

Is the die cast? Investigating the relationship between prior academic achievement and tertiary entrance performance

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About the research

Is the die cast? Investigating the relationship between prior academic achievement and tertiary entrance performance

Ronnie Semo, Emerick Chew, Kate Dowling, Cameron Forrest, Somayeh Parvazian, NCVER

Students who perform well at school academically are more likely to complete Year 12 and experience smoother transitions from education to employment. However, disentangling the effects of prior academic achievement on later performance from other confounding factors, such as socioeconomic status, has proved difficult.

This study uses data from the Longitudinal Surveys of Australian Youth (LSAY), in conjunction with data from the National Assessment Program – Literacy and Numeracy (NAPLAN) and *MySchool*, to consider the contextual factors that affect a student's academic trajectory. Using measures of students' academic achievement, demographic factors, information about the school they attended and subsequent outcomes, the study explores the association between students' academic performance at school and their schooling outcomes, as evidenced by their Australian Tertiary Admissions Rank (ATAR). It investigates whether Year 9 NAPLAN scores can be used to predict students' likelihood of obtaining an ATAR upon completing Year 12, and the likelihood of obtaining a *high* ATAR, controlling for several demographic characteristics.

Key messages

- As their NAPLAN scores increase, individuals from a high socioeconomic background are almost one and a half times more likely to receive an ATAR than individuals from a low socioeconomic background with the same increase in their NAPLAN score.
- Female students and those with a non-English speaking background are almost twice as likely to receive an ATAR compared to their male peers and those with an English-speaking background respectively, while Indigenous students are about half as likely as non-Indigenous students to receive an ATAR.
- Just two factors are associated with achieving a *high* ATAR: Year 9 NAPLAN performance and gender – students with higher NAPLAN scores are almost twice as likely to achieve an ATAR score of 90 or above; and female students are also almost twice as likely as males to achieve ATAR scores of 90 or above.
- Schools play a relatively small role in influencing tertiary entrance performance compared with the individual characteristics of the student, with only about 13% of the variation in a student's tertiary entrance score attributable to the school they attend.
- A position of socioeconomic advantage alone does not translate to exceptional academic success. Instead, strong reading and numeracy skills are key, regardless of a student's background.

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Executive summary

Year 12 completion marks an important milestone for individuals looking to pursue tertiary education. In addition, those who complete Year 12 tend to have more successful transitions from education to work, leading to greater choice in employment pathways, increased job security and higher wages (Chesters & Cuervo 2022; Lee 2010; Ryan 2011; Productivity Commission 2019).

Prior academic achievement consistently stands out as one of the most significant influences of tertiary education pathways, alongside gender, socioeconomic status (SES), school sector and geographic location (Chesters 2019; Le & Miller 2005; Lim 2015; McMillan & Marks 2003). However, research suggests that the various factors influencing tertiary pathways are nuanced and that the significance of these factors is dependent upon the definitions used and the interrelationships between them. Discrepancies may also arise due to variations in the measures employed, the populations or samples under investigation, or analytical methodologies.

Data from the Longitudinal Surveys of Australian Youth (LSAY) present an opportunity to overcome some of these limitations by providing researchers with a nationally representative sample of Australian school students. This dataset includes measures that allow for a detailed investigation of the relationship between academic performance, a student's demographic profile and their educational outcomes. Moreover, linking LSAY data with the National Assessment Program – Literacy and Numeracy (NAPLAN) and the *My School* data allows for a more refined understanding of the association between a student's earlier academic performance at school, the school attended, and their schooling and post-school outcomes.

Using this integrated dataset, the study explores whether NAPLAN assessment data can predict a student's likelihood of obtaining an Australian Tertiary Admissions Rank (ATAR) upon completion of Year 12, as well as the likelihood of a student obtaining a *high* ATAR (defined as an ATAR of 90 or above), while controlling for various demographic characteristics and the school attended. The analysis is performed using a mixed-effect model. The model consists of random and fixed-effect components: the random effect accounts for the variability between schools, while fixed effects account for the variability between individuals' demographic characteristics and NAPLAN achievement scores. The model also includes the interaction between socioeconomic status and NAPLAN achievement to enable an investigation of the combined effect these two variables have on ATAR outcomes.

Findings

Socioeconomic status in isolation did not have a significant effect on the likelihood of a student receiving an ATAR. However, a student's socioeconomic status, in combination with their NAPLAN scores, was the strongest predictor of ATAR achievement when controlling for other factors. For individuals with a high socioeconomic status, the likelihood of receiving an ATAR increases by about 1.35 times with an increase of their NAPLAN scores by comparison with students with a low socioeconomic status and a similar increase in NAPLAN score.

Other important characteristics associated with an increased likelihood of receiving an ATAR included having a non-English speaking background, being female and being non-Indigenous.

When we explore the factors associated with obtaining a *high* ATAR score, the results are quite different. Just two characteristics are found to be important: prior academic achievement and being female. Students with higher NAPLAN scores are almost twice as likely to achieve ATAR scores of 90 or above, controlling for their socioeconomic or language background, gender and indigeneity.

Our analysis also indicated that, while schools play a role in influencing tertiary entrance performance, this impact is relatively small compared with the role that a student's individual characteristics play. Most of the variation in a student's tertiary entrance score can be attributed to their demographic profile or academic ability rather than the school they attend.

Concluding remarks

This study reinforces the important place of academic achievement in every child's success. Although our analysis indicates that socioeconomic status does not play a determining role in the attainment of an ATAR, the combined effect of socioeconomic status and academic ability does influence student options for transitioning to university. Our study demonstrated the compounding advantage gained from having both a high socioeconomic status in conjunction with a strong academic foundation when accessing higher education, underscoring the importance of supporting those who are academically weak.

When it comes to preparing students for tertiary education, the role of the school is limited but it is not unimportant. Schools must ensure that support and opportunities are provided for all students, such that the potential of all young Australians is maximised, with a particular focus on male students and those who fall behind. The unique educational and occupational aspirations of each student must also be recognised, with schools encouraged to identify optimal pathways for each individual.

For those students aspiring to higher education, our study demonstrated that prior academic achievement is the single most important factor in assisting students to achieve that trajectory, meaning that students should not be impeded or discouraged by their individual backgrounds. Providing students with the support they require to perform well at school gives them the best chance of transitioning to higher education, irrespective of their background. A student's post-school aspirations may change over time, but gaining a solid academic foundation in school is key to arming students with a variety of post-school options.

The use of a nationally representative longitudinal dataset linked to national assessment and school administrative data enabled this study to provide further insights into the student trajectory, as well as a more nuanced understanding of the factors that contribute to university entrance performance. This approach also points to some of the research opportunities now possible through linkage, such as recognising the relationship between academic ability at several time points and subsequent educational and employment outcomes. In addition, linked administrative school data offer valuable contextual information about the schools attended by students, allowing for a better appreciation of the influence that schools have on students at different stages of their schooling.



Introduction

The benefits accruing to students who perform at high levels during primary and secondary schooling are well established. Students with higher levels of academic achievement are more likely to complete Year 12 (Lamb 1997; Le & Miller 2002; McMillan & Marks 2003), while young people who complete Year 12 tend to have more successful transitions from education to work (Karmel & Liu 2011; Ryan 2011). Higher levels of education are also associated with several benefits for individuals, including greater choice in employment pathways, increased job security and higher wages, leading to a more prosperous economy (Chesters & Cuervo 2022; Lee 2010; Ryan 2011; Productivity Commission 2019).

However, disentangling the effects of prior academic achievement on later performance from other confounding factors, such as socioeconomic status, can be difficult. In Australia, there is a lack of assessment data that has been combined with survey data, which limits the extent to which research can consider the contextual factors that affect a student's academic trajectory (Carr et al. 2023; Marks 2019). In addition, without comprehensive data on a student's academic ability and their background characteristics, it can be difficult to determine the impact that individual schools have on a student's academic performance (Carr et al. 2023). Longitudinal surveys help to remedy this limitation, as they provide opportunities for analyses of individual changes and transitions across the educational trajectory, particularly when measures of academic ability in combination with information about the school are available.

Data from the Longitudinal Surveys of Australian Youth (LSAY) present one of the few opportunities in the Australian context for researchers to examine a nationally representative sample of young people in which measures of academic achievement are available alongside demographic factors, information about the school they attended and later outcomes. Moreover, with the introduction of the National Assessment Program – Literacy and Numeracy (NAPLAN), opportunities are now available for linking national assessment data from several time points with existing longitudinal studies.

NAPLAN was introduced in 2008 as a means of national standardised testing in Australian primary and secondary schools and allows for comparisons of results across year levels and over time (Goss et al. 2016). The group of young people who commenced the LSAY program at the age of 15 is the first cohort for which NAPLAN data from the primary through to the secondary school years can be explored in combination with demographic information and contextual survey data. Information about the school attended, using *My School* data, administered by the Australian Curriculum, Assessment and Reporting Authority (ACARA), has also made it possible to explore the effects of individual schools on the student trajectory.

Linking these three data sources provides a unique opportunity for investigating in more detail the significance of the NAPLAN assessment and its potential role in predicting later educational outcomes, simultaneously accounting for the background characteristics of the students and the school they attended. One method of investigating the relationship between NAPLAN performance and later academic success is the use of the Australian Tertiary Admission Rank, which is collected via LSAY. The ATAR is a standardised measure of high school achievement calculated by Australian state education authorities for the purposes of university admissions. In addition to granting access to competitive tertiary courses, ATAR scores have been shown to predict the likelihood of completing those courses versus dropping out (Marks 2019; Productivity Commission 2019). Demonstrating an association between NAPLAN and ATAR scores is therefore likely to represent an association between NAPLAN scores and later educational success.

The aim of this study is to use NAPLAN data that have been linked with records from LSAY to better understand the association between students' early academic performance at school and their schooling outcomes using ATAR scores as a measure of tertiary entrance performance.

This report is structured as follows. The first section presents a brief overview of what is currently known about the factors that contribute to academic success in Australia, with a primary focus on tertiary entrance. The subsequent section provides an outline of the data and methodology used in this study, followed by the results of the modelling. The final sections contain a discussion of the results.

Factors that influence tertiary education pathways

Studies on tertiary education pathways in Australia can be organised into two main categories: school leaving and completion; and university entrance, participation and completion. While various methods and definitions have been used in these studies, in the majority of these studies prior academic achievement (in its various forms) has been shown to be one of the most significant factors influencing tertiary education pathways (Chesters 2019; Houg & Justman 2014; Le & Miller 2002; Lim 2015; Marks 2010, 2019; Marks, Hillman & McMillan 2001; McMillan & Marks 2003; Piacentini & Pacileo 2019; Productivity Commission 2019). Other frequently cited factors include gender (Chesters 2019; McMillan & Marks 2003; Marks, McMillan & Hillman 2001; Lim 2015); socioeconomic status (Dean et al. 2023; Houg & Justman 2014, 2015; Le & Miller 2002; McMillan & Marks 2003); school sector (Le & Miller 2002; McMillan & Marks 2003); and geographic location (Lim 2015; Marks, McMillan & Hillman 2001; McMillan & Marks 2003). However, the extent of the influence of these factors relies on the definitions used and consideration of the interrelationship between them. The following brief review of the literature explores some of the complex interconnections between these factors in more detail.

School leaving and Year 12 completion

Given the importance of school education in providing a pathway for tertiary study, the factors that influence school leaving and completion are briefly discussed. Prior research identifies a strong relationship between levels of literacy and numeracy in high school and early school leaving and Year 12 completion. Those with low levels of academic ability are less likely to complete Year 12 and are also far more likely to leave school early (Gemici et al. 2014; Lamb 1997; Le & Miller 2002; Marks & Fleming 1999; McMillan & Marks 2003; Polidano, Hanel & Buddelmeyer 2012). Other factors associated with school non-completion include being male, having a lower socioeconomic status or an English-speaking background, attending a rural or remote school, or attending a government school (Curtis & McMillan 2008; Lamb 1997; Le & Miller 2002; Fullarton et al. 2003; McMillan & Marks 2003). However, studies show that, when controlling for academic achievement, the effect of socioeconomic status on school completion is substantially reduced (Le & Miller 2002; McMillan & Marks 2003). Socioeconomic disadvantage has also been used to explain lower levels of achievement and of Year 12 completion in rural areas. However, a recent study demonstrated that achievement levels in Year 12 in rural areas cannot be entirely attributed to family background or the school the students attend, suggesting instead that a range of complex interconnecting factors are at play, with these being unique to the rural setting (Dean et al. 2023). Differences in school-completion rates between Indigenous and non-Indigenous students can also be largely attributed to differences in academic achievement, while for Indigenous students a high socioeconomic status or living in a metropolitan area does not moderate these disparities as it can for non-Indigenous students (Schellekens et al. 2022).

Student aspirations have also been shown to have a substantial influence on school completion (Curtis & McMillan 2008; Homel & Ryan 2014; Khoo & Ainley 2005; Polidano, Hanel & Buddelmeyer 2012). Khoo and Ainley (2005) found a strong relationship between intentions to complete Year 12 and completion, while

Curtis and McMillan (2008) demonstrated that the influence of background characteristics and academic ability could be moderated by the intention to complete Year 12. For students with low socioeconomic backgrounds, low educational aspirations were found to be the most important predictor of school non-completion, followed by literacy and numeracy achievement (Polidano, Hanel & Buddelmeyer 2012).

Several studies have also explored how patterns of school completion have changed over the decades. While differences between males and females, socioeconomic groups and school sector persist, the relative gap has declined (Curtis & McMillan 2008; McMillan & Marks 2003). The reverse is true when looking at country of birth and region, which saw an increase in non-completion for those whose parents were Australian-born, and those from regional and rural areas.

University entrance, participation and completion

Perhaps not surprisingly, the characteristics of students who take a university pathway are similar to those who complete school. Students with higher levels of literacy and numeracy are more likely to study at university (Chesters 2019; Le & Miller 2005; Lim 2015; Marks 2019; Piacentini & Pacileo 2019; Productivity Commission 2019), and prior academic achievement has been shown to have the greatest effect on tertiary entrance scores (Houng & Justman 2014; Marks 2010, 2019; Marks, McMillan & Hillman 2001). Several of these studies also showed when controlling for academic achievement, the effect of socioeconomic background, while not completely eliminated, was significantly diminished (Cardak & Ryan 2009; Marks 2010; Marks 2019; Marks, Hillman and McMillan 2001) suggesting socioeconomic background has only a moderate relationship with tertiary entrance performance.

Other important characteristics associated with tertiary entrance performance not accounted for by prior educational achievement or socioeconomic status include gender, language background, indigeneity and region. Being female had only a moderately positive effect on tertiary entrance scores, as did coming from a metropolitan area. In contrast, students with an Asian language background had significantly higher scores than their peers, while Indigenous students' tertiary entrance scores were substantially lower than non-Indigenous students (Marks, McMillan & Hillman 2001).

Representing one of the few studies investigating the link between NAPLAN achievement and access to higher education, Houng and Justman (2014) also demonstrate that academic achievement is a powerful predictor of university entrance scores. When analysing the combined effect of NAPLAN test scores and socioeconomic status, while the authors found both were found to be important, the effect of academic achievement was far stronger. In their study examining the interaction between NAPLAN scores and socioeconomic status, Houng and Justman (2015) found that the influence of family background on tertiary entrance scores was reduced for students at the upper or lower ends of the achievement scale. However, for those with NAPLAN scores centred around the middle bands, the effect of socioeconomic background was more pronounced.

Prior academic achievement has also been shown to predict the likelihood of university participation and completion (Cherastidtham & Norton 2018; Chesters 2019; Le & Miller 2005; Lim 2015; Marks 2019; Piacentini & Pacileo 2019; Productivity Commission 2019). Those with higher levels of academic achievement and high socioeconomic status are more likely to undertake university (Chesters 2019; Chesters & Cuervo 2022; Le & Miller 2005; Lim 2015; Marks, McMillan & Hillman). This was also true for females, those with a language background other than English, non-Indigenous students and, to a lesser extent, those from metropolitan areas. With regards to university completions, the importance of these individual characteristics persisted when controlling for academic achievement (Cardak & Vecci 2013; Cherastidtham & Norton 2018; Lim 2015; Marks 2007; McMillan 2005). When exploring the combined effect of socioeconomic status and these background characteristics on university completion, Lim (2015) showed that less

academically inclined students were further disadvantaged if they came from a low socioeconomic status background, while the effect of low socioeconomic status was moderated for those with higher levels of academic performance.

Marks (2019) however argued that socioeconomic status is not an important predictor of university entry or completion, having only a small effect on participation and no effect on completion when prior academic achievement is taken into account. He argues that ‘differences in the university career by region, family type, Indigenous status, and school sector can be simply attributed to differences in university entrance performance (ATAR)’ (p.375). Cardak and Ryan (2009) also found that, when controlling for academic achievement using university entrance scores, university participation was similar for disadvantaged students when compared with those without disadvantage.

This phenomenon has also been observed in other countries. While there persists a gap in university participation across socioeconomic groups, these differences can largely be attributed to differences in academic achievement for disadvantaged students in England, Canada and the US (Jerrim & Vignoles 2015). Prior academic achievement was also found to substantially reduce differences in tertiary education participation rates for both private and public school students in England (Chowdry et al. 2012).

School effects

Attending an independent or Catholic school rather than a government school has been shown to lead to higher levels of educational attainment, as measured by years of schooling, Year 12 results and completion, university entrance scores and university commencement (Dean et al. 2023, Le & Miller 2002; Lim 2015; Marks 2019; Marks, McMillan & Hillman 2001). However, when controlling for factors such as socioeconomic status, prior academic achievement and a student’s sex, studies have also shown no association between school sector and the likelihood of commencing or completing university (Cardak & Ryan 2009; Cardak & Vecci 2013; Chesters 2019; Marks 2007; McMillan 2005).

Several studies demonstrate that schools have only a small effect on student performance when compared with individual characteristics (Dean et al. 2023; Gemici, Lim & Karmel 2013; Jerrim & Vignoles 2015; Lim 2015; Marks 2010). Gemici, Lim and Karmel (2013) found that individual characteristics played a dominant role in influencing tertiary entrance scores and university enrolment. Nevertheless, school characteristics explained about 20% of the variation in ATAR scores. School sector, gender mix and the academic orientation of the school were found to be the most important school characteristics, while the socioeconomic status of the school was not significant.

Marks (2010) used 14 different school-based measures alongside student-level measures to explore their combined effect on university entrance scores. Of the extensive list of school-level measures analysed, only the school’s average academic achievement and academic orientation (that is, pressure for students to do well) had a large effect on tertiary entrance scores, while teacher resources (that is, availability of qualified teachers and teacher ability) were found to be moderate. Similar to the study by Gemici, Lim and Karmel (2013), Marks (2010) found that the school’s socioeconomic status did not influence tertiary entrance performance when the academic performance of the school was taken into account.

Jerrim and Vignoles (2015) also emphasise the limited effect of schools on university entrance. When school effects were added to their model, the likelihood of attending university was largely unchanged when accounting for prior academic achievement and socioeconomic background. In other words, regardless of the schools attended by students, students with similar academic ability from high socioeconomic backgrounds remain more likely to attend university than their disadvantaged peers.

Purpose of this study

Our review of the literature suggests that the factors influencing tertiary pathways are multifarious. This is likely to be due to differences in the measures adopted, the populations or samples under investigation, or the analytical approaches utilised. For example, in Australia, several studies have used longitudinal survey data to explore the relationship between prior academic achievement and tertiary entrance performance but have employed different measures. Marks, McMillan and Hillman (2001) used customised Year 9 assessments to measure prior academic achievement and the Equivalent National Tertiary Entrance Rank (ENTER) to measure tertiary entrance performance. Marks (2010) and Gemici, Lim and Karmel (2013) also used ENTER scores to measure tertiary entrance performance, but calculated prior academic achievement using data from the Programme for International Student Assessment (PISA). Houg and Justman (2014) explored a similar research question with a linked administrative dataset, using NAPLAN and ATAR as their measures. However, due to limitations with availability of linked data at a national level, this study only offered a jurisdictional perspective.

Therefore, the purpose of this study is to determine whether a new, nationally representative, linked data source containing standardised national assessment data can be used to better understand tertiary entrance performance while accounting for a range of factors, such as a student's individual characteristics, their socioeconomic status and school attended. This study also explores the interrelationship between these factors with the aim of establishing whether the same measures examined in earlier studies remain significant.



Data and methodology

Data

This study uses data from the LSAY cohort who commenced the program in 2015 (Y15). Six cohorts have been involved in the LSAY program to date, with cohorts introduced in 1995, 1998, 2003, 2006, 2009 and 2015. LSAY Y15 participants were drawn from those who participated in the Organisation for Economic Co-operation and Development's (OECD) 2015 PISA, which provides a nationally representative sample of school students who were 15 years old in 2015. LSAY respondents participate in annual follow-up telephone or online interviews until they are 25 years old. A total of 14 530 students participated in PISA in 2015. However, sample attrition means that the number of LSAY respondents diminishes with each survey wave (NCVER 2023).

With NAPLAN introduced in 2008, the Y15 cohort is the only LSAY cohort to have had the opportunity to participate in NAPLAN testing in the primary years. From wave 2 in 2016, respondents were asked for their consent to link their NAPLAN test results to their LSAY records. The overall consent rate for the LSAY–NAPLAN linkage was 83%. Of these, 95% could be linked to NAPLAN records from Years 3, 5, 7 or 9, resulting in 79% of respondents with linked NAPLAN data from at least one year level. Not all records could be successfully linked because either the assessment data were not available or details required to undertake the linkage were missing or incorrect (Chew, Semo & Parvazian 2023).

School data from the Australian Curriculum, Assessment and Reporting Authority's *My School* data holdings have also been linked to LSAY records and provide school-level information about the schools attended by students. This allows for an analysis of the effect of the school in the year that LSAY respondents participated in NAPLAN.

These three datasets have been combined to create a multi-linked dataset, consisting of LSAY, NAPLAN and ACARA *My School* data, yielding a sub-sample of 2310 records. The sub-sample are respondents who have available Year 9 NAPLAN scores and the corresponding school they attended in Year 9, and indicated they completed a senior secondary certificate of education.

Outcome variables

We define the ATAR as the outcome measure in the analysis. ATAR is a national percentile ranking between 0.00 and 99.95 and gives a student's relative position compared with all other students in the same age cohort (Australian Department of Education 2017).¹ Eligibility and methods for calculating ATARs across each state vary; however, the Australasian Conference of Tertiary Admission Centres (ACTAC) checks their equivalence nationally. This means ATARs can be compared across states and territories in any one year. Prior to 2020, Queensland used the Overall Position (OP) instead of ATAR as the primary pathway for tertiary entrance. OP is a statewide rank showing a student's position compared with all other OP-eligible students in Queensland. OPs can be converted to the ATAR equivalent using the conversion table provided by the Queensland Tertiary Admission Centre (QTAC).²

1 The average ATAR is usually around 70.00. This is because not all students go on to complete a senior secondary certificate. The average ATAR would be 50.00 only if all students obtained an ATAR (University Admissions Centre 2023). The lowest reported rank is 30.00 and all ranks below this value are reported as 'less than 30' (Australian Department of Education 2017).

2 OP to ATAR conversion table available at: https://www.qtac.edu.au/wp-content/uploads/2020/06/ATARs_OP_bands.pdf.

From wave 3 (2017) until wave 6 (2020), LSAY respondents reported whether they had received an ATAR (or OP for students from Queensland) as part of their annual interview. OPs were converted to the equivalent ATAR using the aforementioned conversion table. In LSAY, respondents will only progress to the ATAR question if they have indicated they received a senior secondary certificate or have an unknown senior secondary certificate outcome. Our analysis is therefore limited to those who responded to the ATAR question; no imputations were made in this study.

Two binary outcomes are examined as part of this study:

- ATAR recipients: ‘1 Yes’ for respondents who received an ATAR; and ‘0 No’ for respondents who did not receive an ATAR
- ATAR high achievers: ‘1 Yes’ for respondents who received an ATAR of 90 or above; ‘0 No’ for respondents who received an ATAR below 90; anyone who did not receive an ATAR was excluded.

Predictor variables

Student-level measures

The student-level measures used in the analysis included gender, Indigenous status, language spoken at home, socioeconomic status and academic achievement.

The socioeconomic status measurement uses the PISA index of Economic, Social and Cultural Status (ESCS). ESCS is a composite score based on parental education, highest parental occupation and home possessions and is standardised with a mean of zero and a standard deviation of one (OECD 2016). Higher ESCS values indicate a higher level of socioeconomic status.

The NAPLAN tests provide each student with a ‘scale score’ for each learning domain, the scores ranging from approximately 0 to 1000 and reported using five scales: one for each of the reading, writing and numeracy domains, and one for each of the two language conventions: spelling, and grammar and punctuation. Each scale is organised into ten bands from Band 1 (low proficiency) to Band 10 (high proficiency).

The scaling of scores means NAPLAN results can be compared across year levels and over time. For our analysis, the sum of Year 9 NAPLAN reading and numeracy scores is included as a single predictor variable to account for the effect of both domains on ATAR.

Tables 1 and 2 show the demographic profile and Year 9 NAPLAN scores of LSAY respondents, according to their ATAR outcomes.

School-level measures

To account for a school’s influence on student outcomes, an anonymised school identifier has been included in the analysis and corresponds to the school the student attended in the year they undertook the Year 9 NAPLAN assessment.

Table 1 Demographic profile of LSAY respondents by ATAR outcomes

	ATAR recipient					ATAR high achievers				
	Yes		No		Total	Yes		No		Total
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	<i>n</i>	%	<i>n</i>	%	<i>n</i>
Gender										
Female	1 141	86.1	185	14.0	1 326	248	29.6	589	70.4	837
Male	815	82.8	169	17.2	984	175	27.3	467	72.7	642
Indigenous status										
Non-Indigenous	1 805	86.5	281	13.5	2 086	409	29.8	966	70.3	1 375
Indigenous	151	67.4	73	32.6	224	14	13.5	90	86.5	104
Language spoken at home										
English	1 772	84.3	329	15.7	2 101	377	28.0	972	72.1	1 349
Language other than English	180	88.2	24	11.8	204	46	35.7	83	64.3	129
Missing	4	80.0	1	20.0	5	0	0.0	1	100.0	1
Socioeconomic status (quintiles)										
Lowest quintile	166	69.8	72	30.3	238	19	18.6	83	81.4	102
Second quintile	276	75.2	91	24.8	367	31	15.4	171	84.7	202
Third quintile	367	79.8	93	20.2	460	54	20.0	216	80.0	270
Fourth quintile	478	88.7	61	11.3	539	95	26.5	263	73.5	358
Highest quintile	665	94.7	37	5.3	702	224	41.1	321	58.9	545
Missing	4	100.0	0	0.0	4	0	0.0	2	100.0	2
Total	1 956		354		2 310	423		1 056		1 479

Table 2 Year 9 NAPLAN scores of LSAY respondents by ATAR outcomes

	ATAR recipient					ATAR high achievers				
	Yes		No		Total	Yes		No		Total
	<i>n</i>	<i>Mean (std err.)</i>	<i>n</i>	<i>Mean (std err.)</i>		<i>n</i>	<i>Mean (std err.)</i>	<i>n</i>	<i>Mean (std err.)</i>	
Year 9 reading score	1 956	629.47 (1.35)	354	563.48 (3.11)		423	674.94 (2.56)	1 056	622.39 (1.63)	
Year 9 numeracy score	1 956	635.00 (1.59)	354	565.65 (2.79)		423	690.68 (3.36)	1 056	624.17 (1.85)	
Sum of Year 9 reading and numeracy scores	1 956	1 264.48 (2.65)	354	1 129.13 (5.31)		423	1 365.62 (4.99)	1 056	1 246.56 (3.07)	
Total	1 956		354		2 310	423		1 056		1 479

Methodology

We analyse the association between NAPLAN achievement scores, respondents' demographics and ATAR using a mixed-effect model. The mixed-effect model consists of a random effect and a fixed effect component, whereby the random effect allows for hierarchical or multi-level modelling to account for variability between clusters or groups (for example, schools), while the fixed effects account for variability between individuals. In other words, the fixed effects represent the average relationships between variables across the entire population, while the random effects account for variability at the individual or group level that is not captured by the fixed effects. These individual/group-specific variations are often due to unmeasured or unobserved factors, which can influence the response variable.

To account for the variability and possible differences of students' NAPLAN achievement scores between schools, we have included de-identified school identifiers as the random effect in our analysis.³ This gives us the hierarchical modelling structure that allows us to analyse according to the schools where respondents undertook their Year 9 NAPLAN assessments.

The mixed-effect models were performed in SAS using proc GLIMMIX and the procedure excludes any records with missing values in the outcome variable, random effect, or fixed effects.

In our study, we aim to identify whether NAPLAN achievement scores predict the likelihood of someone receiving an ATAR and whether it predicts the likelihood of someone achieving an ATAR of 90 and above, while controlling for other socio-demographic factors. To better distinguish the effect of NAPLAN scores on these two ATAR outcomes, we performed two separate mixed-effect analyses, with both models having the same random and fixed effects, the only difference being the outcome variable – one predicting ATAR recipients and the other ATAR high achievers.

Our mixed-effect models were structured as follows:

- **Model 1: ATAR recipients**
 - Outcome variable: Received an ATAR
 - Random effect: School
 - Fixed effects: Year 9 NAPLAN achievement scores, gender, Indigenous status, language spoken at home, SES, and the interaction between NAPLAN achievement scores and SES.
- **Model 2: ATAR high achievers**
 - Outcome variable: Received an ATAR of 90 or above
 - Random effect: School
 - Fixed effects: Year 9 NAPLAN achievement scores, gender, Indigenous status, language spoken at home, SES, and the interaction between NAPLAN achievement scores and SES.

The models include the interaction between socioeconomic status and NAPLAN achievement to investigate the combined effect of these two variables on ATAR outcomes. A significant interaction would imply that the impact of a student's academic achievement differs according to their socioeconomic status. For example, having a higher NAPLAN achievement score would have a different effect on a student from a low socioeconomic status than it would on a student with a high socioeconomic status.

³ Several school measures were tested as the random effect, such as school sector, school's average NAPLAN scores, nesting schools ID under school sector, socioeconomic status of students, and stratum based on the LSAY/PISA sampling structure but school IDs remained the best-performing random effect.

While the linked NAPLAN data provide NAPLAN achievement scores across all four year levels (Years 3, 5, 7, and 9), the number of linked records differs across each year level. Furthermore, high correlation exists between the assessed NAPLAN year levels across all domains, with studies indicating that early NAPLAN scores are reliable predictors of subsequent NAPLAN performance (Houng & Justman 2014). Including highly correlated predictors in regression models introduces the issue of multicollinearity, as the increase in the NAPLAN score of one year level will very likely relate to an increase in the NAPLAN score of the other year levels. The presence of multicollinearity disrupts the effect of the individual predictor on the outcome variable, causing difficulty in distinguishing the impact that each predictor has in the model.

The different sample sizes (that is, number of linked NAPLAN records) across each year level also pose a challenge. This is because standardised coefficients of the mixed-effect models cannot be compared across the year levels due to the difference in the sample deviation calculation arising from the different sample sizes. Therefore, a single year level is more suitable for inclusion in our model.

The choice of year level comes down to a combination of findings from the literature and information based on the linked data itself. Year 9 achievement scores have been shown to be a strong predictor of tertiary entrance performance (Houng & Justman 2014; Marks, McMillan & Hillman 2001). Our data also indicate that Year 9 achievement scores have the highest correlation with both ATAR outcomes (see appendix, table A1). In addition, we have the largest number of linked records available in Year 9 ($n = 4865$) across all the year levels. The combination of these factors led us to choose Year 9 NAPLAN achievement scores in this study.

The two NAPLAN achievement scores that exhibited the highest correlation with ATAR were the numeracy and reading domains (table A2 in the appendix). We also observed from the Year 9 achievement scores that a strong correlation exists between the reading and numeracy domains, $r = 0.68$ (table A3). As noted above, multiple predictors with high correlation present collinearity issues with regression models. Therefore, to account for the effect of both domains in the model, we combined and summed the reading and numeracy scores into a single predictor. If either the reading or numeracy scores were not available, they were not included in the analysis.



Results

This section presents the results from the mixed-effect models, modelling those who received an ATAR (ATAR recipients) and those who received an ATAR of 90 and above (ATAR high achievers) on NAPLAN achievement scores and respondents' socio-demographics. Table 3 shows the variables that were statistically significant in the mixed-effect models for ATAR recipients and ATAR high achievers, while table 4 shows the results of the mixed-effect models reported in odds ratios (not including the random effect). The odds ratio represents the relative likelihood of an event occurring for one level of the predictor variable compared with the reference level of the same predictor variable. An odds ratio greater than one indicates a higher likelihood and an odds ratio less than one indicates a lower likelihood when compared with the reference category. An odds ratio equal to one indicates no difference in likelihood for any of the categories. In the presence of an interaction term, the odds ratio represents the change in odds associated with a one-unit increase in the predictor variable when the other interacting variables are held constant.

Odds ratio estimates for NAPLAN achievement scores are calculated based on an increment of 50 above the mean score. This is a rough approximation of the general increment in Year 9 NAPLAN achievement scores. NAPLAN achievement scores are not entirely linear in their increments, as they are converted using the NAPLAN score equivalence table.⁴ Therefore, we note that, if the increase in NAPLAN achievement scores is larger than 50, the odds ratio output will be larger than those shown in table 4.

Table 3 Characteristics associated with receiving an ATAR score and achieving a *high* ATAR score

Fixed effects	Degrees of freedom	Model 1: ATAR recipients			Model 2: ATAR high achievers		
		F-value	Pr > F	Stat. sig. at 5% level	F-value	Pr > F	Stat. sig. at 5% level
Gender	1	18.6	<.0001	*	15.32	<.0001	*
Indigenous status	1	8.31	0.004	*	1.99	0.1582	
Language spoken at home	1	6.21	0.0128	*	0.39	0.5349	
Socioeconomic status	4	1.97	0.0973		0.15	0.9616	
NAPLAN achievement scores	1	216.52	<.0001	*	145.1	<.0001	*
NAPLAN achievement scores x SES	4	2.58	0.0356	*	0.15	0.9652	

Note: * indicates statistical significance at the 5% level, where the p-value ≤ 0.05 .

⁴ The score equivalence table converts a student's raw score on their NAPLAN tests to its equivalent on the relevant NAPLAN scale score, which ranges from zero to 1000. The raw score is based on the number of questions answered correctly and varies by domain and year level.

Table 4 Odds ratio output for mixed-effect modelling of ATAR recipients and ATAR *high* achievers on NAPLAN achievement scores and respondents' socio-demographic variables

Fixed effects	Model 1: ATAR recipients			Model 2: ATAR high achievers		
	Odds ratio	p-value	Stat. sig. at 5% level	Odds ratio	p-value	Stat. sig. at 5% level
Gender						
Female (reference: Male)	1.84	<.0001	*	1.81	<.0001	*
Indigenous status						
Indigenous (reference: Non-Indigenous)	0.58	0.004	*	0.62	0.158	
Language spoken at home						
Language other than English (reference: English)	2.00	0.0128	*	1.18	0.535	
Socioeconomic status (quintiles)						
Second quintile	1.67	0.083		0.99	0.859	
Third quintile	1.41	0.4449		1.19	0.965	
Fourth quintile	3.65	0.0218	*	1.33	0.767	
Highest quintile (reference: Lowest quintile)	5.64	0.0495	*	2.23	0.901	
NAPLAN achievement scores (assessed at 50 above the mean score at the lowest SES quintile)						
	1.47	<.0001	*	1.79	0.000	*
NAPLAN achievement scores x SES (assessed at 50 above the mean score, reference: lowest quintile)						
Second quintile	1.21	0.0724		0.97	0.853	
Third quintile	1.09	0.3942		1.02	0.934	
Fourth quintile	1.35	0.01	*	1.07	0.710	
Highest quintile	1.35	0.0167	*	1.01	0.951	
Random effect						
	Estimate	Pr > ChiSq	Stat. sig. at 5% level	Estimate	Pr > ChiSq	Stat. sig. at 5% level
School	0.48	0.0004	*	0.5139	<.0001	*

Note: * indicates statistical significance at the 5% level, where the p-value ≤ 0.05 .

ATAR recipients

The results from table 3 showed that gender, Indigenous status, language spoken at home, along with the interaction of NAPLAN achievement scores and SES, are statistically significant predictors of receiving an ATAR. Based on the odds ratio output reported in table 4, females are 1.84 times more likely than males to receive an ATAR, holding all other variables constant. Indigenous individuals are less likely to receive an ATAR than non-Indigenous individuals, with an odds ratio of 0.58. Students who speak a language other

than English at home are twice as likely to receive an ATAR compared with students from an English-speaking background.

The interaction of NAPLAN achievement scores and socioeconomic status is a significant predictor. When comparing an individual from the second-highest or highest socioeconomic quintile with those from the lowest socioeconomic quintile, the likelihood of receiving an ATAR increases as their NAPLAN achievement score increases. More precisely, an individual from the second-highest or highest socioeconomic quintile with an increase of 50 in their NAPLAN achievement scores is 1.35 times more likely to receive an ATAR compared with an individual with the same increment from the lowest socioeconomic quintile. In a scenario where the increment in the NAPLAN scores is greater than 50, then the odds of receiving an ATAR would increase by more than 1.35 times. It can be noted that, while the odds ratio for the top two socioeconomic quintiles are the same in table 4, this does not imply that the gap of the odds ratio between the two quintiles will remain at zero when the increase in NAPLAN scores is greater than 50. However, we have observed with increments of NAPLAN scores of greater than 50 that the gap does remain minimal (or close to zero), which may imply that the effect of socioeconomic status plateaus at the higher socioeconomic quintiles, suggesting a diminishing SES effect.

The random effect of the school is statistically significant when tested against the null model of not having a random effect, as indicated by the p-value of less than 0.05 in table 4. Using the random effect estimate from the output, we can also calculate the intraclass correlation coefficient (ICC), which indicates how much of the variation in the probability of achieving an ATAR is attributable to schools. The ICC is calculated as follows:

$$ICC_{school} = \frac{\text{school random effect estimate}}{\text{school random effect estimate} + 3.29},$$

where 3.29 is the assumed level-1 error variance. More detailed information about the level-1 error variance and ICC is available from Ene et al. (2015). Using the above formula, we obtain an ICC of 0.127, which indicates that approximately 12.7% of the variability in the probability of receiving an ATAR is accounted for by the school.

ATAR high achievers

Results from the ATAR high-achiever model differ from the ATAR recipient model. While gender and Year 9 NAPLAN achievement remain significant in the ATAR high-achievers model, Indigenous status, language spoken at home and the interaction between NAPLAN achievement and socioeconomic status are no longer statistically significant.

The results from our second model indicate that females are 1.81 times more likely than males to achieve an ATAR of 90 or above. In addition, an increase in the Year 9 NAPLAN achievement score increases the likelihood of an individual attaining an ATAR of 90 or above. Specifically, an individual with an increase of 50 above the mean NAPLAN achievement scores is around 1.8 times⁵ more likely than an individual at the mean NAPLAN score to achieve an ATAR of 90 or above.

The random effect of school for ATAR high achievers is also statistically significant when tested against the null model of no random effect. The ICC of school in this model is 0.1351, indicating that schools account for approximately 13.5% of the variance in the probability of achieving an ATAR of 90 or above, noting a higher school impact when compared with the ATAR recipients' model.

⁵ Odds-ratio for an increase of 50 in NAPLAN achievement scores averaged over all SES quintiles is 1.83 for the ATAR high achievers model.

Impact of predictor variables

One of the ways to assess the relative impact of each predictor variable on the outcome variable is through the estimates of standardised coefficients. Standardised coefficients estimate the change in the response variable associated with a change of one standard deviation in the predictor variable. Essentially, standardised coefficients allow us to compare the relative impact of each predictor on the outcome variable by adjusting them all on the same unitless scale. A larger estimate therefore implies a larger impact. The ‘sign’ of the estimate also shows the direction of the impact, where a positive estimate indicates an increasing/positive impact, while a negative estimate indicates a decreasing/negative impact on the outcome variable. Table 5 gives the standardised coefficients of the fixed-effects variables for both models.

Table 5 Standardised coefficients estimates for ATAR recipients and ATAR high achievers

	Model 1: ATAR recipients			Model 2: ATAR high achievers		
	Estimate	p-value	Stat. sig. at 5% level	Estimate	p-value	Stat. sig. at 5% level
Gender						
Female (reference: Male)	14.47	<.0001	*	11.33	<.0001	*
Indigenous status						
Indigenous (reference: Non-Indigenous)	-7.78	0.004	*	-4.77	0.158	
Language spoken at home						
Language other than English (reference: English)	9.44	0.0128	*	1.75	0.535	
Socioeconomic status (quintiles)						
Second quintile	-75.73	0.083		11.75	0.859	
Third quintile	-34.28	0.4449		-3.19	0.965	
Fourth quintile	-125.35	0.0218	*	-22.49	0.767	
Highest quintile (reference: Lowest quintile)	-126.97	0.0495	*	10.11	0.901	
NAPLAN achievement scores (at the lowest SES quintile)						
	45.64	<.0001	*	51.07	0.000	*
NAPLAN achievement scores x SES (reference: lowest quintile)						
Second quintile	82.31	0.0724		-11.60	0.853	
Third quintile	40.49	0.3942		5.69	0.934	
Fourth quintile	153.71	0.01	*	27.41	0.710	
Highest quintile	172.47	0.0167	*	4.89	0.951	

Note: * indicates statistical significance at the 5% level, where the p-value ≤ 0.05 .

The statistical significance of each predictor remains the same as with table 3 for both models. The interpretation of the standardised coefficients is therefore confined to the statistically significant predictors. For ATAR recipients, the interaction between NAPLAN achievement scores and the two highest SES quintiles displays the largest impact on the likelihood of an individual receiving an ATAR, while gender has the second-largest effect. The effect of Year 9 NAPLAN achievement scores increases for higher levels of SES, although we have insufficient evidence to conclude the impact in the lower (second and third) quintiles.

For ATAR high achievers, Year 9 NAPLAN achievement scores have the largest impact on the likelihood of an individual achieving an ATAR of 90 or above, with gender having the second largest effect. These results are discussed in the following section.



Discussion

The purpose of this study was to investigate whether national assessment data, when linked to a nationally representative longitudinal dataset, could be used to predict the likelihood of students obtaining an ATAR at the completion of Year 12, and the likelihood of obtaining a *high* ATAR. We found prior academic achievement, as measured by NAPLAN scores, played an important role for both outcomes. Other important characteristics associated with an increased likelihood of receiving an ATAR included having a non-English speaking background, being female, and being non-Indigenous. These findings are in line with earlier studies (Houng & Justman 2014; Marks, McMillan & Hillman 2001; Marks 2010, 2019).

Our analyses found that the interaction between a student's socioeconomic status and their academic achievement was the strongest predictor of ATAR attainment when controlling for other factors, suggesting that the interplay between socioeconomic status and academic achievement requires further investigation. Our results showed that, for individuals with a high socioeconomic status, the likelihood of receiving an ATAR increases by about 1.35 times as their NAPLAN scores increase when compared with students with a low socioeconomic status with the same increase in academic achievement. This finding demonstrates the compounding advantage that a high socioeconomic status in combination with a strong foundational academic background has on the tertiary trajectory and emphasises the importance of not ignoring those from disadvantaged backgrounds, even when students from such backgrounds have a strong academic foundation.

This significant finding is reflected in other similar studies. When exploring the combined effect of socioeconomic status and background characteristics on university completion, Lim (2015) showed that less academically inclined students were further disadvantaged if they came from a low socioeconomic status background, while the effect of low socioeconomic status was moderated for those with higher levels of academic performance. However, the findings from Houng and Justman's 2015 analysis examining the interaction between NAPLAN and socioeconomic status were more nuanced. The authors found that the impact of socioeconomic status was highest for students with scores centred around the middle band of NAPLAN scores. For those at the upper and lower ends of the achievement scale, the effect of socioeconomic status is less pronounced and greatly diminishes at the extreme ends: students with very low achievement scores have a very low chance of success, while students with very high achievement scores have a very high chance of success, regardless of their socioeconomic background.

When we explore the factors associated with high tertiary entrance performance, the results are very different. The joint effect of socioeconomic status and student achievement is no longer significant, and the importance of characteristics previously found to be associated with receiving an ATAR; namely, language background and Indigenous status, falls away. Instead, just two characteristics are found to influence high tertiary entrance performance: earlier academic achievement and being female. These findings are reflected in several other studies which show prior academic achievement to have the greatest effect on tertiary entrance performance (Houng & Justman 2015; Marks, McMillan & Hillman 2001; Marks 2010, 2019).

In the context of high achievers, our study highlights the importance of prior educational achievement and the limited effect of other background characteristics. Students with higher levels of academic achievement are almost twice as likely to achieve ATAR scores of 90 or above, controlling for their socioeconomic or language background, gender and indigeneity. A position of socioeconomic advantage alone does not translate to exceptional academic success. Instead, strong foundational skills are key, regardless of a student's background. Doing well at school can therefore protect students from the poorer outcomes that are often associated with disadvantage. Houng and Justman (2015) also found that performing well in Year 9

NAPLAN tests to be an important condition for achieving an ATAR of 90 or above. Their study showed that, while the combination of a higher socioeconomic background and higher achievement scores led to an increased likelihood of achieving an ATAR of 90 or above, students with very high (or very low) test scores were less affected by their socioeconomic status. Performing well at school is therefore a necessary condition for achieving an ATAR of 90 or above.

Our analysis also demonstrated that, while schools play a role in influencing students' attainment of an ATAR, their impact is relatively small by comparison with the student's individual characteristics. Most of the variation in a student's ATAR score can be attributed to their demographic profile or academic ability rather than the school they attend. We found that schools were responsible for about 13% of the variation in tertiary entrance scores. Other comparable studies arrived at similar conclusions, with school factors accounting for between 10 and 20% of the variation in tertiary entrance scores (Gemici, Lim & Karmel 2013; Marks 2010).

It is worth noting that these earlier studies explored multiple school factors, including compositional effects, such as school sector, gender mix, socioeconomic status or the academic context of the school, and structural effects, including school size and resources. Despite the inclusion of a comprehensive suite of school-level measures, only a handful of measures were found to be important in these studies. Gemici, Lim and Karmel (2013) found that school sector, gender mix and the academic orientation of the school (measured by pressure from parents, student selection criteria and streaming) were the most important characteristics, while the socioeconomic status of the school was not identified as significant. Marks (2010) also used a range of school-based measures, alongside student-level measures, to explore their combined effect on university entrance scores and found that only the school's average academic achievement and academic orientation (that is, pressure for students to do well) had a large effect on tertiary entrance scores, while the effects of teacher resources (that is, availability of qualified teachers and teacher ability) were found to be moderate. Marks also identified that the school's socioeconomic status did not influence tertiary entrance performance when the academic performance of the school and student characteristics were taken into account.

This study, by contrast, tested several different school measures for random effects such as school sector, average school NAPLAN scores, the socioeconomic status of the school, and the survey design stratum (that is, school sector, state/territory, and geographic location) but found a unique school identifier to be the best fit for our models. Given that the overall variation explained by school effects across other studies is comparable with our analysis, it is evident that the effect of the school cannot be attributed to just one or two school characteristics alone. This study, on the other hand, points to a unique combination of school-level factors that influence tertiary entrance performance.



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Appendix

Table A1 Correlation between ATAR outcomes and NAPLAN achievement scores for all year levels

	Year 3 achievement scores (reading and numeracy)	Year 5 achievement scores (reading and numeracy)	Year 7 achievement scores (reading and numeracy)	Year 9 achievement scores (reading and numeracy)
ATAR recipients	0.34	0.37	0.38	0.39
ATAR high achievers	0.32	0.37	0.42	0.47

Table A2 Correlation between ATAR outcomes and year 9 NAPLAN achievement scores

	Reading score	Numeracy score	Grammar and punctuation score	Spelling score	Writing score
ATAR recipients	0.37	0.35	0.33	0.30	0.31
ATAR high achievers	0.40	0.43	0.39	0.32	0.32

Table A3 Correlation between domains of year 9 NAPLAN achievement scores

	Reading score	Numeracy score	Grammar and punctuation score	Spelling score	Writing score
Reading score	1.00	0.68	0.73	0.63	0.57
Numeracy score	-	1.00	0.67	0.55	0.49
Grammar and punctuation score	-	-	1.00	0.64	0.57
Spelling score	-	-	-	1.00	0.54
Writing score	-	-	-	-	1.00



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