VARIANCE IN PERFORMANCE
BETWEEN STUDENTS WITHIN SCHOOLS
AND
BETWEEN SCHOOLS

Petra Lietz

Australian Council for Educational Research

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Explanatory note:

In this report, the terms below are used as follows:

"Total variance" or "overall differences between highest and lowest performers":

The total variance in performance, consisting of a between-student within-school component and a between-school component.

"Student-level variance" or "between-student variance" or "between-student within-school variance":

Differences in performance between students within schools.

"School-level variance" or "between-school variance":

Differences in performance between schools.

CONTENTS

EXECUTIVE SUMMARY

One of the aims of the national agenda for education is to foster the achievement of Australian students in key learning areas such as numeracy and literacy. A central question, in this context, is at which level resources should best be allocated in order to maximize their effect on improving learning outcomes. Put differently, the question is whether it is more effective to direct resources to schools, their staff and infrastructure or to students and their families.

To address this question, the South Australian Department of Education and Children Services (DECS) commissioned the Australian Council for Educational Research (ACER) in April 2009 to undertake: a) multilevel analyses of the Australian PISA assessments for Australia overall in 2000, 2003 and 2006 and by State and Territories for 2006; and b) a literature review of published studies that have reported multilevel analyses aimed at mapping and explaining differences in achievement between students within schools and between schools.

Results of these analyses are summarized below. First, findings are presented regarding the proportioning of differences in achievement that can be attributed to the student and the school level. Second, results of a review of published results of factors explaining those differences are provided.

1. Proportions of variance at the student and the school level in Australia…

…and other countries

- In Australia, about **20%** of the differences in performance at the 15-year-old level are found **between schools** while around **80%** are located **between students within schools**. This is comparable to the proportioning of variance found in Canada and the UK. In New Zealand, differences between schools are slightly smaller (about 17%) than in Australia whereas differences between schools are slightly larger in the USA (about 25%) than they are in Australia.

- The country with the **smallest amount of variance between schools** is **Finland** (about 5%) whereas in **Germany** a **large proportion** (about 52%) of the differences is located **between schools**.

- Countries with a smaller amount of total variance (i.e. the variance between-students within-schools plus the variance between schools) than is found in Australia include Canada and Finland whereas Germany has a larger amount of total variance. New Zealand, the UK and the US tend to have similar differences between the highest and lowest performers to those reported for Australia.

…for different learning outcomes

- The total variance between students within schools and between schools is somewhat smaller in mathematics than it is in reading and science. This means that **performance in mathematics is more homogeneous** in Australia than it is in reading and science.

- That component of the variance that is located **between schools** tends to be **slightly smaller for science** than it is for mathematics and reading.

…over time

- The **variance between schools** tended to be **slightly lower in the PISA 2000** assessment compared with the 2003 and 2006 assessments.

…across States and Territories[1]

- New South Wales, Victoria and Western Australia reflect the proportions of variance associated with the school level (20%) and the student level (80%) that are found for Australia as a whole.
- In the Australian Capital Territory (15%), Queensland (12%) and **South Australia (16%)** the **variance** related to the **school level** is somewhat **smaller** than for Australia as a whole.
- In the Northern Territory (25%) and Tasmania (23%) the school-level variance tends to be slightly higher than for Australia overall.
- In **South Australia**, the **differences between high and low achievers** are the **smallest** for any of the Australian States.
- The above observations hold for mathematics, reading and science.

2. What accounts for differences in achievement….

…between students within schools?

- In Australia, the PISA index **of economic, social and cultural status of students (ESCS),** which is based on parents' education, occupation and possessions at home, accounts for **about five** per cent of the between-student within-school variance. This is about the same as it is in Canada, Finland and the UK and a bit lower than in New Zealand and the USA. In Germany, this index explains less of the variance between students, mainly because the between-student within-school variance is smaller there than it is in other countries.
- Other variables that explain differences in achievement between students include **attitudes** towards the subject (mathematics, reading, science), **self-efficacy** (i.e. students' confidence in being able to perform specific tasks in reading, mathematics and science) and time spent on **homework**.
- Multilevel analyses of data from different countries indicate that roughly one quarter of the differences between students within schools (or 19 percent of the total variance between students within schools and between schools) can be explained by the aforementioned student-level variables. When student ability or prior performance is included as a predictor the variance explained between students within schools increases to about 40 percent (or 32 per cent of the total variance between students within schools and between schools).

[1] Note: As PISA is primarily designed to provide accurate estimates for participating countries, the multilevel analyses by Australian States and Territories using PISA 2006 data should be taken as indicative only as they are based on a small number of schools in some States and Territories. To obtain more accurate estimates that allow a robust comparison of the proportioning of variances into school- and student level components within States, data from studies that access larger numbers of schools and students would need to be analyzed. In order to seek to explain the variance, these data sets would need to contain comprehensive student background information.

…between schools?

- In Australia, the PISA index of **economic, social and cultural status of students and schools (ESCS)** explains **between twelve and fifteen per cent** of the **between-school variance**.

- Combined with the effect of **ESCS** at the student level, this means that, in Australia, the economic, social and cultural status on achievement **explains** about **eleven per cent of the total variance** in performance.

- The amount of **between-school variance explained by ESCS is lower** than the OECD average, about the same as it is in New Zealand and the UK, a bit lower than it is in the US (about 17%) and much lower than it is in Germany (about 52%). In Canada (about 7%) and Finland (about 2%), however, the effect of this index is smaller.

- Multilevel analyses conducted with data from Germany and the USA indicate that about three quarters of the differences between schools can be explained by school type (public/private), socio-economic status of the school and school location (urban/rural).

- Other variables that explain differences in performance between schools include **some resource variables** (e.g. specialized science lab, library), **emphasis on academic achievement,** and amount of **homework assigned**.

Conclusion

In Australia, the largest differences in performance are related to **differences between individual students (about 80%)** rather **than differences between schools (about 20%)**. In South Australia, this proportioning appears to be similar, with differences between schools maybe even a bit smaller than for Australia overall.

As a consequence, **initiatives aimed at individual students** are likely to have a **greater impact on performance** than initiatives aimed at schools. However, decisions about the types of initiatives sought have to give consideration to what the aims and priorities are: **To raise mean performance? To reduce differences in performance between all students? To increase performance levels of lower achieving students? To extend higher performing students?**

Finally, a review of research into factors explaining differences in performance between students and schools shows, on the one hand, consistent and large effects of factors such as socio-economic status, ethnicity, gender or school type that do not lend themselves readily to being influenced. On the other hand, malleable variables that emerge between students include **self-efficacy, aspirations, interest,** and **homework effort.** Between schools, **emphasis on academic achievement, homework policies** and **some resource variables (e.g. specialized science lab, library)** tend to explain differences in performance. Policy and decision-makers will **need to clarify their main questions** regarding these variables. Then, focused analytical work can provide evidence to guide these important decisions.

1
INTRODUCTION

One of the aims of the national agenda for education is to foster the achievement of Australian students in key learning areas such as numeracy and literacy. A central question, in this context, is at which level resources should best be allocated in order to maximize their effect on improving learning outcomes. Put differently, the question is whether it is more effective to direct resources to schools, their staff and infrastructure or to students and their families.

One approach to examining this question is to ascertain how much of the differences in learning outcomes can be attributed to schools and to what extent differences are linked to students and their individual circumstances. Resources are likely to be allocated more effectively where the differences are greater.

The work reported herein took two approaches to addressing this question: A quantitative analysis of Australian data from the Programme for International Student Assessment (PISA) and a literature review of publications on the topic. More specifically, the two components involved the following:

1. **Quantitative analysis of Australian data from the Programme for International Student Assessment (PISA) using Hierarchical Linear Modeling (HLM)**

   Multilevel analyses of information from national representative samples of 15-year-old students and their schools obtained by the Programme for International Student Assessment (PISA) allowed the proportioning of variance into differences in performance that were attributable to schools and those related to students. In addition, comparative analyses were undertaken in three key learning areas as the PISA achievement tests focused on reading in 2000, on mathematics in 2003 and on science in 2006.

   Due to the larger number of students and schools that participated in the Australian PISA data collection in 2006 compared with 2000 and 2003, multilevel analyses by State/Territory were undertaken for the most recent available cycle only. However, even with the larger numbers in 2006, the results from these analyses should be taken as indicative only. More comprehensive data sets would have to be analyzed in order to obtain robust estimates of the proportions of variance associated with the student and the school level within States and Territories in Australia.

2. **A literature review of multilevel analyses aimed at explaining differences between students within schools and between schools**

   This review explored published results of multilevel analyses that have attempted to split the variance in performance in mathematics, science or reading into that proportion that could be attributed to schools and that proportion that could be attributed to differences between students.

The review covered the last 20 years and focused on Australia and selected OECD countries. Canada, New Zealand, the UK and USA were selected because they share the Anglo-Saxon cultural background with Australia. The other countries were chosen because of their extreme proportions of variance whereby Finland had the smallest variance between schools whereas Germany had the largest between-school variance in science achievement of all OECD countries in PISA 2006. This is due to Germany's educational system which involves the streaming of students into different types of schools depending on academic achievement at the end of primary school (Grade 4 in most German States).

In addition to providing information regarding the proportions of variance associated with each level, the studies were screened for the predictors that were included in the analyses. In a first step, all predictors that were included were noted. In a second step, those predictors that were found to be significant were highlighted. The resulting list of significant predictors was summarized to arrive at a picture of factors found to explain differences in academic performance between students and between schools.

Major Research Questions

The following research questions were guiding the quantitative analyses:

1. In Australia, what is the proportion of variance associated with the school and the student level respectively?

2. In Australia, do the proportions of variance associated with the school and the student level differ depending on the learning outcome, namely reading, mathematics and science?

3. Have the proportions associated with the school and the student level changed in Australia over the six-year period from 2000 to 2006?

4. Are the differences in performance associated with the school and the student level in South Australia similar to Australia as a whole?

The following research questions were guiding the literature review:

1. Which split in variance in performance between students and schools has been reported in previously published research for Australia and selected OECD countries?

2. Which factors have emerged in these multilevel analyses as explaining differences between students and between schools?

2

QUANTITATIVE ANALYSIS OF AUSTRALIAN PISA DATA USING HIERARCHICAL LINEAR MODELING (HLM)

In Table 1.1, details regarding the number of schools and number of students who participated in Australia in the three PISA cycles are given. It should be noted that each PISA cycle focused on one of three learning outcomes. This focus was reading in 2000, mathematics in 2003 and science in 2006. While the two other learning outcomes were also assessed in each cycle, it should be kept in mind that the learning area which was the focus of a particular cycle was measured with more test items and hence greater accuracy than the two other learning outcomes.

In addition, the assessment procedure was slightly different in the PISA 2000 compared with the 2003 and 2006 cycles. In PISA 2000, all students were examined in reading but only about one quarter was assessed in mathematics and another quarter in science. In PISA 2003 and 2006, achievement data were available on all three learning outcomes for all students.

Multilevel analyses using hierarchical linear modeling (HLM, Raudenbush et al., 2004) of the Australian PISA data from each cycle and for each learning outcome were undertaken in order to obtain estimates of that proportion of the variance in performance attributable to schools and the proportion associated with students. These proportions are also sometimes referred to as the "between-school" and "between-student within-school" (hereafter shortened to "between-student") variances.

Table 1.2 provides the results of these analyses. The mean score and its standard error are only given to contextualize the analyses. In all cycles and for all learning outcomes, Australia performed significantly above the OECD average which was set to 500 for all cycles and learning outcomes. In terms of trends in achievement over time, science performance stayed the same across the six years whereas performance in reading remained about the same between 2000 and 2003 but dropped significantly between 2003 and 2006. Maybe due to a change in the framework because mathematics became a focus in 2003 and hence was developed more fully a decline in mathematics performance could be observed between 2000 and 2003. However, it remained steady from 2003 to 2006.

The third column in Table 1.2 shows the total variance, that is the differences in performance for each cycle and each learning outcome. The higher the total variance, the greater the differences are between high and low performing students. Thus, in 2000, the largest variance for the learning outcomes could be observed for reading, whereas in 2003 and 2006 largest differences between high and low performers were found in science. In all three cycles, the total variance was smallest for mathematics. In other words, the differences between high and low achievers were consistently lower in mathematics than they were in reading and science.

HLM produces estimates of the amount of variance associated with each level in the analysis. These were converted into percentages and recorded in columns four and five of Table 1.2. In 2000, for example, the variance in mean scores between schools in reading was 17 per cent while 83 per cent of the variance was found between students. These proportions were similar to those observed for mathematics and science. Also, while the proportions of variance related to schools were slightly higher in 2003 and 2006 than they were in 2000, these differences should not be interpreted as being significant and might have been due to changes in the design between cycles.

Table 1.1 Number of schools and students participating in the three PISA cycles: Australia overall and South Australia

PISA cycle	N of schools Australia	N of schools South Australia	N of students Australia	N of students South Australia
2000 (focus reading)				
Reading	231	29	5176	625
Mathematics	231	29	2859	345
Science	231	29	2860	355
2003 (focus mathematics)	321	34	12551	1234
2006 (focus science)	356	43	14170	1593

Table 1.2 Proportions of variance[a)] associated with the student and the school level in Australia for the three PISA cycles

PISA cycle	Mean score [b)]	SE [c)]	Total variance [d)]	Variance between schools (in %)	Variance between students (in %)
2000 (focus reading)					
Reading	528	3.5	10204	17	83
Mathematics	533	3.5	7721	15	85
Science	528	3.5	8712	16	84
2003 (focus mathematics)					
Reading	525	2.1	9753	23	77
Mathematics	524	2.1	9168	21	79
Science	525	2.1	10299	19	81
2006 (focus science)					
Reading	513	2.1	9102	21	79
Mathematics	520	2.2	7853	22	78
Science	527	2.3	10174	18	82

Notes:

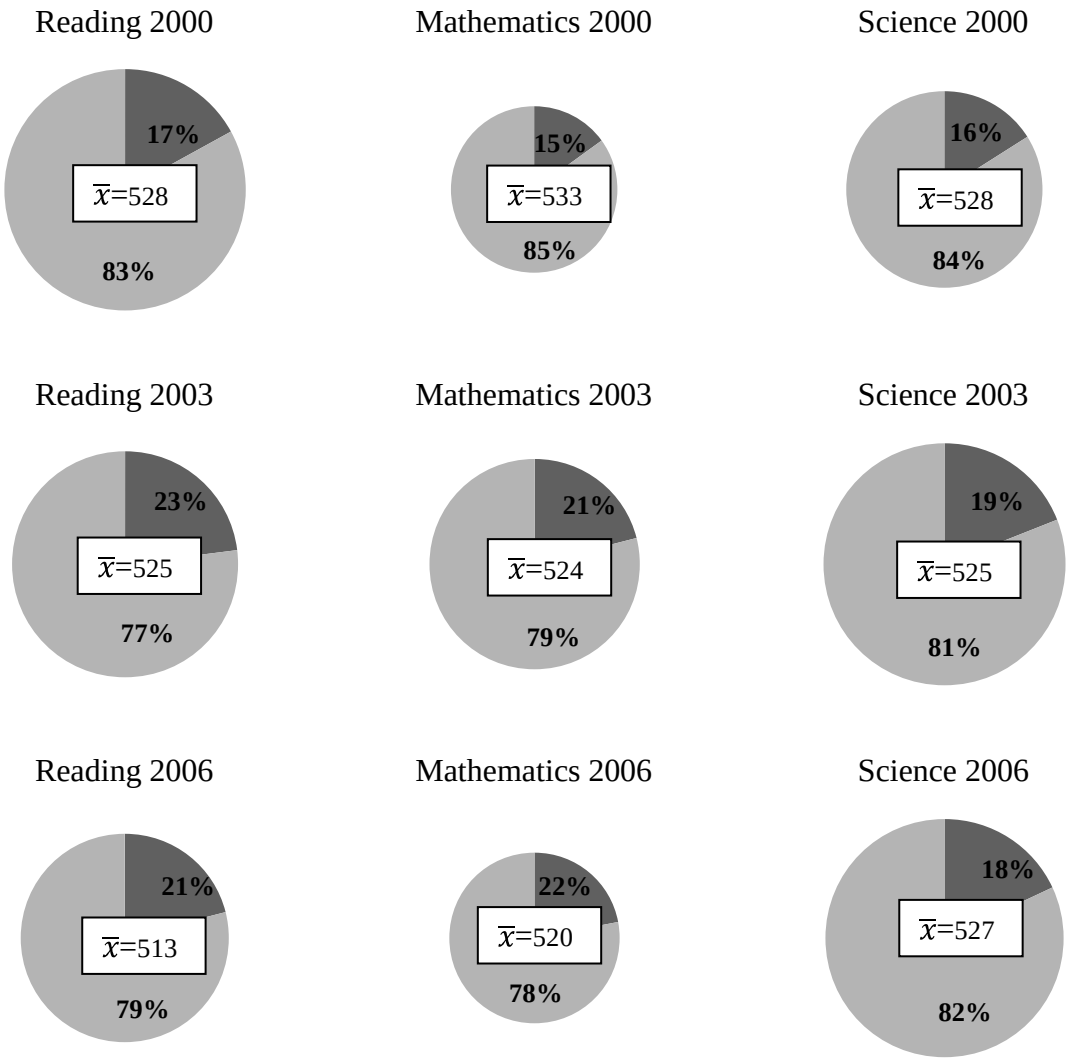
a) The analyses were undertaken using the software package HLM 6.06 (Raudenbush et al., 2004). Weights were applied to the student and the school levels as follows: In 2000: W_FSTUWT at the student level and WNTSCHBW at the school level; in 2003: W_FSTUWT at the student level and SCWEIGHT at the school level; in 2006: W_FSTUWT at the student level and W_FSCHWT at the school level. For details regarding the computation and application of the weights see PISA 2003 Data Analysis Manual, SPSS (OECD, 2005) PISA 2006 Technical Report (OECD, 2009). Analyses were also undertaken using only the student weight (W_FSTUWT) at the student level. The resulting estimates of the between-school variance increased by between one and two percent.

b) Australia's mean score was significantly higher than the OECD mean (500) in all subject areas and all assessment cycles.

c) SE=Standard error

d) Total variance=Between-student within school + between school variance

Figure 1 Variance in performance between students and between schools
Australia Overall – PISA data (15-year-old students)



Notes

Visualization of Table 1.2.

Darker shaded area : Between-school variance.

Lighter shaded area : Between-student variance.

$\bar{x}$: Mean score for a domain (reading, mathematics, science) in that year (2000, 2003, 2006).

Reference for sizes of pie charts is Science 2003 as it had the largest total variance (i.e. differences between the highest and lowest performing students). Mean scores may differ from published scores due to differences in the weights used in the analyses.

Figure 1 is an illustration of the results of the proportioning of variance analyses. In total, nine pie charts represent the results, one for each of the three learning outcomes in each of the three cycles. The mean score is given in the middle of the chart. The dark shaded area reflects the between-school variance while the light shaded area indicates the between-student variance. The different sizes of the pie-charts reflect differences in the total variance associated with each learning outcome in each PISA cycle. Thus, the largest pie chart is shown for science 2003 as the total variance was largest for this learning outcome and cycle. All other charts are relative in size to this one. As can be seen, the smallest total variance was observed for mathematics in 2000. As was already apparent from the numbers in Table 1.2, the sizes of the pie-charts illustrate that the differences between high and low performance were smaller in mathematics than they were in reading and science in all assessment cycles.

Multilevel analyses aimed at proportioning the variance in performance occurring between students and between schools within States and Territories were also undertaken. However, due to the smaller number of students and schools that participated in the Australian PISA data collections in 2000 and 2003, multilevel analyses by State/Territory were undertaken for 2006 only. However, even with the larger numbers in 2006 (see Table 1.3), the results from these analyses should be taken as indicative only. More comprehensive data sets would have to be analyzed to obtain robust estimates of the proportions of variance associated with the student and the school level within States and Territories in Australia. Results of the analyses are given in Table 1.4.

The first column shows the State/Territory for which the analyses were undertaken. Then, results of the analyses are recorded, first for science, followed my mathematics and lastly for reading. For each learning outcome, the mean score, its standard error, the total variance as well as the variance between schools and between students are provided. In general, the same proportions that were found for Australia overall, namely 20 per cent of variance between schools and 80 per cent of variance between students, also emerged for the States and Territories. Indeed, these were the exact proportions for Western Australia in science and the ACT and Victoria in mathematics. In South Australia, the between-school variance tended to be slightly smaller and the between-student within-school variance slightly larger than for Australia overall. In addition, the total variance recorded for South Australia showed the smallest differences between high and low achievers of all Australian States and Territories while at the same time recording the fourth highest performance. Across all learning outcomes, differences between schools were somewhat smaller in Queensland and somewhat larger in the Northern Territory and Tasmania.

In summary, the analyses showed that, in Australia, differences in performance between individual students were around 80 per cent while differences in performance between schools were around 20 per cent. This could be observed for all learning outcomes and in all assessment cycles. Thus, differences were far greater between students than they were between schools. The multilevel analyses by States and Territories should be treated with caution due to the small number of schools and students involved in some instances. However, results showed roughly the same picture, with an indication that differences between schools were somewhat smaller in Queensland and somewhat larger in the Northern Territory and Tasmania.

Table 1.3 Number of schools and students participating in Australian States and Territories: PISA 2006

PISA 2006	N of schools	N of students
ACT	26	986
NSW	80	3373
NT	22	771
QLD	57	2402
SA	43	1593
TAS	34	1289
VIC	56	2272
WA	38	1484
Australia Overall	356	14170

Table 1.4 Proportions of variance associated with the student and the school level in Australian States for PISA 2006[a) b)]

	Science					Mathematics					Reading				
PISA 2006	**Mean score**	**SE**	**Total variance**	**Variance between schools (in %)**	**Variance between students (in %)**	**Mean score**	**SE**	**Total variance**	**Variance between schools (in %)**	**Variance between students (in %)**	**Mean score**	**SE**	**Total variance**	**Variance between schools (in %)**	**Variance between students (in %)**
ACT	549	4.9	10745.99	15	85	539	5.6	7986.36	20	80	535	5.0	8721.15	15	85
NSW	535	4.6	10015.75	19	81	523	5.0	7900.89	26	74	519	4.4	9043.88	24	76
NT	490	6.6	16245.41	25	75	481	6.2	12146.90	32	68	460	10.6	20349.30	45	55
QLD	522	4.2	10270.54	12	88	519	4.4	7941.97	15	85	509	3.5	9341.97	15	85
SA	**532**	**4.9**	**9256.40**	**16**	**84**	**520**	**4.3**	**7041.41**	**18**	**82**	**514**	**4.9**	**7889.85**	**17**	**83**
TAS	507	4.6	10667.43	23	77	502	3.8	7527.93	21	79	496	4.6	9741.97	27	73
VIC	513	4.9	9845.91	18	82	513	4.0	7523.47	20	80	504	4.3	8276.96	16	84
WA	543	6.8	10365.68	20	80	531	6.5	8414.59	25	75	524	6.0	8629.29	21	79
Austr. Overall	527	2.3	10332.71	19	81	520	2.2	7900.93	22	78	513	2.1	9039.00	21	79

a) No weights used at any level.

b) These results should only be taken as indicative as they are based on a relatively small number of schools in some States/Territories. Hence, the reported variance estimates have a large error associated with them and little can be said about the significance or otherwise of differences.

3

LITERARTURE REVIEW OF MULTILEVEL ANALYSES AIMED AT EXPLAINING DIFFERENCES BETWEEN STUDENTS AND SCHOOLS

The quantitative analyses reported in the previous section were complemented by a literature review for two purposes. The first purpose was to put the results of the quantitative analyses into an international perspective. The second purpose was to obtain an overview of factors that might explain differences in performance between students and between schools.

The literature search focused on two-level analyses that were aimed at proportioning the variance into their between-students and between-schools components in mathematics, reading and science. In addition, studies had to attempt to explain differences in performance by adding student- and school-level predictors into the analyses. The geographical focus, in addition to Australia, was selected OECD countries. Canada, New Zealand, the UK and USA were selected because they shared the Anglo-Saxon cultural background with Australia. The other countries were chosen because of their extreme proportions of variance whereby Finland had the smallest and Germany the largest variance between schools as regards science performance across all OECD countries in PISA 2006. The German heterogeneity was due to an educational system which involved the streaming of students into different types of schools depending on academic achievement at the end of primary school (Grade 4 in most German States).

Literature searches were conducted across four databases, namely the Australian Education Index, ERIC, Education Research Complete (published by EBSCOhost) and British Education Index. The literature was searched for the period 1990 to 2009. Keywords used in the searches included statistical terms (e.g. multilevel analysis or variance), details of data used in the analyses (e.g. TIMSS or PISA) and names of authors that were known to publish relevant articles. A complete list of search terms and their combinations is provided in Appendix 1.

The abstracts retrieved as a result of those searches (about 75) were subsequently screened. Those abstracts that were considered to point to relevant articles were located as full-text documents. Some articles were found not to provide the necessary details and could therefore not be included in the overview. Other articles were excluded because they focused more on the technical aspects of multilevel analyses and were therefore not addressing the questions guiding the literature review. Finally, the time consuming nature of reading through full-length academic articles meant that only half the studies were screened. However, while it would have been desirable to review all of the retrieved articles, it was felt that already from those in the review a coherent picture emerged and that the additional articles would have contributed largely to consolidating this emerging picture.

Results of the review are presented in Table 1.5. The first five columns provide contextual information. Thus, the first column specifies the study number and a complete bibliographic reference for each study is given in Appendix 2. Columns two, three, four and five provide information concerning the data set employed in the analyses, the Grade or Year levels of the samples involved, the country for which data were examined and the achievement area (i.e. mathematics, reading or science test score) used as the outcome measure of student learning.

In the subsequent columns, information of interest to the current study is provided. The proportion of variance associated with the student level is given in column six while column seven specifies the between-school variance reported in the respective article.

In addition to providing information regarding the proportions of variance associated with each level, studies were screened for the predictors included in the analysis. In a first step, all predictors that were included were noted. In a second step, those predictors that were reported to be significant were highlighted. Finally, the amount of variance explained by those variables remaining in the analysis was recorded.

As an example, the first study used information from the National Assessment of Educational Progress (NAEP) program in 2003 and analyzed Grade 4 data for the United States in the subject area of reading. The proportioning of variance analysis revealed that 75 per cent of the variance was located at the student level (column 6) while 25 per cent of the variance was found between schools (column 7). Predictors included in the analysis at the student level were gender, race, whether or not students had a PC at home, socio-economic status of the home (SES) and students' absences from school. Of these predictors, only race and SES turned out to be significant (highlighted in bold in column 8) and jointly explained 20 per cent of the variance between students within schools (column 9). In other words, 15 per cent of the total variance in Grade 4 reading performance (=20% of the 75% between-student variance) could be explained by differences in race and SES.

In column ten, the school-level predictors employed in the analysis are listed. They included school type, teacher experience and certification, student absenteeism, school location (urban/rural), per cent disadvantaged students (a combination of percentages of students who were eligible for free lunch, had a disability and spoke a first language other than English) and school size. Of these variables, only school type emerged as a significant predictor that explained 74 per cent of the variance in reading performance at Grade 4 level between schools (column 11). Thus, 18.5 per cent (=74% of the 25% between-school variance) of the total variance could be explained by school type. When taking into consideration the results at the student level, this meant that student gender and SES together with school type explained about one third (15% between students within schools and 18.5% between schools) of the total variance in reading achievement of Grade 4 students in the USA.

Next, the information presented in Table 1.5 is summarized, first for the student level followed by the school level, to arrive at a picture of factors that explain differences in academic performance between students and between schools.

In terms of proportions of variance associated with the student and school levels, Finland and Germany were extreme cases. In Finland, differences between schools were smallest (around 5%) whereas they made up more than half of the variance in Germany (around 52 %). This was a consequence of a highly streamed educational system in Germany which separated students into schools depending on their academic achievement at the end of primary school (Grade 4 in most German States). Apart from these extremes, the analyses showed that between 15 and 35 per cent of the variance was found between schools and between 85 and 65 per cent was associated with differences between students.

The additional information regarding the total variance in performance provided by the PISA 2006 report (study 14) allowed a comparison of the overall differences between highest and lowest achievers in the respective countries. In most cycles and for most learning outcomes, only for Canada and Finland were smaller amounts of variance recorded than for Australia. In other words, the differences between highest and lowest achievers tended to be smaller in Australia than they were in the other countries in the review.

Furthermore, PISA reported the amount of variance explained by the index of economic, social and cultural status (ESCS) between students within schools and between schools. This index incorporated the highest level of education and occupation of either parent as well as

home possessions and differed somewhat from other indicators of socio-economic status in that it incorporated cultural possessions such as classic literature, books of poetry and works of arts. The amount of variance between students within schools that was explained by ESCS ranged from one per cent in Germany for mathematics, reading and science in PISA 2006 to ten per cent in New Zealand for reading in PISA 2003 and science in PISA 2006. Between schools, ESCS accounted for none of the variance in Finland for mathematics in 2000 and up to 64 per cent of the variance in Germany for science in 2006.

With around five per cent of the variance accounted for between students within schools, Australia lies in the middle of the countries in the comparison. The amount of variance explained by ESCS between schools is around 15 per cent for Australia, which is similar to the amount of variance explained by this index in New Zealand, the UK and the US and puts it above Finland and Canada but below Germany. This means that, in Australia, the differences in achievement depending on ESCS were greater than they were in Canada and Finland, about the same as they were in New Zealand, the UK and the USA and lower than they were in Germany.

In addition to various measures of socio-economic status, other student-level variables that emerged from the literature review as being significant in explaining performance differences were ethnicity, language spoken at home, gender, some measure of students' socio-economic status and/or wealth. In addition, variables such as students' expectations regarding future education and occupation, their interest in the subject matter, homework effort, whether or not students felt in control of their learning and had confidence in their abilities more generally (self-concept) or regarding specific tasks (self-efficacy) emerged as having a significant effect on achievement.

Together, these student-level variables tended to explain between 18 and 25 per cent of the differences in performance between students within schools, regardless of whether the subject area was mathematics, reading or science. When a measure of student ability was added to the analysis, for example verbal ability or average grade in the previous year, the variance explained between students within schools tended to increase to between 30 and 40 per cent (see studies 5, 12 and 13).

At the school level, significant predictors included school type, the location of the school (urban, suburban, rural) and the socio-economic background of the school for which average student SES was frequently used as an indicator. In addition, school resources such as access to a library or specialised science laboratory, school climate, emphasis on academic excellence and homework policies were sometimes reported to explain differences in performance between schools. Together, these school-level variables explained about three quarters of the differences between schools or 19 per cent (75*25) of the total variance in performance.

Factors such as cultural possessions and social communication in the students' homes as well as many teacher-related variables concerning instruction and context (e.g. teacher support, student/teacher relationships, teacher decision making power) did not emerge as significant predictors in the studies included in this literature review. Several explanations for the absence of such effects may apply. First, any effects of these variables might have been outweighed by the other, more powerful variables in the analyses. Second, the measures used as indicators for these behaviours might have lacked in sensitivity to differentiate sufficiently between teachers. Third, the analyses included in the review focused on the student and school levels which might have prevented instructional variables being considered at the appropriate level, namely in between the student and the school level.

4

SUMMARY AND CONCLUSION

This report was aimed at partitioning the variance in academic performance into differences between students and differences between schools. In addition, it sought to provide a picture of student- and school-level factors that contributed to explaining these differences in performance. These aims were pursued by two means, namely two-level hierarchical linear analyses of Australian PISA data for 2000, 2003, 2006 and a literature review of published studies that have undertaken multilevel analyses aimed at mapping and explaining differences in achievement between students and between schools.

A number of research questions were developed and are answered below.

In Australia, what is the proportion of variance associated with the school and the student level respectively?

In Australia, of the total variance in performance, about 20 per cent is located between schools and about 80 per cent between students.

In Australia, do the proportions of variance associated with the school and the student level differ depending on the learning outcome, namely reading, mathematics and science?

No, the proportions of variance associated with the school and the student level are very similar for the three learning outcomes under review, namely mathematics, reading and science. However, there is some indication that the total variance in mathematics is somewhat smaller than it is in reading and science. In other words, differences between high and low achievers are greater in reading and science than they are in mathematics where the performance is more homogeneous.

Have the proportions associated with the school and the student level changed in Australia over the six-year period from 2000 to 2006?

In general, the proportions associated with the school and the student levels have remained the same although there is an indication that the between-school variance was slightly smaller in 2000 than it was in 2003 and 2006. This might be a consequence of differences in the study design, though.

Are the differences in performance associated with the school and the student level in South Australia similar to Australia as a whole?

Yes, the proportions of variance are similar with some indication that the between-school variance is slightly smaller in South Australia than it is for Australia overall in all three learning outcomes.

Which split in variance in performance between students and schools has been reported in previously published research for Australia and selected OECD countries?

A selection of published research studies reveals an amount of between 15 and 35 per cent of between-school variance and between 85 and 65 per cent of between-student variance. This is excluding extreme cases such as Finland, where the between-school variance is much smaller (about 5%) and Germany, where the between-school variance is much larger (about 52%), due to an academically streamed educational system.

Which factors have emerged in these multilevel analyses as explaining differences between students and between schools?

Factors that explain differences between students within schools include gender, ethnicity, home language and socio-economic status as well as subject matter interest, self-concept, self-efficacy, educational and occupational aspirations and homework effort. As a rough estimate across different studies and countries, these factors explain up to a quarter of the between-students within-school variance, increasing to between 30 to 40 per cent if a measure of student ability is included as a predictor in the analysis.

Factors that contribute to explaining differences in performance between schools are fewer as less of the total variance is located between schools than between students within schools. Still, a number of significant factors emerge from the international analyses, namely school type and location, socio-economic background of the school as well as school climate, emphasis on academic excellence and homework policies. Across different countries and data sets, these school-level factors explain roughly up to three quarters of the differences in performance between schools.

In conclusion, given the proportions of variance associated with the student and school levels, initiatives aimed at individual students are likely to have a greater impact on performance than initiatives aimed at schools. However, decisions about the types of initiatives to be implemented have to give consideration to what the aims and priorities are: To raise mean performance? To reduce differences in performance between all students? To increase performance levels of lower achieving students? To extend higher performing students?

Finally, a number of student- and school-level variables have been identified that contribute to explaining differences in performance. Here, policy- and decision-makers have to make explicit their questions regarding those variables. These questions can then guide further analyses of empirical data in order for the available evidence to inform the decision-making process.

Table 1.5 Results of selected published multilevel analyses

Study #	**Data**	**Grade(s)**	**Country**	**Outcome** (Achievement in school subject)	**% Student-level variance**	**% School-level variance**	**Student level predictors** in the multilevel Analysis; Significant ones marked in **bold**	**Variance explained – Student level**	**School level predictors** in the multilevel Analysis; Significant ones marked in **bold**	**Variance explained-School level**	**Comments**
1	NAEP 03	4	USA	Reading	75	25	Gender **Race** PC at home **SES** Absences	20	**School type** (public/ private: Catholic, Lutheran) Tch experience, certification Std absenteeism School location %disadvantage (stds eligible for free lunch, with disability, ESL/AFL School size	74	
1	NAEP 03	4	USA	Maths	71	29	As above	22	**School type** (public private(Catholic, Lutheran)	73	
1	NAEP 03	8	USA	Reading	66	34	As above	23	**School type** (public private(Catholic, Lutheran, Christian Conservative)	75	
1	NAEP 03	8	USA	Maths	65	35	As above	26	As above	70	
2	NAEP 1985-86	3, 7, 11	USA	Maths	N/A	N/A	Gender **% Black** **% Hispanic** **SES**	N/A	**$/student (Gr 7, 11)** PCs/student Science lab **Specialized sci lab (Gr 11)** Math tracking Sci tracking Std/tch ratio **School size (Gr 3, 11)** **Team-taught classes** **Departmental structure (Gr 3)** Rigor of acad standards Change in academic standards **Amount homework (Gr 7, 11)** Teacher control over standards Years principal Years principal in ed admin Years principal teaching Principal's time academic Principal's time parents % teachers in minority groups Time teacher academic Time teacher with parent	N/A	Effects of student-level predictors increase with increasing Grade; school level predictors have largest effect in Gr 7 Results for science model very similar to mathematics

Table 1.5 Results of selected published multilevel analyses (ctd.)

Study #	Data	Grade(s)	Country	Outcome (Achievement in school subject)	% Student-level variance	% School-level variance	**Student level predictors** in the multilevel Analysis; Significant ones marked in **bold**	Variance explained – Student level	**School level predictors** in the multilevel Analysis; Significant ones marked in **bold**	Variance explained-School level	Comments
3	NAEP 1990	4, 8, 12	USA	Maths	N/A	N/A	**Gender(Gr 12)** **Race** **SES** Maths useful (Gr 12: neg) Enjoy maths (Gr 12: "enjoy maths" pos) Math not more for boys	N/A	School size Std/tch ratio $/student PCs/std % using PC Various instr. strategies; only ones significant: **Doing problems from textbooks** **Use of calculator (neg Gr 3; pos Gr 12)** School safety (absenteeism, unsafe, disruption) Hrs/week maths instruction	N/A	
4	NAEP 1990	12	USA	Maths	70	30	**Social class** **Minority status** **Gender** **Grade 9 GPA**	45	**Avg.# acad. maths courses taken** **% in college prep program** **% math curr in acad. courses** **Avg. Grad 9 GPA** **School SES** Minority concentration School size	32	
5	TIMSS 1995	8/9	Australia	Maths	82	18	Single-parent SES **Word knowledge score** **Self efficacy** **Locus of control** Attitude to maths Maternal press **Std aspirations**	33	Tch ed. level Yrs teaching Tch satisfaction Emphasis on problem solving **Student cantered limitations** Resource limits School location School SES Avg class behaviour Avg maternal press School size Admin violations Level of misbehaviour	8	Student cantered limitations: The extent to which teaching is limited by - Student with different acad. abilities - Uninterested students - Disruptive students - Students with special needs - Students with widely different backgrounds

Table 1.5 Results of selected published multilevel analyses (ctd.)

Study #	**Data**	**Grade(s)**	**Country**	**Outcome** (Achievement in school subject)	**% Student-level variance**	**% School-level variance**	**Student level predictors** in the multilevel Analysis; Significant ones marked in **bold**	**Variance explained – Student level**	**School level predictors** in the multilevel Analysis; Significant ones marked in **bold**	**Variance explained-School level**	**Comments**
6	PISA 2000	15-Year-Olds	Germany	Reading	46	54	Gender **Home possessions** **Grade** **SES** **Classize** **Verbal self-concept** **Absenteeism** **Reading interest**	27	**Library access** **Assessment policy** **Importance of achievement** Instr/week **P/t teachers** **Incl. primary school** School type **PC/std** **School climate** School size Instr resources Teacher participation	59	
7	PISA 2000	15-Year-Olds	Finland	Reading	84	16	**PCUse** TchExp of school work **Gender** **Grade** **ReadInt** **Acad. self-concept** **SES**	23	Admission procedures **TchIgnore (-)** AcadPress Instructional grouping Extra lessons **%girls** Primary FreqReports SchSize StdBehav UpSec	18	Academic self concept composed of verbal, maths, gen., effort & perseverance Primary: Sec school contains primary school UpSec: Sec school contains upper sec TchIgnore: Extent tch ignores stds needs
8	NAEP 2003	4	USA	Maths	71	29	**Race** **Gender** **Home Resources** **Limited Eng prof(-)** **Individualized ed. Plan(-)** **Lunch(-)**	18	**School type** **% lunch** **Mean Home res** **% minority** **% Limited Eng prof** **Urbanity** **Region**	76	Limited Eng prof (-) at std level (+) at sch level; School type: Gr4: All types of private schools performed worse than public schools in final model

Table 1.5 Results of selected published multilevel analyses (ctd.)

Study #	Data	Grade(s)	Country	Outcome (Achievement in school subject)	% Student-level variance	% School-level variance	**Student level predictors** in the multilevel Analysis; Significant ones marked in **bold**	Variance explained – Student level	**School level predictors** in the multilevel Analysis; Significant ones marked in **bold**	Variance explained-School level	Comments
9	NAEP 2000	4	USA	Maths	66	34	**Race** **SES** **Gender** **Disability** (The following are teacher reported practices): Calculator use De-emphasize facts&skills **Collab. problem solving** **Non-number curr emphasis** Writing about maths Manipulatives Reasoning Mult.choice assessment use **Tch knowledge of NCTM standards**	70	**SES** %White&Asian **School type**	16	Separate models were estimated, one for each of the instructional emphases
9	NAEP 2003	8	USA	Maths	63	37	**Race** **Gender** **Home Resources** **Limited Eng prof(-)** **Individualized ed. Plan(-)** **Lunch(-)**	24	**School type (see comment)** **% lunch** **Mean Home res** **% minority** **% Limited Eng prof** **Urbanity** **Region**	72	School type: Gr8: Catholic&Cons.Christian schools but not Lutheran, other private and charter schools performed worse than public schools in final model
10	PISA 2000	15-year-olds	UK	Reading	86	14	**Gender** **SES** **Learning ethos** **School ethos** **FamEdSup** **AchPress**	12	Single-sex **SchSES** School type	75	Separate models for retrieving info, interpreting tests, reflection&eval (results for retrieving info but all three similar); SES: Based on HISEI, Wealth, HEDRES; Learning ethos: Cultural and social communication and possessions, cultural activities. Hmwktime, joy and diversity reading; School ethos: Teacher support, disciplinary climate, tch/pupil relation sense of belonging

Table 1.5 Results of selected published multilevel analyses (ctd.)

Study #	Data	Grade(s)	Country	Outcome (Achievement in subject)	% Student-level variance	% School-level variance	Student level predictors in the multilevel Analysis; Significant ones marked in **bold**	Variance explained – Student level	School level predictors in the multilevel Analysis; Significant ones marked in **bold**	Variance explained-School level	Comments
11	Sec. Int'l Science Study (SISS)	14-year-olds	Australia	Science	85	15	**Sex** **EnjSci** **Ethnicity** **Verbal Ability** **Quant.Ability** **SES**	43	Areapop Tch/std ratio **% fem.tch** Tchdecision-making Par/Tch interaction Oper. cost **Avg SES** **Avg VerbAb** **Av QuantAb** Minority Avg EnjSci Schtype Single-sex school	76	
12	PISA 2000	15-year-olds	Canada	Reading	N/A	N/A	**Gender** **SES** **Family wealth** **Single-parent(-)** **Family size(-)** **Immigrant(-)** **Home lang(-)** **Home ed resources** **Cultural comm.** **Cultural acts.** Cultural poss Social comm. **ParInvolve(-)** **Enjoy reading** **Diverse reading** **Time reading** **StdExpSES** **StdExpFutEd** **Time hmwk** **Familiar PC** **P-t work** School mobility Time language hmwk	N/A	Urbanity **%female stds** Tch/std ratio Schmaterialres Schinstructionalres **Disciplinary climate** Acad press Std behaviour **Sense of belonging** Tch morale **Sch autonomy** Time lang arts Comparison with nat. perf. Sch size % tch language arts degree %tch part in prof devlpmt Tch shortage %PC/std Tch support Tch behaviour Std/tch rel-ship Tch decision-making	N/A	Two two-level models: 1. students within schools; 2. schools within provinces; Time reading measured by 3 variables 1/2hr(+) 1 hr (0) 2 or 3 hrs(-); P/t work: Summer hols (-) Weekday (-) Weekend (+)

Table 1.5 Results of selected published multilevel analyses (ctd.)

Study #	Data	Grade(s)	Country	Outcome (Achievement in subject)	% Student-level variance	% School-level variance	**Student level predictors** in the multilevel Analysis; Significant ones marked in **bold**	Variance explained – Student level	**School level predictors** in the multilevel Analysis; Significant ones marked in **bold**	Variance explained-School level	Comments
13	Long. Study of American Youth (NAEP 1987+tch+std survey 88)	10/11	USA	Science	95	5	Sex **Attitude** **Ability** Motivation **Time** **Home** Peer **Media**	37	Urbanity **SchAbility** SchAttitude SchMotivation SchHome SchPeer SchMedia SchTime **Class** Instr. Quality	86	Attitude: Interest, usefulness Motivation: Persistence, intrinsic motive Time: Homework/week Home: PEd, PExp Duncan SES Media: Read 6 books/week Read newspap often Class: %std expect bachelor; % stds plan to take more sci than required; Instr. Quality: Lab skills, conduct experiments, require written reports
14	PISA 00		Australia	Science	83	17	**Std ESCS*** For details of the PISA index of economic, social and cultural status refer to note at end of table	5	**Std ESCS+ Sch ESCS***	12	For this study, the total variance (betw-stds within school+betw-schools) in performance is given in this column 8 866
	PISA 00		Canada	Science	84	16	**Std ESCS***	5	**Std ESCS+ Sch ESCS***	6	7 830
	PISA 00		Finland	Science	95	5	**Std ESCS***	5	Std ESCS+ Sch ESCS*	1	7 351
	PISA 00		Germany	Science	51	49	Std ESCS*	3	**Std ESCS+ Sch ESCS***	44	9 791
	PISA 00		New Zealand	Science	83	17	**Std ESCS***	8	**Std ESCS+ Sch ESCS***	14	9 868
	PISA 00		USA	Science	67	33	**Std ESCS***	5	**Std ESCS+ Sch ESCS***	27	9 226
	PISA 00		Australia	Maths	83	17	**Std ESCS***	6	**Std ESCS+ Sch ESCS***	12	8 066
	PISA 00		Canada	Maths	82	18	**Std ESCS***	5	**Std ESCS+ Sch ESCS***	5	7 104
	PISA 00		Finland	Maths	95	5	**Std ESCS***	6	Std ESCS+ Sch ESCS*	0	6 316
	PISA 00		Germany	Maths	48	52	Std ESCS*	2	**Std ESCS+ Sch ESCS***	45	9 654
	PISA 00		New Zealand	Maths	82	18	**Std ESCS***	8	**Std ESCS+ Sch ESCS***	14	9 432
	PISA 00		USA	Maths	68	32	**Std ESCS***	8	**Std ESCS+ Sch ESCS***	27	8 825
	PISA 00		Australia	Reading	82	18	**Std ESCS***	8	**Std ESCS+ Sch ESCS***	15	10 313
	PISA 00		Canada	Reading	82	18	**Std ESCS***	6	**Std ESCS+ Sch ESCS***	9	8 875
	PISA 00		Finland	Reading	94	6	**Std ESCS***	6	Std ESCS+ Sch ESCS*	1	7 484

Table 1.5 Results of selected published multilevel analyses (ctd.)

Study #	Data	Grade(s)	Country	Outcome (Achievement in subject)	% Student-level variance	% School-level variance	Student level predictors in the multilevel Analysis; Significant ones marked in **bold**	Variance explained – Student level	School level predictors in the multilevel Analysis; Significant ones marked in **bold**	Variance explained-School level	Comments
14	PISA 00		Germany	Reading	45	55	Std ESCS*	2	**Std ESCS+ Sch ESCS***	50	10 062
	PISA 00		New Zealand	Reading	84	16	**Std ESCS***	9	**Std ESCS+ Sch ESCS***	14	11 359
	PISA 00		USA	Reading	72	28	**Std ESCS***	7	**Std ESCS+ Sch ESCS***	25	9 865
	PISA 03		Australia	Science	80	20	**Std ESCS***	5	**Std ESCS+ Sch ESCS***	15	10 283
	PISA 03		Canada	Science	84	16	**Std ESCS***	6	**Std ESCS+ Sch ESCS***	7	9 845
	PISA 03		Finland	Science	96	4	**Std ESCS***	8	Std ESCS+ Sch ESCS*	1	8 209
	PISA 03		Germany	Science	49	51	**Std ESCS***	4	**Std ESCS+ Sch ESCS***	45	11 004
	PISA 03		New Zealand	Science	82	18	**Std ESCS***	9	**Std ESCS+ Sch ESCS***	14	10 658
	PISA 03		USA	Science	78	22	**Std ESCS***	7	**Std ESCS+ Sch ESCS***	16	10 271
	PISA 03		Australia	Maths	79	21	**Std ESCS***	4	**Std ESCS+ Sch ESCS***	15	9 036
	PISA 03		Canada	Maths	83	17	**Std ESCS***	4	**Std ESCS+ Sch ESCS***	7	7 626
	PISA 03		Finland	Maths	95	5	**Std ESCS***	8	Std ESCS+ Sch ESCS*	1	6 974
	PISA 03		Germany	Maths	48	52	Std ESCS*	2	**Std ESCS+ Sch ESCS***	44	9 306
	PISA 03		New Zealand	Maths	82	18	**Std ESCS***	8	**Std ESCS+ Sch ESCS***	15	9 457
	PISA 03		USA	Maths	74	26	**Std ESCS***	7	**Std ESCS+ Sch ESCS***	19	9 016
	PISA 03		Australia	Reading	79	21	**Std ESCS***	4	**Std ESCS+ Sch ESCS***	15	9 345
	PISA 03		Canada	Reading	84	16	**Std ESCS***	4	**Std ESCS+ Sch ESCS***	6	7 771
	PISA 03		Finland	Reading	96	4	**Std ESCS***	6	Std ESCS+ Sch ESCS*	1	6 521
	PISA 03		Germany	Reading	47	53	Std ESCS*	2	**Std ESCS+ Sch ESCS***	46	10 218
	PISA 03		New Zealand	Reading	83	17	**Std ESCS***	10	**Std ESCS+ Sch ESCS***	15	10 744
	PISA 03		USA	Reading	76	24	**Std ESCS***	7	**Std ESCS+ Sch ESCS***	19	10 139
	PISA 06		Australia	Science	82	18	**Std ESCS***	4	**Std ESCS+ Sch ESCS***	13	9 926
	PISA 06		Canada	Science	82	18	**Std ESCS***	3	**Std ESCS+ Sch ESCS***	7	8 743
	PISA 06		Finland	Science	94	6	**Std ESCS***	6	Std ESCS+ Sch ESCS*	1	7 301
	PISA 06		Germany	Science	40	60	Std ESCS*	1	**Std ESCS+ Sch ESCS***	49	9 908

Table 1.5 Results of selected published multilevel analyses (ctd.)

Study #	Data	Grade(s)	Country	Outcome (Achievement in subject)	% Student-level variance	% School-level variance	**Student level predictors** in the multilevel Analysis; Significant ones marked in **bold**	Variance explained – Student level	**School level predictors** in the multilevel Analysis; Significant ones marked in **bold**	Variance explained-School level	Comments
14	PISA 06		New Zealand	Science	84	16	**Std ESCS***	10	**Std ESCS+ Sch ESCS***	15	11 230
	PISA 06		UK	Science	81	19	**Std ESCS***	6	**Std ESCS+ Sch ESCS***	15	11 156
	PISA 06		USA	Science	77	23	**Std ESCS***	8	**Std ESCS+ Sch ESCS***	19	11 186
	PISA 06		Australia	Maths	79	21	**Std ESCS***	3	**Std ESCS+ Sch ESCS***	12	7 658
	PISA 06		Canada	Maths	79	21	**Std ESCS***	3	**Std ESCS+ Sch ESCS***	6	7 268
	PISA 06		Finland	Maths	93	7	**Std ESCS***	6	Std ESCS+ Sch ESCS*	2	6 499
	PISA 06		Germany	Maths	56	64	Std ESCS*	1	**Std ESCS+ Sch ESCS***	54	9 665
	PISA 06		New Zealand	Maths	85	15	**Std ESCS***	7	**Std ESCS+ Sch ESCS***	11	8 468
	PISA 06		UK	Maths	78	22	**Std ESCS***	4	**Std ESCS+ Sch ESCS***	12	7 779
	PISA 06		USA	Maths	73	27	**Std ESCS***	6	**Std ESCS+ Sch ESCS***	16	8 028
	PISA 06		Australia	Reading	79	21	**Std ESCS***	4	**Std ESCS+ Sch ESCS***	12	8 687
	PISA 06		Canada	Reading	77	23	**Std ESCS***	4	**Std ESCS+ Sch ESCS***	8	9 142
	PISA 06		Finland	Reading	90	10	**Std ESCS***	4	Std ESCS+ Sch ESCS*	2	6 575
	PISA 06		Germany	Reading	20	80	Std ESCS*	1	**Std ESCS+ Sch ESCS***	64	12 245
	PISA 06		New Zealand	Reading	82	18	**Std ESCS***	9	**Std ESCS+ Sch ESCS***	11	10 749
	PISA 06		UK	Reading	79	21	**Std ESCS***	4	**Std ESCS+ Sch ESCS***	12	10 071

Note:
* The indicator of socio-economic status in PISA 2006 (ESCS) was based on five indices:
Highest occupational status of parents (HISEI), highest educational level of parents (in years of education), and home possessions (HOMEPOS). HOMEPOS consisted of three indices, namely WEALTH, CULTPOSS and HEDRES. Countries could select items aimed at differentiating well between homes within countries in terms of socio-economic status. In Australia, this meant that WEALTH included whether or not students at home had their own room, a link to the Internet, a dishwasher, a DVD/VCR player, cable/pay TV, plasma TV, digital camera. It also included the number of cellular phones, TVs, computers and cars in the household. CULTPOS covered whether or not students had classic literature, books of poetry and work of arts in their homes. Finally, HEDRES reflected whether or not students had a desk at which to study, a quiet place to study, a computer that could be used for school work, educational software, books to help with school work and a dictionary. ESCS was used as a student-level variable and was also aggregated and used as a school-level variable in the OECD analyses (OECD, 2009).

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Thomson, S., & DeBortoli, L. (2008). *Exploring scientific literacy: How Australia measures up: The PISA 2006 survey of students' scientific, reading and mathematical literacy skills*. Camberwell, Vic.: Australian Council for Educational Research.

Appendix 1

Details regarding the literature search

Three main searches were conducted for the Australian Education Index, ERIC, Education Research Complete (published by EBSCOhost) and British Education Index. *All* three searches were restricted to records with the assigned subject terms of either *mathematics, reading* and/or *science/s*. The first search also restricted citations by relevant statistical terms (see List 1) together with organisations/report titles likely to have referred to the relevant PISA data (see List 2). The second search further restricted citations to those with the assigned subject terms of *achievement, performance* and/or *success* as long as a relevant statistical term and an organisation/report title term were also located in any available text. The final search limited citations to those written by a key author (see List 3) as long as the citation or text also had one of the relevant statistical terms and one of the organisation/report title terms.

List 1 - Statistical terms:
variance or variability or variation or "multilevel analysis" or "multilevel model" or HLM or "hierarchical linear model*" or mlwin or mln*

List 2 - Organisations/report titles terms:
"First International Mathematics Study" or FIMS or "First International Science Study" or FISS or "Second International Science Study" or SISS or "Six Subject Survey" or "third international mathematics and science study" or "trends in international mathematics and science study" or TIMSS or PISA or "programme for international student assessment" or "reading literacy study" or "reading comprehension study" or NAEP or "national assessment of educational progress" or OECD or "organisation for economic co-operation and development" or IEA or "international association for the evaluation of educational achievement" or NCES or "national center for education statistics" or "national surveys" or pirls or "progress in international reading literacy study"

List 3 – Authors:
Raudenbush S or Goldstein H* or Muthen B* or Adams R* or Khoo S* or Bryk A* or Le Tendre or Postlethwaite T* or Ross Ken or Hattie J* or Heyneman* J* or Keeves John or Afrassa Tilahun or Gregory Kelvin or McGaw B**

Appendix 2 Two-level analyses included in the literature review

Study # Author(s)

1 Braun, H., F. Jenkins, et al. (2006). *A closer look at Charter schools using hierarchical linear modeling.* NCES 2006-460. Washington: National Center for Education Statistics.

2 Arnold, C. L., P. D. Kaufman, et al. (1992). *School Effects on Educational Achievement in Mathematics and Science: 1985-86*. National Assessment of Educational Progress. Research and Development Report. Washington: National Centre for Education Statistics.

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13 Young, D.A., Reynolds, A.J. & Walberg, H.J. (1996). Science achievement and educational productivity: A hierarchical linear model. *The Journal of Educational Research, 89*(5), pp. 272-278

14 OECD (2007). *PISA 2006. Science competencies for tomorrow's world. Volume 1: Analysis*. Paris: Organisation for Economic Co-operation and Development.

Note: Authors are not in alphabetical order for reasons of layout of Table 1.5 in the text.