# Gender and socioeconomic differences in science achievement in Australia: From SISS to TIMSS

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## Abstract

Gender differences in science amongst year 8 students in Australia in TIMSS 2003 were a surprise, given two decades of programs designed to increase girls' participation levels in science. This study examines student and school-level characteristics simultaneously using hierarchical linear modelling to estimate the ability of each to explain gender differences in science achievement for students with differing socioeconomic backgrounds. Using separate datasets for low and high socioeconomic background schools, adjusting for the students' background and personal characteristics and elements reflecting the context of their schools, there were still significant gender differences in Australia. Comparisons are made with similar studies using data from the Second International Science Study

**Keywords:** *Multilevel, science achievement, gender, socioeconomic status*

## Introduction

Australia has a long history of participation in international studies of both mathematics and science, from the First International Science Studies (FISS, 1968 - 1972) to all four combined mathematics and science studies – the Third International Mathematics and Science Study (TIMSS, 1995), the partial (Grade 8 and 9) repeat in 1999, (TIMSS-R) and the Trends in International Mathematics and Science Study (TIMSS 2003 and 2007).

The results for the oldest group of students who participated in the FISS drew attention to gender differences in favour of boys in participation and achievement in science, in physics especially, in a number of countries including Australia (Comber and Keeves, 1973). At around the same time, the Australian governments and education authorities commissioned a report on differences in education and outcomes for girls and boys. This report, Girls, schools and society (Commonwealth Schools Commission, 1975), described vast differences in educational outcomes, with boys more likely to stay at school and undertake a wide variety of subjects than girls. Girls' experience of more limited subject choice subsequently restricted their entry into many areas of higher education and the workforce, and in a growing economy this could no longer continue. Resulting government policy throughout the 1970s and 1980s focussed on encouraging girls to stay to school longer and to participate in non-traditional areas of study, particularly mathematics and science (see also Miland, 1984). These policies worked to a certain extent: girls have been completing school in greater numbers than boys since the mid-1970s, and this has translated into higher rates of transition into higher education.

The Second International Science Study (SISS) in the early 1980s found that while similar patterns to those in FISS were still observable (boys outperforming girls), the magnitude of the differences had decreased in many countries, including Australia, where programs to reduce the gender gap had been implemented. The trend towards declining gender differences in science continued with TIMSS 1995, in which there was no significant difference in the achievement of boys and girls in science. In the most recently reported TIMSS study, TIMSS 2003, there was no significant gender difference in science achievement at primary school level, nor were there gender differences in attitudes to science at this level in Australia. By early in their secondary schooling, however, boys outscored girls in all of the science content areas, significantly in all but life science. Girls also exhibited lower levels of self-confidence in science than boys, and did not value science to the same extent as boys. This trend has continued with the most recently conducted TIMSS 2007 study, although these findings have not as yet been published.

These findings are cause for concern. They indicate that the National Goals for Schooling in the Twenty First Century, embodied in the Adelaide Declaration (MCEETYA, 1999) have not as yet been achieved. These goals called for schooling to be socially just, so that “students’ outcomes from schooling are free from the effects of negative forms of discrimination based on sex, language, culture and ethnicity, religion or disability; and of differences arising from students’ socio-economic background or geographic location”. As well as being socially just for all students to receive a solid education, it is imperative that for society as a whole, we encourage and develop a strong scientific base. This was highlighted in the recent report Australia’s Teachers: Australia's Future - Advancing Innovation, Science, Technology and Mathematics (Commonwealth of Australia, 2003). This report highlighted the necessity of science education to Australia’s position in a global economy, arguing that

Australia’s ability to prosper in this environment depends on high levels of R&D. These in turn require that more young people achieve scientific and technical qualifications with a strong base in the physical and biological sciences and mathematics. By itself, this will not be enough. Policies and strategies are required to ensure a broad base of scientific, mathematical and technological literacy for all students. This means that science, technology and mathematics education must be given high priority nationally, in all education systems and every school.

One of the most important factors in previous studies of achievement by gender has been students' socioeconomic background. Analysis of the characteristics of effective schools in previous TIMSS studies, for example, have argued that home background and affluence are powerful predictors of science achievement, and that schools located in and drawing their clientele from affluent communities have more advantaged students attending the school (Martin, Mullis, Gregory, Hoyle and Shen, 2000). Another important factor that has been the subject of some investigation (and controversy) is single-sex versus coeducational schooling (see, for example, Lee & Bryk, 1989, Marsh, 1989). The Lee and Bryk study concluded that single-sex schools provide an advantage to their students, particularly to girls. Marsh's study found no such differences.

A series of studies using data from the Second International Science and Study (SISS) used hierarchical linear modelling to investigate the contribution of schools to gender differences in science, finding, inter alia, that while significant gender differences were observed, school effects such as average socioeconomic level were more powerful in explaining differences in achievement than gender (Young & Fraser, 1992a; Young & Fraser, 1992b; Young & Fraser, 1993).

Secondary analysis of the Australian TIMSS 1995 data indicated that systematic inequities continued to be an issue in the Australian education system, with about one-quarter of the variance in science achievement in the population 2 sample attributed to differences between schools. One study found that "other things equal, there is a greater difference according to socioeconomic background at secondary than primary school. The higher the level of socioeconomic status, the more likely students are to be able to access resources such as well-educated parents who also have the financial resources to obtain extra help if it is required" (Thomson, Lokan, Lamb & Ainley, 2003, p. 120).

Multilevel analysis of the TIMSS 2003 science data found that approximately 40 per cent of the variance in achievement in student's achievement scores was attributable to differences between schools (Thomson & Fleming, 2004). Significant predictors of performance included gender, aspirations and self-confidence and the socioeconomic variables books in the home and parental education. A clear trend was for higher levels of the variables (other than gender) to be reflected in higher levels of science achievement. The only significant predictor found at the school level was the principals' report of the level of disadvantage of the school.

This study explores some of the relationships between socioeconomic background, gender and science achievement, drawing on data from TIMSS 2003. It is argued that socioeconomic background, gender and school attended influence the gender gap in science. It is acknowledged that at an aggregate level, boys outperform girls in science in Australian year

8 classes. The next questions that should be asked is: Is it all girls? Do some girls score as well in science as their male classmates? Are there school factors that affect this relationship?

## Methodology

TIMSS 2003 utilised a stratified two-stage stratified cluster sampling design, with schools selected with probability proportional to size from 24 strata (the eight states and territories of Australia and the three school types: Independent, Catholic and government). From each of these schools, one Year 8 class was selected at random for testing. Student data were weighted according to the underlying proportion of students in the particular strata in the population. The complex sampling design means that normal assumptions of simple random sampling are violated, and so for statistical significance to be valid the hierarchical nature of the data must be accounted for. The Australian sample for TIMSS 2003 was 5 355 students (2 384 girls and 2 296 boys) selected from 230 schools. The sample population for the SISS study for the equivalent group, 14-year-old students, was similar: 4 917 students (2 565 girls and 2 352 boys) from 233 schools, stratified in the same manner.

While the results of fitting single-level multivariate models to the data provides some information, it does not allow for the inherent hierarchical structure of the TIMSS data, namely: student scores (level-1) clustered within schools (level-2). Hierarchical linear modelling (HLM) techniques were used to handle the issues with such data, recognising that within hierarchies the group as a whole influences the members of the group, and traditional univariate or multivariate analysis methods fail to account for this influence.

## Variables

The outcome variable for this study was the TIMSS measure of science achievement (SCIENCE). Student background variables included gender of the student (GENDER), student's age in months (AGE), student's aspirations (STUD_ASP: higher education or not higher education), self-confidence in science (SELFCON) and the extent to which students value science (VALUING). At the school level, contextual variables included geographic location of the school (GEOLOC: metropolitan, regional, rural), the school type (SCHL_TYP: coeducational or single-sex), the principals' report of the level of good school and class attendance (GSCA)[1] and average socioeconomic status (AV_SES).

[1] This is measured as the extent to which principals report that lateness, absenteeism and skipping classes is a problem in the school.

*Socioeconomic status*

Students were asked in the student questionnaire to describe the highest level of education of their mother and their father. The higher of the parents' educational level provided the parental education variable, which was then converted into years of schooling (6 years for completed primary school, 10 years for some secondary school, 12 years for completed secondary school, 14 years for post-secondary trade education, 15 years for undergraduate degree, 17 years for postgraduate degree). *Books in the home* is a ordinal variable with 1 representing none or very few books through to 5 representing more than 200 books. Students are also asked to answer yes or no about whether they had in their home a calculator, computer, dictionary, study desk, own bookshelves, mobile phone, musical instrument and internet connection. The total *number of possessions* was then added to the number representing the category of books in the home and the number of years of parental education to create a combined socioeconomic variable. This variable was divided into quartiles to examine achievement for TIMSS 2003 and a similar variable developed and used to describe achievement for TIMSS 1995. The variable was aggregated to school level to provide a school-level average socioeconomic status variable, and this was divided into quartiles to examine the extreme groups. The school socioeconomic background variable and the quartiles were merged back onto the student data file. Thus each student in a school was assigned their school's average socioeconomic background and socioeconomic quartile scores.

## Findings and Discussion

Do girls and boys in Australian schools perform differently in science? Table 1 provides the mean scores for Year 8 science overall for males and females in TIMSS 1995 and TIMSS 2003. This table shows the difference in scores between boys and girls in Australian schools, which is an educationally, as well as statistically, significant 20 score points. Australia's overall science mean score increased significantly between TIMSS 1995 and TIMSS 2003, and this was largely the result of a significant increase in boys' scores. While the girls' average score also appeared to have increased, it was not by as much as the boys', and was not significant.

[Take in Table 1 about here]

Further exploratory analysis was carried out in order to investigate the extent to which this was true for all males and all females, within the parameters of the TIMSS data collection. The investigation reported in this paper compared students in schools that were in the highest and lowest socioeconomic quartiles. Table 2 presents some of the characteristics of students in these schools.

Curiously, there is quite a gender imbalance in the lowest socioeconomic quartile, but none in the highest. As all the lower socioeconomic quartile schools were coeducational (compared to 44% of the high socioeconomic quartiles), this requires some further investigation at a later date. Not surprisingly however, the proportion of Indigenous students (which is about 4% in the underlying population) is highest in low socioeconomic quartile schools and almost non-existent in high socioeconomic schools. In terms of geographic location, most of the schools in the high socioeconomic quartile were in metropolitan areas, and there were none in rural areas. In contrast, about 14 per cent of schools in the lowest socioeconomic quartile were in rural or remote areas of Australia. Two of the variables used to define socioeconomic background showed striking differences: almost half of the students in schools in the highest socioeconomic quartile had a large number of books in the home, compared with around one-fifth of students in schools in the lowest socioeconomic quartile, and parents in high socioeconomic quartile schools had, on average, around two and a half years more schooling than those in the lowest quartile. Almost all in the highest socioeconomic quartile schools had aspirations to attend university, compared with around two-thirds of those at the lower level.

[Take in Table 2 about here]

The magnitude of gender differences for Australian Year 8 students for both TIMSS 1995 and TIMSS 2003 can be seen in Figure 1 for students in the highest socioeconomic quartile schools and those in the lowest socioeconomic quartile schools.

[Take in Figure 1 about here]

This figure highlights two key findings. First, the gender differences in the TIMSS 1995 study were not large for schools in either the highest or lowest socioeconomic quartiles (eight score points and three score points respectively). While there were clearly differences in achievement between those students in the highest and those in the lowest socioeconomic groups, these differences were similar for boys and girls within each group (94 score points for males and 89 score points for females). Second, this situation seems to have deteriorated in TIMSS 2003 (although overall achievement has increased), where the gender differences for students in both socioeconomic quartiles are larger than in TIMSS 1995 (21 score points for students in low socioeconomic quartile schools and 14 score points for students in high socioeconomic quartile schools). It is of interest that although the difference was statistically significant at lower levels of socioeconomic background, at the higher level results of univariate analysis were not significant.

If these findings were to be used to inform policy, there are a number of different conclusions that could be drawn. One is that the practices or policies of schools in the highest socioeconomic quartile somehow ameliorate gender differences in science. To investigate the relationship between gender and achievement for students in each socioeconomic quartile, the data were split into these two groups and analysed separately using hierarchical linear modelling.

*HLM: The unconditional model*

The initial stage in hierarchical linear modelling (HLM) involves the estimation of the total variance of the dependent variable, science achievement, and the partitioning of this variance into the within- and between-schools components. This analysis was conducted using HLM6 (Raudenbush, Bryk, Cheong, Congdon & du Toit, 2004).

Table 3 shows the final estimate of the variance components for the null models for each group. For the lowest socioeconomic quartile approximately 19 per cent of the variance was at school level, with the remaining 81 per cent found to be within-school variance. For the highest socioeconomic quartile 28 per cent of variance was found to be associated with school-level factors, with the remaining 72 per cent found to be within-school variance.

*Student background model*

In order to investigate the effect of student background variables, along with how gender differences and social differences in science achievement varied from school to school for each of the two groups, the following model was used:

$$\text{Science}ij = ß_{0j} + ß_{1j}\,(\text{GENDER}_{ij}) + ß_{2j}\,(\text{AGE}_{ij}) + ß_{3j}\,(\text{STUD\_ASP}_{ij}) + ß_{4j}\,(\text{SELFCON}_{ij}) + ß_{5\ j}(\text{VALUING}) + R_{ij} \qquad \text{(Equation 1)}$$

The beta coefficients can be described as follows:

$ß_{0j}$= Mean science achievement of students in school j

$ß_{1j}$ = The extent to which gender differences are related to science achievement in school j

$ß_{2j}$ = The extent to which differences in age among students in school j is related to their science achievement

$ß_{3j}$ = The extent to which differences in student's aspirations to higher education among students in school j are related to their science achievement

$ß_{4j}$ = The extent to which differences in self-confidence among students in school j is related to their science achievement

$ß_{5j}$ = The extent to which differences in students level of valuing science in school j is related to their science achievement

Table 4 shows the effects of the student background variables on science achievement for both high and low socioeconomic quartile schools. The effect of gender was around the same for students in both groups of schools, with an advantage of between 15 and 18 score points for boys in each case. The effect of students' age was similar and non-significant for both groups. In the student attitudinal variables there were some interesting differences. Student aspirations were much stronger an influence for students in low socioeconomic quartile schools, with students aspiring to higher education scoring 28 points extra, on average, above those with no such aspirations, other things constant. For students in high socioeconomic quartile schools there was no significant effect of aspirations, possibly because so few did not aspire to university. Self-confidence was a much stronger influence for those in high socioeconomic quartile schools, with those students with high levels of self-confidence scoring, on average, 22 points more than those with low levels of self-confidence, other things equal. Though not as large a difference as for high socioeconomic quartile schools, for those in lower socioeconomic quartile schools the effect was still 11 points for students with higher levels of self-confidence. The effects of students' valuing of science was important for both groups of students, but the effect for those in low socioeconomic schools was a little stronger (10 points vs 6 points).

[Take in Table 4 about here]

The background variables accounted for about 20 per cent of the variance in high socioeconomic quartile schools and about 13 per cent in the low socioeconomic quartile schools.

The next step was to examine the influence of school effects on science achievement. As the data were split on highest and lowest socioeconomic quartiles, a number of school-level variables were not able to be used, notably average socioeconomic background. School type, whether a school is coeducational or single-sex, was only able to be used in the analysis for the high socioeconomic quartile schools, as there were no single-sex schools in the low socioeconomic quartile schools group.

As well as including the level-1 model shown in equation 1, the following level-2 model was incorporated in order to examine school effects on gender equity in science. The model used examined gender by allowing it to vary across schools in the random coefficient regression model, while keeping the other covariates fixed. The use of random slopes in this model means that the effects of gender are assumed to vary from school to school, with some schools reinforcing the effects of gender and some ameliorating the effects.

For low socioeconomic quartile schools:

$$\beta 0j = \gamma 00 + \gamma 01\ (GSCAj) + \gamma 02\ (GEOLOCj) + \mu 0j$$
$$\beta 1j = \gamma 10 + \mu 1j$$
$$\beta 2j = \gamma 20$$
$$\beta 3j = \gamma 30$$
$$\beta 4j = \gamma 40$$
$$\beta 5j = \gamma 50$$

For high socioeconomic quartile schools:

$$\beta 0j = \gamma 00 + \gamma 01\ (GSCAj) + \gamma 02\ (GEOLOCj) + \gamma 02\ (SCHL\_TYP) + \mu 0j$$
$$\beta 1j = \gamma 10 + \mu 1j$$
$$\beta 2j = \gamma 20$$
$$\beta 3j = \gamma 30$$
$$\beta 4j = \gamma 40$$
$$\beta 5j = \gamma 50$$

(Equation 2)

The results of this regression for students in the lowest socioeconomic quartile schools are shown in Table 5, and for highest socioeconomic quartile schools in Table 6.

[[Take in Table 5 about here]

[Take in Table 6 about here]

At the school level, principals' reports of the level of attendance problems at the school: lateness, absenteeism and skipping classes, had a significant relationship with achievement in the low socioeconomic quartile schools only. In these schools each additional point on the index was reflected in 23 additional score points in science, on average. Geographic location was not significant for either type of school. For high socioeconomic quartile schools, this final model accounted for 28 per cent of the total between-schools variance and around 18 per cent of the within-schools variance. For schools in the lowest socioeconomic quartile, the model accounted for 41 per cent of the between-schools variance and 13 per cent of the within-schools variance.

The three key findings from these final analyses are:

- There are significant gender differences in both high or low socioeconomic quartile groups;
- Gender slope is significant for the low socioeconomic quartile schools but not the high socioeconomic quartile schools; and
- Different factors affect student achievement depending on their socioeconomic milieu.

## Conclusion and Implications

The purpose of this analysis was to examine the performance of Australian boys and girls in science, and in particular to investigate the gender difference seen nationally in more detail. Overall, boys' scores increased significantly from TIMSS 1995 to TIMSS 2003, while the scores of girls remained the same. The data were examined for differences related to both gender and socioeconomic background, and it was found that the gender differences were more pronounced for students in the lowest socioeconomic quartile. Recognising the inherent hierarchical nature of the data, multilevel modelling techniques were used to examine the relationship between contextual school factors and student background factors.

While the majority of the variance was at the student level, a substantial amount was also found to be between schools. Overall, about one-quarter of the variance in science achievement for Year 8 students in Australia was between-school variance. For the lowest socioeconomic quartile schools this was about 20 per cent, for the higher socioeconomic quartile schools it was almost 30 per cent. This indicates that the differences in science achievement are much greater between schools in the highest socioeconomic quartile than between schools in the lowest socioeconomic quartile. Student-level variables such as gender, socioeconomic status, age, self-confidence, valuing of science and aspirations accounted for about 15 per cent of the variance in the lowest socioeconomic quartile schools and about 20 per cent of the variance in the highest socioeconomic quartile schools.

Gender differences were found to be similar in both school socioeconomic groups. The final model, which included both student background variables and school-level variables, and by design accounted for the clustered nature of the data, found that in the highest socioeconomic quartile schools boys outperformed girls by about 16 score points and in the lowest socioeconomic quartile schools by about 18 score points, holding other factors constant. The difference seen in Figure 1 was just an artefact of the effects of other factors and that gender differences are apparent in both high and low socioeconomic groups. This emphasises the need to account for the clustered nature of the data in analyses, in order to make the best recommendations for policy.

The factors with the strongest relationship with achievement were different for the two different groups of schools: for students in the lowest socioeconomic quartile schools these were aspirations and lack of school-level attendance problems while for students in high socioeconomic schools self-confidence was the most influential factor. Another important finding is that the effects of gender varied across the lowest socioeconomic quartile schools but not across the highest. This suggests that in the lowest socioeconomic quartile schools there are things that some schools do to ameliorate gender differences, but things other schools do that exacerbate them. In comparison in the higher socioeconomic group, the relationship between gender and achievement is more uniform: boys consistently and fairly uniformly outperform girls. If Australia's overall science achievement is to increase, the achievement levels of girls, and generally of students in the lowest socioeconomic quartile, must be improved. For reasons of equity this should be a priority.

These analyses indicate that the school a student attends is important. Students attending schools with a high average socioeconomic level have an advantage over students in poorer schools, whatever their own backgrounds. Similarly boys generally outperform girls, whatever their background. The analyses have shown, however, that these effects are not immutable. Further investigations will focus on the lowest socioeconomic groups and attempt to identify the characteristics of the schools which have performed at a higher level than would have been expected, given their nature and background. Aspirations for further education are one example of an effect on which schools and indeed teachers can have an influence.

Student background variables accounted for a substantial proportion of the variance, indicating that achievement levels in even high-socioeconomic and therefore high achieving schools can be boosted by improving the self-confidence of their students and the value they place on science.

Many of the findings in this study are similar to those of previous studies using data from the Second International Science Study, some 20 years ago. In that study there were significant effects of both individual and school-level socioeconomic status, and of individual and school-level mathematics achievement. So in twenty years, has little changed in Australian science education? Programs to increase the participation levels of girls have come and gone, and appear to not had a lasting effect for all students. Girls are just as educationally disadvantaged as they were two decades ago, and girls from poor backgrounds seem to be doubly disadvantaged. The challenge remains to the Australian education system to address these disadvantages if we are to take our place on the international science stage.

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Gender and socioeconomic differences in science achievement in Australia: From SISS to TIMSS

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Table 1 Mean scales sores (and standard errors) for science achievement, TIMSS 1995 and 2003, overall and by gender

| | Overall | Males | Females |
|---|---|---|---|
| TIMSS 1995 | 519 (3.6) | 519 (4.7) | 507 (4.1)** |
| TIMSS 2003 | 534 (3.4) | 537 (4.6) | 517 (4.6)** |

** Statistically significant at p< 0.01

Table 2 Student and school characteristics, high and low socioeconomic level schools

| | | Low SES schools | High SES schools |
|---|---|---|---|
| Gender (% students) | Male | 39 | 51 |
| | Female | 61 | 49 |
| Ethnicity (% students) | Indigenous | 8 | 1 |
| | Non-Indigenous | 92 | 99 |
| Geographic location | Metropolitan | 59 | 87 |
| (% schools) | Regional | 28 | 13 |
| | Rural | 14 | 0 |
| >200 books in home (% students) | | 19 | 46 |
| Mean parents years of schooling | | 11.6 | 14.3 |
| Aspirations to university (% students) | | 65 | 91 |
| School type (% schools) | Co-educational | 100 | 44 |
| | Single-sex | 0 | 56 |

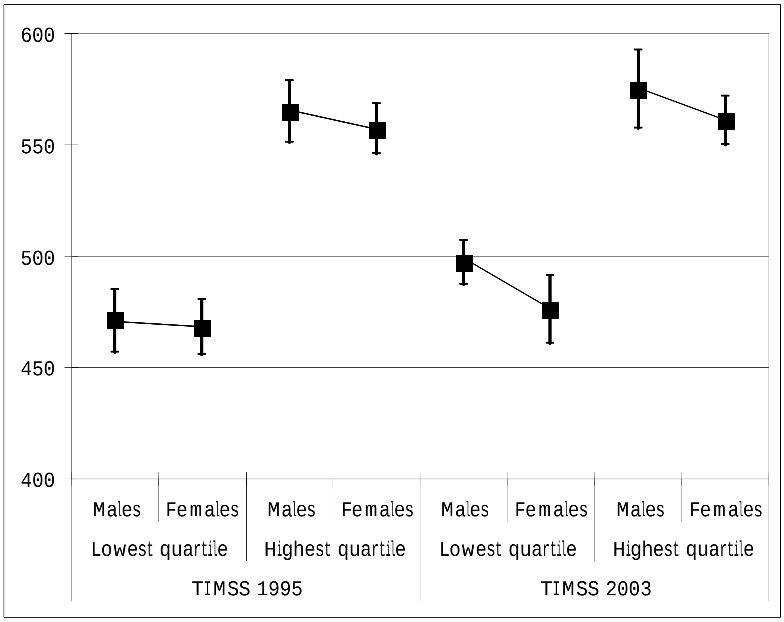


Figure 1 Means and confidence intervals for science achievement for highest and lowest school socioeconomic quartiles, Year 8 TIMSS 1995 and TIMSS 2003

Table 3 One-way ANOVA model of science achievement, high and low socioeconomic quartiles

| | **Lowest socioeconomic quartile** | | | **Highest socioeconomic quartile** | | |
|---|---|---|---|---|---|---|
| *Fixed effect* | *Coefficient* | *se* | *t-ratio* | *Coefficient* | *se* | *t-ratio* |
| Average school achievement, $\gamma_{00}$ | 483 | 7.4 | 64.7 *** | 565 | 6.7 | 84.0*** |

| *Random effect* | *Variance component* | *df* | *χ2* | *sig* | *Variance component* | *df* | *χ2* | *sig* |
|---|---|---|---|---|---|---|---|---|
| School mean, $\mu_{oj}$ | 1124 | 41 | 267 | *** | 1236 | 42 | 403 | *** |
| Level-1 effect, $r_{ij}$ | 3780 | | | | 3063 | | | |

*** Statistically significant at p< 0.001

Table 4  Estimated effects of student background variables in high socioeconomic and low socioeconomic quartile schools

| | **Low SES schools** | | | **High SES schools** | | |
|---|---|---|---|---|---|---|
| *Fixed effect* | *Coefficient* | *se* | *t ratio* | *Coefficient* | *se* | *t ratio* |
| Mean science achievement, $\beta_0$ | 479 | 6.0 | 79.8*** | 608 | 74.3 | 8.2 *** |
| Gender, $\beta_1$ | -18 | 6.5 | -2.7 ** | -15 | 5.2 | -2.9 ** |
| Student age, $\beta_2$ | -1 | 0.8 | NS | -0.5 | 0.4 | NS |
| Student aspirations, $\beta_3$ | 28 | 7.4 | 3.8*** | 14 | 8.6 | NS |
| Self-confidence, $\beta_4$ | 11 | 5.2 | 2.1* | 22 | 3.2 | 6.9 *** |
| Valuing, β5 | 10 | 4.5 | 2.3* | 6 | 3.2 | 2.0 * |

*** Statistically significant at p< 0.001, ** Statistically significant at p< 0.01, * Statistically significant at p< 0.05

Estimation of variance components

| Random effects | Variance | df | χ 2 | p | Variance | df | χ 2 | p |
|---|---|---|---|---|---|---|---|---|
| Intercept slope, $\mu_{0j}$ | 873 | 41 | 228 | *** | 942 | 42 | 334 | *** |
| Level-1, $r_{ij}$ | 3371 | | | | 2518 | | | |

Table 5 Estimated effects of school context, low socioeconomic quartile schools

| | Low SES schools | | |
|---|---|---|---|
| *Fixed effect* | *Coefficient* | *se* | *t ratio* |
| Mean science achievement, $\gamma_{00}$ | 529 | 44.1 | 12 *** |
| GSCA, $\gamma_{01}$ | 23 | 5.4 | 4.3 *** |
| GEOLOC, $\gamma_{02}$ | 2 | 7.1 | NS |
| Gender slope, $\gamma_{10}$ | -18 | 6.1 | -2.9 ** |
| Age slope, $\beta_{2j}$ | -1 | 0.7 | NS |
| Student aspirations, $\beta_{3j}$ | 34 | 7.4 | 4.5 *** |
| Self-confidence, $\beta_{4j}$ | 12 | 4.8 | 2.6 * |
| Valuing , $\beta_{5j}$ | 10 | 3.9 | 2.6 * |

*** Statistically significant at p< 0.001, ** Statistically significant at p< 0.01, * Statistically significant at p< 0.05

| Random effects | Variance | df | χ 2 | p |
|---|---|---|---|---|
| Intercept slope, $\mu_{0i}$ | 463 | 35 | 92 | *** |
| Gender slope, $\mu_{1j}$ | 202 | 45 | 62 | * |
| Level-1 | 3305 | | | |

Table 6 Estimated effects of school context, high socioeconomic quartile schools

| | High SES schools | | |
|---|---|---|---|
| Fixed effect | Coefficient | se | t ratio |
| Mean science achievement, γ00 | 615 | 108 | 7.5*** |
| GSCA, $\gamma_{01}$ | 16 | 8.0 | NS |
| GEOLOC, $\gamma_{02}$ | -3.8 | 10.5 | NS |
| SCHL_TYP, $\gamma_{03}$ | 0.2 | 12.7 | NS |
| Gender slope, $\gamma_{10}$ | -15 | 5.4 | -2.3** |
| Age slope, $\beta_{2j}$ | -1 | 0.6 | NS |
| Student aspirations, $\beta_{3j}$ | 14 | 8.7 | NS |
| Self-confidence, $\beta_{4j}$ | 22 | 3.2 | 6.9*** |
| Valuing , $\beta_{5j}$ | 6 | 3.2 | NS |

*** Statistically significant at p< 0.001, ** Statistically significant at p< 0.01, * Statistically significant at p< 0.05

| Random effects | Variance | df | χ 2 | p |
|---|---|---|---|---|
| Intercept slope, μ0j | 795 | 42 | 19 | *** |
| Gender slope, $\mu_{1j}$ | 95 | 45 | 2 | NS |
| Level-1, $r_{ij}$ | 2517 | | | |