Pathways of PISA low-achievers: Success despite the odds?

Sue Thomson & Kylie Hillman
Australian Council for Educational Research[1]

Introduction

In 1997, the OECD launched the Programme for International Student Assessment (PISA). PISA was the result of a desire by governments to monitor the outcomes of education systems in terms of student achievement on a regular basis and within an internationally accepted common framework. The overall aim of PISA is to measure how well 15-year-olds approaching the end of their compulsory schooling are prepared for meeting the challenges they will face in their lives beyond school. PISA's orientation towards the future of these students is reflected in its literacy approach, which is concerned with the capacity of students to apply their skills and knowledge in a particular subject area, and to analyse, reason and communicate effectively as they do so. The PISA model of assessment focuses on reading literacy, mathematical literacy and scientific literacy. In each cycle there is a major emphasis on one of these domains and a lesser emphasis on the other two domains (in PISA terms; 'major' and 'minor' domains).

In 2000, the first PISA assessment was carried out in 32 countries (including 28 OECD member countries). This assessment was repeated in a further 11 partner (non-OECD) countries in 2001. The focus of this first assessment was reading literacy, with a lesser emphasis on mathematical and scientific literacy. In 2003, PISA was conducted in 41 countries, including all 30 OECD countries. The major focus of this assessment was mathematical literacy, with less emphasis on reading and scientific literacy. PISA 2006 completed the first full cycle of assessment, with a primary focus on scientific literacy and minor assessments in reading and mathematical literacy. Almost 60 countries participated in this round of PISA.

PISA was designed to help governments not only understand but also to enhance the effectiveness of their educational systems. PISA collects reliable information every three years and derives educational indicators that can be used to monitor differences and similarities over time. PISA findings are being used internationally to:

- compare literacy skills of students in one country to those of students in other participating countries;
- establish benchmarks for educational improvement, in terms of the mean scores achieved by other countries or in terms of a country's capacity to provide high levels of equity in educational outcomes and opportunities; and
- understand the relative strengths and weaknesses of individual education systems.

Mathematical literacy, the major assessment in PISA 2003, placed its primary emphasis on the real-world problem situation, and on the mathematical knowledge and competencies that are likely to be useful to deal effectively with the problem. In 2003, the Australian PISA

[1] The authors would like to acknowledge funding support from the Australian Government Department of Education, Employment and Workplace Relations through an ARC Research Infrastructure Equipment & Facilities (**RIEF**) project grant.

sample became a commencing cohort for the Longitudinal Surveys of Australian Youth (LSAY).

LSAY is a series of surveys that focuses on the progress of young Australians as they move from their mid-teens to their mid-twenties, from their initial education to independent working life. These surveys provide descriptions of what young Australians are doing as they negotiate the transition from school.

The follow up of the PISA sample through the connection with LSAY provides a unique opportunity to investigate the pathways of those young people who scored poorly on the PISA mathematics tests in 2003 through the later years of secondary school and into further education, training or employment, and to relate their outcomes to other variables, particularly sociodemographic background variables, gender and interests as measured in PISA. The PISA data provides a wealth of information not only about student level factors influencing achievement, but also about school-level influences such as school-level perception of school climate and resourcing, while the longitudinal survey data enable the detailed mapping of individual pathways, as well as facilitating causal analyses.

PISA scores and proficiency levels

As well as mean scores, PISA also provides a profile of students' mathematical performance using *proficiency levels*. Descriptions have been developed to characterise typical student performance at each level. The levels can be used to summarise the performance of students, to compare performance across subgroups of students, and to compare average performance among groups of students.

For PISA 2003 mathematics, six levels of proficiency were defined and described. The continuum of increasing mathematical literacy was divided into five bands, each of equal width, and two unbounded regions, one at each end of the continuum. The information about the items in each band has been used to develop summary descriptions of the kinds of mathematical competencies associated with different levels of proficiency. These summary descriptions can then be used to encapsulate typical mathematical proficiency of students associated with each level. As a set, the descriptions encapsulate a representation of growth in mathematical literacy.

Low achievers

The OECD has defined proficiency level 2 on the PISA scales as representing a baseline level of literacy at which students begin to demonstrate the competencies that will enable them to actively participate in life situations. Students performing below this baseline, it is argued, are at serious risk of not being able to adequately participate in the 21st century workforce and contribute as a productive citizen (see, for example, OECD, 2004)[2] and it could well be argued that this is a group of young people most vulnerable in a context of insecurity and precarity. In Australia, however, the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) determined that "the national standards … should be set at a 'proficient' standard, rather than a 'minimum' standard"

[2] OECD (2004). Learning for tomorrow's world: First results from PISA 2003. OECD: Paris

(MCEETYA, 2006),[3] and set the key performance measure as the percentage of students achieving at or above Proficiency Level 3 on each of the OECD PISA literacy scales.

The sample for this project was chosen based on the proficiency level of the students in mathematics, the major assessment domain in PISA 2003. Table 1 provides the number of students in the 2003 assessment, and the number retained in each subsequent year, who were below proficiency Level 3 in mathematics, in reading, and in mathematics and reading.

The reasons for basing the sample for this study on the number of students who did not reach the MCEETYA baseline standard in mathematics were twofold. Firstly, this would maximise the number of students available for analysis, and secondly, the assessment of mathematics, as the major domain, is a more robust measure than the assessment of reading literacy in the same cycle.

Table 1 Number of Low Achieving students (PL <3) in annual LSAY surveys, 2003-2007, unweighted

	Year of survey				
Assessment used in definition	2003	2004	2005	2006	2007
Math	3238	2779	2441	2022	1638
Read	2767	2351	2048	1700	1359
Math+Read	2171	1837	1586	1292	1020

Research conducted using data from the Longitudinal Surveys of Australian Youth (LSAY) has reported a strong relationship between achievement by Year 9 and school completion and participation in post-secondary education and training (e.g. Fullarton, Walker, Ainley and Hillman, 2003) [4], and also that low achievers are more likely to leave school early, enter apprenticeships or attempt to enter the labour force immediately upon leaving school (McMillan and Marks, 2003)[5]. Nevertheless, this relationship is not always so simple; not all Year 9 low achievers fail to complete Year 12, indeed many continue with their education and training at TAFE or university and go on to stable employment.

Success

A key feature of this research is the multifaceted definition of a successful outcome that has been employed. Previous research that has investigated the relationships between earlier achievement and post-school destinations and outcomes has tended to use a unidimensional definition of a 'successful' outcome, focusing on participation in tertiary education or employment. The definition of 'success' used in this project was expanded to

[3] Performance Measurement and Reporting Taskforce (PMRT) (2006). Measurement framework for national key performance measures. Available at *www.mceetya.edu.au/verve/_resources/2006_Measurement_FW_for_national_KPMs_Final.pdf*.

[4] Fullarton,S., Walker,M., Ainley,J., and Hillman,K. (2003). Patterns of Participation in Year 12. Longitudinal Surveys of Australian Youth. Research Report 33: Australian Council for Educational Research .

[5] McMillan.J., and Marks,G. (2003). School Leavers in Australia: Profiles and pathways. Longitudinal Surveys of Australian Youth. Research Report 31: Australian Council for Educational Research.

include satisfaction with life, as well as whether they are fully occupied with education, employment or a combination of these activities, providing a more well-rounded view of outcomes than has been used in the past. Those who are fully engaged and happy with their lives were designated as having a 'successful outcome' for the subsequent modelling.

The analysis reported in this paper aims to:

- describe the post-school pathways of low mathematics achievers; and
- identify what differentiates low-performing students who have positive and successful outcomes from those who have less successful outcomes.

Identifying the factors that contribute to the 'resilience' of these low performing young people has implications for policy development in two main ways: firstly, identifying the differences between low-performing students who go on to have positive outcomes and those who do not can be used to improve the targeting of resources and assistance towards students and schools who need it most (improving the efficiency of the use of resources); secondly, information about school level factors that are related to better outcomes in later life for low performing students can be used to improve school environments and thus outcomes for all students (improving the effectiveness of schooling).

Post-school pathways

The main activities of the low achieving sample were identified for each of the subsequent years they remained in LSAY. Movement between the ten activities is presented in Figure 1 (Attachment).

Despite their low achievement, the majority of the young people actually remained at secondary school until late 2005 and, when interviewed in 2006 (or subsequent years), indicated that they had completed Year 12 and had been awarded the appropriate qualification for their state.[6] From there, over one third of the young people moved into employment – part time or full time – while less than one third went on to tertiary education at a university, TAFE or some other facility.

For those who chose to leave secondary school early without completing their qualification, the labour force appeared to be a more attractive option than taking up an apprenticeship or traineeship. Around one in six of these young people had attempted to enter the labour force in 2005, although with varying degrees of success – close to five per cent were still looking for work while the proportion who were in part time work was slightly larger than the proportion who had found full time employment.

As has been found in other research using the LSAY data from older cohorts, there is a degree of stability of activity in the post-secondary years that can be a boon to those who make a transition into positive activities, but may be a more negative experience for those who have initial difficulties in finding their place. In each year, the majority of young people who had a full time job the previous year continued to be in full time employment, while for those who were unemployed, around one quarter were unemployed the following year. Around one third, however, made the transition to part time or full time employment, indicating that for some young people at least, unemployment was a stop along the path rather than a pathway in and of itself. In 2007, this group of young people who may have

[6] Close to two-thirds of those who remained in the study in 2007 had completed their Year 12 qualification.

been expected to be experiencing difficulties given their low achievement, were doing relatively well. Around 40 per cent of those who were contacted in 2007 were in some form of further study or training, just over 30 per cent were in full time employment and another 17 per cent were working part time. The unemployment rate among this group of young people was just under six per cent, while estimates for unemployment around this time was around 3.5 per cent for teenagers (age 15 to 19) or over 10 per cent for youth (Dusseldorp Skills Forum, 2007[7]; UNDP, 2007[8]).

The main activities of those young people who remained in the study in 2007 were then classified as being representative of *full engagement* (full time work – 35 hours or more on average per week; full time study or training; part time students who were working part time or full time hours), *partial engagement* (those working less than 35 hours per week on average, part time students who were not employed) or *non-engagement* (those who were looking for work but not employed and those who were not looking for work but not employed – not in the labour force).

Overall, the outcomes in terms of engagement in education or employment for this group of young people appear fairly positive, with close to six in ten fully engaged in education or training, employment or a combination of these. However, in comparison to published statistics, the situation for this particular group of young people begins to look less favourable. Australian Social Trends 2005 (ABS, 4102)[9] reported on the engagement of different groups of young Australians and found that only 14 per cent of young people aged between 15 and 19 were not fully engaged in 2004, which rose to 31 per cent when only those who had left school in the previous year were considered. In comparison, over 40 per cent of this group of young people were not fully engaged in 2007, although the majority had actually left school late in 2005.

Successful or not – Investigating the differences

The next focus of this study was to investigate whether there were factors that differentiated low performing students who were classed as successful and those who had less positive outcomes. Traditionally, such questions, with a dichotomous outcome variable, are investigated using logistic regression analysis. Because of the way in which the PISA sample is constructed, however, with students clustered within schools, hierarchical logistic analysis was carried out. The sample included 1596 students from 294 schools.

The following student (Level 1) characteristics were tested in the modelling. The source of the item is indicated. For all categorical or dichotomous variables the first category is considered the reference group.

- Gender (PISA: female, male)
- Indigenous (PISA: no, yes)
- Have Year 12 certificate (LSAY: no, yes)

[7] Dusseldorp Skills Forum. (2007). How young people are faring 2007: At a glance. Glebe: DSF.
[8] UNDP (2007). http://hdrstats.undp.org/countries/data_sheets/cty_ds_AUS.html
[9] Australian Bureau of Statistics. (2005). Australian social Trends. Available http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/D3D7FAA735DDA645CA25703B00774A0B/$File/41020_2005.pdf

- Socioeconomic background (PISA). This analysis used the index of economic, social and cultural status (ESCS), which was created in PISA to capture the wider aspects of a student's family and home background. The ESCS is based on the highest level of the father's and mother's occupations, the highest level of education of the father and mother converted into years of schooling; the number of books in the home; and access to home educational and cultural resources. This was divided into quartiles based on data for the whole cohort and then two dummy variables were created: medium SES (which combined the second lowest and second highest quartiles) and high SES, meaning low SES was the reference group used.
- Post-school plans (LSAY). In their initial LSAY survey, students were asked about their plans for the future. Four dummy variables were developed, including the reference group who planned attending university. The other groups were *plan to do apprenticeship or traineeship, plan to go on to Technical and Further Education (TAFE), plan to get a job* and *don't know*.

Two indices were developed in PISA to assess students' motivation to learn mathematics. The *interest in mathematics* index focuses on students' own, or internal, motivations to learn and the *instrumental motivation in mathematics* index, which focuses on the external rewards that encourage students to learn. These indices were scaled using a weighted maximum likelihood estimate (OECD, 2004). Values on the index were standardised so that the mean value for the OECD student population was zero and the standard deviation was one. Thus negative responses on these indices indicate a response that was more negative than the OECD average.

- Interest in mathematics (PISA). In this set of items students were asked to think about their views on mathematics and indicate their agreement on the following statements:
    - I enjoy reading about mathematics.
    - I look forward to my mathematics lessons.
    - I do mathematics because I enjoy it.
    - I am interested in the things I learn in mathematics.
- Instrumental motivation (PISA). Students' levels of *instrumental motivation* were measured by seeking their responses to statements about the importance of mathematics for their future study and career prospects. Students were asked their level of agreement for each of the following questions:
    - Making an effort in mathematics is worth it because it will help me in the work that I want to do later on.
    - Learning mathematics is important because it will help me with the subjects that I want to study further on in school.
    - Mathematics is an important subject for me because I need it for what I want to study later on.
    - I will learn many things in mathematics that will help me get a job.

Two of the items used in the analyses were part of the LSAY questionnaire and broadly examined the *quality of school life*. These used Likert scales and the overall score for the construct was formed as the average of the items that comprised the scale. The scales were

- Positive Affect: Your school is a place where
    - you feel happy,
    - you like learning,
    - you get enjoyment from being there;

    - you really like to go each day;
    - you find that learning is a lot of fun;
    - you feel safe and secure
- Opportunity: Your school is a place where
    - the things you learn are important to you;
    - the work you do is good preparation for your future;
    - you have gained skills that will be of use to you;
    - the things you learn will help you in your adult life;
    - you are given the chance to do work that really interest you;
    - the things you are taught are worthwhile.

At the school level four variables were used in the modelling. These variables together provide a contextual background for students in terms of school climate: where their school is located, the type of neighbourhood and the general feelings about student behaviour and teacher-student relations at the school (among 15 year olds).

- School location (PISA: Metropolitan, non-Metropolitan)
- School-average socioeconomic background. This variable was aggregated from the student-level socioeconomic background for the cohort.
- School average student behaviour. This variable was aggregated from the student-level variable, which was the average response to four Likert items: Your school is a place where students are eager to learn; work hard; make good progress; and are well behaved.
- School average teacher-student relationship. This variable was also aggregated from the student-level variable, which was the average response to six Likert items: Your school is a place where teachers know their subject matter well, explain things clearly, are well prepared and organised, have ability to communicate with students, maintain student interest, manage student discipline well.

Results

Figure 2 shows the results for the whole group sample graphically. In this figure, the solid bars represent the odds ratio of the event, and the lines represent the confidence interval around this odds ratio. Significant odds are indicated with an asterisk. In this section we will refer to both the calculated odds ratios and the associated predicted probabilities. For the reference group an odds ratio of 1 and the associated predicted probability[10] of 0.5 means that success is as likely as failure, thus odds ratios significantly higher or lower than 1, with associated predicted probabilities higher or lower than 0.5, mean that success or failure are more or less likely.

Of the student background variables, only socioeconomic background was found to be significant, with those low achieving students from medium and high socioeconomic backgrounds more likely to be successful than students from a low socioeconomic background (the omitted comparison group). For students from an average socioeconomic background, the odds ratio was 1.3. The associated predicted probability of average socioeconomic students being successful was 0.57. Similarly for higher socioeconomic background the predicted probability was 0.58. Gender and Indigenous status were not found to be significant influences on the likelihood of success among low achieving youth, and neither was the attainment of a Year 12 certificate.

[10] The predicted probability is calculated as probability = odds /(1+odds)

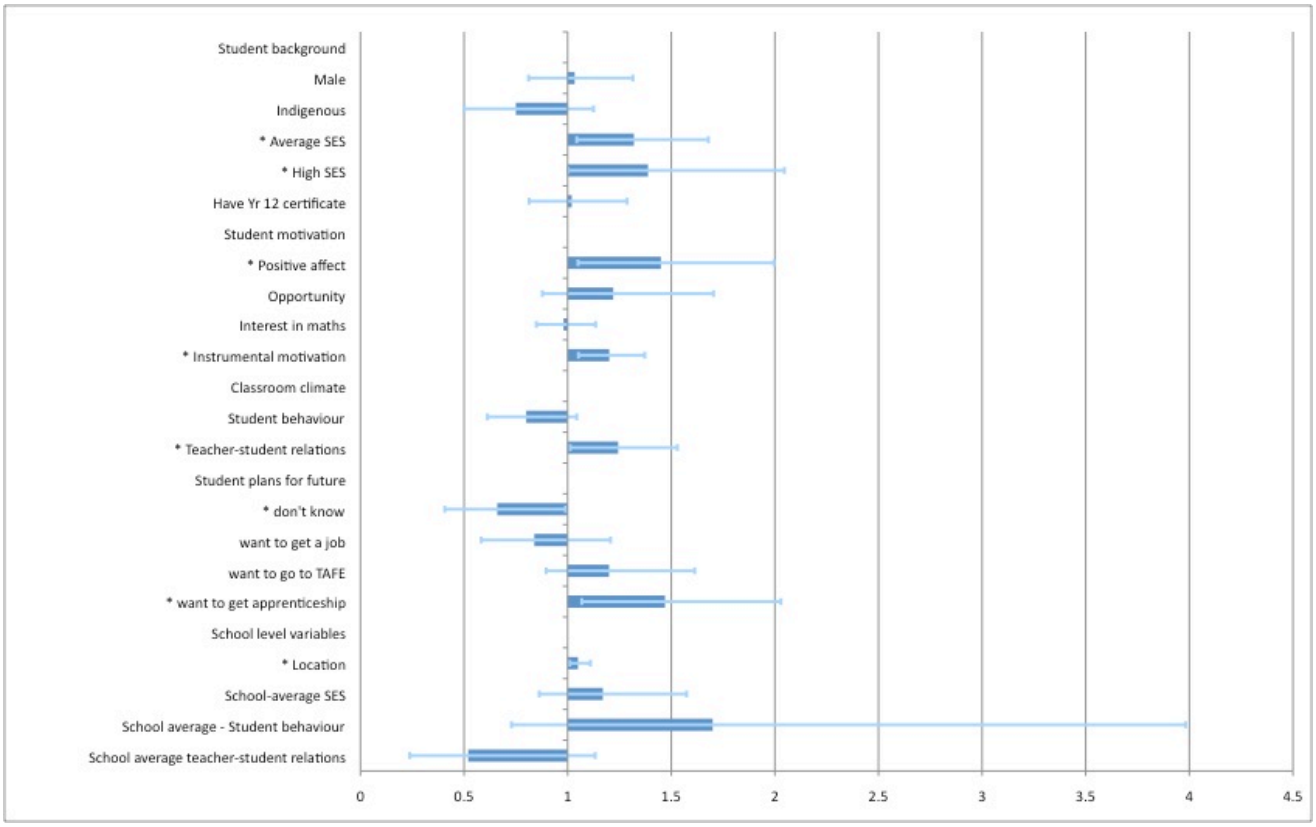

Figure 2 Odds ratios for multilevel model of students' successful outcomes

The next set of variables refer to student motivation. Of these, two were found to be significant: Positive Affect and Instrumental Motivation. The predicted probability of a successful outcome for students with a higher score on Positive affect was 0.59 and for those with a higher score on Instrumental motivation, 0.54.

Of the perceived classroom climate variables, only perceived teacher-student relationships were found to be significant, with those students perceiving a more positive classroom climate more likely to be successful in later years.

In terms of student plans for the future, the expressed aim of obtaining an apprenticeship was associated strongly and positively with later success, while not having any definite aim was found to be significantly negatively related to success, with the probability of success for those students answering "I don't know" to this question around 0.4.

Finally, of the school level variables investigated, the only one that was found to have a significant influence was location. Students from a non-metropolitan location were found to be significantly more likely to be successful than students from a metropolitan location, all other things equal.

The next step in the analysis was to examine the same model separately for males and females. Figure 3 shows the results of the analysis for males and Figure 4 for females.

What we can learn from these separate analyses is that different factors influence the probability of male and female students succeeding. For males, the most important influence is the aim to get an apprenticeship, with a predicted probability of success for students expressing such an ambition of 0.6. In comparison, for females there were no significant effects of expressing an ambition; the only significant effect found was a strong negative influence for not expressing any aim whatsoever. Female students who expressed no ambition at all had a predicted probability of only 0.2 of success.

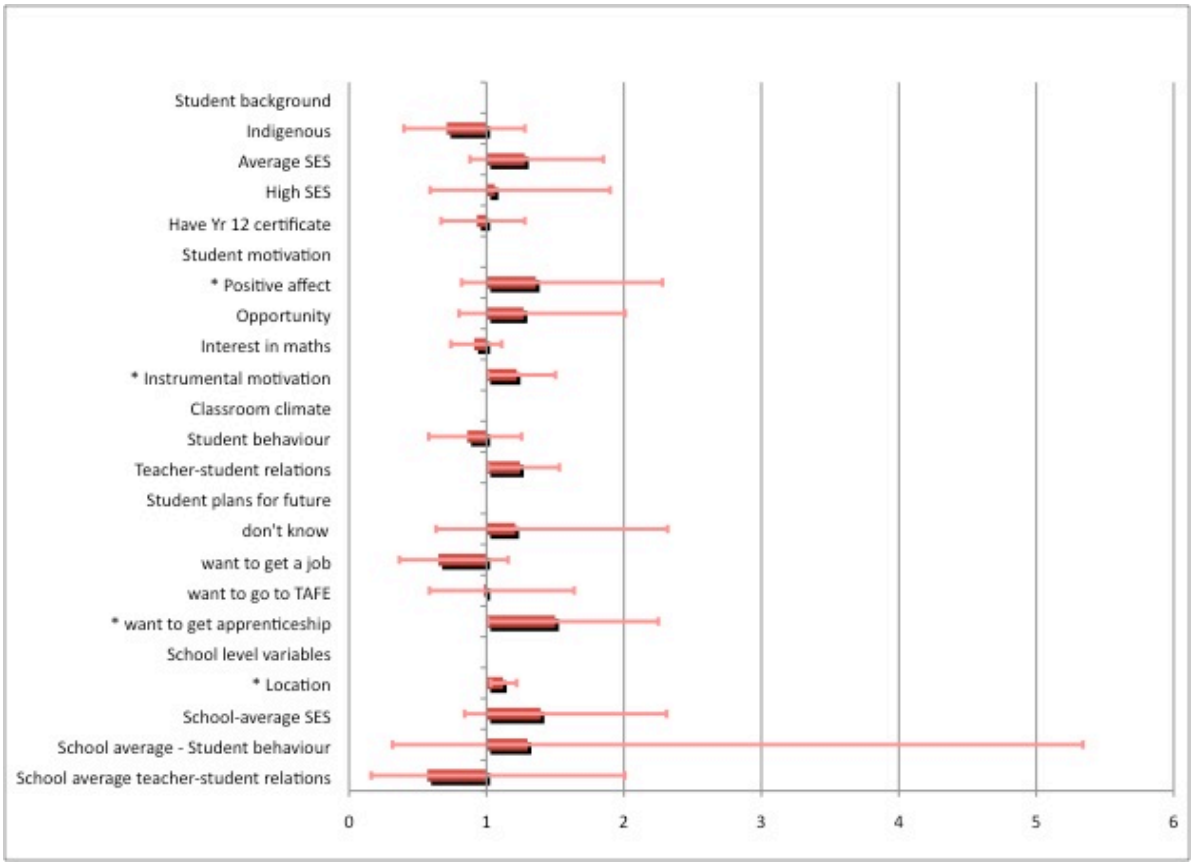

Figure 3 Odds ratios for multilevel model of male students' successful outcomes

For male students, location had a significant effect on success, with male students from a non-metropolitan area having a probability of 0.53 of success compared to those male students in metropolitan areas, other things equal.

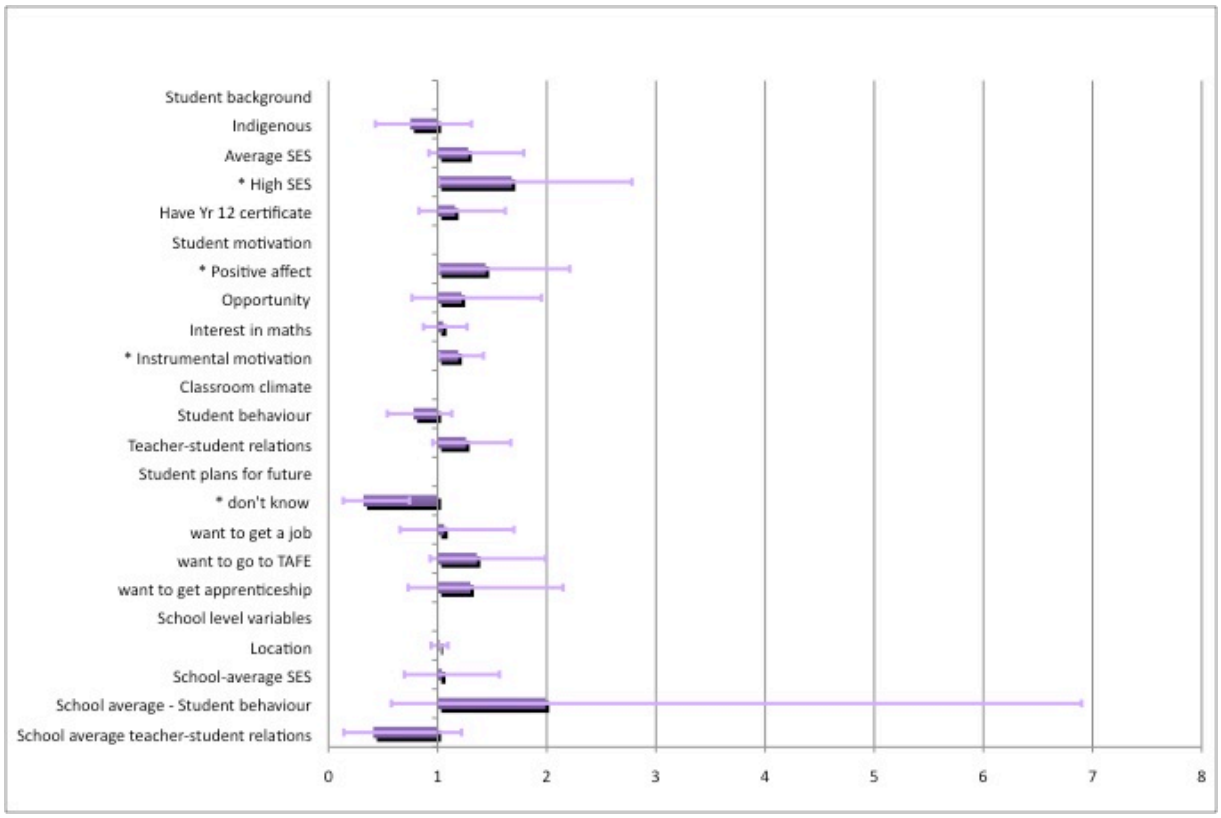

Figure 4 Odds ratios for multilevel model of female students' successful outcomes

Instrumental motivation was again found to have a significant positive effect on success. The probability of success for both male and female students who had a more practical view about learning mathematics was around 0.55. For female students, Positive Affect also exerted a strong positive effect on success. The probability of success was 0.59 for females who had a high score on Positive Affect.

The final variable that had strong positive effect on achievement for female students only was high socioeconomic background. Female students with such backgrounds were much more likely to be successful than those from lower socioeconomic backgrounds; the predicted probability of success for high socioeconomic background females was 0.63.

Discussion

What can we conclude from these analyses? Overall, it is clear that low achieving students from a low socioeconomic background have a lower likelihood of success than similar students from more affluent homes. There are many reasons for this, including the possibility of parents recognising the limitations of their child and putting in place some form of scaffolding in order to assist their child.

Indigenous status, all other things equal, was not found to have a significant effect on success or failure. This finding adds further strength to the current debate in Australia that it is not Indigenous status per se that is related to poorer outcomes, but the strong interrelationship between Indigenous status and disadvantage.

The strong influence of motivation on students' later outcomes is an important message for parents, teachers and policy-makers. Finding that students who recognise the value of mathematics for their future success are more likely to achieve this success, and that includes being happy with many aspects of their personal lives as well as their future and career, suggests that a focus on the practical applications of mathematics in everyday life may go some to improving the outlook for students who are not quantitatively inclined and are not achieving well in the mathematics classroom.

Similarly, ensuring that the school experience is a positive one not only impacts on students' lives at the time they are at school but appears to continue to influence them once they have left. Female students, in particular, were more likely to be fully engaged in education, employment or a combination of these and to be happy with their situation, if they had enjoyed being at school, enjoyed learning and felt safe and secure. While it is not possible to eliminate all stress or negative experiences from secondary school, findings such as this remind us of the important aim of education to foster the social and emotional development of young people, as well as their academic development, and that school can be a positive experience for all students, regardless of their achievement level, if the emphasis is placed on personal goals and expansion, rather than constant comparison and ranking.

At the same time, young people should be encouraged to think carefully about their future and to make strategic plans. Those young people, particularly females, who were not achieving well in mathematics and who had not thought about what they might do after leaving school were much less likely to be fully engaged and happy with their lives four years down the track. The importance of careers advice for young people has been emphasised in other LSAY reports using data from the full cohort from PISA 2003 (Rothman & Hillman, 2008[11]), and the importance of choosing school subjects mindful of where such choices may lead or not lead in another LSAY report examining the consequences of Year 12 subject

[11] Rothman, S., & Hillman, K. (2008). Career Advice in Australian Secondary Schools: Use and Usefulness. Longitudinal Surveys of Australian Youth. Research Report 53: Australian Council for Educational Research.

choice (Thomson, 2005)[12]. The role of apprenticeships as a pathway for young males (predominantly) is important, but we should not forget that applied mathematics will be a part of most of these vocations and that their mathematics education needs to continue outside the classroom if they choose this pathway. A builder, plumber or mechanic who cannot calculate materials needed, distances covered or add up charges correctly will not succeed in his chosen profession anymore than a banker or dentist would.

The finding that low achieving students in non-metropolitan areas are more likely to succeed than their metropolitan counterparts, all other things equal, is not simple to interpret, and requires further investigation. It could be hypothesised that jobs or apprenticeships are easier to access out of city area, but counter to that is that there should be more opportunities for low-achieving students to access work in manufacturing, for example, in metropolitan areas.

[12] Thomson, S. (2005). Pathways from School to Further Education or Work: Examining the consequences of Year 12 course choices. Longitudinal Surveys of Australian Youth. Research Report 42: Australian Council for Educational Research.