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Classroom And School Factors Affecting Mathematics Achievement: a Comparative Study of the US and Australia Using TIMSS

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Abstract

Recent work on differences in mathematics achievement has highlighted the importance of classroom, teacher and school factors. The present study used data from the Third International Mathematics and Science Study (TIMSS) to look at student, classroom and school factors influencing mathematics achievement in the United States (US) and Australia. It found that classroom differences account for about one-third of the variation in student achievement in the United States and over 0ne-quarter in Australia. Much of the classroom variation was due to compositional and organisational factors. This has important implications for policy regarding the improvement of mathematics achievement in schools.

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Introduction

There is widespread interest among industrialised countries in improving the levels of mathematics achievement in schools. Apart from the economic benefits it is argued this would bring by better preparing young people for the numeracy demands of modern workplaces, and raising the overall skill levels of the workforce, there are also social benefits tied to improving access for larger numbers of young people to post-school education and training opportunities and laying stronger foundations to skills for lifelong learning. The interest in raising levels of achievement has led to a focus on identifying the range of factors that shape achievement as well as understanding how these factors operate to limit or enhance the achievement of different groups of students.

This paper examines student, classroom and school factors influencing mathematics achievement in the United States (US) and Australia. To do this it uses data from the Third International Maths and Science Study (TIMSS). A recent paper using this data has shown that in Australia while student background variables influence differences in achievement in mathematics, classroom and school variables also contribute substantially (Lamb & Fullarton, 2000). How much does this result hold in the US? Are the factors influencing maths achievement the same in both contexts?

School and classroom effectiveness

The early literature on school effectiveness placed an emphasis on the ability and social backgrounds of students in identifying the factors that shape academic performance, and suggested that schools had little direct effect on student achievement. Coleman et al. (1966), for example, in a major study of US schools seemed to cast doubt on the possibility of improving school achievement through reforms to schools. They found that differences in school achievement reflected variations in family background, and the family backgrounds of student peers, concluding that “schools bring little influence to bear on a child’s achievement that is independent of his background and general social context” (Coleman et al., 1966, p.325). A later analysis of the same data set by Jencks and his colleagues reached the same conclusion, “our research suggests … that the character of a school’s output depends largely on a single input, namely the characteristics of the entering children. Everything else — the school budget, its policies, the characteristics of the teachers — is either secondary or completely irrelevant” (Jencks et al., 1972, p. 256). However, the methodology employed in this early work did not take account of the hierarchical nature of the data, and was not able to separate out school, student and classroom factors. The importance of recognising this structure was noted by Raudenbush & Willms (1991, p. xi):

> An irony in the history of quantitative studies of schooling has been the failure of researchers’ analytic models to reflect adequately the social organisation of life in classrooms and schools. The experiences that children share within school settings and the effects of these experiences on their development might be seen as the basic material of educational research; yet until recently, few studies have explicitly taken into account of the effects of particular classrooms and schools in which students and teachers share membership.

More recent school effectiveness research has used multi-level modelling techniques to account for the clustering effects of different types of data. The results of such studies show, according to the meta-analysis of school effectiveness research undertaken by Bosker & Witziers (1996), that school effects account for approximately eight to ten per cent of the variation in student achievement, and that the effects are greater for mathematics than for language. A number of studies have shown that there are substantial variations between schools (Mortimore et al., 1988; Nuttall et al., 1989; Smith & Tomlinson, 1989; Lamb, 1997).

Several studies have concluded that classrooms as well as schools are important and that teacher and classroom variables account for more variance than school variables (Scheerens et al., 1989; Scheerens, 1993). Schmidt et al (1999) in their comparison of achievement across countries using TIMSS data reported that classroom-level differences accounted for a substantial amount of variation in several countries including Australia and the United States. But are these differences due more to teachers, to classroom organization, to pupil management practices or other factors?

Recent work on classroom and school effects has suggested that teacher effects account for a large part of variation in mathematics achievement. In the United Kingdom, a recent study of 80 schools and 170 teachers measured achievement growth over the period of an academic year, using start-of-year and end-of-year attainment data (Hay Mcber, 2000). Using multi-level modelling techniques, the authors modelled the impact teachers had on achievement growth. They claimed that over 30 per cent of the variance in pupil progress was due to teachers. They concluded that teacher quality and teacher effectiveness, rather than other classroom, school and student factors, are large influences on pupil progress.

A number of Australian studies have also pointed to teachers having a major effect on student achievement. In a three-year longitudinal study of educational effectiveness known as the Victorian Quality Schools Project, Hill and his colleagues (Hill, 1994; Hill & Rowe, 1996; Hill et al., 1996; Rowe & Hill, 1994) examined student, class/teacher and school differences in mathematics and English achievement. Using multi-level modelling procedures to study the interrelationships between different factors at each level – student, classroom and school – the authors found in the first phase of the study that at the primary level 46 per cent of the variation in mathematics was due to differences between classrooms, while at secondary level the rate was almost 39 per cent. Further analyses showed that between-class differences were also important in examining student growth in mathematics achievement, and that differences in achievement progress located at the classroom level ranged from 45 to 57 per cent (Hill & Rowe, 1996; Rowe & Hill, 1998).

In explaining the large classroom-level differences in student achievement in mathematics, Hill and his colleagues highlighted the role of teacher quality and teacher effectiveness. They contended that while not fully confirmed, they had "evidence of substantial differences between teachers and between schools on teacher attitudes to their work and in particular their morale" (Hill, 1994) and this supported the view that "it is primarily through the quality of teaching that effective schools make a difference" (Rowe & Hill, 1994). In further work that examined the impact of teacher professional development on achievement they again argued that differences between teachers helped explain much of the variation in mathematics achievement

(Hill & Rowe, 1996; Hill & Rowe, 1998).

However, alternative explanations for the large classroom-level differences were also provided by Hill and his team. They pointed to the possibility that classroom-level pupil management practices such as streaming and setting accounted for the class effects. This was not pursued by the authors who stated that in all of the schools they surveyed the classes were of mixed ability (Hill, 1994; Rowe & Hill, 1994). Another possibility was an under-adjustment for initial differences, that is, they did not control adequately for prior achievement differences. A further explanation considered was the possibility of inconsistency in teacher ratings used in the measure of student achievement in mathematics. This possibility was also deemed by Hill and his colleagues as unlikely to have had a major bearing, though its influence was not ruled out. However, the authors did not use, or argue for the use of, more objective, independently assessed mathematics tests.

Other studies have shown that contextual variables such as student body composition and organisational policies play an important role in mathematics achievement. Teacher background attributes such as gender, number of years teaching and educational qualifications have been shown to be important factors in student achievement (Larkin, 1984; Anderson, 1989), as have a variety of school effects such as school size (Lee & Smith, 1997) and mean student social composition (Fullarton & Lamb, 2000).

These studies suggest that classrooms and schools matter, as well as student background. A range of studies has examined different effects, however few have been able to utilise the range of contextual variables available in TIMSS. This paper uses the TIMSS data to investigate the interrelationships among different factors at the student, classroom and school levels in both the United States and Australia. A key issue is to investigate whether teacher quality and classroom effectiveness account for classroom-level variation in mathematics achievement or are there other factors of more importance. To do this, we examine patterns of Grade 8 student achievement by partitioning variance using multi-level modelling procedures to estimate the amount of variance that can be explained at the student, classroom and school levels. By introducing different classroom and teacher variables, the paper tests the extent to which factors linked to teachers and those linked to classroom organisation and practice influence achievement.

If differences in mathematics achievement are heavily influenced by variations in the quality of teachers and teacher effectiveness, as the work of Hill and his colleagues suggests, then there are major policy implications for schools and school systems in terms of changing the provision and quality of teacher training, taking more care in teacher selection practices, re-shaping and investing more heavily in teacher professional development, and reforming the way in which schools deploy teachers and monitor their effectiveness. Alternatively, if other features of classrooms and schools explain more of the variation then schools and school systems may not obtain the expected benefit in increased mathematics achievement by targeting teachers.

Data and method

TIMSS was sponsored by the International Association for the Evaluation of Educational Achievement (IEA) and was conducted in 1996. It set out to measure, across 45 countries, mathematics and science achievement among students at different ages and grades. In total, over half a million students from more than 30 000 classes in approximately 15 000 schools provided data. Not only were comprehensive mathematics and science tests developed for the study, there were questionnaires developed for students, their teachers and their school principals. Prior to the development of the tests, an extensive analysis of textbooks and curriculum documents was carried out. Mathematics and science curriculum developers from each country also completed questionnaires about the placement of and emphasis on a wide range of mathematics and science topics in their country's curricula. Together the data provide a unique opportunity to examine an extensive range of contextual variables that influence mathematics and science achievement.

TIMSS investigated mathematics achievement at three stages of schooling with the following target populations:

- Population 1: adjacent grade levels containing the largest proportion of nine-year-old students at the time of testing;
- Population 2: adjacent grade levels containing the largest proportion of thirteen-year-old students at the time of testing; and
- Population 3: the final year of schooling.

This study utilises data from the US and Australian samples of Population 2 students. For Population 2, the original TIMSS design specified a minimum of 150 randomly selected schools per population per country, with two classes randomly selected to participate from each of the adjacent grade levels within each selected school. However, due to the cost of collecting such data, most countries were unable to achieve this position, and the United States and Australia were two of only three countries which selected and tested more than one class per grade level per school. The importance of the sampling design used in the US and Australia is that it enables differences between schools to be separated from differences between classes within schools. In this way we are able to analyse school and classroom differences.

For the purposes of comparison, the analysis in the current paper is restricted to Grade 8 students and classes. The final sample numbers are presented in Table 1.

Table 1
The sample sizes

	United States (Grade 8)	Australia (Grade 8)
Students	7087	6916
Classrooms	348	309
Schools	183	158

Variables

The main aim of this analysis of the TIMSS data was to compare for the United States and for Australia the relationships between student achievement in mathematics and factors at the student, classroom and school levels. Table 2 provides details of the variables that were used in the analysis.

Student background variables

The sex of each student was recorded, as well as the number of people living in the student's household. A variable representing socioeconomic status (SES) was computed as a weighted composite comprising the mother's and father's level of education, the number of books in the home and the number of possessions in the home. Language background was measured as the self-assessed level of skill in the language of the test. Family formation was based on whether or not the student lived with one parent or both.

Student mediating variables

A composite variable was derived to represent the student's enjoyment of mathematics. This variable consisted of positive responses to five attitude prompts; 'I usually do well in mathematics', 'I like mathematics', 'I enjoy learning mathematics', 'Mathematics is boring', and 'Mathematics is an easy subject'. A further variable was computed to represent student's perceptions of the importance of mathematics. This variable was comprised of responses to the items 'Mathematics is important to everyone's life', 'I would like a job involving mathematics', 'I need to do well in mathematics to get the job I want', 'I need to do well in mathematics to please my parent(s)', 'I need to do well in mathematics to get into the university/post-school course I prefer', and 'I need to do well in mathematics to please myself'. An additional variable was created representing the amount of time spent on mathematics homework. This was based on a scale from 0 to more than 4 hours per night.

Classroom variables

A number of classroom variables were collected or derived for this analysis. The stream, track of set of the class was derived if setting was a practice used in the school to organise maths classes. Mean SES was derived at the class level. A variable was derived if the classrooms within schools in the data set had the same teacher. The background attributes of teachers — gender, number of years teaching and educational qualifications — were also controlled for. Estimates of the amount of homework teachers set for classes, the extent of their reliance on a prescribed textbook, and the amount of time they spent teaching mathematics were also derived.

School level variables

Mean SES was derived for each school to provide a control for the social composition of the school. In addition, a measure of the school size was used, ranging from schools of less than 250 students through to schools of more than 1250 students. Average class sizes, time dedicated to mathematics teaching across a school year, and school climate measured by the levels of absenteeism and behavioural disturbances were also included. Rural or urban location of the school and explicit school policy relating to the selection of pupils (open admission from the surrounding area, academic selection of pupils) were also variables included in the analysis.

Table 2
Student, classroom and school variables

	Population 2
STUDENT LEVEL	
Student background variables	
Sex	Student's gender
Language background	Level of skill in language of test
Family size	Number of people living in student's home
Socioeconomic status	A composite variable representing family wealth, parents' education and number of books in the home
Birthplace of parents	Both parents born outside the United States or Australia
Single parent family	Student lives with one parent
Student mediating variables	
Time spent on homework	Self-reported assessment of length of time spent doing mathematics homework
Attitude to mathematics	A composite variable measuring attitudes to mathematics.
Importance of mathematics	A composite variable reflecting the perceived importance of mathematics to the student.
CLASSROOM LEVEL	
Classroom composition variables	
Stream	The stream, track or set of the class if setting a practice at the school
Mean SES	Average SES for the class
Same teacher	Whether the same teacher taught more than one class in the data set
Classroom teacher variables	
Gender	Teacher's gender
Education. qualifications	Teacher's qualifications
Years teaching	Number of years of teaching
Homework	The amount of homework that teachers set for their mathematics class
Textbook	Extent of teachers' reliance on a mathematics textbook
Time teaching	Amount of time spent teaching mathematics
SCHOOL LEVEL	
Mean socioeconomic status	Average SES for the school
School size	Measure of the number of students attending the school
Average class size	Average of the class sizes in mathematics for the school
School climate	Measured by levels of student absenteeism and levels of reported classroom disturbance
Location	Rural or urban location of the school
Selection	Explicit school policy regarding the selection of its students

Method

This study looks at the effects of classrooms, teachers and schools after controlling for student-level factors. An appropriate procedure for doing this is hierarchical linear modelling or HLM (Bryk & Raudenbush, 1992). This procedure allows modelling of outcomes at several levels (e.g. student level, classroom level, school level), partitioning separately the variance at each level while controlling for the variance across levels.

In the present study the interest is on variability within and between classrooms and schools. Two sets of analyses were undertaken to measure the levels of variation, one for the United States and one for Australia. The first set was based on the data for Population 2 and modelled mathematics achievement of Grade 8 students in the United States. In the analyses several models were tested each adding successively a new group or layer of variables. The first involved fitting a variance-components model to estimate the amount of variance due to the effects of students (level 1), within classrooms (level 2), within schools (level 3) by running the models without any explanatory variables. The second model introduced a group of student background variables comprising sex, socioeconomic status (SES), family size, birthplace of parents, language background, and family formation (single parent or intact family). The third model added a set of mediating variables to the student background variables. The mediating variables included attitudes towards mathematics, views on the importance of mathematics, and time spent on mathematics homework. The fourth model contained a set of classroom composition variables relating to mean socioeconomic status (SES), stream or track, and whether the classes in Grade 8 had the same teacher or not. The next model added a set of teacher variables including the sex of the teacher, qualifications, years of teaching experience, the amount of homework the teacher sets, the amount of time they spend teaching mathematics, and the amount of time in class they spend teaching using a set textbook. The final model added several school-level factors including the mean SES of the school, school size, average class size, the type of school community (rural and remote, suburban, city-based), student selection policy (academically selective, open admission), time dedicated to mathematics teaching, and school climate measured by student absenteeism and level of behavioural disturbances.

By examining changes in the size of the variance components estimates after the addition of each group of variables it was possible to measure the effects of student, teacher, classroom and school-level factors that influence mathematics achievement. In this way it was possible to estimate the extent to which factors linked to teachers rather than classroom composition and organisation shape differences in mathematics achievement and to what extent student-level and school-level factors influence achievement.

The second set of analyses was based on data for Australia. The same sequence of models was applied.

Results

Student, classroom and school variance in mathematics achievement

Table 3 presents the results of the HLM analyses for the United States and Table 4 presents the results for Australia. The variance components estimates are presented in column 2. The third column presents the percentages of variance (intraclass correlations) in mathematics achievement located at each of the levels — student, classroom and school. The final column contains the percentages of variance explained at each level after controlling for the different groups of variables.

As a first step, a fully unconditional (null) model was tested. This model, the equivalent of a one-way ANOVA with random effects, estimates variances in the outcome variable at the student, classroom and school levels. The results suggest for both the United States and Australia considerable variation in mathematics achievement at the classroom and school levels. Over one-half (54.1 per cent) of the estimated variation in mathematics achievement in the United States occurs at the student-level. However, differences between classrooms also account for a substantial amount of variance — 33.8 per cent. Differences between schools accounted for the remaining 12.1 per cent of variance. This suggests a moderate though significant level of variation between schools. The results for Australia show a smaller level of variance at the classroom (27.9 per cent) and school (10.4 per cent) levels, though the results suggest that differences between classrooms and between schools are an important source of variation in mathematics achievement.

Table 3
Variance in Grade 8 mathematics achievement explained by three-level HLM models: United States, population 2, TIMSS

	Variance	Variance between levels (%)	Variance explained at each level (%)
Variance within classrooms (level 1 variance)	4685.8	54.1	
After controlling for:			
Student background variables	4466.3		4.7
Student mediating variables	4124.1		12.0
Variance between classrooms (level 2 variance)	2924.5	33.8	
After controlling for:			
Student background variables	2485.8		15.0
Student mediating variables	2465.0		15.7
Classroom- composition variables	1035.1		64.6
Classroom- teacher variables	891.7		69.5
Variance between schools (level 3 variance)	1043.1	12.1	
After controlling for:			
Student background variables	840.1		19.5
Student mediating variables	935.4		10.4
Classroom- composition variables	495.1		52.5
Classroom- teacher variables	559.7		46.3
School-level variables	420.5		59.7

Table 4
Variance in Grade 8 mathematics achievement explained by three-level HLM models: Australia, population 2, TIMSS

	Variance	Variance between levels (%)	Variance explained at each level (%)
Variance within classrooms (level 1 variance)	5415.6	61.7	
After controlling for:			
Student background variables	5014.2		7.4
Student mediating variables	4370.6		19.3
Variance between classrooms (level 2 variance)	2446.6	27.9	
After controlling for:			
Student background variables	2045.7		16.4
Student mediating variables	1771.4		27.6
Classroom- composition variables	627.8		74.3
Classroom- teacher variables	541.7		77.9
Variance between schools (level 3 variance)	908.3	10.4	
After controlling for:			
Student background variables	417.4		54.0
Student mediating variables	451.6		50.3
Classroom- composition variables	289.0		68.2
Classroom- teacher variables	258.3		71.6
School-level variables	200.9		77.9

The next step in the analysis involved adding the student-background predictors (SES, gender, language background, family size, single parent family, birthplace of parents) to the model of mathematics achievement. This allowed differences between classrooms and schools to be adjusted for differences at the individual level. The results presented in column 4 show that differences in the background characteristics of students in the United States accounted for 4.7 per cent of the estimated variance at the student-level, 15.0 per cent of the variance between classrooms, and 19.5 per cent of the variance at the school-level. The Australian results show a higher level of explained variance — 7.4, 16.4 and 54.0 per cent, respectively. It suggests that student background factors explain more of the between-school variance in Australia than in the United States.

Adding the student mediating variables (time spent on homework, attitudes towards mathematics, and views on the importance of maths) in the next step substantially increased the percentages of explained variance at the student level. When achievement is adjusted for the student background and mediating variables the amount of variance explained at the student-level increased to 12.0 per cent in the

United States and 19.3 per cent in Australia. At the classroom-level the amount of variance explained increased only modestly to 15.7 per cent in the United States and 27.6 per cent in Australia. The results suggest that while the mediating variables are important to explaining student-level variance, they do not add much to our understanding of classroom and school-level variance.

The next step involved the inclusion of the classroom-composition variables — mean SES, high stream or track classroom, low stream or track classroom, non-streamed or tracked classroom, same teacher across classrooms — further increases the percentage of variance explained at the classroom-level. The between-classroom variance explained jumped from 15.7 per cent to 64.6 per cent in the United States, and from 27.6 to 74.3 per cent in Australia. It suggests that classroom organization and composition factors are important to explaining classroom differences in students achievement.

Teacher effects would appear to be quite small, at least based on the changes that occur after adding in the available teacher variables — years of teaching experience, sex of the teacher, qualifications, time spent teaching mathematics, textbook-based teaching methods, and amount of homework set. This group of variables increased the explained variance at the classroom level by only about 3 per cent in both the United States and Australia. The school-level variables also added little to the explained variances.

The school-level variables add more to the explained variance in the United States than they do in Australia. The combined effects of the mean SES of the school, school size, average class size, admissions policy, and features of school climate explain roughly 13 per cent of variance between schools in the United States and about 6 per cent in Australia.

Student, classroom and school factors shaping mathematics achievement

Table 5 presents the results from the HLM analyses for the United States and Table 6 the results for Australia.

At the first level of analysis, shown in the first columns of Table 5, it can be seen that all of the variables, other than family size, have a significant effect on achievement in mathematics for students in the United States. As has been found in previous studies, gender has a significant negative effect on mathematics achievement. That is, Grade 8 girls' achievement levels are still not equal to that of boys. Also, as has been found in previous studies, students from a higher SES background, those with more family cultural resources (as measured by books at home), and those from two-parent rather than single parent families tend to have higher achievement levels in mathematics. Language background is also important. Students from non-English speaking backgrounds tend to have lower levels of achievement than those from English-speaking backgrounds.

For Australia, while Grade 8 girls tend not to do as well as boys in maths, the differences are not significant. Similarly, there are not significant differences linked to family size or family formation. The most influential variables for Australian students are SES and language background. Students from higher SES origins achieve significantly higher than those from lower SES backgrounds. Students from non-English-speaking backgrounds do significantly worse in mathematics than those from English-speaking families.

The mediating variables — attitudes towards maths, perceived importance of maths, time spent on mathematics homework — have strong independent effects, at least in Australia (see column 3). They are influential predictors of maths achievement. But they not only have independent effects, they also transmit or relay some of the effects of the different student background variables. This is evident from the drop in the sizes of the estimates for SES and family formation when the mediating variables are included in the model.

The results for the mediating variables are weaker for students in the United States. The estimates for time spent on mathematics homework and for attitudes towards mathematics are smaller than for Australian students. The estimate for perceived importance of mathematics is positive, though not significant. It suggests that the perceived importance of mathematics is a greater influence on mathematics achievement in Australia than in the United States. This is supported by the differential increase in explained variance reported at the base of the tables. The figures show that while the mediating variables increase the level of explained variance in Grade 8 mathematics achievement by approximately 14 per cent in Australia, they increase the level by only 3 per cent in the United States.

In summary, the differences between males and females are greater in the United States than in Australia. In the United States, gender differences, SES and family formation have both a direct effect on achievement and a transmitted effect through their influence on attitudes to mathematics and amount of time spent on homework. These findings reinforce previous studies showing that student background has an effect, both directly and indirectly, on student achievement in mathematics. In Australia, SES and language background are important predictors of mathematics achievement, working independently as well as through their influence on attitudes towards mathematics, perceived importance of mathematics and time spent on homework.

The results presented in the previous section show that as well as student-level factors classrooms and schools also matter. The next stages of the modelling investigate the effects of classroom variables on achievement.

Table 5
HLM estimates of Grade 8 mathematics achievement: United States, population 2, TIMSS

	Level 1 model – student background variables	**Level 1 model – student mediating variables**	**Level 2 model – classroom composition variables**	**Level 2 model – classroom teacher variables**	**Level 3 model – school variables**
INTERCEPT	488.3***	488.6***	489.5***	489.4***	489.4***
STUDENT-LEVEL VARIABLES					
Background variables					
Female	-10.7***	-9.2***	-9.2***	-9.1***	-9.1***
SES	11.1***	9.9***	7.8***	7.7***	7.8***
Language	-11.2***	-11.3***	-10.9***	-10.7***	-10.4***
Parents not born in United States	6.4**	4.8*	5.7**	5.5*	6.2*
Family size	-1.0*	-1.2*	-0.8	-0.8	-0.8
Single parent family	-4.3**	-3.1*	-2.9*	-3.0*	-2.9*
Mediating variables					
Time spent doing homework		-3.7***	-4.3***	-4.4***	-4.4***
Positive attitudes towards maths		7.0***	7.0***	7.0***	6.9***
Perceived importance of maths		0.4	0.4	0.4	0.4
CLASSROOM-LEVEL VARIABLES					
Classroom composition					
Mean SES			23.4***	22.7***	29.5***
Top stream or track			28.2***	27.7***	29.2***
Bottom stream or track			-20.6***	-22.4***	-22.7***
No streaming or tracking			-16.8**	-16.7**	-18.5**
Same teacher			5.5	4.4	4.6
Teacher attributes					
Sex of the teacher				4.3	4.3
Educational qualifications				-2.6	-2.5
Years in teaching				0.6**	0.6**
Amount of homework set				2.3***	2.7***
% time teaching maths				0.0	0.0
Amount of time using textbook				-2.3*	-3.7*
SCHOOL -LEVEL VARIABLES					
SES					10.2***
School size					0.0
Average class size					-0.9
Academically selective					-2.6
Open admission					11.4
Type of community					-11.1***
Time dedicated to maths teaching					0.0
Behavioural disturbances					-0.3
Absenteeism					-0.7
Total Variance Explained					
Level 1 (61.7)	10.0	13.0			
Level 2 (27.9)			34.7	35.6	
Level 3 (10.4)					37.2

*Significant at the .10 level; **Significant at the .05 level; ***Significant at the .01 level

Table 6
HLM estimates of Grade 8 mathematics achievement: Australia, population 2, TIMSS

	Level 1 model – student background variables	Level 1 model – student mediating variables	Level 2 model – classroom composition variables	Level 2 model – classroom teacher variables	Level 3 model – school variables
INTERCEPT	516.6***	516.0***	516.4***	516.4***	516.5***
STUDENT-LEVEL VARIABLES					
Background variables					
Female	-2.1	1.4	0.9	0.9	1.0
SES	8.7***	7.5***	6.6***	6.6***	6.6***
Language	-14.9***	-16.7	-16.3***	-16.3***	-16.0***
Parents not born in Australia	2.0	0.7	1.2	0.9	1.2
Family size	-1.2	-1.0	-0.9	-0.8	-0.8
Single parent family	-1.1	-0.4	-0.8	-0.8	-0.8
Mediating variables					
Time spent doing homework		-10.3***	-11.7***	-12.0***	-11.9***
Positive attitudes towards maths		11.3***	11.2***	11.2***	11.2***
Perceived importance of maths		2.4***	2.4***	2.4***	2.4***
CLASSROOM-LEVEL VARIABLES					
Classroom composition					
Mean SES			24.6***	21.4***	22.5***
Top stream or track			38.6***	35.6***	34.6***
Bottom stream or track			-45.4***	-41.1***	-37.3***
No streaming or tracking			0.2	0.9	0.8
Same teacher			-1.5	-1.1	-0.2
Teacher attributes					
Sex of the teacher				-0.0	-0.0
Educational qualifications				0.4	0.5
Years in teaching				0.3	0.3
Amount of homework set				3.7***	3.8***
Time teaching maths				0.0	0.0
Amount of time using textbook				3.9***	4.1***
SCHOOL -LEVEL VARIABLES					
SES					1.2
School size					0.0
Average class size					-0.4
Academically selective					3.8
Open admission					-0.8
Type of community					-3.4*
Time dedicated to maths teaching					0.0
Behavioural disturbances					-0.5
Absenteeism					-0.1
Total Variance Explained					
Level 1 (61.7)	14.7	24.8			
Level 2 (27.9)			39.7	41.0	
Level 3 (10.4)					41.7

*Significant at the .10 level; **Significant at the .05 level; ***Significant at the .01 level

Tables 5 and 6 show that for the United States and for Australia tracking or streaming has a large impact on mathematics achievement. There is a strong positive effect for classes in the top band in schools with streaming or tracking policies. In the United States, classes in the top track or stream gain 28 points on average over classes which are in the middle track or band. The advantage in Australia is larger at 38 points. Students in the United States in the lowest track or band have significantly lower results than students in the middle track or band. Tracking or streaming clearly benefits those students in the higher band classes, but leads to significantly poorer achievement in lower band classes. The achievement in classes in the lower bands or streams is moderately, though significantly, lower than classes that are not streamed or set in Australia. In the United States, however, the result for non-tracked or streamed classes is not much better than that for the bottom track or stream. There are differences in the number of classes that are tracked or streamed between the countries. In Australia, 48 per cent of classes were not streamed or tracked, compared to only about 20 per cent in the United States.

Classroom social composition (mean SES) has strong independent effects on student achievement in mathematics, and this applies both in the United States and Australia. In both countries there are achievement advantages to being located in classrooms largely composed of students from higher SES backgrounds. The results show that the higher the mean SES composition of classes, the higher the achievement.

In the United States, approximately 30 per cent of the sampled classes were taught by the same teacher in each school. In Australia, the rate was about 10 per cent. The results suggest that having the same teacher does not have any effect on the results for Australia or the United States. This does not support the recent research on teacher effects which has suggested that it is teacher effects rather than other classroom factors that are the major influences on mathematics achievement. If this was the case, we might have expected smaller classrooms differences where classes have the same teacher.

The classroom composition and organization variables added substantially to the levels of explained variance in both countries. Addition of the pupil grouping variables and classroom composition factors increased the total variance explained from 13 to 34.7 per cent in the United States, and from 24.8 to 39.7 per cent in Australia.

The next step in the analysis was to add the teacher attribute variables to the achievement models. Sex of the teacher and educational qualifications had no significant effect on student achievement. Teacher experience, as measured by years of teaching, had a small but significant positive effect in the United States, suggesting that the more experienced teachers achieved better results. This did not apply in Australia.

In both countries, the results suggest that classes where teachers set more homework were associated with higher levels of achievement. In Australia, there was also a positive significant impact in classrooms where the amount of time teachers spent using a prescribed textbook was greater. The results suggest that in classes where teachers use more traditional textbook-based methods the results are better. This did not apply in the United States where the effect was negative and significant, suggesting that the results were better where teachers used alternative methods.

The teacher effect variables in both countries added only marginally to the levels of variance in mathematics achievement.

The addition of the school-level factors — mean SES, school size, average class size, admissions policy, rural or urban location of school, and length of time given to mathematics instruction, and school climate — also adds only a small amount to explaining total levels of variance in both countries. However, these variables do contribute more to explaining school-level variance in the United States than in Australia. In Australia, the only factor that is significant is the type of community and the result suggests that students in schools in rural locations achieve higher in mathematics than students in city and urban areas (beta = –3.4). In the United States, school level SES has a positive impact on mathematics achievement suggesting that students in schools with a higher mean SES do better in mathematics than students in schools with lower levels of SES, other things equal. Social composition of the school influences mathematics achievement. The type of community or location of the school also matters. The result implies, consistent with the result for Australia, that schools located in rural areas promote higher levels of mathematics achievement than those in inner city locations. While consistent with the result for Australia, the effect is much stronger in the United States.

Discussion

What can we learn from the TIMSS data about differences in mathematics achievement? One thing we learn is that differences between classes and schools matter in both the United States and Australia. Early studies examining patterns of student achievement in mathematics had concluded that schools have little impact above and beyond student intake factors. The results from TIMSS show, consistent with current research on school effectiveness, that not only do schools make a difference, but classrooms as well. There are strong classroom effects and modest school effects on maths achievement. These effects are linked to particular classroom and school-level factors.

The pooling of pupil resources that are associated with the grouping of students — reflected by mean SES and stream or track — heavily influence mathematics achievement. In both the United States and Australia achievement is highest in those classes and schools with higher concentrations of students from middle class families and students in the highest track or stream. Therefore, the effects of residential segregation more broadly and school-level pupil management policies more locally (policies such as setting or tracking) shape the contexts within which differences in maths learning and achievement develop. The findings support the view that such context setting factors are important influences. School-level pupil management practices such as setting or streaming contribute to the classroom effects by shaping classroom composition. Within this context the effects of teachers are quite modest, in contrast to the claims of other research. This is supported in the current research by the non-significant results in both countries linked to having the same teacher across different classrooms. Having the same teacher did not reduce, significantly, differences between classrooms, suggesting that composition factors and pupil grouping practices are far more influential.

Policies regarding pupil management are critical. Schools which formally group students according to maths achievement or ability promote differences in mathematics achievement. The benefits of this practice are large for students who enter higher band or track classes. They receive substantial gains in achievement. The cost is for those students in the lower band or stream classes. They have significantly lower levels of achievement compared to their top streamed peers in the United States and also their unstreamed peers in Australia. In Australia, in terms of mathematics achievement, it is better for students to be in a school that does not stream or track mathematics classrooms than in a bottom stream or track in a school where streaming or tracking is policy. It suggests that the different learning environments created through selective pupil grouping may work to inhibit student progress in the bottom streams and accelerate it for those in the top streams.

These findings do not support the view of recent research arguing that the differences in quality of teachers and teacher effectiveness accounts for much of the classroom variation in mathematics achievement. Rather they support an alternative explanation, that the types of pupil grouping practices schools employ shape the classroom learning environments in ways that affect student progress and student achievement, and it is these kinds of differences that more significantly influence classroom effects. By this, it is not suggested that the quality of teachers does not matter or that all teachers have the same effectiveness. Teachers do matter. In the United States, more experienced teachers promote higher levels of achievement. The approach they take to homework, measured by the amount of time they set for homework, has a modest but significant effect on achievement, after controlling for other factors. Those more often using less traditional textbook approaches also promote higher levels of achievement. By contrast, in Australia, teachers using more traditional approaches appeared to enhance achievement. But while these teacher effects have an impact, what the TIMSS results suggest is that the organisational and compositional features of classrooms have a more marked impact on mathematics achievement.

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