2

Features of Teaching and Learning

This chapter reports on the observed associations between various aspects of teaching and learning strategies and mathematics performance. The chapter examines characteristics of students, schools and countries and studies the distribution of these characteristics. This kind of examination leads to a number of questions such as: How much do students benefit from a classroom atmosphere that is conducive to learning? To what extent do some students employ more effective learning strategies or devote more time to learning than others? Do individual countries' education systems provide different conditions for teaching and learning to different students and in different schools?

INTRODUCTION

To what extent do students aged 15 benefit from teaching and learning strategies associated with the acquisition of mathematical competence? This chapter looks at characteristics of students, schools and countries in terms of various features of teaching and learning. It studies in particular the distribution of these characteristics. For example, to what extent do some students benefit more than others from a classroom atmosphere conducive to learning? To what extent do some students employ more effective learning strategies or devote more time to learning than others? Do individual countries' education systems provide different conditions of teaching and learning for different students and in different schools?

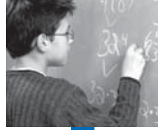
This chapter reports on the extent to which there are observed associations between various aspects of teaching and learning and mathematics performance. The analysis reveals the extent to which the factors whose presence or absence is being investigated are those that tend to go together with higher student achievement. It does not describe the extent to which teaching and learning strategies leads to higher performance; this information appears in Chapter 3, which uses modelling to explore how such strategies may or may not be related to outcomes.

A compelling case can be made that mathematics is fundamentally a school subject. It is difficult to imagine that any significant level of mathematical competence, particularly in its more formalised sense, could be acquired outside of the school setting. Only the most motivated students will be able to acquire any significant level of mathematical competence, particularly in its more formalised sense, outside the school setting. In this respect, mathematics learning happens in a different way from language learning. There is no direct mathematical equivalent of the bedtime story, nor is mathematics used, in anything other than a rudimentary way, in everyday communication among people. At the same time, full participation in many modern societies requires more than a basic knowledge of mathematics, and a high level of mathematical competence is essential in many occupational areas. In addition, mathematics is the foundation of much of the scientific and technical activity that distinguishes advanced from less advanced societies. Developing students' mathematical competence at a much higher level than is required for everyday communication is thus a goal of most school programmes.

One can hypothesise that school and classroom activities should have more impact on overall mathematics achievement than on overall language achievement. Almost all students in OECD countries have exposure to mathematics teaching at least up to the age of 15, the age level assessed in PISA.[1] To what extent can differences in student performance be attributed to differences in the level of exposure to mathematics instruction? More particularly, is it possible to associate differences in performance with the various different approaches to teaching and learning? In investigating the extent of all these differences, this chapter concentrates on differences among schools and students within countries, which are greater overall than differences across countries.

FACTORS DESCRIBING TEACHING AND LEARNING

PISA uses students' and school principals' responses to questionnaires in order to construct indicators of teaching and learning. As described in Chapter 1, PISA has developed a series of indices which are the indicators of teaching and learning strategies presented in this report, such as the *index of disciplinary climate in mathematics lessons* and the *index of co-operative learning*. Each index is



derived from students' reports on a number of statements. For example, the *index of disciplinary climate in mathematics lessons* is derived from student responses to five statements, including how frequently there was noise and disorder in their mathematics lessons ("every lesson", "most lessons", "some lessons", "hardly ever" or "never"). This chapter presents descriptive information on student responses to each of the statements within the PISA indices. Please note that the bases of all modelling in Chapter 3, however, are the PISA indices.

While the main purpose of this chapter is to provide a profile of teaching and learning, it also supplies preliminary indications as to whether the factors described have any relationship with student performance in mathematics. This analysis is important in order to pick out those factors which might be significant in the overall picture of teaching and learning. For example, any discussion of how much homework is given in different schools should reference the investigation of whether more homework produces better learning outcomes. However, the simple effects of each factor on student performance in mathematics reported in this chapter should be treated with caution, just as first indications. First, PISA is a cross-sectional study and therefore cannot demonstrate that certain student or school characteristics lead to better performance. Rather, PISA shows associations or relationships between particular student or school characteristics and student performance. These "bivariate" associations – that is, the simple effect of the factor on student performance, not taking into account any other factors – do not indicate causality and, to a varying degree, may exist because of their correlation with other teaching and learning or background factors. For instance, if students who experience an orderly classroom environment do well in mathematics but also tend to come from socially advantaged home backgrounds, it might be their home advantages rather than the atmosphere in which they learn, or a combination of the two, which explain the relationship with performance. Indeed, there is likely to be a link between these two factors, as students from more advantaged backgrounds are probably going to be better attuned to the culture and expectations of the school. Chapter 3 explores these interactions and separates out the unique effects of each factor.

This chapter examines variation in teaching and learning strategies within countries, especially among schools within countries. The analysis therefore centres around within-country distributions as represented by percentile ranks. The wider the range of values covered in these distributions, the greater the variability in teaching and learning within countries. In particular, the analysis considers such variations across schools by looking at the distribution of school-level results. Use of time and teaching strategies may logically be seen as characteristics of a school and not of an individual student.[2] On the other hand, one may logically consider student learning strategies as characteristic of individuals, as well as being influenced by school characteristics and teaching strategies. The chapter examines student learning strategies in terms both of variation among students and of variation among schools.

The analysis below looks in turn at four broad groups of variables: time inputs, student learning strategies, teaching strategies and the learning climate.

ALLOCATION AND USE OF TIME

Overview

Much research on teaching and learning is grounded, at least implicitly, in the issue of allocation and use of time. The Carroll model (Carroll 1963 and 1989) and variations on this model have provided the theoretical underpinning for the investigation of time allocation and use. Researchers accept the fundamental proposition that learning is a function of time (though obviously not of time alone), although the details of that functional relationship continue to be the subject of research and debate. Many other factors that affect learning can be formulated in terms of time. For example, a positive disciplinary climate may be conceived as one that minimises lost time and maximises the time students spend on tasks. Similarly, motivation can be considered, to some degree, as time spent in perseverance, one of the factors explicitly identified in the Carroll model.

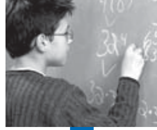
From a policy perspective, time is important because central authorities can regulate overall time allocations, such as the length of the school year and school day – and sometimes time allocations to specific subject areas. In addition, more detailed measures of time such as the length of class periods, transition times, homework and time spent on tasks in the classroom may be modified through school and district policies and through particular teaching and learning strategies. Indeed, many teaching strategy variables may be conceptualised as strategies for maximising time on task.

The PISA 2003 survey produced results on three main aspects of time use: instructional time, extra tuition and homework. These aspects cover the main identifiable time that students spend on learning activities. Table 2.1 summarises the results for these three areas. It shows that in a few countries, there are large variations in the time devoted to learning, but many countries have school systems with low variability in this respect. Norway epitomises the latter group, where instruction time is uniform, where only a tiny minority take out-of-school classes and students report doing similar amounts of homework. By contrast in Mexico, weekly instruction time varies greatly from one school to another, most students have extra tuition outside school and whereas one-quarter of students do more than seven hours of homework per week, one-quarter do less than four hours.

Are these differences important? The PISA survey can provide only limited answers to this question. Inconsistencies in the measures of instructional time (see below) have led to its relationship to performance not being modelled in this case. For example, time spent on extra tuition may help students perform better in mathematics, but since it is often weaker students who need to have this extra help, it is not associated with higher achievement. However, students spending more time doing homework overall tend to do better in mathematics in most countries, but the size of the difference is generally small. Thus, PISA provides a tool to compare variations in learning time, while offering little evidence on their effects (see also Chapter 3).

Instructional time

The report measures total instructional time by questions on the school questionnaire about the number of weeks in the school year and questions on the student questionnaire about the length of class periods and the number of class periods per week. The product of these two constitute an *index of total minutes per week*. The product of period length and total mathematics periods per week gives an *index of total mathematics minutes per week*. Finally, the ratio of mathematics minutes to total minutes yields an *index of the proportion of total time that is spent on mathematics*.



The distributions of number of weeks in the school year appear in Table A.1 of Annex A, Descriptive Statistics.[3] On average in the OECD countries, the school year consists of 37 weeks, with most countries within two weeks of this average. However, the Czech Republic and the partner country Brazil have a 41-week school year, while Mexico averages only 24 weeks. Indeed,

Table 2.1
Distribution of learning time and relationship with performance

OECD average	How much does this vary within each country? Variability within middle half of schools (interquartile range) except where specified	How is this associated with performance? (Bivariate effect on mathematics score, significant effects only)
	Instruction time	
36.7 instructional weeks per year	OECD average range = 1.9 weeks Most variability: 6 to 9 weeks in Hong Kong-China, Japan, the Slovak Republic and in Indonesia Least variability: 0 weeks in Denmark, Finland, Greece, Luxembourg, Norway, the United Kingdom and the United States, and in Latvia, Serbia and Thailand	No analysis
24.4 instructional hours in school week	OECD average range = 3.9 hours Most variability: 13 hours in Mexico and 20 hours in the United States Least variability: <1 hour in Norway, the United Kingdom, Finland and Luxembourg, and <2 hours in Latvia and Poland	
888 total instructional hours per year	OECD average range = 155 hours per year Most variability: 702 hours in the United States, 333 to 260 hours in Austria, Hong Kong-China, Mexico, Uruguay and Japan Least variability: <90 hours in Norway, Greece, Finland, Luxembourg, the United Kingdom, Denmark, the Czech Republic, Latvia, Iceland and Hungary	
	Extra tuition	
20% of students report being tutored (individually) in total and 15% in mathematics	Tutoring in total and in mathematics: Highest percentages: 90% of students in Mexico, 53% in Turkey (total only) Lowest percentages: fewer than 10% of students in Finland, Denmark, Norway, Japan, Belgium, Sweden, Liechtenstein and Netherlands	Negative: students receiving extra help tend to be weaker performers
25% of students report attending out-of-school lessons (in groups) in total and 13% in mathematics	Out-of-school lessons in total: Highest percentages: 92% in Mexico, 67% in Turkey and 66% in Greece Lowest percentages: <10% in Germany, Austria, Norway and France	
	Homework	
Students report doing 5.9 hours per week of homework or other study set by teachers in total	OECD average range = 2.7 hours Most variability: 5.9 hours in Italy, 4.7 hours in Hungary, 4.4 hours in Greece and 4.2 hours in the Russian Federation Least variability: 1.5 hours or less in Finland, Sweden, Denmark and Luxembourg	Positive in 24 countries: in 7 where effect is strongest, each hour of homework associated with 3 score points in mathematics. Negative in 4 countries.
Students report doing 2.4 hours per week of homework or other study set by mathematics teachers	OECD average range = 1 hour Most variability: 2.1 hours in Macao-China and Thailand and 1.7 hours in Italy Least variability: 0.5 hours or less in Luxembourg, Finland and Liechtenstein.	Positive in 10 countries, negative in 18. But performance difference small over observed range of homework practice.

only one-quarter of all schools in Mexico report at least 23 school weeks per year,[4] although a few Mexican schools do have much longer years, with 5% of schools reporting at least 42 weeks per year.

As the example of Mexico indicates, there are striking differences in the variation of number of instructional weeks in the school year within different countries. In one-half of the participating countries, the school year is more or less a standard length (varying by no more than one week). In Japan, the Slovak Republic, as well as the partner economies Hong Kong-China and Indonesia, the quarter of schools with the longest school years have at least six weeks more school time than the quarter of schools with the shortest school years. While this finding might relate to the degree of central direction of school systems, countries as different as the United States and the partner country Latvia are among those with little variation in the school year, while Japan and the partner economy Hong Kong-China have wide variations, despite their relatively centralised education systems.

The distributions of total weekly instructional time appear in Table A.2. Overall, the average amount of instructional time in a school week in the OECD countries is 24.4 hours. Again, the variation across countries is considerable, with the longest weeks in Korea and the partner country Thailand (around 30 hours each), and the shortest in the partner country Brazil (19 hours). In fact, the ratio of the most to the fewest hours in the school week (1.6) is similar to the ratio of the most to the fewest weeks in the school year (1.7). The United States, Austria, Mexico, Japan, Korea and Italy, as well as the partner economies Hong Kong-China, Uruguay and Brazil, show the greatest internal variation in length of week (at least 200 hours difference between the 25th and 75th percentiles).

Combining the number of weeks in the school year with the instructional time per week gives an *index of total instructional time per year.* The distributions for this index appear in Table A.3. Overall, students in the OECD countries receive an average of 888 hours of instruction per year. Most OECD countries, with the exception of Korea (1074 hours), Austria (991 hours) and Mexico (565 hours), fall within a range of 85 hours, or about 10% of the total. The partner economies Thailand, Liechtenstein and Macao-China all provide over 1000 hours of instruction per year. The amount of total instructional time per year varies substantially among schools within each country: within most countries, there is a difference of 400 or more hours between schools at the 5th and 95th percentile on this measure.

These figures are partially inconsistent with those reported by the OECD (2005). This finding raises some concern about the reliability of some of the time figures as reported by students, which may account for unusually low correlations found between some time indices and achievement. For this reason, the report excludes many of the time indices from the final model presented in Chapter 3. However, the Carroll model suggests that the large variations in time allocation between countries and between schools is likely to be of greater significance for mathematics achievement than the results here would indicate. In order to allow a more thorough investigation of this issue, a method of obtaining consistent measures of these major elements of time needs to be found.

The distributions of hours per week devoted to mathematics instruction appear in Figure 2.1. In the OECD countries, mathematics instructional time averages 3 hours and 18 minutes per week. Among countries, means vary from around 4.5 hours in the partner economies Hong Kong-China

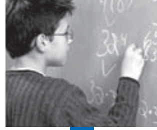
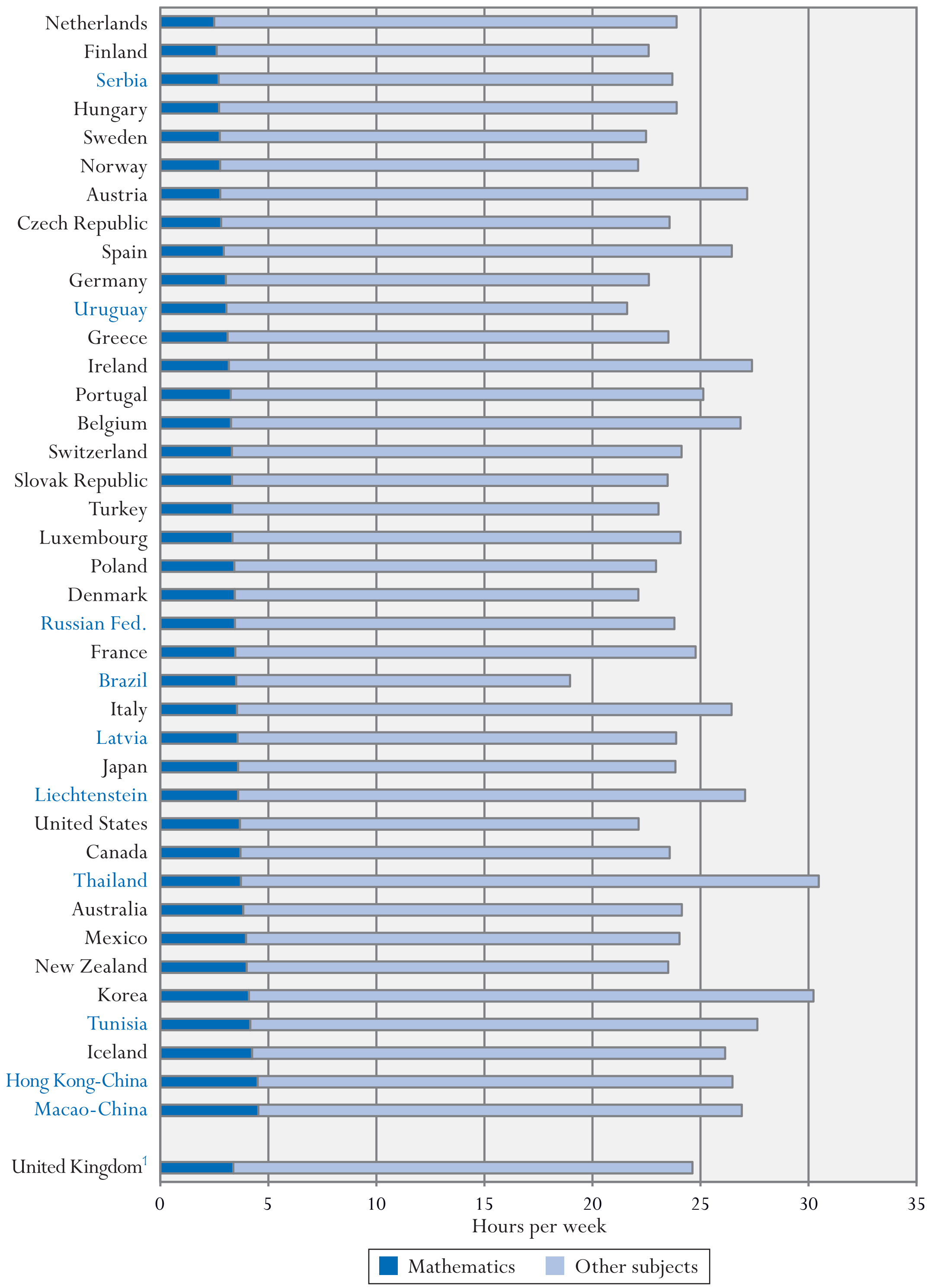


Figure 2.1 ■ **Hours per week spent on homework for mathematics and other subjects**



Note: Countries are ranked in ascending number of hours per week of mathematics homework.

1. Response rate too low to ensure comparability.

Source: OECD PISA 2003 Database.

and Macao-China to 2.5 hours in the Netherlands, close to a two-fold difference. In addition, on average in the OECD the within-country variation in mathematics teaching time per week is 1 hour (see Table A.4). However, Canada stands out as the OECD country with the most pronounced differences: a quarter of all students spend less than 1.5 hours a week learning mathematics, while another quarter spend nearly six hours or more.

Tutoring and out-of-school classes

Some students participate in organised mathematics learning outside the regular school programme, mainly in the form of being tutored or attending additional classes in school subjects. The difference between these is essentially whether the instruction is individual or group-based. There may be many reasons for such activities. In highly competitive systems, for example, these activities may be seen by students and parents as a means of obtaining a competitive edge. Even in less competitive environments, tutoring and other out-of-school work may be a means of attaining high achievement, improving the performance of students who are not doing well or compensating for perceived limitations in what the school can provide.

In the questionnaire, students report the number of hours per week they work with a tutor and spend attending out-of-school classes, both overall and specifically in mathematics. Because relatively few students in most countries report any time at these activities, it is not meaningful to reproduce or compare average times by school. Instead, for each country the report provides a computation of the proportion of students declaring any time spent at these activities, and the most common (modal) number of hours per week for those reporting non-zero time. These results appear in Figure 2.2.

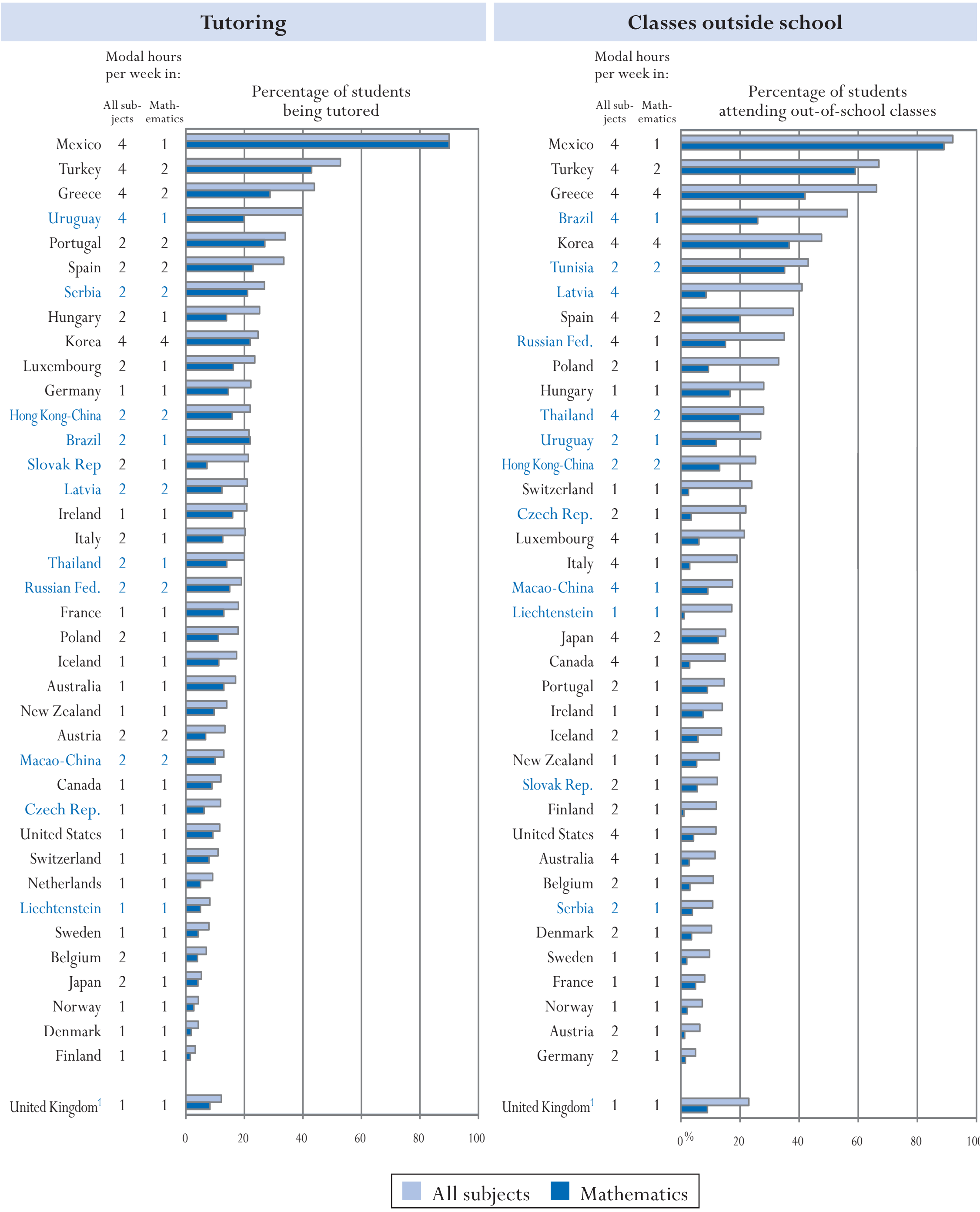
It is clear that this extra tuition plays a much greater role in some countries than others. Almost all students in Mexico report that they are both tutored and attend out-of-school classes. The proportions are also quite high in Greece and Turkey.[5] However, in most countries, the proportions of students reporting tutoring in mathematics are considerably smaller, averaging 20% overall and 15% for mathematics across the OECD countries.

It might be expected that high proportions of time spent on these activities would be associated with shorter school weeks, indicating that students find ways to compensate for limited instructional time. However, these measures are essentially uncorrelated. That being said, within most countries there is a distinct negative correlation with mathematics performance (see Chapter 3). This finding indicates that tutoring and extra classes tend to help compensate for weak performance more than to support already able students to advance further. The likelihood that students will take extra tuition if they are weak performers makes it very difficult to assess its overall value in a study that does not track individual students: in PISA, no link can be made between extra tuition and good performance.

Homework

There is a considerable literature supporting the claim that homework is a factor contributing to achievement (Marzano, 2003). However, lack of controls for ability in many studies, and thus the possibility that lower-ability students will spend more time at homework than their higher-ability peers, confounds this relationship. The PISA student questionnaire asks two questions about

Figure 2.2 ■ Hours per week spent on tutoring and out-of-school classes



Note: Countries are ranked in descending order of the percentage of students either being tutored or attending out-of-school classes in all subjects.

1. Response rate too low to ensure comparability.

Source: OECD PISA 2003 Database.

homework: the first on hours per week of homework set by all teachers and the second on hours per week of homework set by mathematics teachers. For total time spent on homework each week, there is in fact a positive correlation with performance (see Chapter 3); this is consistent with the other research showing the benefits of homework.

There are marked differences between countries in the total amount of homework reported (see Table A.5). The partner country, the Russian Federation, reports most total homework, a mean of more than 12 hours per week. In addition, Italy, Hungary, the Slovak Republic, Greece and Poland, and the partner country Latvia, also show mean homework times of between 8 and 10.5 hours. At the other extreme, mean homework times per week are less than 4 hours in Korea, Finland, Japan, the Czech Republic, Sweden and Austria.

If homework is beneficial, to what extent are students in some schools disadvantaged compared to others by doing less homework? The largest variations across the middle 50% of schools, in hours, occur in Italy, Hungary, Greece, and the partner country, the Russian Federation, as depicted in Figure 2.3. The variation is great relative to the (sometimes small) national average for homework in certain other countries as well. For example in Japan, the quarter of students with the least homework do a maximum of 1 hour and 48 minutes each week, while the quarter with the most do over 4.5 hours. In Hungary, the bottom quarter do up to 7 hours and 42 minutes, but the top quarter do over 12 hours' homework per week. Students in all schools in the top quarter do more than twice as much homework as students in the bottom quarter in Japan and the Netherlands. The ratio of the top to the bottom quarter of schools is at least 1.8 in Australia, Austria, Belgium, Canada, the Czech Republic, Italy and Mexico, and the partner economies Hong Kong-China and Thailand, showing that in general there are important differences between the homework norms of schools and that this finding does not just apply at the extremes of the distribution.

The pattern for mathematics homework times is similar to that for total homework, with close correlation between country rankings for both (see Table A.6).

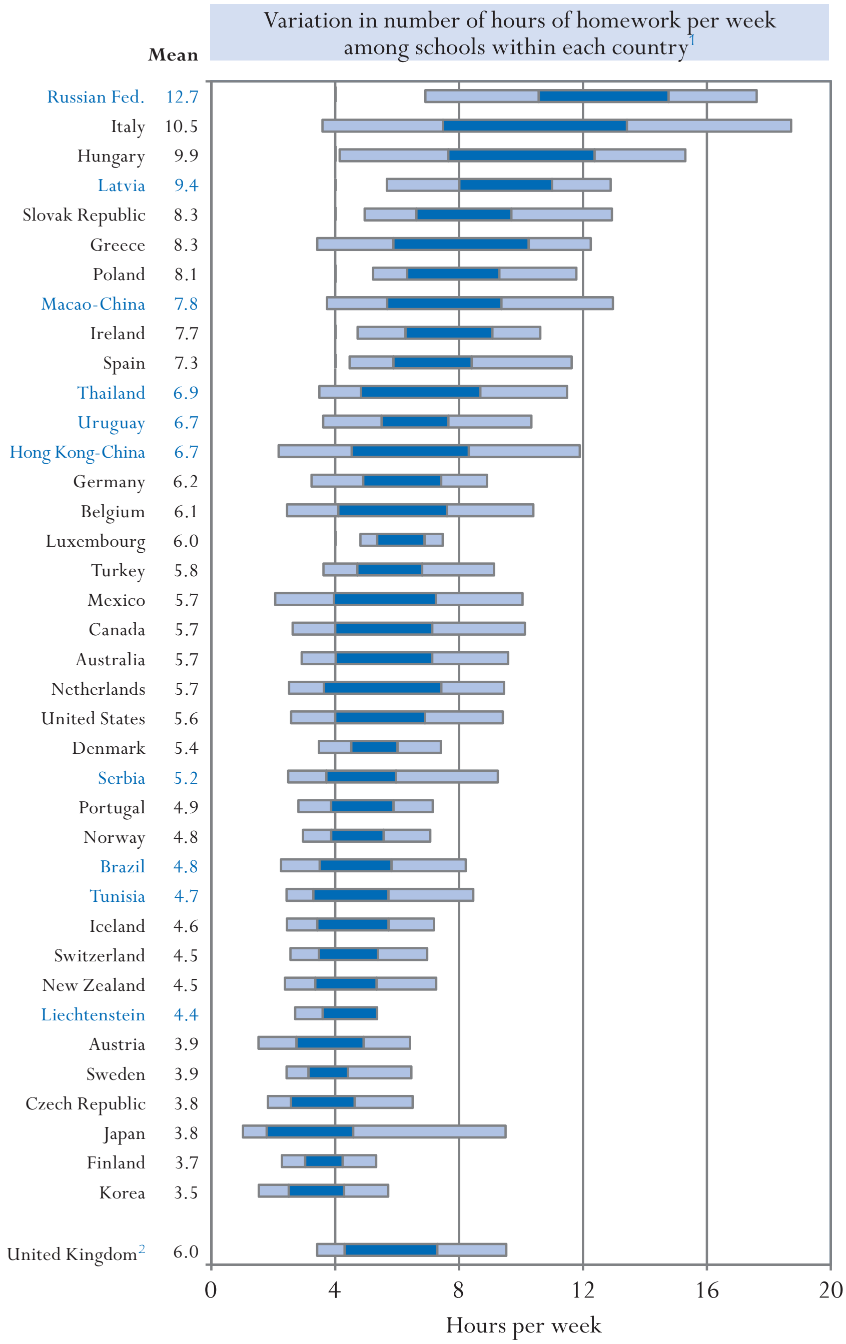
Other components of time

The PISA student questionnaire also contains a number of questions about time spent on remedial and enrichment activities and other school-related work. Unfortunately, the responses for these questions are too unreliable to report. The absence of large amounts of data for many countries suggests that many students may simply have left the response blank if the amount of time spent on such activities was zero. In addition, in many countries the same students reported participation in both remedial and enrichment activities. Since this seems implausible, it is possible that many students misinterpreted these questions.

STUDENT LEARNING STRATEGIES AND PREFERENCES

A series of questions about how students study mathematics forms the assessment of student learning strategies. A second related set of questions asks whether students prefer a competitive or co-operative environment for learning mathematics. In both cases, students indicate, using a four-point scale, their degree of agreement or disagreement with a series of statements about how they learn mathematics. These items on learning strategies form the basis for three indices: the *index of memorisation/rehearsal,* the *index of elaboration strategies* and the *index of control strategies*. Collectively, these

Figure 2.3 ■ **Hours per week of homework or other study set by teachers in total**



Note: Countries are ranked in descending order of the average number of hours spent on homework or other study set by teachers in total.

1. Bars extend from the 5th to the 95th percentile. At the 5th percentile only 5% of schools have fewer hours per week of homework. A school at the 95th percentile has more hours per week of homework than 95% of the other schools. The darker middle section denotes the variation between the middle 50% of schools (25th and 75th percentiles).
2. Response rate too low to ensure comparability.

Source: OECD PISA 2003 Database.

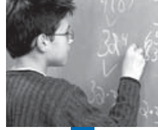
are meta-cognitive strategies because they represent general rather than content-specific approaches to the cognitive processes involved in learning. Research has shown that meta-cognitive skills and self-regulated learning strategies are important components of effective independent learning (Zimmerman and Schunk, 2001).

Readers are cautioned that the PISA 2000 analysis of student learning strategies shows limitations in comparing the overall use of these strategies across countries. Evidence suggests that in many cases students mean different things in different cultures when answering questions about their learning strategies. In this survey, there is also evidence to suggest that students in some countries reply to the same question in general with greater optimism or pessimism than do students in other countries, producing a response bias. For example, students in Finland, Japan, Korea, and the Netherlands tend to agree that they adopt various learning strategies much less than do students in Mexico and the partner countries Brazil and Tunisia, despite the much lower performance in PISA of students in the last three countries

Table 2.2

Distribution of the use of learning strategies/preferences and relationship with performance in mathematics

Variable	How much does this vary within each country? Variation within middle half of schools (interquartile range) Measured on index scale standardised relative to international standard deviation of individual learner characteristics	How is this associated with performance? (Bivariate effect on mathematics score, significant effects only)
	Use of learning strategies	
Memorisation/ rehearsal	OECD average range: 0.30 standard deviations Most variability: 1.04 in the partner country Liechtenstein, 0.50 in Germany, 0.44 to 0.42 in Austria, Switzerland, Mexico, the United States and in the partner country Indonesia Least variability: 0.17 in Luxembourg, 0.21-0.23 in Greece and Japan, and in the partner economies Thailand, Latvia and Macao-China	Positive association in 17 countries, negative in 14. (When accounting for other factors, mainly negative: see Chapter 3.)
Elaboration	OECD average range: 0.32 Most variability: 0.56 in Austria, 0.47 in Germany, 0.45 in Italy and 0.46 in the partner country Liechtenstein Least variability: 0.21 in Portugal and Finland, and in the partner economies Latvia and Macao-China	Positive association in 25 countries, negative in just one. (When accounting for other factors, mainly negative: see Chapter 3.)
Control	OECD average range: 0.31 Most variability: 0.52 in Korea, 0.41 in Canada, Mexico and Germany, 0.40 in Belgium and Turkey Least variability: 0.21 in Finland, 0.22 in Luxembourg, 0.23 in Hungary, 0.19 in the partner country Latvia and 0.23 in the partner country Thailand	Positive association in 21 countries, negative in just one. (Mixed picture when accounting for other factors: see Chapter 3.)
	Learning preferences	
Preference for competitive learning	OECD average range: 0.35 Most variability: 0.55 in Austria, 0.53 in Korea, 0.45 in Italy and 0.46 in the partner country Liechtenstein Least variability: 0.15 in the partner economy Macao-China, 0.19 in Greece and 0.20 in the partner country Latvia	Positive association in 29 countries, negative in none. (Most countries show no effect when accounting for other factors: see Chapter 3.)
Preference for co-operative learning	OECD average range: 0.30 Most variability: 0.42 in Austria, 0.41 in Mexico, 0.40 in Korea, the United States and in the partner country Serbia Least variability: 0.20 in Australia and Hungary, 0.21 in Finland, 0.22 in Greece and the partner country Thailand	Positive association in 9 countries, negative in 15. (Most countries show no effect when accounting for other factors: see Chapter 3.)



Students' preferences for learning situations influence learning behaviour; PISA presents two indices on this. Students who try harder to learn mathematics so that they can be the best in their class or obtain the best marks in their mathematics tests show a preference for competitive learning, while students who report that they work best with other students show a preference for co-operative learning. Preferences for competitive or for co-operative learning are not mutually exclusive and students could report a preference for both learning situations. These are relatively straightforward concepts, representing a combination of student dispositions and the climate of the school and the society in which the student functions.

Table 2.2 gives an overview of the results, in terms of the variability of the use of learning strategies/preferences in different schools and the degree to which these strategies are associated with performance. Similar patterns emerge for each learning strategy. In each case, a group of countries with the smallest school differences shows less than one-half the variability seen in countries with the greatest differences. How much this matters depends on the degree to which particular learning strategies help improve student learning, and on this question, there is a mixture of evidence. Overall, the factors that are most commonly associated with strong results are the controlling of one's own learning and a preference for competitive learning. (Note that this preference is not an alternative to a preference for co-operative learning, and it is possible to be positive about both.) But the associations shown here, and in particular that between controlling one's learning and PISA performance, appear to be weaker and less consistent for mathematics than for reading, as reported for PISA 2000 by Artelt *et al.* (2003). This evidence may indicate that different strategies have a different impact on learning in mathematics as compared to reading.

The following analysis therefore concentrates on the within-country distribution of these learner characteristics. Country-specific response bias does not necessarily affect the within-country models that form the basis for subsequent analysis. However, the possibility that various sub-groups within countries respond differently cannot be ruled out. It is impossible to be sure whether response bias contributes to these differences.

Memorisation/rehearsal strategies

Students use memorisation strategies (*e.g.* learning facts or rehearsing examples) for many tasks; such strategies are appropriate when the learner needs to retrieve information, as presented, without any further elaboration or processing. To measure the extent to which students use memorisation strategies in participating countries, the PISA *index of memorisation strategies* derives from the following four items:

- STQ34f I go over some problems in mathematics so often that I feel as if I could solve them in my sleep (*sleep*).
- STQ34g When I study for mathematics, I try to learn the answers to problems off by heart (*heart*).
- STQ34i In order to remember the method for solving a mathematics problem, I go through the examples again and again (*examples*).
- STQ34m To learn mathematics, I try to remember every step in a procedure (*procedure*).

Figure 2.4 shows the percentage of students in each country agreeing or strongly agreeing with these statements and the distribution across schools of the memorisation index. The first point to note is that in most countries substantially more students say they go through examples and remember steps in procedures than say they learn by heart or in a way that means they can solve problems in their sleep. A large majority of students clearly use examples and procedures as memorisation tools. It is likely that the sleep and heart questions represent more extreme methods of memorisation than the examples and procedures questions.

Memorisation is the one learning strategy that appears from the PISA 2000 results to allow direct comparisons across countries. In PISA 2003, there are wide differences across countries in the extent of use of memorisation strategies. Students report a comparatively higher use of memorisation strategies in Mexico and in several of the partner countries (notably Indonesia, Brazil, Thailand and Tunisia), followed by the United States, Australia, Greece and Canada. Conversely, students in Japan, Denmark, Korea, Finland and Switzerland and in the partner country Liechtenstein report a comparatively low use of memorisation strategies. For the most part, the distribution across schools on these variables is symmetrical, with similar numbers of schools at both the high and low ends.

As shown in Figure 2.4, relatively wide differences in the use of memorisation in different schools appear in Germany, Austria, Switzerland, Mexico and the United States, and the partner countries Liechtenstein and Indonesia.

Elaboration strategies

Elaboration is a measure of the extent to which students acquire understanding of new material by relating it to prior learning and knowledge. Elaboration strategies, unlike memorisation strategies, can help to deepen students' understanding of the knowledge and skills in use. The PISA *index of elaboration strategies* derives from the percentage of students agreeing or strongly agreeing with the following five items:

- STQ34b When I am solving mathematics problems, I often think of new ways to get the answer (*new ways*).
- STQ34e I think of how the mathematics I have learnt can be used in everyday life (*everyday*).
- STQ34h I try to understand new concepts in mathematics by relating them to things I already know (*already know*).
- STQ34k When I am solving a mathematics problem, I often think about how the solution might be applied to other interesting questions (*applied*).
- STQ34n When learning mathematics, I try to relate the work to things I have learnt in other subjects (*other subjects*).

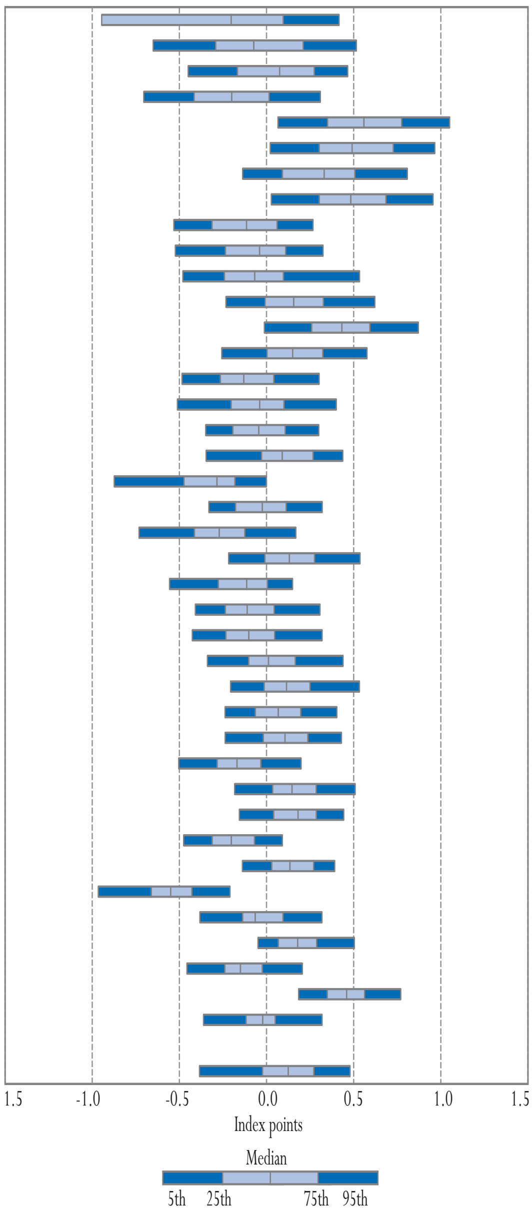
The data for these questions and the *index of elaboration* appear in Figure 2.5. In general, learning new ways, applying mathematics to everyday events, and relating concepts to things already known are more prevalent than applying solutions to other interesting questions or relating work to learning in other subjects. Here, some of the widest differences among schools are in Austria, Germany, Italy and the partner country Liechtenstein. Very narrow differences in countries such as Portugal, Finland and Poland, and the partner economies Latvia, Macao-China, Indonesia and Thailand,

Figure 2.4 ■ **Students' use of memorisation/rehearsal strategies to learn mathematics**

- **A** I go over some problems in mathematics so often that I feel as if I could solve them in my sleep.
- **B** When I study for mathematics, I try to learn the answers to problems off by heart.
- **C** In order to remember the method for solving a mathematics problem, I go through the examples again and again.
- **D** To learn mathematics, I try to remember every step in a procedure.

	A	B	C	D
Liechtenstein	36	27	50	61
Germany	42	34	61	68
Austria	43	29	70	78
Switzerland	32	33	54	74
Mexico	41	82	68	92
Indonesia	68	52	88	79
United States	42	67	70	83
Brazil	30	62	88	88
Norway	31	41	61	79
France	25	37	70	82
Serbia	33	24	84	68
Canada	33	58	70	83
Tunisia	43	52	81	78
Uruguay	46	42	82	62
Portugal	27	43	66	74
Czech Republic	40	34	62	75
Russian Fed.	24	50	63	71
Turkey	44	30	78	75
Korea	30	34	61	52
Iceland	26	55	62	72
Denmark	19	45	50	69
New Zealand	31	66	70	74
Netherlands	41	34	61	61
Sweden	33	56	63	61
Belgium	28	36	71	76
Italy	30	32	79	84
Slovak Republic	60	32	59	82
Spain	31	40	76	85
Ireland	28	57	77	75
Hong Kong-China	34	47	64	56
Hungary	44	30	74	89
Australia	30	64	71	80
Finland	26	44	54	72
Poland	36	62	71	78
Japan	21	27	45	62
Macao-China	36	55	69	53
Greece	29	60	75	81
Latvia	19	40	71	74
Thailand	48	90	71	85
Luxembourg	42	27	72	73
United Kingdom[2]	30	63	70	76

Variation in students' use of memorisation strategies among schools within each country[1]



Note: Countries are ranked in descending order of variation among the middle 50% of schools in use of memorisation strategies.

1. At the 5th percentile students at only 5% of schools have less of a preference for the use of memorisation strategies. Students at a school at the 95th percentile have a stronger preference for the use of memorisation strategies than students in 95% of the other schools.
2. Response rate too low to ensure comparability.

Source: OECD PISA 2003 Database.

imply that learning by using elaboration strategies in these countries follows very consistent patterns across schools. Note, however, that students' average use of elaboration strategies varies greatly among these countries: comparatively fewer students in Finland report using elaboration strategies compared to other students in OECD countries, whereas in the other countries comparatively more students report that they use elaboration strategies, with the partner countries Indonesia and Thailand among the top five countries.

Control strategies

Students who control their learning ensure that they set clear goals for themselves and monitor their own progress in reaching them. The PISA *index of control strategies* derives from the following five items:

STQ34a When I study for a mathematics test, I try to work out what are the most important parts to learn (*important*).

STQ34c When I study mathematics, I make myself check to see if I remember the work I have already done (*check memory*).

STQ34d When I study mathematics, I try to figure out which concepts I still have not understood properly (*concepts*).

STQ34j When I cannot understand something in mathematics, I always search for more information to clarify the problem (*clarify*).

STQ34l When I study mathematics, I start by working out exactly what I need to learn (*exactly*).

As Figure 2.6 shows, students tend to agree more strongly with these statements than was the case for the other two learning strategies. There is also less variation between countries than for the other learning strategies.

Among the strategies students report that they use to learn mathematics examined in PISA 2003, the most commonly used are control strategies, along with the examples and procedures strategies of the memorisation index. In all of these cases, on average at least two-thirds of students in the OECD countries answer positively. There are therefore high latent correlations between the index of control strategies and the index of memorisation/rehearsal strategies in all countries (see Annex B, Table B.1, Correlations among selected index variables).

Some countries show large differences in the use of control strategies from one school to another. In particular, Korea has an interquartile range that is equal to the range from the 5th to the 95th percentile in Finland. In other words, the middle half of schools in Korea shows the same variability in the use of control strategies as the middle 90% of schools in Finland.

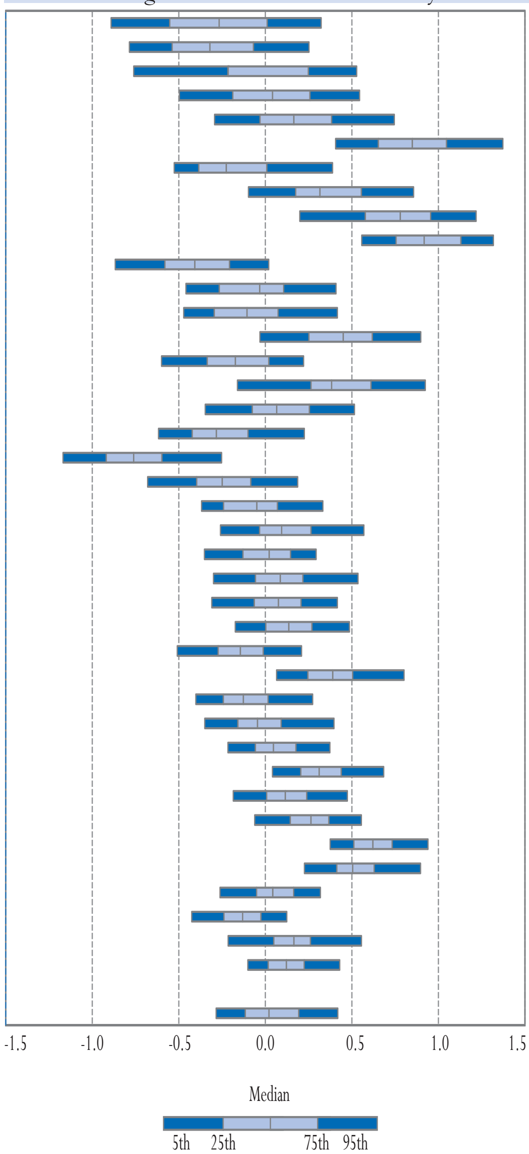
These variations in the use of control strategies are particularly important because, as will be seen in the following chapter, the use of such strategies is linked to higher performance in Korea and seven other countries.

Figure 2.5 ■ **Students' use of elaboration strategies to learn mathematics**

- **A** When I am solving mathematics problems, I often think of new ways to get the answer.
- **B** I think of how the mathematics I have learnt can be used in everyday life.
- **C** I try to understand new concepts in mathematics by relating them to things I already know.
- **D** When I am solving a mathematics problem, I often think about how the solution might be applied to other interesting questions.
- **E** When learning mathematics, I try to relate the work to things I have learnt in other subjects.

	A	B	C	D	E
Austria	41	41	60	29	40
Germany	36	42	56	27	36
Liechtenstein	44	44	70	35	41
Italy	54	51	64	43	44
United States	56	55	70	48	52
Mexico	78	89	84	67	71
Belgium	44	36	58	40	40
Uruguay	64	66	72	52	52
Brazil	78	83	85	68	57
Tunisia	74	79	78	85	72
Korea	40	34	55	27	21
Switzerland	44	47	66	37	45
France	45	47	52	48	44
Turkey	68	60	72	57	68
Norway	35	59	58	35	37
Serbia	60	62	78	62	54
Canada	53	52	64	43	47
Netherlands	40	27	56	36	41
Japan	42	12	52	21	15
Luxembourg	54	40	44	37	34
Iceland	38	57	65	38	38
New Zealand	54	60	67	43	47
Hong Kong-China	58	51	63	43	40
Spain	55	63	63	44	44
Denmark	47	57	66	42	47
Russian Fed.	32	68	68	48	57
Ireland	41	49	60	33	36
Slovak Republic	65	69	80	43	67
Hungary	34	56	65	31	38
Sweden	48	61	64	33	41
Australia	53	55	65	41	44
Greece	50	75	71	56	52
Czech Republic	33	77	76	38	49
Poland	52	64	80	46	59
Thailand	64	90	81	74	75
Indonesia	74	86	82	71	43
Macao-China	56	54	65	40	38
Finland	43	51	62	27	40
Portugal	64	53	73	60	41
Latvia	44	72	75	38	49
United Kingdom[2]	52	52	67	38	47

Variation in students' use of elaboration strategies among schools within each country[1]



Note: Countries are ranked in descending order of variation among the middle 50% of schools in students' use of elaboration strategies.

1. At the 5th percentile students at only 5% of schools have less of a preference for the use of elaboration strategies. Students at a school at the 95th percentile have a stronger preference for the use of elaboration strategies than students in 95% of the other schools.

2. Response rate too low to ensure comparability.

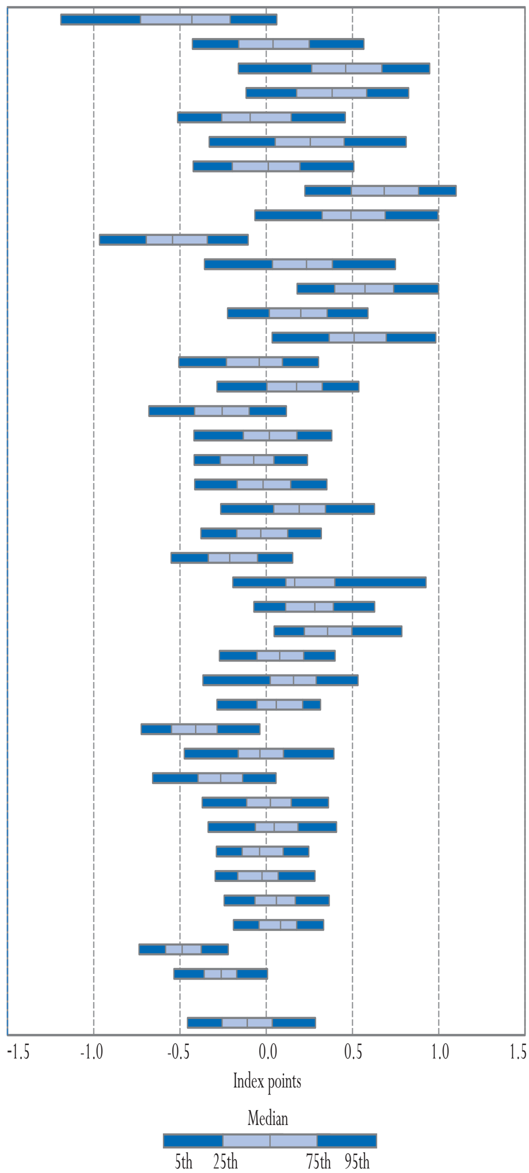
Source: OECD PISA 2003 Database.

Figure 2.6 ■ **Students' use of control strategies to learn mathematics**

- **A** When I study for a mathematics test, I try to work out what are the most important parts to learn.
- **B** When I study mathematics, I make myself check to see if I remember the work I have already done.
- **C** When I study mathematics, I try to figure out which concepts I still have not understood properly.
- **D** When I cannot understand something in mathematics, I always search for more information to clarify the problem.
- **E** When I study mathematics, I start by working out exactly what I need to learn.

	A	B	C	D	E
Korea	75	60	75	56	47
Canada	87	75	87	74	77
Mexico	95	83	93	80	85
Germany	90	71	89	66	88
Belgium	85	71	85	67	80
Turkey	88	85	85	61	86
United States	86	72	83	74	79
Tunisia	91	80	86	88	83
Serbia	90	83	90	87	85
Japan	81	65	76	50	26
Italy	90	76	91	83	85
Brazil	93	92	91	91	86
Uruguay	91	79	88	72	78
Austria	86	81	91	70	84
Hong Kong-China	87	76	89	64	82
France	91	72	87	78	78
Norway	87	61	78	66	59
Iceland	89	73	84	58	76
Russian Fed.	87	74	86	71	71
Spain	84	79	84	66	82
Switzerland	89	63	89	72	80
Ireland	90	75	86	69	76
Denmark	84	68	86	78	57
Liechtenstein	85	60	89	72	81
Greece	89	85	90	79	79
Indonesia	95	96	91	88	89
Slovak Republic	91	79	90	78	83
Portugal	91	86	85	77	88
Macao-China	87	77	91	65	89
Sweden	79	57	84	72	41
New Zealand	88	77	86	69	73
Netherlands	86	59	82	58	81
Australia	89	77	86	69	79
Czech Republic	84	82	93	80	80
Poland	91	80	86	75	79
Thailand	94	82	85	74	76
Hungary	90	76	88	76	78
Luxembourg	83	78	84	66	71
Finland	88	46	82	48	59
Latvia	84	67	84	71	66
United Kingdom[2]	89	77	86	65	75

Variation in students' use of control strategies among schools within each country[1]



Note: Countries are ranked in descending order of variation among the middle 50% of schools in students' use of control strategies.

1. At the 5th percentile students at only 5% of schools have less of a preference for the use of control strategies. Students at a school at the 95th percentile have a stronger preference for the use of control strategies than students in 95% of the other schools.
2. Response rate too low to ensure comparability.

Source: OECD PISA 2003 Database.

Preference for competitive learning situations

The report classifies a second set of questions into two indices representing preference for competitive and for co-operative learning situations. These are not mutually exclusive, as a student may want to perform well, but still enjoy working together with his or her peers. Indeed, the results for several countries suggest that these learning preferences may be complementary rather than conflicting (OECD average latent correlation is 0.35; see Table B.1).

The items comprising the *index of competitive learning* are:

STQ37a I would like to be the best in my class in mathematics (*best*).

STQ37c I try very hard in mathematics because I want to do better in the exams than others (*exams*).

STQ37e I make a real effort in mathematics because I want to be one of the best (*effort*).

STQ37g In mathematics I always try to do better than the other students in my class (*do better*).

STQ37j I do my best work in mathematics when I try to do better than others (*best work*).

Figure 2.7 shows the percentage of students agreeing or strongly agreeing to each of these items and gives the distributions across schools on the index. Here there is a wide range across countries in levels of agreement to the individual items, although, as discussed above, this could reflect cultural bias in response. As for earlier items, students in Mexico, Turkey and the partner country Tunisia show high percentages of agreement. The United States is relatively high on this index, as are the partner countries Brazil and Indonesia. Among the countries whose students performed the best in mathematics in PISA 2003, students in Hungary, the Netherlands, Japan, Switzerland, Austria, Belgium and Finland tend to report being less competitive on average compared to other countries.

Within countries, students who compete with their peers tend to do better in PISA, as is shown in Chapter 3. However, in some countries, there is considerably less of an ethos of competition in some schools than in others. Students' reports of preference for competitive learning situations vary most among schools in Austria, Korea and Italy and the partner country Liechtenstein. In fact, all students in the middle 50% of schools in Austria report a preference below the OECD average for competitive learning situations (Figure 2.7).

Preference for co-operative learning situations

The items comprising the PISA *index of co-operative learning* are:

STQ37b In mathematics I enjoy working with other students in groups (*group*).

STQ37d When we work on a project in mathematics, I think that it is a good idea to combine the ideas of all the students in a group (*project*).

STQ37f I do my best work in mathematics when I work with other students (*other students*).

STQ37h In mathematics I enjoy helping others to work well in a group (*helping*).

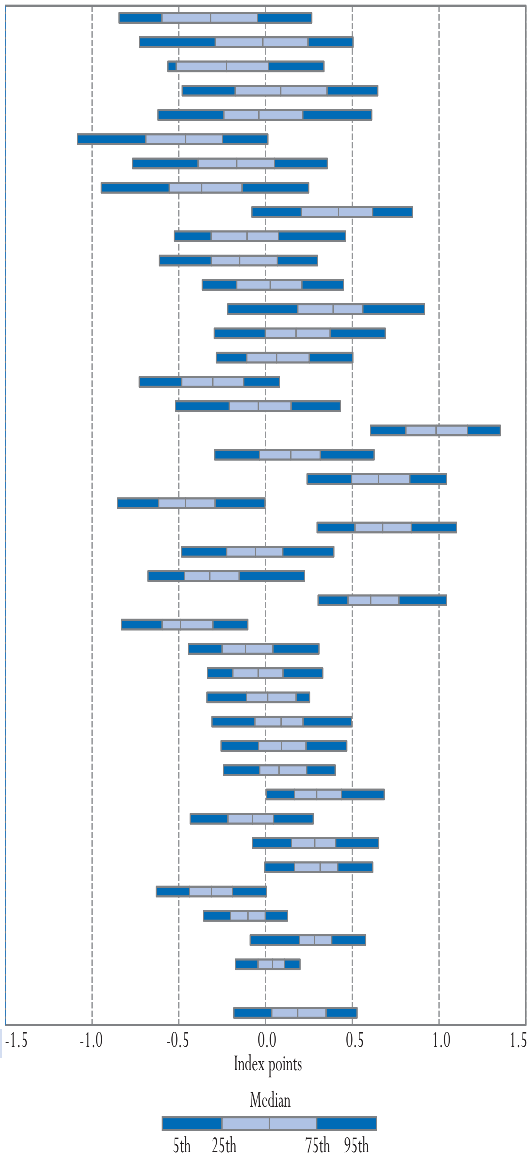
STQ37i In mathematics I learn most when I work with other students in my class (*learn most*).

Figure 2.7 ■ Students' preference for competitive learning situations

- **A** I would like to be the best in my class in mathematics.
- **B** I try very hard in mathematics because I want to do better in the exams than others.
- **C** I make a real effort in mathematics because I want to be one of the best.
- **D** In mathematics I always try to do better than the other students in my class.
- **E** I do my best work in mathematics when I try to do better than others.

	A	B	C	D	E
Austria	59	36	46	32	32
Korea	78	44	29	48	39
Liechtenstein	68	34	46	33	32
Italy	65	54	54	48	47
Germany	64	51	53	35	35
Japan	31	41	21	32	51
Serbia	53	40	38	35	38
Switzerland	55	32	40	32	33
United States	78	71	68	58	53
Uruguay	56	54	47	35	29
France	m	m	m	m	m
Spain	65	47	49	42	50
Brazil	83	60	70	46	47
Canada	71	61	58	46	45
Ireland	74	52	56	38	38
Norway	53	38	37	32	33
Denmark	45	60	49	32	50
Tunisia	90	87	79	79	74
New Zealand	67	62	54	46	47
Turkey	88	69	75	69	69
Netherlands	45	29	20	25	29
Mexico	87	71	81	72	76
Sweden	70	45	43	33	34
Belgium	48	36	36	31	36
Indonesia	m	m	m	m	m
Hungary	36	28	23	26	36
Czech Republic	51	55	41	40	33
Russian Fed.	57	60	43	35	38
Luxembourg	61	53	52	40	39
Slovak Republic	57	71	48	49	42
Hong Kong-China	71	73	53	33	45
Poland	72	60	53	40	40
Australia	74	83	59	52	47
Portugal	66	38	47	31	47
Iceland	82	61	60	52	37
Thailand	69	75	72	59	62
Finland	45	33	49	31	29
Latvia	66	42	36	33	42
Greece	74	62	60	43	61
Macao-China	67	65	44	26	42
United Kingdom[2]	70	64	58	45	47
OECD average	**63**	**52**	**49**	**41**	**43**

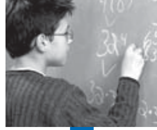
Variation in students' preference for competitive learning situations among schools within each country[1]



Note: Countries are ranked in descending order of variation among the middle 50% of schools in students' preference for competitive learning situations.

1. At the 5th percentile students at only 5% of schools have less of a preference for the use of competitive learning situations. Students at a school at the 95th percentile have a stronger preference for the use of competitive learning situations than students in 95% of the other schools.
2. Response rate too low to ensure comparability.

Source: OECD PISA 2003 Database.



Results for these items and for the *index of co-operative learning* appear in Figure 2.8. Again, there is a wide response range across countries and across schools within countries and, in this case, the previous analysis of PISA 2000 shows that these questions are interpreted similarly across different cultures.

In terms of percentage agreement, support for co-operative learning is generally higher than that for competitive learning. Students in some countries – such as the United States, as well as in the partner countries Brazil and Tunisia – score relatively highly on both indices, while students in Japan, for example, report comparatively low preference for both learning situations. In other countries, there are clear indications of differences in preference for these two learning situations. For example, students in Korea, Iceland, Mexico and Turkey report stronger preference for competitive than co-operative learning situations, while students in Switzerland and Portugal report stronger preference for co-operative learning situations. However, only in Switzerland do there seem to be two distinct groups of students reporting preference for either one or the other of the learning situations (there is very weak correlation between the two indices, 0.09). In general, the results indicate that some students report preferences for both learning situations with positive latent correlations of at least 0.20 between the two indices in 21 of the OECD countries (Table B.1).

These results, combined with those for memorisation, elaboration and control, suggest that learning strategies may be relatively undifferentiated. This issue requires further investigation to determine if the results obtained are a function of response bias or whether these various strategies are, indeed, complementary. For the purpose of further analysis, both because of the theoretical and policy interest of these indices and because the models used allow the effects of each index to be examined while accounting for other factors, the report retains the indices as defined.

TEACHING STRATEGIES AND CLIMATE

Central to the effectiveness of teaching and learning is the actual manner in which teaching takes place: both the teaching methods employed and the atmosphere in the classroom. Since these two aspects interact, the report considers teaching strategies and climate together.

As noted earlier, there are limits to the amount of detail on teaching strategies that can be gathered in a broad survey, especially in the absence of a teacher questionnaire. Nevertheless, a number of items connected with teaching strategies appear on the PISA 2003 school and student questionnaires. The school questionnaire contains items on staff consensus about mathematics teaching, staff preference for traditional versus new teaching methods, consensus on goals, teacher morale, pride and enthusiasm, teacher expectations of students, assessment practices, student grouping and enrichment, and remedial mathematics activities. The student questionnaire contains a set of items on the frequency of occurrence of specific behaviours and events in their mathematics lessons. Students' answers form the basis of two indices: the *index of teacher support* and the *index of disciplinary climate*. A further set of items gathers students' views on how well students and teachers get along in their school in general. The answers combine to form the *index of student-teacher relations*.

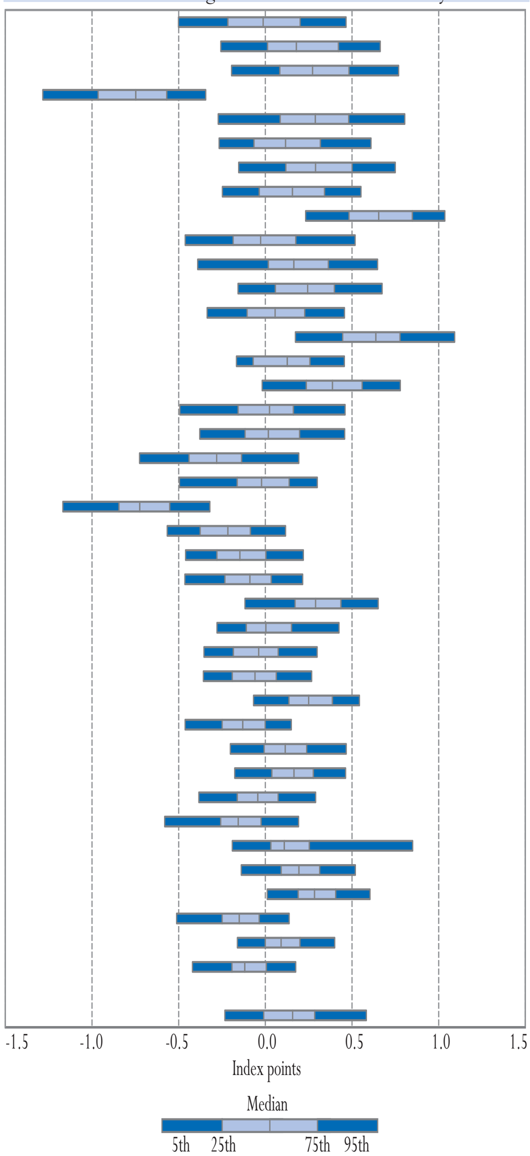
Note that although strategies and climate are closely related, they have a different significance in the analysis in this report. The teaching strategies described here do not appear in the model presented in Chapter 3. They were omitted because these strategies have either low correlations with achievement or only small effects, which may be a result of the indirect way they are reported, that is, via

Figure 2.8 ■ Students' preference for co-operative learning situations

- **A** In mathematics I enjoy working with other students in groups.
- **B** When we work on a project in mathematics, I think that it is a good idea to combine the ideas of all the students in a group.
- **C** I do my best work in mathematics when I work with other students.
- **D** In mathematics I enjoy helping others to work well in a group.
- **E** In mathematics I learn most when I work with other students in my class.

	A	B	C	D	E
Austria	63	73	46	69	53
Mexico	68	78	66	61	74
Serbia	77	82	59	83	64
Korea	29	50	17	44	31
United States	77	80	66	73	64
Italy	72	79	69	67	58
Turkey	73	73	66	76	70
Canada	77	79	57	67	59
Brazil	82	90	86	83	75
Germany	69	64	46	69	55
Switzerland	76	76	49	73	60
Denmark	79	80	81	76	55
Spain	72	72	58	71	66
Tunisia	79	81	65	82	75
Macao-China	71	72	65	61	73
Uruguay	83	85	63	81	69
Norway	70	77	57	64	60
France	m	m	m	m	m
Iceland	57	72	37	66	37
Hong Kong-China	71	67	65	55	71
Japan	32	39	39	46	38
Sweden	64	84	36	56	46
Netherlands	73	74	50	63	54
Ireland	68	72	51	65	52
Portugal	76	86	78	83	62
Indonesia	m	m	m	m	m
Czech Republic	69	86	48	72	53
Russian Fed.	73	63	53	60	69
Slovak Republic	79	89	68	80	69
Latvia	71	73	50	60	57
Poland	78	88	64	63	61
New Zealand	82	78	61	71	63
Belgium	73	78	50	68	53
Luxembourg	66	68	44	56	49
Liechtenstein	76	78	46	78	61
Greece	67	78	67	76	71
Thailand	84	88	77	81	68
Finland	71	67	51	68	52
Australia	64	78	61	72	63
Hungary	65	82	48	64	52
United Kingdom[2]	83	79	64	70	63
OECD average	**69**	**75**	**55**	**67**	**57**

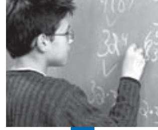
Variation in students' preference for co-operative learning situations among schools within each country[1]



Note: Countries are ranked in descending order of variation in students' preference for co-operative learning situations between schools at the 25th and 75th percentiles.

1. At the 5th percentile students at only 5% of schools have less of a preference for the use of co-operative learning situations. Students at a school at the 95th percentile have a stronger preference for the use of co-operative learning situations than students in 95% of the other schools.
2. Response rate too low to ensure comparability.

Source: OECD PISA 2003 Database.



school principals rather than by individual teachers. Thus, the responses do not provide data about individual students' experience of instruction, but only about the perceptions of school principals. However, student descriptions of classroom climate and of student-teacher relations give information about individual students' experiences of the context in which teaching takes place. This information can be compared to each student's performance in mathematics; thus, these climate factors do appear in the model presented in Chapter 3.

Teacher consensus on key school policies

Traditional versus new ways of mathematics teaching

PISA 2003 asks school principals a set of questions to gauge the extent to which there are consistent and shared (academic) goals in the teaching of mathematics within their schools. One possible factor associated with effective departments or schools is a high degree of consensus about key school policies. In the first of three item sets, school principals report on teacher support for innovative versus traditional teaching practices in their school. On average in the OECD countries:

School principals report:	Percentage of students in such schools
Mathematics teachers are interested in trying new methods and teaching practices.	83%
There is a preference among mathematics teachers to stay with well-known methods and practices.	60%
There are frequent disagreements between "innovative" and "traditional" mathematics teachers.	22%

The percentages of students in each country whose school principals agree with these statements appear in Table A.7.[6] There is strong agreement in most countries that teachers are interested in trying new methods and practices: 80% or more students in 19 of the OECD countries and in all of the partner countries are in schools where the principal agrees with this proposition. School principals in the Netherlands and Japan are least likely to report this: only 59% (the Netherlands) and 63% (Japan) of students are in schools whose principal reports teachers' interest in new methods and practices. There is considerably more variation across countries on the question of teacher preference for traditional methods and practices. For example, among OECD countries, only in Hungary, the Slovak Republic, Turkey, Luxembourg and Italy are 80% or more of students in schools where the principal agrees this is the case. Fewer than 50% of students are in such schools in nine OECD countries and two partner countries. While school principals in several countries – notably Hungary and the Slovak Republic, as well as the partner economies Hong Kong-China, the Russian Federation, Thailand and Tunisia – report high agreement on both propositions, the country-level correlation between the two statements is close to zero. Nevertheless, the within-country correlations are generally negative, indicating that school principals tend to attribute only one of these methods to their teachers. In general, principals report that within their schools, mathematics teachers with different approaches work well together. In 19 OECD countries and in six partner countries, fewer than 25% of students are in schools where principals report frequent disagreements between innovative and traditional mathematics teachers. However, around 50% of students in Mexico and the partner country Indonesia are in schools where the principal reports frequent disagreements between innovative and traditional teachers, and this is also the case for at least one-third of students in Turkey, Portugal and Belgium and the partner countries Uruguay and Brazil.

Teacher expectations

In the second item set that collects information on consistent and shared (academic) goals, PISA 2003 also asks school principals their opinions on teacher expectations within their school. On average in the OECD countries:

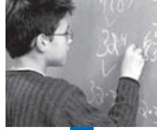
School principals report:	Percentage of students in such schools
There is consensus among mathematics teachers that academic achievement must be kept as high as possible.	89%
There is consensus among mathematics teachers that it is best to adapt academic standards to the students' level and needs.	71%
There are frequent disagreements between mathematics teachers who consider each other to be "too demanding" or "too lax".	19%

The percentages of students in each country in schools where the principal agrees with these statements appear in Table A.8. Again, the majority of students in almost all countries are in schools whose principals report that there is consensus among mathematics teachers that academic standards should be kept as high as possible. This finding concerns at least 90% of students in 16 OECD countries and five partner countries, and it falls to fewer than 80% of students only in Sweden, Portugal, Japan, Turkey and the partner country Brazil. The range of agreement to the statement on adapting academic standards to the students' level and needs is extremely wide. While in 11 of the OECD countries and nine of the partner countries, more than 80% of students are in schools whose principals agree that academic standards should be adapted to meet students' levels and needs, this is the case for only 16% of students in Luxembourg and 23% in Germany. Again, the country-level correlation between these variables is close to zero. However, within most countries there is a small positive correlation, suggesting that school principals do not perceive these two kinds of expectations as conflicting. Regarding the statement about disagreements among mathematics teachers concerning whether or not they perceive their counterparts to be too demanding or too lax, school principals in most countries believe the level of disagreement to be low – such disagreement affects fewer than 15% of students in 14 OECD countries. Again, more than 50% of students in Mexico and in the partner country Tunisia are in schools whose principals report that there are frequent disagreements among mathematics teachers concerning their expectations of students, and this also concerns at least one-third of students in Turkey, Luxembourg, Portugal and Italy and in Uruguay, Serbia, Brazil and Thailand.

Goals of mathematics teaching

The third item set asks principals to report specifically on the mathematics teaching goals in their schools. On average in the OECD countries:

School principals report:	Percentage of students in such schools
There is consensus among mathematics teachers that the social and emotional development of the student is as important as their acquisition of mathematical skills and knowledge in mathematics classes.	72%
There is consensus among mathematics teachers that the development of students' mathematical skills and knowledge is the most important objective in mathematics classes.	81%
There are frequent disagreements between mathematics teachers who consider each other as "too focused on skill acquisition" or "too focused on the affective development" of the student.	13%



The results for each country are presented in Table A.9. Here, the first statement gives equal preference to both kinds of goals but the second gives preference to the mathematical skills and knowledge goal. The degree of agreement among school principals is relatively strong for both statements, although the mathematical skills and knowledge goal generally receives stronger support than the idea of equal value for both kinds of goals. In the Netherlands, Luxembourg, the United Kingdom and New Zealand there is stronger support for the development of mathematical skills and knowledge as the most important teaching objective (a difference of at least 25 percentage points of students) while the reverse is true in Poland. Again, most school principals in most countries do not encounter frequent disagreements over these priorities among teachers, although Mexico is a notable exception. In particular, such disagreements only affect a small minority of students (5% or fewer) in Japan, New Zealand and the United Kingdom and the partner country Liechtenstein.

Streaming and grouping

Streaming refers to the assignment of students to classes based on ability. Grouping refers to within-class arrangements that differentiate students by ability. Streaming may thus be thought of as a matter of school policy or perhaps of policy at higher levels of authority. Grouping, however, is something that can be introduced by individual teachers, within or outside any broader policy framework. School principals answer questions about both these practices. In the case of streaming, the questions attempt to differentiate between streaming by difficulty with the same content or with different content. On average in the OECD countries:

School principals report for some or all classes:	Percentage of students in such schools
Mathematics classes study similar content, but at different levels of difficulty.	30% all classes; 37% some classes
Different classes study different content or sets of mathematics topics that have different levels of difficulty.	15% all classes; 37% some classes

The percentages of principals in each country who report that their schools practice streaming by difficulty, and by content and difficulty, in some or all classes appear in Table A.10. While a majority of schools in most countries practice streaming by difficulty, the actual proportions differ widely by country. In the United Kingdom, New Zealand, Ireland, Norway, Spain, the United States and Sweden, at least 90% of students encounter streaming into different classes by difficulty for some or all classes, although they study similar content. School principals in Australia, Canada, Poland and the partner economies Hong Kong-China, Latvia and the Russian Federation also report a high degree of streaming by difficulty in at least some classes. Conversely, 30% or fewer students in Greece, the Czech Republic and Austria are in schools whose principals report that there is streaming by difficulty in at least some classes. The pattern for streaming by content and difficulty is different to that for streaming by difficulty only. While there is a relatively high correlation across countries between streaming for content and difficulty and streaming by content only for streaming in some classes, the correlation between these two variables is low for streaming in all classes. There are a few clear examples: school principals in Norway, Poland and Portugal report high levels of streaming by difficulty only (for more than 70% of students) and low levels by content combined with difficulty (for fewer than 25% of students).

With regard to within-class grouping, on average in the OECD countries:

School principals report for some or all classes:	Percentage of students in such schools
Students are grouped by ability within their mathematics classes.	14% all classes; 30% some classes
In mathematics classes, teachers use a pedagogy suitable for students with heterogeneous abilities (*i.e.* students are not grouped by ability).	40% all classes; 34% some classes

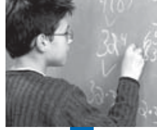
The results for all countries appear in Table A.11. Because there is considerable overlap in the results when the analysis includes the "some classes" category, the report presents results both with "some classes" and "all classes" combined and for "all classes" only. For the combined categories, the extent of ability grouping in at least some classes varies across countries from 70% or more of schools in New Zealand, Australia, the United Kingdom, Ireland and Korea, and the partner countries, the Russian Federation and Latvia, to fewer than 10% in Greece and Luxembourg. There is much less variation in the use of homogeneous grouping under this measure. With the exception of Germany, Japan, Turkey and the United Kingdom and the partner country Brazil, at least 60% of students are not grouped by ability within mathematics classes.

At first glance, one might expect responses to these questions to show negative correlations to one another. However, the wording of the second question makes it possible to respond positively or negatively to both. Although the countries reporting the lowest levels of ability grouping report high levels of teaching to heterogeneous groups, the opposite is not usually the case. The between-country correlation of these two variables is close to zero, as are most of the within-country correlations, a finding explained by the results in the second two columns of Table A.11. Although many countries practice ability grouping in at least some classes, relatively few do so in all classes. The United Kingdom, Australia and Ireland are exceptions, where close to 50% of schools report ability grouping for all classes. However, the majority of students in many more countries are in classes suitable for students with heterogeneous abilities. In Norway, Denmark and Poland, as well as the partner country Indonesia, at least 70% of students are in mathematics classes with pedagogy suitable for students of all abilities. This figure is at least 60% for students in Portugal, Greece and the partner economies Macao-China and Tunisia.

Assessment

For this item, principals estimate the frequency of the use of various types of assessment in their schools, on a scale ranging from "never" to "more than once a month". Table A.12 shows the percentages of schools reporting the use of the different assessment types more than three times a year. The table also includes data on use of assessment only once or twice a year. This enables information to be included on the use of standardised tests, because it is rare to employ this form of assessment often, even where the application of standardised tests is a prominent feature of education systems.

It is clear from Table A.12 that teacher tests and student assignments comprise the most frequent types of assessments, with each of these occurring three to five times a year or more in over 80% of schools in almost all countries. Teacher ratings also show a high level of use in most countries (75% of students on average in the OECD countries attend schools where the principal reports teacher ratings are used at least three times a year). Use of student portfolios occurs less often than the other internal forms of assessment, but with wide variation across countries.



Standardised tests are the least frequently used on average and show the most variation in use across countries. However, frequency of use is not the best indicator of the influence of standardised tests, which may be used to make high-stakes decisions involving students' future education or careers. Table A.12 shows that far more countries use standardised tests one to two times a year than three to five times or more. Although the issue of high-stakes use is a source of considerable controversy, there is no measure in PISA of high-stakes use of standardised tests. In some countries, such as Austria and Belgium, and the partner country Uruguay, standardised tests seem relatively rare. It is not possible to determine from these data if standardised tests are centrally mandated. However, in a few countries, notably Finland, Iceland, the United States, Sweden, Korea and Norway, as well as partner country Latvia, there is almost universal use of standardised tests at least once a year (95% of students or more).

A few countries stand out as using most forms of assessment relatively more frequently or infrequently than others. For example, Turkey emerges as a country where none of the forms is frequently in use in a majority of schools. Teacher ratings, teacher tests and student assignments are frequently used for the majority of students in many countries, but notably in Austria, Belgium, Germany, Iceland, Portugal, Spain, Sweden, the United States and the partner countries Brazil and Latvia, with frequent use by around 90% or more of students. Further, in Spain and the partner country Brazil there is above-average use of both student portfolios and standardised tests. Use of student assignments is extensive as a form of assessment in all countries: the OECD average is 86% of students being subject to this form of assessment more than three times a year, but in Greece, only 15% of students are similarly assessed.

The second aspect of assessment measured by the school questionnaire is the use of assessment results. The various purposes of assessment, and the percentages of schools using it for those purposes, appear in Table A.13.

By far the most common use of student assessment is for reporting to parents. More than 90% of schools in almost all countries use assessment for this purpose. Its use for student retention and promotion is also common, except in Denmark, Iceland and Korea. In countries where social promotion is a matter of national policy, no schools should report using assessment for this purpose. Nevertheless, there is no way to determine, in cases where a few schools report use for this purpose, if the data are unreliable or if a few schools are not following national policies. While the issue of social promotion deserves further attention from a policy perspective, the PISA questionnaires do not address it in more detail.

The remaining uses of assessment are highly variable across countries. For example, use for comparison with national standards occurs in more than 80% of schools in the United States, the United Kingdom, New Zealand, Hungary and Iceland, but in fewer than 10% of schools in Denmark and Belgium, and in the partner economy Macao-China. A similar pattern exists for comparison with other schools. Denmark stands out in this overall picture, with only a very small number of schools using assessment for any purposes other than reporting to parents and curriculum improvement.

STUDENT PERCEPTIONS OF THE LEARNING ENVIRONMENT: OVERVIEW

The remaining factors to consider in this section concern the degree to which students report that their classroom climate and their relations with teachers have characteristics likely to be conducive to learning. A summary of the distribution of these factors and the extent to which they appear to be related to performance appears in Table 2.3.

As will be shown further in Chapter 3, these factors are particularly important because students who learn in a positive climate where they interact well with their teachers tend to perform better in mathematics. This relationship is clearest for disciplinary climate. Factors related to teacher support and relations have an association with performance that is perhaps complicated by extra support being given to weaker students. Nevertheless, the importance of these factors for teaching and learning is obvious.

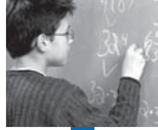
It is notable here that (as shown in Table 2.3) the magnitude of the variability between schools is greater than for the learning strategies and preference factors considered earlier. The middle half of schools within each country vary on average by at least 0.40 of a standard deviation for climate-related factors, compared to around 0.30 of a standard deviation for learning strategies. This result indicates that for climate factors, more of the variation in the experiences of individuals can be attributed to variations among schools. Even in a country like Finland, where there are below-average levels of variation in climate factors among schools, there is actually about the average variation level for learning strategies.

Classroom climate

The measurement of classroom climate uses a series of items on the student questionnaire related to degree of teacher interest and support for students, and elements of time use and disruption.

Table 2.3
Distribution of students' experience of classroom climate and teacher-student relations, and the relationship of these factors with performance

Variable	Variability within countries: Variability within middle half of schools (interquartile range) Measured on index scale standardised relative to international standard deviation of individual learner characteristics	Relationship with performance (Bivariate effect on mathemetics score, significant effects only)
Classroom climate (a) Teacher support	OECD average range: 0.42 standard deviations Highest variability: 0.61 in Austria, 0.55 in the Slovak Republic, 0.54 in Italy and 0.60 in the partner country Serbia Lowest variability: 0.22 in Korea, 0.25 in the Netherlands and 0.19 in Macao-China and Liechtenstein	Small positive association in 13 countries, negative in 7. (When accounting for other factors, mainly negative: see Chapter 3.)
Classroom climate (b) Disciplinary climate	OECD average range: 0.50 standard deviations Highest variability: 0.79 in Japan, 0.76 in Austria, 0.68 in the Czech Republic and Hungary and 0.79 in Liechtenstein Lowest variability: 0.29 in Luxembourg, 0.36 to 0.38 in New Zealand, Greece, the Netherlands, Korea and in the partner countries Indonesia, Brazil, Thailand and Macao-China	Significant positive association in almost all countries. (Remains when accounting for other factors: see Chapter 3.)
Teacher-student relations	OECD average range: 0.41 standard deviations Highest variability: 0.61 in Tunisia, 0.60 in Liechtenstein, 0.55-0.58 in Austria, Switzerland and in the partner countries Serbia and Brazil Lowest variability: 0.32 in New Zealand, 0.33 in Portugal and 0.31 in the partner country Thailand	Positive association in 12 countries, in some cases relatively strong; negative association in 11 countries, in all cases weak. (Positive associations weaker when accounting for other factors: see Chapter 3.)



These questions require response on a frequency-of-occurrence scale ranging from "every lesson" to "never or hardly ever". The 11 items on this scale combine to form two indices: the *index of teacher support* and the *index of disciplinary climate*. As with some other aspects of teaching strategies, these indices may be considered as characteristic of a classroom rather than of a student. In the absence of a classroom identifier, the most appropriate level at which to examine these variables is the school level. The extent to which these indices vary across schools within a country is an indicator of school-system differentiation. However, it must be recognised that assessment of variations among teachers within a school is lost when the aggregation is to the school level.

Teacher support

The five items making up the *index of teacher support* are:

STQ38a The teacher shows an interest in every student's learning (*interested*).

STQ38c The teacher gives extra help when students need it (*extra help*).

STQ38e The teacher helps students with their learning (*helps learning*).

STQ38g The teacher continues teaching until students understand (*understand*).

STQ38j The teacher gives students an opportunity to express opinions (*opinions*).

Figure 2.9 shows the percentages of students reporting that these factors occur in every lesson or most lessons. The box plots give the range of variation across schools in each country.

A majority of students in almost all countries report that teacher support activities occur in all or most lessons. This result indicates, in absolute terms, perception of a high level of teacher support. There is a particularly strong perception of teacher support in Mexico and Turkey, and in the partner countries Brazil and Thailand; there is a comparatively weak perception of teacher support in Austria, Germany, Japan and Luxembourg. Students in Australia, Canada, Denmark, Finland, Iceland, New Zealand, Portugal, Sweden and the United States all perceive a higher level of teacher support than the average in OECD countries.

Within countries, differences in support across the middle 90% of schools range from just over half a standard deviation in Korea and the partner economy Macao-China to about one-and-a-half standard deviations in the Slovak Republic and the partner country Serbia.

Disciplinary climate

The *index of disciplinary climate in mathematics lessons* consists of the following five items:

STQ38b Students don't listen to what the teacher says (*don't listen*).

STQ38f There is noise and disorder (*noise*).

STQ38h The teacher has to wait a long time for students to "quieten down" (*quiet down*).

STQ38i Students cannot work well (*can't work well*).

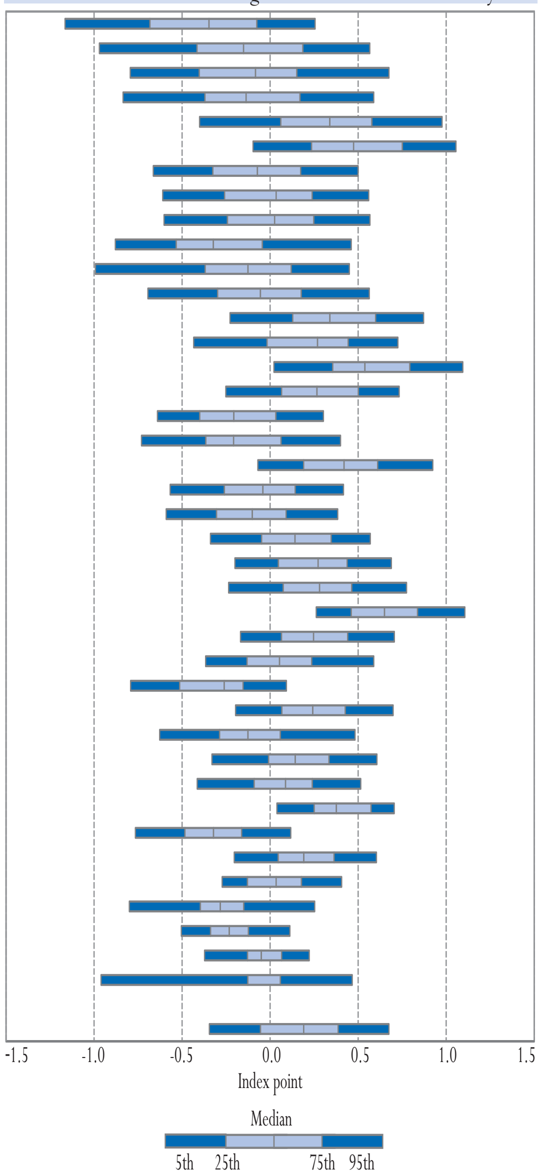
STQ38k Students don't start working for a long time after the lesson begins (*late start*).

Figure 2.9 ■ Students' views on teacher support in their mathematics lessons

- A: The teacher shows an interest in every student's learning.
- B: The teacher gives extra help when students need it.
- C: The teacher helps students with their learning.
- D: The teacher continues teaching until the students understand.
- E: The teacher gives students an opportunity to express opinions.

	A	B	C	D	E
Austria	49	59	45	51	52
Serbia	53	49	54	51	55
Slovak Republic	57	58	65	52	60
Italy	57	49	70	61	61
Uruguay	77	51	81	75	73
Mexico	81	68	78	70	73
Hungary	54	64	72	55	62
Ireland	62	62	75	68	50
Switzerland	55	73	67	61	69
Germany	43	59	59	54	53
Czech Republic	47	75	59	51	57
Spain	65	48	72	65	60
United States	69	78	84	71	63
Iceland	66	69	89	78	59
Brazil	81	71	86	81	76
Portugal	67	73	82	71	67
Poland	51	61	62	55	55
France	48	63	66	62	50
Turkey	77	74	82	68	70
Greece	43	62	74	59	71
Belgium	49	65	66	64	53
Denmark	57	68	85	73	69
Tunisia	71	62	77	70	62
Canada	63	80	86	71	62
Thailand	85	77	88	83	79
Russian Fed.	67	74	80	67	71
Latvia	51	72	82	63	64
Luxembourg	53	61	49	57	59
Australia	64	78	85	72	63
Norway	55	60	81	60	58
New Zealand	63	77	84	68	59
Finland	54	77	86	61	62
Indonesia	64	66	81	78	81
Japan	50	62	73	50	47
Sweden	69	70	87	71	62
Hong Kong-China	62	67	74	68	60
Netherlands	49	66	49	60	54
Korea	58	56	79	40	49
Macao-China	60	57	68	64	57
Liechtenstein	55	72	63	60	66
United Kingdom[2]	63	75	83	73	57
OECD average	**58**	**66**	**73**	**62**	**60**

Variation in students' views on teacher support in their mathematics lessons among schools within each country[1]

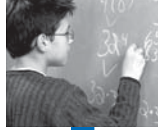


Note: Countries are ranked in descending order of variation of students' views of teacher support in mathematics between schools at the 25th and 75th percentiles.

1. At the 5th percentile students at only 5% of schools have a more negative view of teacher support in their mathematics lessons. Students at a school at the 95th percentile have a more positive view of teacher support in their mathematics lessons than students in 95% of the other schools.

2. Response rate too low to ensure comparability.

Source: OECD PISA 2003 Database.



Percentage responses to the "all lessons" and "most lessons" categories on the index variable appear in Figure 2.10. Please note that this scale is "reverse scored" so that low levels of agreement with the five statements can be interpreted as representing a positive disciplinary climate.

The frequency data show that students in most countries perceive their mathematics classes as having mainly positive disciplinary climates. The majority view of students that the behaviours presented in the statements occur relatively infrequently, compared to the frequencies reported for teacher support, indicates that students are making distinctions between positive and negative statements about classroom climate. That is, there is less indication of response bias here than for the statements based on the agree/disagree scales.

In absolute terms, the differences between countries are not particularly large on this scale. Even for countries at the negative end of the index, the frequencies of occurrence of the negative behaviours tend to be in the 30% to 40% range while those for countries at the positive end, the frequencies are in the range of 20%.

The variation among schools within countries is higher here than for the teacher support variable. The narrowest distributions among schools occur in Luxembourg, New Zealand, Greece, the Netherlands and Korea, as well as in the partner economies Indonesia, Brazil, Thailand and Macao-China, while the widest occur in Japan, Austria, the Czech Republic and Hungary and in the partner country Liechtenstein.

Student-teacher relations

A third index, the *index of student-teacher relations*, is an indicator of students' views on their school climate. The items included in this index are the following, with responses on a four-point agree-disagree scale:

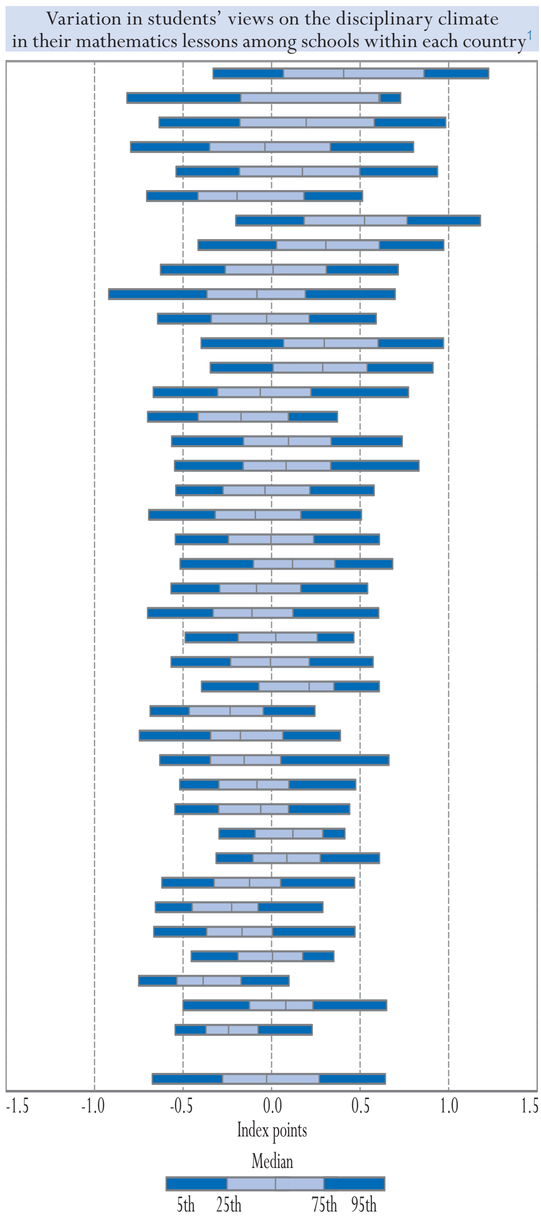
- STQ26a Students get along well with most teachers.
- STQ26b Most teachers are interested in students' well-being.
- STQ26c Most of my teachers really listen to what I have to say.
- STQ26d If I need extra help, I will receive it from my teachers.
- STQ26e Most of my teachers treat me fairly.

Figure 2.11 shows the patterns of agreement with these items and the range of variation across schools. The level of agreement with these statements is moderate to high, with percentages in the 50 to 80% range in most cases. The pattern across countries is quite similar to that for teacher support, and shows a comparable range, with more than one-and-a-quarter standard deviations between the 5th and 95th percentiles in Austria, Norway, Mexico and Germany and the partner countries Tunisia, Serbia and Brazil, and more than one-and-a-half standard deviations in Switzerland.

Figure 2.10 ■ Students' views on the disciplinary climate in their mathematics lessons

- **A** Students don't listen to what the teacher says.
- **B** There is noise and disorder.
- **C** The teacher has to wait for a long time for students to "quieten down".
- **D** Students cannot work well.
- **E** Students don't start working for a long time after the lesson begins.

	A	B	C	D	E
Japan	19	17	14	25	15
Liechtenstein	26	28	33	28	25
Austria	31	27	33	27	30
Czech Republic	36	34	34	25	25
Hungary	28	28	30	22	19
France	33	46	38	25	42
Russian Fed.	22	16	18	19	15
Germany	22	25	32	26	26
Belgium	28	37	34	19	33
Italy	37	42	39	25	33
Uruguay	32	37	32	24	31
Latvia	27	20	20	18	21
Ireland	32	32	25	19	21
Spain	30	35	36	24	35
Iceland	31	41	36	25	26
Poland	33	27	30	21	22
Switzerland	28	33	32	26	31
Australia	34	42	32	20	27
Denmark	32	43	28	20	27
Canada	29	39	28	18	31
United States	32	34	26	19	27
Sweden	26	36	33	20	28
Slovak Republic	39	34	34	25	28
Portugal	28	35	30	22	27
Mexico	29	27	26	24	34
Hong Kong-China	21	17	19	19	20
Norway	34	41	36	28	36
Finland	36	48	35	19	32
Turkey	24	33	35	31	31
Serbia	33	32	28	27	28
Tunisia	26	37	36	33	52
Macao-China	18	15	17	21	20
Korea	27	72	19	18	21
Netherlands	27	42	36	19	39
Greece	35	43	35	29	39
New Zealand	38	47	37	23	31
Thailand	22	27	32	23	28
Brazil	35	38	38	30	63
Indonesia	25	32	37	22	30
Luxembourg	35	48	43	39	35
United Kingdom[2]	33	42	36	22	29



Note: Countries are ranked in descending order of variation of student views on the disciplinary climate in their mathematics lessons between schools at the 25th and 75th percentiles.

1. At the 5th percentile students at only 5% of schools have a more negative view of disciplinary climate in their mathematics lessons. Students at a school at the 95th percentile have a more positive view of disciplinary climate in their mathematics lessons than students in 95% of the other schools.
2. Response rate too low to ensure comparability.

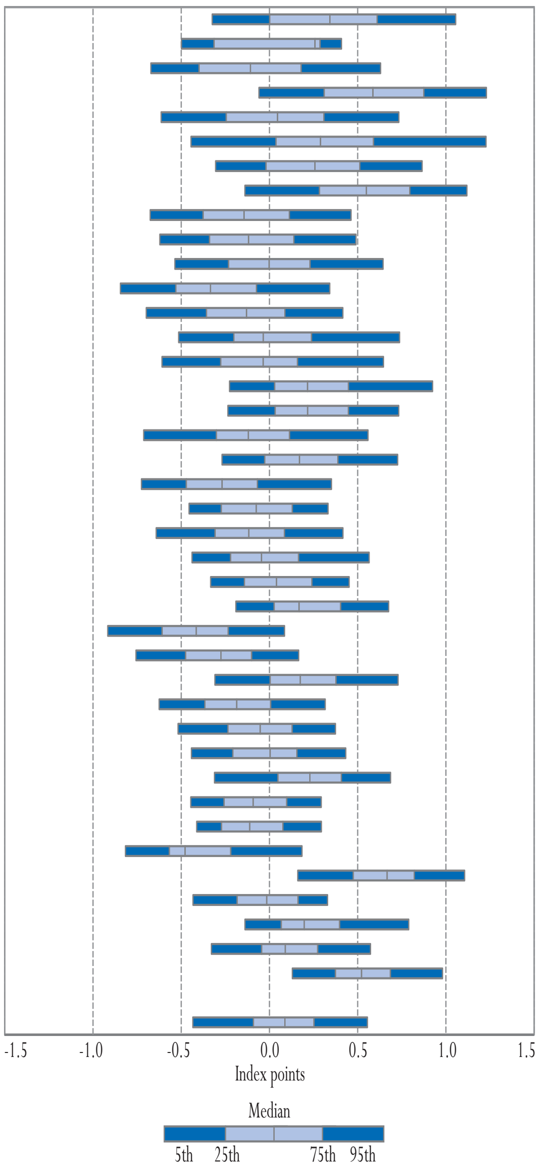
Source: OECD PISA 2003 Database.

Figure 2.11 ■ Students' views on student-teacher relations

- **A** Students get along well with most teachers.
- **B** Most teachers are interested in students' well-being.
- **C** Most of my teachers really listen to what I have to say.
- **D** If I need extra help, I will receive it from my teachers.
- **E** Most of my teachers treat me fairly.

	A	B	C	D	E
Tunisia	64	60	78	78	75
Liechtenstein	66	66	60	72	79
Serbia	56	62	59	73	70
Brazil	80	82	79	88	85
Austria	73	64	58	67	78
Switzerland	70	74	70	82	82
Denmark	78	80	71	82	90
Mexico	85	85	77	80	84
Spain	62	70	66	65	75
Greece	68	60	66	68	71
Iceland	70	70	65	77	76
Italy	59	65	59	58	65
Hungary	63	59	74	72	68
Latvia	74	76	70	71	79
Germany	66	60	58	67	75
Uruguay	81	77	78	77	77
Canada	73	78	72	90	84
Norway	74	66	55	75	74
Turkey	80	60	74	75	66
Slovak Republic	65	47	62	67	76
Netherlands	70	68	64	84	84
France	m	m	m	m	m
Russian Fed.	76	59	74	61	77
Hong Kong-China	84	65	66	83	75
Australia	78	82	72	87	86
Japan	64	45	54	58	67
Poland	67	47	62	68	69
United States	71	75	70	88	87
Czech Republic	64	66	56	78	74
Belgium	69	69	66	81	76
Ireland	72	78	60	77	82
Sweden	81	78	72	81	83
Macao-China	81	58	58	75	73
Korea	84	65	55	85	70
Luxembourg	56	53	50	53	67
Indonesia	m	m	m	m	m
Finland	73	64	64	86	81
Portugal	83	80	76	84	84
New Zealand	72	79	68	85	84
Thailand	93	91	84	86	91
United Kingdom[2]	71	79	62	87	81
OECD average	**71**	**68**	**65**	**76**	**77**

Variation in students' views on student-teacher relations among schools within each country[1]



Note: Countries are ranked in descending order of variation of student views on student-teacher relations between schools at the 25th and 75th percentiles.

1. At the 5th percentile students at only 5% of schools have a more negative view of student-teacher relations. Students at a school at the 95th percentile have a more positive view of student-teacher relations than students in 95% of the other schools.
2. Response rate too low to ensure comparability.

Source: OECD PISA 2003 Database.

SUMMARY: A PROFILE OF MATHEMATICS TEACHING AND LEARNING

Overall, the results of this analysis show a complex and widely varying picture of mathematics instruction both within and across participating countries. While it is almost impossible to present a simple summary, a qualitative profile can be developed by looking at mid-ranked countries and at those at the extremes of the various distributions.

Students in participating countries spend an average of 37 weeks per year in school. Most countries show only small differences between schools in the number of weeks in the school year. This evidence undoubtedly reflects either national consensus or national regulation of the school year. However, in several countries the between-school differences are striking. On average, the school week is 24.4 hours long, again with only small differences between schools in most countries. Multiplying number of weeks in the school year by hours per week gives a measure of total instructional time per year. This measure averages close to 1 000 hours in most countries, but ranges from a high of over 1300 hours in the partner country Thailand to fewer than 800 hours in Mexico. According to this measure, the school year is more variable within countries than the number of school weeks would suggest.

On average in the OECD countries, 15-year-olds report that they spend approximately 200 minutes per week, or 14% of total instructional time, on mathematics. This figure compares to averages of 17% of total compulsory instructional time spent on mathematics by 9-to-11-year-olds and 13% spent by 12-to-14-year-olds, as reported in the 2004 OECD-INES Survey on Teachers and the Curriculum.

In most countries, the profile shows that fewer than 20% of students have a tutor or participate in school-related classes outside school hours, and the amount of time spent on such activities is relatively small even for those who do participate. However, a few countries show very high proportions of students taking part in such activities. This finding is essentially unrelated to the amount of time spent in school. It is difficult to identify the factors that contribute to students' and parents' decisions to pursue such activities, and in particular whether such decisions relate to competitive environments, attempts to mitigate poor school performance or concern with the quality of schooling. It is also unclear if having a tutor or participating in out-of-class lessons relates to socio-economic status. However, the highest participation rates in these activities occur in a few countries with relatively low socio-economic levels. This evidence suggests several possibilities, including a strong emphasis on education as a way to improve individual economic prospects or, conceivably, the availability of inexpensive education services outside regular schools. Alternatively, of course, it is possible that the results represent anomalies due to misunderstanding of the question or another form of response bias.

According to the profile, almost all students do some homework outside school, both in mathematics and in other subjects. On average, students spend close to six hours per week on homework, of which about 2.5 hours is on mathematics. Proportionally, mathematics occupies more of students' homework time than of their school time, suggesting that there is greater emphasis on homework in mathematics than in other subject areas. There is substantial homework variation across schools in most countries. In some cases, the within-country variation is as great as the average variation across countries. This evidence suggests that the amount of homework completed is largely a function of school policies.

Of the three meta-cognitive learning strategies, it is clear that students use elaboration and control strategies more than memorisation/rehearsal strategies. However, the results indicate that, among the memorisation/rehearsal strategies, students favour using examples and trying to learn procedures over simple "learn by heart" memorisation. Within the elaboration cluster, learning to relate concepts to what is already known is more common and less variable than other strategies. Most of the specific strategies within the control cluster receive high support from students, with relatively little variation across countries. There is also relatively little variation across schools for these strategies, especially elaboration and control, suggesting that these are stable student attributes rather than highly influenced by the school. Memorisation and elaboration show higher than usual variation across schools in only a small number of countries.

In general, the profile shows students reporting stronger preferences for co-operative than for competitive learning situations in mathematics. In a few countries, students express strong preferences for both learning situations, while in others there is a clear division. While these constructs may intuitively appear mutually exclusive, or at least negatively related, the data do not support this argument.

Most school principals agree that their teachers are open to innovative teaching practices. There is more variation across countries in teacher support for traditional ways of teaching. The correlations between these two factors within countries are negative, indicating that school staff tend to support either traditional or innovative methods. In most countries, there is relatively little indication of disagreement among staff about these approaches.

A large majority of school principals in all countries believe that their teachers expect high academic standards of their students and that the development of mathematical skills and knowledge is the most important objective of mathematics teaching. However, there is wide variation across countries in the degree of support for adapting standards to student abilities. Most school principals also report that their teachers support the proposition that social and emotional goals are as important as acquiring mathematics skills and knowledge.

The profile shows that there are wide variations among countries in the degree of streaming of students into different mathematics classes based on ability. Streaming is particularly prevalent in the United Kingdom, New Zealand, Ireland, the United States, Australia and Canada. Variations occur among countries that otherwise have regional or cultural similarities. For example, streaming is prevalent in Norway and Sweden, but not in Denmark or Finland. Similarly, there is a high level of streaming in the partner economy Hong Kong-China but a relatively low level in Japan and in the partner economy Macao-China. The use of within-class grouping is much more widely variable than streaming. Surprisingly, many countries that practice high degrees of streaming also have high levels of within-class grouping. This combination is frequent in New Zealand, Australia, the United Kingdom, Ireland, the United States, Sweden, the Netherlands, Canada and the partner countries, the Russian Federation and Latvia.

The most frequently used methods of assessment in almost all countries are teacher tests and student assignments. Teacher ratings are also often used in most countries. However, there is considerable variation among countries in the use of standardised tests and student portfolios. School principals in most countries report that 20 to 39 student assessments take place each year. Since the assessment questions were not specific to mathematics, it is not clear if this is within subjects

or over all subjects. The most common use of assessments is for reporting to parents. Use of assessment for student retention is also common. However, in a few countries, notably Denmark, Iceland and Korea, this is only rarely the case. Use of assessments for comparison with national standards varies widely: this is the case in more than 80% of schools in some countries and in fewer than 10% of schools in others. Denmark stands out as rarely using assessment for any purpose other than reporting to parents.

The profile indicates a majority of students in most countries agreeing that activities associated with teacher support are frequently used in their classrooms and that student-teacher relations are generally positive. Most students feel that teachers take an interest in their learning, that teachers give them help when needed, that they have an opportunity to express opinions and that teachers treat them fairly. There are few extremes here, suggesting that most students in most countries have a positive view of their teachers. The smaller-than-average proportions of students who report noise and disruption and other disciplinary problems reinforce this finding. However, there appears to be more variation across schools in the *index of disciplinary climate in mathematics lessons* than in the *index of teacher support*, and more between-school differences on this set of variables than for learning strategies.

Differences that matter

The above description seems to show, in particular, that students' relations with their teachers and the disciplinary climate are two factors associated with better performance in which variation across schools can be considerable. The implication of this is that a more consistently positive teaching environment can contribute to reductions in between-school differences in performance, and this is more obviously so than might be the case for other factors examined here. The problem, as noted earlier, is that there is a likely interaction between disciplinary climate and student-teacher relations on the one hand and socio-economic and other student background factors on the other, possibly leading to a mutually reinforcing or mutually detrimental effect on achievement. This issue needs to be investigated more thoroughly than is possible in this overview study and can be revisited in PISA 2012.

However, the limited association with performance and degree of difference across schools for any one element studied suggests that a combination of teaching and learning factors may give students in one school an advantage over those in another. One noticeable trend in the summary tables in this chapter is that some countries show high levels of between-school differences across many factors, while others show consistently low levels of difference. In particular, Austria, Hungary, Italy and Mexico are among those countries with the widest variations in a range of factors, while Finland has relatively low variations on many factors. The combined impact of differences is likely to have a cumulative effect on student performance.

In interpreting the patterns presented in this profile, a central issue is the extent to which variations in teaching and learning practices affect students' chances of success, and where such differences are most significant. In some cases variations across countries are considerable, but they need to be interpreted with caution. Of greater interest is the large variation in teaching and learning factors between schools in some countries, giving unequal chances to different students. Also, the relationships noted in this chapter between teaching and learning strategies and student performance in mathematics represent simple correlations. The analysis of these relationships is refined in Chapter 3, using models in which the effect of a particular teaching or learning strategy is examined while adjusting for other variables.

Notes

1 There are a few exceptions to this among OECD countries. In particular, in Mexico, Portugal and Turkey, fewer than 90% of students aged 15 are enrolled in school (OECD, 2005).

2 Strictly speaking, teaching strategies should be thought of as characteristic of a teacher. However, in the absence of a teacher questionnaire, student perceptions of teaching strategies have been aggregated to the school level and considered representative of the school. In addition, some of the time variables, such as instructional weeks per year and instructional hours per week, are better conceptualised as school-level than as student-level factors. Nevertheless, in some countries, the existence of streaming and the fact that PISA students may be found in more than one grade implies that within-school differences in time allocation and use may also be important. Such differences are neither characteristic of schools nor of individual students but of sub-units within schools, and hence are not examined here.

3 The graphs in this chapter have been arranged in descending order of the range from the 25th to the 75th percentile. This order is designed to allow easy inspection of differences between schools within countries.

4 *Education at a Glance: OECD Indicators 2005* (OECD, 2005) shows Mexico's average total instructional hours as slightly longer than the OECD average.

5 Caution is required here as it is possible that students in some countries are giving what they perceive to be socially desirable responses.

6 Results based on the school questionnaire are presented as tables rather than graphs because multiple series bar graphs for a large number of countries are difficult to read and interpret. In this situation the tables are more compact than comparable graphs.

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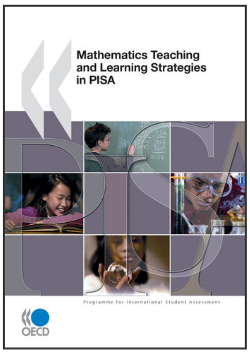

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