CLOSING THE GAPS BETWEEN SCHOOLS: ACCOUNTING FOR VARIATION IN MATHEMATICS ACHIEVEMENT IN AUSTRALIAN SCHOOLS USING TIMSS 95 AND TIMSS 99

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Abstract

Effective schools research looks at ways in which schools 'add value' to their programs through their organizational and instructional practices and how they are successful in providing the opportunity for all students to achieve their potential. This study examines school effectiveness using multilevel modeling to explore influences on mathematics achievement at grade 8 using TIMSS 1995 and TIMSS 1999. Building on the models of school effectiveness developed by Martin, Mullis, Gregory, Hoyle & Shen (2000), for the Australian Year 8 cohorts, the study reported in this paper explores a wider range of explanatory variables at student, class and school level. The current study will look specifically at the effects on achievement of particular methods of teaching and resource allocation in schools to attempt to identify the variables which have the greatest effect on student outcomes. In addition, the inclusion of a verbal ability score, used in Australia in TIMSS 95, is used as a student-level predictor. This variable has previously been found to be highly predictive of achievement in mathematics (Fullarton, Lokan, Lamb & Ainley, in press). It is anticipated that the results of the multilevel analysis will provide additional information and direction for schools to become more successful places of learning.

INTRODUCTION

In their study of effective schools in mathematics using TIMSS data, Martin, Mullis, Gregory, Hoyle and Shen (2000) found that only in the Netherlands were the differences between the highest achieving third of schools and the lowest achieving third of schools greater than in Australia (p. 17). As it is not explicit policy in most Australian schools to stream or track students, it is essential that data such as that available from international studies such as TIMSS are explored in depth to attempt to tease out the factors that make a difference to students' achievement. It could be thought that effective schools are simply those that achieve strong academic results, however it is important that we are able to separate the effects of schools and classes from the background characteristics of the students who attend the school (Raudenbush & Willms, 1995; Willms, 1992). Some schools deliver their curriculum to students who are well prepared and supported by their home background in terms of cultural and social capital, educational aspirations and resources. Others most certainly do not. An effective school is one that raises achievement levels despite its student intake characteristics; that is, a school that adds value for students who might otherwise not have access to a quality education.

Effective schools research thus looks at ways in which schools 'add value' to their programs through their organisational and instructional practices and how they are successful in providing the opportunity for all students to achieve their potential. Alternately, it might look at what inhibits schools from delivering effective curriculum, and so provide schools with this information to inform their practices.

Early literature on school effectiveness suggested that schools actually had little direct effect on student achievement, and studies such as that by Coleman et al., (1966) found that differences in school achievement reflected variations in family background, and the family backgrounds of student peers, and concluded 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). However this early work was unable to take account of the hierarchical nature of the data, and so researchers were not able to accurately separate out school, classroom and student factors. 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 that school effects generally account for eight to ten per cent of the variation in student achievement (Mortimore, Sammons, Stoll, Lewis & Ecob, 1988; Nuttall, Goldstein, Prosser & Rasbash, 1989; Smith & Tomlinson, 1989; Lamb, 1997), and that the effects are greater for mathematics than for language (Bosker & Witziers, 1996). Others studies have concluded that classrooms as well as schools are important and that teacher and classroom variables account for more variance than school variables (i.e., Scheerens, Vermeulen & Pelgrum, 1989; Scheerens, 1993). Schmidt, McKnight, Cogan, Jakwerth & Houang (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.

Other work on classroom and school effects has suggested instead that it is teacher effects that account for a large part of variation in mathematics achievement. In the United Kingdom, a 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 achievement data (Hay Mcber, 2000). Using multi-level modelling techniques, the study modelled the impact teachers had on achievement growth. The report on the work claimed that over 30 per cent of the variance in pupil progress was due to teachers. It concluded that teacher quality and teacher effectiveness, rather than other classroom, school and student factors, are large influences on pupil progress.

Several 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, Holmes-Smith & Russell, 1996; Rowe & Hill, 1994) examined student, class/teacher and school differences in mathematics and English achievement. Using multilevel 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 secondary school level almost 39 percent of the variation in mathematics was due to differences between classrooms. 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 et al., 1996; Hill & Rowe, 1998).

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 and educational qualifications have been shown to be important factors in student achievement (Larkin & Keeves, 1984; Anderson, Ryan & Shapiro, 1989), as have a variety of school effects such as school size (Lee, 1997) and mean student social composition.

These studies suggest that while student background is clearly an important influence on achievement, classrooms and schools also matter. This paper adds to other secondary analyses of TIMSS data that attempt to disentangle the effects of instruction and school organisational practices from the effects of student background. While this disentanglement can never be totally successful, multilevel modelling techniques provide a more statistically accurate picture because they enable a statistical allowance to be made for student background (at the individual level) and social context (at the school level) and because they take into account the 'nesting' of students within classes within schools. The study builds on the models of school effectiveness developed by Martin et al. (2000). The models developed by Martin et al.(2000) had limitations imposed on the variables examined (because not all variables were administered in all countries), however the study reported in this paper has fewer limitations, and so explores a more detailed set of explanatory variables at student and school level for TIMSS 95, and replicates the analysis as far as is possible for TIMSS 99.

The key issue this paper examines is whether there are identifiable classroom practices or school organisational practices that account for school-level variation in mathematics achievement or whether there are other factors that are of more importance. To do this, we examine patterns of Grade 8 and Grade 9 students' mathematics achievement by partitioning variance using multi-level modelling procedures to estimate the amount of variance that can be explained at the student and school levels for TIMSS 1995 and for TIMSS 1999. By introducing different school, classroom and teacher variables, we test the extent to which factors linked to teachers and those linked to classroom organisation and practice influence achievement.

If differences in mathematics achievement are influenced by variations in teacher's backgrounds or teaching practices, then there may be 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 only.

DATA AND METHODS

This study uses data from Australian Grade 8 and Grade 9 (Population 2) students who participated in the Third International Maths and Science Study (TIMSS 95), and from the IEA's 1999 repeat of TIMSS at Population 2 (TIMSS 99). In 1995, 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 containing the largest proportion of 13-year-old students within each selected school. However due to the cost of collecting such data, most countries were unable to achieve this position, and Australia was one of only three countries (the others being the United States and Cyprus) which selected and tested more than one class per school.

For the 1999 TIMSS Repeat study, the target population for Population 2 was defined as the upper of the two adjacent grades identified as Population 2 in TIMSS 1995. In TIMSS 1999 data from only one class per school was collected, and so we are only able to examine differences at the classroom/school level. Students in different states of Australia start school at differing ages, and make the transition to secondary school at different ages. Therefore students selected for TIMSS 1999 were in Grade 8 in the Australian Capital Territory, New South Wales, Tasmania and Victoria, and in Year 9 in the Northern Territory, Queensland, South Australia and Western Australia. The data file for TIMSS 1995 as been altered so that the data used for the TIMSS 95 and TIMSS 99 analyses include the same age groups, and the data will be analysed on two levels only so as to be comparable.

Modelling the effects of student-level and school-level variables on student achievement necessitates the use of multi-level (or hierarchical linear) modelling techniques. Students are grouped or nested within schools, and so students within a classroom or school will be more similar than students between classes or schools, and standard regression analysis will result in smaller standard errors and possibly incorrect conclusions. Analysis of school-level variables at the individual student level will result in aggregation bias, underestimating the effects of those variables that are estimated at the inappropriate level, while aggregating student-level data to the school level fails to fully capture the effects of variables such as achievement that may operate at both levels of analysis. For example, achievement measured at the student-level is an indicator of a student attribute, whereas school-average achievement at the school-level becomes a proxy measure of a school's normative environment. In other words, the average achievement level of a school has an effect on students above and beyond the effect of their own individual achievement.

MLM techniques allow researchers to model student-level outcomes within schools and then to identify and model any between-school differences that occur (Bryk & Raudenbush, 1992). By decomposing any observed relationships into separate between-school and within-school components, confounding of relationships can be avoided and the correct interpretation of empirical relationships can be made. The analyses in this study were carried out using MlwiN (Rasbash et al., 2000).

VARIABLES USED IN THE ANALYSES

Mathematics Achievement. To measure student performance, these analyses use the TIMSS mathematics achievement test scores for individual students. The TIMSS achievement tests are based on IRT (Item Response Theory) scale scores, meaning that each student was not given all of the test questions, but only a few items within each content area of each subject. The answers to these questions were then used to create "plausible values" to compute the mathematics achievement score each student hypothetically would have received if given all of the possible test questions.

Home Background Index. Previous research has emphasised the need to take into account the effects of student background and the social composition of the school itself. In this instance, Home Background is used as a measure of socio-economic status. Ainley, Graetz, Long and Batten (1995) described socioeconomic status as a broad concept that comprises three main dimensions: occupation, education and wealth/income. Each of these can influence a child's educational attainment in a number of ways. For example, parents' educational or occupational status might be related to attitudes and expectations about education from early childhood onwards, while income might be related to an ability to purchase educational aids and resources and access particular schools. In a recent report from the Longitudinal Surveys of Australian Youth (LSAY), socio-economic background was found to positively influence students at the individual level and more so at the school level (Rothman & McMillan, 2003). Parental education / occupation is used in this study as one of the factors to make up the Home Background Index variable. The total number of possessions in the home (representing family wealth) and number of books in the home (representing home literacy support) were also included in this variable.

Single parent family (TIMSS 95 only). This variable was constructed from students' responses to questions about with whom they lived. Those who lived with a mother but no father or stepfather, or with a father but no mother or stepmother, were coded as single-parent families. This variable is then able to test to some extent the perception that children from single-parent families are less likely to succeed at school.

Word Knowledge Score (TIMSS 1995 only). The Word Knowledge score was developed for IEA studies by Thorndike (1973) to provide a control variable for verbal ability. The test presents the student with a number of word pairs and requires the student to decide whether the words in each pair are (near) synonyms or (near) antonyms. This test was used in the First and Second International Science Studies (FISS and SISS) and appears as a useful variable in the reports of those studies (e.g., Comber & Keeves, 1973; Rosier & Banks, 1990). A slightly modified version of

Thorndike's original test was included in the TIMSS 1995 Student Questionnaires in Australia because of the perceived increasing verbal nature of the mathematics and science achievement tests. Inclusion of a 'control' variable for verbal ability seemed as important for TIMSS as it was for FISS and SISS, although this was not done internationally and the test was dropped for TIMSS 1999.

Self-efficacy. Self-efficacy beliefs (*I am good at mathematics*) are typically moderately correlated with achievement. Bandura (1986) has argued that this is because people with high assurance in their capabilities approach difficult tasks as challenges to be mastered rather than as threats to be avoided. Higher self-efficacy has been associated with higher achievement in mathematics in a number of studies (e.g., Lokan, et al., 2001; Mullis, *et al.*, 2000; Zammit, Routitsky & Greenwood, 1999).

Locus of control. A belief in luck or ability in order to do well in mathematics can be quite debilitating beliefs. Weiner (1972) argued that the reasons people give for their successes and failures fall into four categories; ability, effort, task difficulty and luck. Outcomes that are both internally controlled and stable are perceived to be the result of a person's ability – a factor which is specific to the individual but over which the individual has no control. Luck is seen as capricious, and outcomes due to luck are perceived as both external and unstable. Students who attribute their failures to lack of ability (or luck) are unlikely to increase effort, because they feel that the reasons for their failure are beyond their control. Students who feel that success is contingent on their actions have been found to be more highly motivated than students who use ability or luck attributions (Kloosterman, 1988).

Maternal Press. To probe the influence of mother's press for academic success, students were asked how important their mother thought it was for them to do well in the academic areas of mathematics, English and science.

Attitudes to mathematics. This variable comprised student's responses to items about liking mathematics, enjoying mathematics, mathematics (not) being boring, mathematics being important to everyone's life, and wanting a job using mathematics. This is intuitively correct: if you enjoy what you are learning then you're more likely to focus on the work at hand and thus achieve better results. Martin et al. (2000) reported significantly greater percentages of students in the higher achieving third of schools with a positive attitude towards mathematics.

Students' aspirations. It is likely that their home and school background shapes students' aspirations for university study. Research shows that a characteristic of effective schools is high academic expectations for their students (Purkey & Smith, 1982), and the findings from Martin et al. (2000) certainly support this. Student aspirations is also a factor that schools can attempt to influence, by making expectations explicit and providing information and support to students who may not otherwise contemplate attending university.

Classroom behaviour. Students were asked the extent to which they agreed with statements about student behaviour during lessons. These included whether students often neglected their work, whether students were orderly and quiet, and whether students do exactly as the teacher says. Whilst interpretation of these items is a little difficult (for example is a classroom where students are ALWAYS orderly and quiet a good or a bad thing?) the coding of this variable was guided by the data analysis for TIMSS 1995 (Lokan et al., 1996). This analysis indicated that highest achievement levels were found in classrooms where students reported moderate levels of orderliness and quiet, while the relationships between achievement and the other two variables were more straightforward (linear).

Teacher Background variables. Included in the models are teacher's level of education and number of years teaching experience. Whilst neither guarantees good teaching, there is some evidence from previous studies that higher teacher educational levels are related to higher student achievement in mathematics (Fullarton, Lokan, Lamb & Ainley, 2004), and theoretically teachers with greater experience should be able to assist students in achieving better outcomes.

Teacher Satisfaction. This reflected teachers' choice of teaching as a career and whether they felt that their work was valued. Teachers were asked whether teaching was their first choice of career and whether they would change careers if they had the opportunity, and whether they felt that their work was valued by students and by society.

Limits on teaching (background and physical). Teachers were asked to what extent their mathematics teaching was limited by a variety of factors, some which could be considered due to student or school background (e.g., by students with differing academic abilities, disruptive students, uninterested parents, high student/teacher ratio, low morale, threats to personal safety) and some which could be considered to be due to physical constraints (e.g., shortage of computer hardware/software, inadequate physical facilities).

Teacher Emphasis on Mathematics Reasoning and Problem-solving. In TIMSS 95 and TIMSS 99 it was found that student achievement was higher in many countries when teachers placed an emphasis on mathematical reasoning and problem solving. The scale consists of the teacher's rating of how frequently they ask students to explain the reasoning behind an idea, represent and analyse relationships using tables, charts and graphs, work on problems for which there was no obvious solution, and write equations to represent relationships. In Australian schools in TIMSS 99, fewer than 7 per cent of teachers were in the high range for this scale, although the proportion had increased since TIMSS 1995.

Teacher preparedness (TIMSS 99 only). In TIMSS 99 teachers were asked to rate their preparedness (or confidence) to teach various aspects of the curriculum. This item sums their responses on the 12 items.

School location. School location is not generally an issue with mathematics achievement in Australia, however some PISA analyses have highlighted higher achievement levels in urban areas (Lokan et al., 2001), and Martin et al. (2000) also found some differences in mathematics achievement in TIMSS 95 in Australia.

School size. There is some evidence that there is a weak positive relationship with achievement for school size (Banks, 1992).

All variables were normalised in MlwiN so that comparison of importance could be easily gauged. A number of student level variables (such as class behaviour, maternal press) and teacher level variables (emphasis on problem solving, preparedness to teach) were aggregated (using MlwiN) to school level. Normalising scores assigns expected values from the standard Normal Distribution according to the ranks of the original scores.

RESULTS

For this analysis, a number of multilevel models were estimated. The initial model (null model) is used to estimate the amount of between-school and within-school variance. Table 1 provides the proportion of variance at each level for TIMSS95 and TIMSS99.

Table 1: Proportion Of Variation In TIMSS 1995 and TIMSS 1999 Mathematics Achievement Due To Between-School Differences And Within-School Differences

	Between-school	*Within-school*
TIMSS95		
Parameter estimate	0.277	0.732
Standard error	0.033	0.012
t-ratio	8.39	61
% of variance	**27**	**73**
TIMSS99		
Parameter estimate	0.477	0.531
Standard error	0.054	0.012
t-ratio	8.8	44.2
% of variance	**47**	**53**

It can be seen that there is a substantial amount of variance between schools in both TIMSS studies. The t-ratio obtained by dividing the parameter estimate by the standard error is very large in both cases, indicating significant and stable variation.

To examine the effects of the different variables on mathematics achievement, a series of models was built for each TIMSS cohort by successively adding blocks of variables. The first model incorporated just the home background index. Since the literature tells us that this is the most important background variable, its inclusion at this level will tell us how much of the difference in average student mathematics achievement between schools can be attributed to student home background. The exploratory models that follow examine how student and school factors are related to differences in mathematics achievement after controlling for home background.

The second model added a set of student-level variables incorporating aspirations, maternal press, locus of control, attitude to maths, and the verbal ability score for TIMSS95. The third model added a group of teacher variables, aggregated to school level, and the final model added a group of school climate variables. Table 2 shows the models developed for TIMSS95 and Table 3 for TIMSS99. For each variable the parameter estimate is included with its standard error in brackets. Significant variables are shown in bold.

Both Table 2 and Table 3 show that at the student-level, Home Background Index, which is a composite of highest parents' educational level, number of books in the home and number of possessions in the home, is a strong predictor of achievement in mathematics. It accounts for almost 15 per cent of the variance in mathematics achievement for TIMSS95 and for almost 14 per cent for TIMSS99. Students who come from a home rich in resources, both in terms of number of books and number of possessions, and rich in terms of parental education, performed at significantly higher levels than those students whose family backgrounds were poorer in one or more of these.

Model 2 in Table 2 shows that belonging to a single parent family does not have an effect on mathematics achievement, nor does holding positive (or negative) attitudes to mathematics. As this last finding somewhat contradicts prior research (Fullarton et al., 2004), it bears further investigation. It may be that the effect is being mediated through another variable.

In this model, the strongest influences on mathematics achievement were *Self-efficacy*, *Word knowledge*, and *Student's aspirations*. Students with high levels of belief in their own ability, those with high levels of verbal ability and those who want to attend university, all achieved at a higher level in mathematics than those in other categories. While these variables have strong independent effects, the addition of this group of variables also moderated the effects of home background, meaning that the effects of home background are also transmitted through the variables in question. These variables stayed strong and significant whatever else was added to the equation.

Students' locus of control was found to be a significant negative influence on achievement, although the effect was not as strong as the variables already discussed. Maternal Press was also found to be a weak positive influence on achievement, indicating that at Year 8 some students do still listen to their mothers!

Teacher background variables such as teachers' level of education, amount of experience, and satisfaction with their job, were all found to be non-significant. The only teacher factor to have an influence on achievement was found to be negative: teachers' perception that their teaching was inhibited by factors such as teaching students with a range of abilities, disruptive students, low morale, etc., was related negatively to their students' achievement.

Similarly, none of the school climate variables had any relationship with student achievement, perhaps being swamped by the huge effect found for average school achievement. These findings suggest that the average achievement level of a school does have an influence on students over and above their own achievement.

Table 2: Estimates Of Influences On Mathematics Achievement In Schools, Population 2, Australia, TIMSS 1995

	Model 1 *Home background*	*Model 2* *Model 1 plus student variables*	*Model 3* *Model 2 with teacher background*	*Model 4* *Model 3 with school and teacher variables*
Intercept	-.01 (.04)	-.04 (.03)	-.15 (.04)	-.00(.03)
Student-level variables				
Home Background Index	**.28 (.01)**	**.15 (.01)**	**.14 (.02)**	**.12 (.02)**
Mediating variables				
Single parent family		.03 (.03)	-.02 (.04)	-.00 (.04)
Word Knowledge Score		**.26 (.01)**	**.24 (.02)**	**.22 (.02)**
Self efficacy		**.29 (.01)**	**.30 (.02)**	**.29 (.02)**
Locus of control		**-.08 (.01)**	**-.09 (.02)**	**-.09 (.02)**
Attitude to maths		.01 (.01)	.00 (.02)	.00 (.02)
Maternal Press		**.03 (.01)**	.02 (.02)	.03 (.02)
Student's aspirations		**.21 (.02)**	**.23 (.03)**	**.18 (.03)**
School and Teacher level variables				
Teacher attributes				
Level of education			.05 (.04)	.00 (.02)
Years teaching			-.01 (.04)	.00 (.02)
Satisfaction			.02 (.04)	.01 (.02)
Teaching practices and restrictions				
Emphasis on problem solving and reasoning		.00 (.05)	.00 (.03)	
Student centred limits			**-.13 (.04)**	-.02 (.03)
Resource limits			.00 (.05)	-.03 (.03)
School climate variables				
Location				-.06 (.04)
Mean home background index			.05 (.03)	
Mean class behaviour				.00 (.02)
Average maternal press				.01 (.02)
School size				.00 (.00)
Admin violations				.02 (.02)
Level of misbehaviour				.00 (.02)
Average school maths achievement				**.41 (.04)**
σ^2_μ (between schools)	**.18 (.02)**	**.12 (.02)**	**.10 (.02)**	**.00 (.00)**
σ^2_e (between students)	**.67 (.01)**	**.50 (.01)**	**.51 (.01)**	**.49 (.01)**
% of variance in mathematics achievement accounted for by model				
	14.9	38.8	40.0	48.8

The findings for TIMSS99 (Table 3) are similar to those for TIMSS95. The effect of *Home Background* at an individual level was not found to be as strong in TIMSS99 as in TIMSS95, perhaps reflecting a slightly different wealth measure in the list of items in the home. Verbal ability as measured by the *Word Knowledge Test* was not available, however *self-efficacy* was highly significant (t = 17). *Students' aspirations* was also significant and *locus of control* was negatively associated with achievement.

Some differences can be seen in the model with the addition of the teacher and class variables. Teaching experience was initially found to be a significant positive influence on mathematics achievement, as was teaching with an emphasis on mathematical reasoning and problem solving, while a negative association with achievement was found for students whose teachers thought that their teaching was limited by the aforementioned student constraints. However none of these survived the addition of the school level variables, in particular the average school-level mathematics achievement. There appear to be very strong benefits in terms of achievement levels for students to be in schools where they rub shoulders with other higher ability students.

DISCUSSION

A requirement for the identification of influences on student achievement is the use of methods of analysis that simultaneously take account of influences at both individual and school level. Ideally, samples would be taken of at least two classes in each sampled school, so that a thorough investigation could be made of influences at class level as well. Although this analysis would have been possible for the Australian TIMSS95 data, it was not possible for TIMSS99, and so a compromise was made so as to be able to accurately compare results for the two cohorts. However as a consequence of the design of the TIMSS samples, the reports of the results in this paper are able to be of an 'other things equal' form.

One set of conclusions from these analyses relate to background influences at the level of the individual student. First, the analyses for both TIMSS95 and TIMSS99 showed the expected influence of student home background on achievement in mathematics. Student background, and the social background of other students at the school, is a major influence on students' achievement. This influence was much larger for the 1995 cohort, however this influence was much reduced when the Word Knowledge score was added into the analysis. In other words social background influences achievement not only through its effect on verbal ability (reflected in Word Knowledge) but also through its direct effects. Lower scores on the Home Background Index were associated with lower scores on the Word Knowledge test and this is in turn reflected in lower levels of achievement in mathematics. No such analysis can be conducted for TIMSS99, however the effect of the Home Background Index was smaller at each stage of the model than for TIMSS95.

Table 3: Estimates Of Influences On Mathematics Achievement In Schools, Population 2, Australia, TIMSS 1999

	Model 1 *Home background*	*Model 2* *Model 1 plus student variables*	*Model 3* *Model 2 with teacher background*	*Model 4* *Model 3 with school and teacher variables*
Intercept	**.03 (.05)**	**-.09 (.05)**	**-.06 (.05)**	**-.07 (.03)**
Student-level variables				
Home Background Index	**.14 (.02)**	**.08 (.02)**	**.07 (.02)**	**.07 (.02)**
Mediating variables				
Self efficacy		**.34 (.02)**	**.34 (.02)**	**.34 (.02)**
Locus of control		**-.07 (.02)**	**-.07 (.02)**	**-.07 (.02)**
Attitude to maths		.02 (.02)	.02 (.02)	**.15 (.02)**
Maternal Press		**.06 (.02)**	**.07 (.02)**	**.03 (.02)**
Student's aspirations		**.16 (.03)**	**.19 (.04)**	**.24 (.04)**
Class and Teacher level variables				
Teacher attributes				
Level of education			.04 (.07)	.02 (.03)
Years teaching			**.10 (.04)**	.00 (.02)
Satisfaction			-.02 (.05)	.01 (.02)
Teaching practices and restrictions				
Emphasis on problem solving and reasoning			**.10 (.05)**	.01 (.02)
Student centred limits			**-.18 (.05)**	.00 (.02)
Resource limits			-.01 (.05)	.00 (.02)
Preparedness to teach			.04 (.06)	.01 (.02)
School climate variables				
Location				.02 (.06)
Mean home background index			.05 (.03)	
Mean class behaviour				.02 (.02)
Average maternal press				-.06 (.04)
School size				.07 (.05)
Admin violations				-.01 (.03)
Level of misbehaviour				-.02 (.02)
Average school maths achievement				**.61 (.02)**
σ^2_μ (between schools)	**.37 (.04)**	**.29 (.04)**	**.22 (.03)**	**.00 (.00)**
σ^2_e (between students)	**.50 (.01)**	**.43 (.01)**	**.44 (.01)**	**.46 (.02)**
% of variance in mathematics achievement accounted for by model	**13.5**	**28.6**	**34.7**	**46.1**

A second set of conclusions concerns the mediating variables. These are most important findings since these are perceptions that are amenable to change by teachers and schools. Self-efficacy was found to be one of the strongest associations with achievement. Students with high self-efficacy beliefs had higher levels of mathematics achievement, even after allowing (in TIMSS95) for the influence of verbal ability (Word Knowledge). In addition, student's aspirations were found to be a strong positive influence in both TIMSS95 and TIMSS99, while locus of control had a negative influence. Teachers and schools (as well as parents) have the ability to influence both of these. Good career advice to students and high expectations could influence students who are unsure about their future. Of course there is nothing in our data that indicates whether or not these students actually do go on to university, but it appears to be beneficial to achievement to hold the goals. Locus of control generally becomes more positive with student maturation, however in the meantime there are a number of things teachers can do to assist the process. Simply being more explicit to students about the causes of success and failure can make a difference to students' attributions.

A third set of conclusions refers to school and teacher influences on achievement. For TIMSS95 almost 30 percent of the variation in mathematics achievement was associated with differences between schools, while for TIMSS99 almost 50 percent of the variation was found to be between schools. It is unclear at this stage why there should be so much difference between the two studies. The strongest effect at school level is the academic background of the school. This is consistent with the perspective that the resources that students bring with them to the classroom influence the learning that takes place and therefore achievement.

Few teacher background or teaching characteristics were found to have a significant influence on achievement. This is not because teachers don't matter, but may be because it is hard to capture the details of what happens in classrooms from teachers' answers to survey questions. Research using NAEP data in the US has certainly found that the effects of classroom practices and teacher characteristics are comparable in size to those of student background (Weglinsky, 2002).

In conclusion, what can TIMSS tell us about closing the gaps between schools in terms of raising achievement in mathematics? It tells us that schools can ensure that students have high levels of verbal ability. They can encourage students to aspire to university (although that then presents a dilemma with a shortage of university places in Australia). They can encourage students' self-efficacy beliefs – and surely in all subjects, not just mathematics. They can be explicit about the attributions students make for success and failure – encouraging attributions such that students feel in control of their learning. If teachers and schools encourage students in these ways they will not only encourage higher levels of achievement but also a more engaged and responsive student body.

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