlated with academic achievement as did Sirin (2005).

Holding everything else constant, in three of the four final models, shifting a student from a school at the bottom of the ICSEA distribution to one in the top two ICSEA bands is estimated to increase their NAPLAN score in literacy and numeracy by a larger margin than a shift in their parental education to the completion of Year 12. This result however, did not hold for Year 3 numeracy. In this model (table 3, model 2) it is estimated that the student would need to move to a school in the top ICSEA band in order to have a larger effect on their numeracy result than an increase in parental education would provide, holding everything else constant.

Our results show that girls perform better, on average, than boys in literacy tests but worse, on average, than boys in numeracy confirm the findings of previous research (Marks, 2014b). The finding that Indigenous students had lower scores than non-Indigenous students provides more evidence that the achievement gap between Indigenous and non-Indigenous students appears early in the academic career. Although the gap appears to narrow over time, it is unlikely that Indigenous students will achieve at similar levels as their non-Indigenous peers. For NESB students, reading scores were, on average, substantially lower than for non-NESBB students, however, there was little difference in numeracy scores. Although previous research suggests that NESB students tend to achieve at similar or higher levels as non-NESB students by Year 12 (Considine and Zappala, 2002; Gemici *et al*., 2013 and Marks, 2014b), our results indicate that after controlling for parents' education, the achievement gap increases between Years 3 and 5 in the ACT. Students in smaller schools performed better on NAPLAN tests than students in large schools, particularly in Year 3 literacy tests.

These results have important implications for longer terms outcomes for these students and their ability to complete school and transition successfully into the labour market. It has highlighted some key variables in determining educational outcomes at the primary level which can be identified in policy development. For example, attention should be directed to the determinants of Indigenous disadvantage and that of NESB students highlighted here given the longer term implications of outcomes for schooling and labour market performance.

Previous research confirms that negative effects identified in primary school do not dissipate over the educational career, therefore, interventions designed to alleviate inequality in educational attainment may have more of an effect if enacted in the early stages of schooling, particularly in the first three years.

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