Student Learning: Attitudes, Engagement and Strategies

INTRODUCTION

Schools need to maintain and develop children's positive disposition to learning…

Most children come to school ready and willing to learn. How can schools foster and strengthen this predisposition and ensure that young adults leave school with the motivation and capacity to continue learning throughout life? Without the development of these attitudes and skills, individuals will not be well prepared to acquire the new knowledge and skills necessary for successful adaptation to changing circumstances.

…help students acquire the skills to manage their own learning…

In school, teachers manage much of students' learning. However, learning is enhanced if students can manage it themselves; moreover, once they leave school, people have to manage most of their own learning. To do this, they need to be able to establish goals, to persevere, to monitor their learning progress, to adjust their learning strategies as necessary and to overcome difficulties in learning. Students who leave school with the autonomy to set their own learning goals and with a sense that they can reach those goals are better equipped to learn throughout their lives.

…foster students' interest in and positive attitudes towards the subjects they learn…

A genuine interest in school subjects is important as well. Students with an interest in a subject like mathematics are likely to be more motivated to manage their own learning and develop the requisite skills to become effective learners of that subject. Hence, interest in mathematics is relevant when considering the development of effective learning strategies for mathematics. In contrast, anxiety about learning mathematics can act as a barrier to effective learning. Students who feel anxious about their ability to cope in mathematics learning situations may avoid them and thus lose important career and life opportunities.

…and strengthen student engagement with school more generally.

Finally, the majority of students' learning time is spent in school and as such the climate of the school is important for the creation of effective learning environments. If a student feels alienated and disengaged from the learning contexts in school, his or her potential to master fundamental skills and concepts and develop effective learning skills is likely to be reduced.

To shed light on this, PISA assessed student approaches to learning…

A comprehensive assessment of how well a country is performing in education must therefore look at these cognitive, affective and attitudinal aspects in addition to academic performance. To this end, PISA 2003 establishes a broader profile of what students are like as learners at age 15, one that includes students' learning strategies and some of the non-cognitive outcomes of schooling that are important for lifelong learning: their motivation, their engagement and their beliefs about their own capacities. Since the focus of PISA 2003 was on mathematics, most of these issues were analysed in the context of mathematics as well.

…and this chapter gives a profile of…

This chapter reports and analyses these results. It seeks to provide a better understanding of how various aspects of students' attitudes to learning and their learning behaviour relate to each other and to student performance, it observes how these relationships differ across countries, and it explores the distribution of relevant characteristics among students, schools and countries. After summarising existing evidence and explaining how students' characteristics as learners are measured and reported in 2003, the chapter analyses in turn:

- *Students' engagement with mathematics and school*. This is related both to their own interest and enjoyment and to external incentives. Subject motivation is often regarded as the driving force behind learning, but the analysis extends the picture to students' more general attitudes towards school including students' sense of belonging at school.

…students' engagement with mathematics and school…

- *Students' beliefs about themselves*. This includes students' views about their own competence and learning characteristics in mathematics, as well as attitudinal aspects, which have both been shown to have a considerable impact on the way they set goals, the strategies they use and their performance.

…students' beliefs about themselves as learners…

- *Students' anxiety in mathematics*, which is common among students in many countries and is known to affect performance.

…their anxiety in mathematics…

- *Students' learning strategies*. This considers what strategies students use during learning. Also of interest is how these strategies relate to motivational factors and students' self-related beliefs as well as to students' performance in mathematics.

…and student learning strategies.

The chapter places considerable emphasis on comparing approaches to learning for males and females. Although Chapter 2 has shown gender differences in student performance in mathematics to be moderate, this chapter shows that there are marked differences between males and females in their interest in and enjoyment of mathematics, their self-related beliefs, as well as their emotions and learning strategies related to mathematics. An important reason why these additional dimensions warrant policy attention is that research shows them to influence decisions about enrolment in school tracks or study programmes and courses where mathematics is an important subject. These decisions may, in turn, shape students' post-secondary education and career choices.

It also examines gender differences in student approaches to learning, which can influence future learning and career paths.

When interpreting the analyses reported in this chapter, three caveats need to be borne in mind. First, constructs such as interest in and enjoyment of mathematics and the use of particular types of learning strategies are based on students' self-reports, and not on direct measures. To measure directly whether students actually adopt certain approaches to learning, one would need to examine their actions in specific situations. This requires in-depth interview and observation methods of a type that cannot be applied in a large-scale survey like PISA (Artelt, 2000; Boekaerts, 1999; Lehtinen, 1992). While PISA collects information on the extent to which students generally adopt various learning strategies that have been shown to be important for successful learning outcomes, such necessary preconditions for successful learning do not guarantee that a student will actually regulate his or her learning on specific occasions. However, by looking at such characteristics and at students' views on how they see themselves, one can obtain a good indication of whether a student is likely to regulate his or her own learning, and this is the approach taken by PISA. At the centre of this approach is the hypothesis that students who approach learning with confidence, with strong motivation and with a range of learning strategies at their disposal are more likely to be successful learners. This hypothesis has been borne out by the research referred to in Box 3.1.

Bear in mind that the characteristics discussed in this chapter are self-reported…

…that cultural differences make cross-country comparison of some of the learner characteristics difficult…

Second, students across countries may vary with respect to how they perceive and respond to the questionnaire items on which the constructs are based. This is quite understandable since the survey asks students to make subjective assessments about things such as how hard they work, while at the same time students perceive their attitudes and behaviour within a frame of reference shaped by their school and culture. It cannot be taken for granted, for example, that a student who says that he or she works hard has characteristics comparable to a student in another country who says the same: cultural factors can influence profoundly the way in which such responses are given. This is emphasised by research showing that self-reported characteristics are vulnerable to problems of comparability across cultures (*e.g.,* Heine *et al.,* 1999; van de Vijver and Leung, 1997; Bempechat, *et al.,* 2002) and has been confirmed by analyses of students' responses in PISA. Analyses of PISA 2000 data (OECD, 2003b) as well as PISA 2003 data have shown that for some of the student characteristics measured in PISA, most notably their self-beliefs and their sense of belonging at school, valid cross-country comparisons can be made. In these cases, similar relationships between self-reported characteristics and student performance within and across countries indicate that the characteristics being measured are comparable across countries. In contrast, for other measures – most notably interest in mathematics, instrumental motivation, the use of elaboration and control strategies – cross-country comparisons are more difficult to make.

…though not impossible…

Nevertheless, even where cross-country comparisons of student reports are problematic, it is often still possible to compare the distribution of a particular characteristic among students within different countries. Thus, for example, while the average level of instrumental motivation in two countries may not be comparable in absolute terms, the way in which student scores on a scale of instrumental motivation are distributed around each country's average can be compared in building up country profiles of approaches to learning. Differences among subgroups within countries as well as structural relationships between students' approaches to learning and their performance on the combined PISA mathematics test will therefore be the main focus of the results presented here.

…and that, while analyses of associations raise questions of causality, these remain difficult to answer.

Third, while analyses of associations raise questions of causality, these remain difficult to answer. It may be, for example, that good performance and attitudes towards learning are mutually reinforcing. Alternatively, it could be that students with higher natural ability both perform well and use particular learning strategies. Other factors, such as home background or differences in the schooling environment, may also play a part. However, research has identified some measurable learning characteristics of students that are associated with the tendency to regulate learning, as well as with better performance. Research has also shown that learning is more likely to be effective where a student plays a proactive role in the learning process – for example drawing on strong motivation and clear goals to select an appropriate learning strategy.[1] These are the basis for this chapter.

Existing evidence on student approaches to learning and how it frames PISA's approach

PISA draws on existing research…

Evidence from earlier research has played an important role in the construction of the PISA measures on learner characteristics, both in terms of establishing which aspects of students' learning approaches are important and in terms of developing accurate measures of those approaches.

…that has focused on how students regulate their own learning.

Research on effective student approaches to learning has focused on understanding what it is for a student to regulate his or her own learning. This focus derives both from the direct evidence (Box 3.1) that such regulation yields benefits in terms of improved student performance and also from the assumption (albeit not presently backed by strong research) that lifelong learning is reliant on self-regulation. The latter view is increasingly important in analysis of educational outcomes. For example, a large conceptual study on *Defining and Selecting Competencies,* carried out by the Swiss Federal Statistical Office in collaboration with the OECD, identified three key categories of the broader outcomes of schooling. One of these, personal skills, was defined in terms of "the ability to act autonomously" (Rychen and Salganik, 2002).[2]

Self-regulated learning involves motivation and the ability to adopt appropriate goals and strategies…

Although there have been varying definitions of self-regulated learning, it is generally understood to involve students being motivated to learn, selecting appropriate learning goals to guide the learning process using appropriate knowledge and skills to direct learning and consciously selecting learning strategies appropriate to the task at hand.

Box 3.1 ■ **Students who regulate their learning perform better**

There is a broad literature on the effects of self-regulated learning on scholastic achievement. Students who are able to regulate their learning effectively are more likely to achieve specific learning goals. Empirical evidence for such positive effects of regulating one's learning and using learning strategies stems from:

- Experimental research (*e.g.,* Willoughby and Wood, 1994);
- Research on training (*e.g.,* Lehtinen, 1992; Rosenshine and Meister, 1994); and
- Systematic observation of students while they are learning (*e.g.,* Artelt, 2000) including studies that ask students to think aloud about their own awareness and regulation of learning processes (*e.g.,* Veenman and van Hout-Wolters, 2002).

Research demonstrates the importance of a combination of such factors in a particular learning episode (*e.g.*, Boekaerts, 1999). Students must be able to draw simultaneously on a range of resources. Some of these resources are concerned with knowledge about how to process information (cognitive resources) and awareness of different available learning strategies (metacognitive resources). Learners may be aware of appropriate learning strategies, but not put them into use (Flavell and Wellman, 1977). Therefore, students also need motivational resources that contribute to their readiness, for example, to define their own goals, interpret success and failure appropriately, and translate wishes into intentions and plans (Weinert, 1994).

…as well as the interaction between what students know and can do and their dispositions.

Self-regulated learning thus depends on the interaction between what students know and can do on the one hand, and on their motivation and dispositions on the other. PISA's investigation of student approaches to learning is therefore based on a model combining these two broad elements. They interact strongly with each other. For example, students' motivation to learn has a profound impact on their choice of learning strategies because, as shown below, some strategies require a considerable degree of time and effort to implement (Hatano, 1998).

Studies investigating how students actually regulate learning and use appropriate strategies have found particularly strong associations between approaches to learning and performance. Less direct but easier to measure, students' attitudes and behaviours associated with self-regulated learning – such as their motivation and tendency to use certain strategies – are also associated with performance, albeit generally less strongly.

Measuring whether students are likely to adopt effective approaches to learning

PISA considered student characteristics that make positive approaches to learning more likely…

Following the principle described above – that certain characteristics make it more likely that students will approach learning in beneficial ways – PISA examined a number of such characteristics and asked students several questions about each of them in the context of mathematics. These categories came under the four broad elements of motivation, self-related beliefs, emotional factors and learning strategies. Figure 3.1 sets out the characteristics being investigated, giving a brief rationale for their selection, based on previous research, as well as examples of exactly what students were asked. The full set of questions is shown in Annex A1.

…based on reasonably reliable self-reports.

To what extent can one expect an accurate self-assessment by 15-year-olds of their learning approaches? Evidence from selected countries shows that by the age of 15, students' knowledge about their own learning and their ability to give valid answers to questionnaire items have developed considerably (Schneider, 1996). It can thus be assumed that the data provide a reasonable picture of student learning approaches.

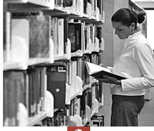


Figure 3.1 ■ **Characteristics and attitudes of students as learners in mathematics**

Category of characteristics and rationale	Student characteristics used to construct a scale to report results
A. Motivational factors and general attitudes towards school Motivation is often considered the driving force behind learning. One can distinguish motives deriving from external rewards for good performance such as praise or future prospects and internally generated motives such as interest in subject areas (Deci and Ryan, 1985). Students' more general attitudes towards school and their sense of belonging at school were also considered both as predictors for learning outcomes and as important outcomes of schooling in themselves.	**1. *Interest in and enjoyment of mathematics.*** Students were asked about their interest in mathematics as a subject as well as their enjoyment of learning mathematics. Interest in and enjoyment of a subject is a relatively stable orientation that affects the intensity and continuity of engagement in learning situations, the selection of strategies and the depth of understanding. **2. *Instrumental motivation in mathematics.*** Students were asked to what extent they are encouraged to learn by external rewards such as good job prospects. Longitudinal studies (*e.g.,* Wigfield *et al.,* 1998) show that such motivation influences both study choices and performance. **3. *Attitudes toward school.*** Students were asked to think about what they had learned at school in relation to how the school had prepared them for adult life, given them confidence to make decisions, taught them things that could be useful in their job or been a waste of time. **4. *Sense of belonging at school.*** Students were asked to express their perceptions about whether their school was a place where they felt like an outsider, made friends easily, felt like they belonged, felt awkward and out of place or felt lonely.
B. Self-related beliefs in mathematics Learners form views about their own competence and learning characteristics. These have considerable impact on the way they set goals, the strategies they use and their achievement (Zimmerman, 1999). Two ways of defining these beliefs are: in terms of how well students think that they can handle even difficult tasks – self-efficacy (Bandura, 1994); and in terms of their belief in their own abilities – self-concept (Marsh, 1993). These two constructs are closely associated with one another, but nonetheless distinct. Self-related beliefs are sometimes referred to in terms of self-confidence, indicating that such beliefs are positive. In both cases, confidence in oneself has important benefits for motivation and for the way in which students approach learning tasks.	**5. *Self-efficacy in mathematics.*** Students were asked to what extent they believe in their own ability to handle learning situations in mathematics effectively, overcoming difficulties. This affects students' willingness to take on challenging tasks and to make an effort and persist in tackling them. It thus has a key impact on motivation (Bandura, 1994). **6. *Self-concept in mathematics.*** Students were asked about their belief in their own mathematical competence. Belief in one's own abilities is highly relevant to successful learning (Marsh, 1986), as well as being a goal in its own right.

C. Emotional factors in mathematics Students' avoidance of mathematics due to emotional stress is reported to be widespread in many countries. Some research treats this construct as part of general attitudes to mathematics, though it is generally considered distinct from attitudinal variables.	**7.** ***Anxiety in mathematics.*** Students were asked to what extent they feel helpless and under emotional stress when dealing with mathematics. The effects of anxiety in mathematics are indirect, once self-related cognitions are taken into account (Meece *et al.,* 1990).
D. Student learning strategies in mathematics Learning strategies are the plans students select to achieve their goals: the ability to do so distinguishes competent learners who can regulate their learning (Brown *et al.,* 1983). Cognitive strategies that require information processing skills include, but are not limited to, memorisation and elaboration. Metacognitive strategies, entailing conscious regulation of one's own learning, are measured in the concept of control strategies.	**8.** ***Memorisation / rehearsal strategies.*** Students were asked about their use of learning strategies for mathematics that involve representations of knowledge and procedures stored in memory with little or no further processing. **9.** ***Elaboration strategies.*** Students were asked about their use of learning strategies for mathematics that involve connecting new material to prior learning. By exploring how knowledge learned in other contexts relates to new material students acquire greater understanding than through simple memorisation. **10.** ***Control strategies.*** Students were asked about their use of learning strategies for mathematics that involve checking what one has learned and working out what one still needs to learn, allowing learners to adapt their learning to the task at hand. These strategies are used to ensure that one's learning goals are reached and are at the heart of the approaches to learning measured by PISA.

STUDENTS' ENGAGEMENT WITH LEARNING IN MATHEMATICS AND SCHOOL MORE GENERALLY

This section examines four aspects of student engagement with mathematics and school and relates these to performance.

This section describes four constructs collected from students in PISA 2003 that are related to a positive disposition to school and learning and then proceeds to report how these variables relate to achievement. Two of the constructs are specific to learning in mathematics (interest in and enjoyment of mathematics or intrinsic motivation, and instrumental or external motivation), while two relate to more general engagement with schooling (attitude towards school and sense of belonging at school). As well as being related thematically, these variables are related to each other empirically – *i.e.* there are strong associations between them.

Interest in and enjoyment of mathematics

Intrinsic motivation shows whether students have interest which encourages them to study hard.

Motivation and engagement can be regarded as the driving forces of learning. They can also affect students' quality of life during their adolescence and can influence whether they will successfully pursue further educational or labour market opportunities. In particular, given the importance of mathematics for students' future lives, education systems need to ensure that students have

Box 3.2 ■ **Interpreting the PISA indices**

The measures are presented as indices that summarise student responses to a series of related questions constructed on the basis of previous research (Annex A1). The validity of comparisons across countries was explored using structural equation modelling. In describing students in terms of each characteristic (*e.g.,* interest in mathematics), scales were constructed on which the average OECD student (*e.g.,* the student with an average level of interest) was given an index value of zero, and about two-thirds of the OECD student population are between the values of -1 and 1 (*i.e.,* the index has a standard deviation of 1). Negative values on an index do not necessarily imply that students responded negatively to the underlying questions. Rather, a student with a negative score responded less positively than students on average across OECD countries. Likewise, a student with a positive score responded more positively than the average in the OECD area. As each indicator is introduced below, a diagram shows more precisely which scores are associated with particular responses.

Wherever standard deviations are reported, these refer to the standard deviation of the distribution in the OECD area.

Box 3.3 ■ **Comparing the magnitude of differences across countries**

Sometimes it is useful to compare differences in an index between groups, such as males and females, across countries. A problem that may occur in such instances is that the distribution of the index varies across countries. One way to resolve this is to calculate an effect size that accounts for differences in the distributions. An effect size measures the difference between, say, the interest in mathematics of male and female students in a given country, relative to the average variation in interest in mathematics scores among male and female students in the country.

An effect size also allows a comparison of differences across measures that differ in their metric. For example, it is possible to compare effect sizes between the PISA indices and the PISA test scores.

In accordance with common practices, effect sizes less than 0.20 are considered small in this volume, effect sizes in the order of 0.50 are considered medium, and effect sizes greater than 0.80 are considered large. Many comparisons in this chapter consider differences only if the effect sizes are equal to or great than 0.20, even if smaller differences are still statistically significant.

For detailed information on the construction of the indices, see Annex A1.

both the interest and the motivation to continue learning in this area beyond school. Interest in and enjoyment of particular subjects, or *intrinsic motivation*, affects both the degree and continuity of engagement in learning and the depth of understanding reached. This effect has been shown to operate largely independently of students' general motivation to learn (see also the last section of this chapter). For example, a student who is interested in mathematics and therefore tends to study diligently may or may not show a high level of

general learning motivation, and vice versa. Hence, an analysis of the pattern of students' interest in mathematics is important. Such an analysis can reveal significant strengths and weaknesses in attempts by education systems to promote motivation to learn in various subjects among different sub-groups of students.

Students feel much less positive overall about mathematics than reading…

In PISA 2000, which focussed on reading, students felt generally positive about reading. In contrast, students in PISA 2003 (as well as in PISA 2000) expressed less enthusiasm for mathematics. For example while, on average across OECD countries, about half of the students report being interested in the things they learn in mathematics, only 38 per cent agree or strongly agree with the statement that they do mathematics because they enjoy it.

Less than one-third report looking forward to their mathematics lessons. In fact, in countries such as Belgium, Finland, France, Korea, Iceland, Italy, Latvia, the Netherlands, Portugal, Serbia[3] and Spain fewer than half as many students who report an interest in the things they learn in mathematics, say that they look forward to their mathematics lessons (Figure 3.2).

…and it is important to understand reasons for this and how negative attitudes to mathematics can be avoided.

It is, of course, well established that intrinsic motivation tends to be lower at later stages of schooling and students seem often to lose interest in and enjoyment of mathematics after primary education. This is partly an effect of increasing differentiation of students' interests and their investment of time as they grow older. However, to what extent is lower interest in mathematics an inevitable outcome, and to what extent a consequence of the ways in which schooling takes place and mathematics is taught? One way to examine this is to explore how educational systems vary in this respect and to what extent any observed differences among schools within countries in student motivation relate to differences in educational policies and practices.

A standardised scale shows the strength of students' interest and enjoyment.

Students' reports of their interest in and enjoyment of mathematics can be represented on an index constructed so that the average score across OECD countries is 0 and two-thirds score between 1 and -1. A positive value on the index indicates that students report interest in and enjoyment of mathematics higher than the OECD average. A negative value indicates an interest lower than the OECD average (Box 3.2).[4]

While this kind of measure cannot be easily compared across cultures…

The OECD averages mask significant differences among countries. For example, in the Czech Republic, Hungary and Japan 40 per cent or less of students agree or strongly agree that they are interested in the things they learn in mathematics, while more than two-thirds of students in France, Mexico and Portugal, as well as in the PISA partner countries Brazil, Indonesia, the Russian Federation, Thailand, Tunisia, and Uruguay agree or strongly agree with this statement. This being said, research in PISA 2000 pointed out that it is difficult to interpret the meaning of absolute values on the index of interest in and enjoyment of mathematics across countries and cultures (Figure 3.2 and Table 3.1).

Nevertheless, even if absolute index values are difficult to compare across countries, it is reasonable to compare how closely student interest in and enjoyment of mathematics relate to student performance within each country. While the results from PISA 2003 do not necessarily show that countries with "more interested" students achieve, on average, better mathematics results (in fact, students in one of the best performing countries, Japan, report the lowest interest in and enjoyment of mathematics), the results do show that, within each country, students with greater interest in and enjoyment of mathematics tend to achieve better results than those with less interest in and enjoyment of mathematics. However, the strength of this relationship varies by country.

…it is possible to examine how student motivation relates to mathematics performance…

Table 3.1 shows in more detail the relationship between students' interest in and enjoyment of mathematics and mathematics performance. This is done by dividing students into four groups according to their value on the index. The average mathematics score of students in each of the four groups is shown for each country. When comparing across countries how well students in the top quarter and the bottom quarter of the index perform in mathematics, readers should bear in mind that the overall level of interest in mathematics itself varies between countries, so that these score differences should be interpreted with respect to each country mean. The third panel of Figure 3.2 summarises the relationship between interest in and enjoyment of mathematics and mathematics performance. The length of the bar shows the increase in mathematics scores per unit (*i.e.,* one OECD standard deviation) of the index of interest in and enjoyment of mathematics. The values to the right of the bar show the percentage of variance in mathematics performance that is explained by the index of interest in and enjoyment of mathematics. On average across OECD countries, the increase is equal to 12 score points. But the increase ranges from a negligible or very modest impact in Austria, Hungary, Luxembourg, Mexico, the United States and the partner countries Indonesia, Liechtenstein, Serbia, Thailand and Tunisia to between 27 and 36 score points, or roughly half a proficiency level in mathematics or the equivalent of the performance difference corresponding to a year of schooling,[5] in Denmark, Finland, Japan, Korea, Norway, Sweden and the partner country Hong Kong-China. Finland, Japan and Korea stand out because their average performance in mathematics is high but students do not express strong interest in mathematics. Nevertheless, the performance gap within these countries between students who express greater or lesser interest is also high, with the PISA index of interest in and enjoyment of mathematics explaining 11 per cent of the variance in mathematics performance in Finland and 8 per cent in Japan.

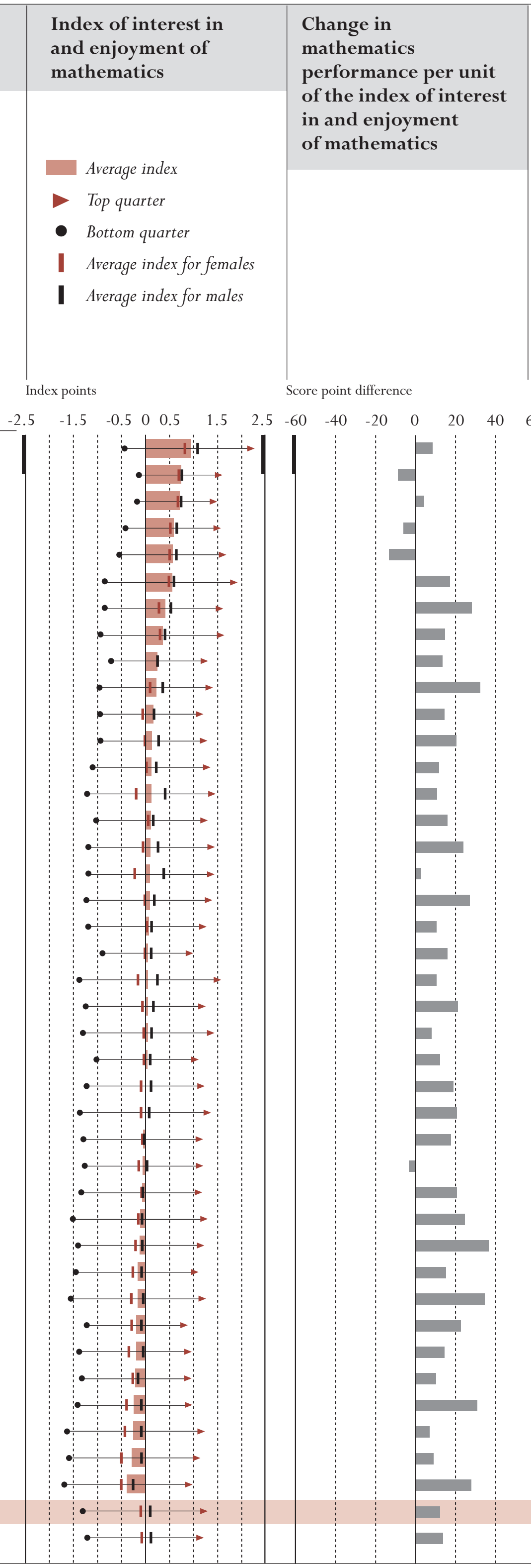
…and this comparison reveals that the association is much stronger in some countries than in others.

As noted before, the causal nature of this relationship may well be complex and is difficult to discern. Interest in the subject and performance may be mutually reinforcing and may also be affected by other factors, such as the social backgrounds of students and their schools. Indeed, as shown later in Table 3.12, the relationship between intrinsic motivation and student performance in mathematics diminishes considerably or even becomes negligible in most

Even though interest in mathematics cannot be clearly said to cause better performance, it is of value in its own right.

Figure 3.2 ■ Students' interest in and enjoyment of mathematics

	Percentage of students agreeing or strongly agreeing with the following statements: I enjoy reading about mathematics.	I look forward to my mathematics lessons.	I do mathematics because I enjoy it.	I am interested in the things I learn in mathematics.	Percentage of explained variance in student performance
Tunisia	76	63	67	82	1.0
Indonesia	78	65	74	70	0.5
Thailand	70	66	69	84	0.1
Mexico	64	50	45	87	0.4
Brazil	52	47	61	80	1.4
Turkey	60	50	58	65	3.0
Denmark	48	47	59	65	8.8
Uruguay	40	51	48	70	2.2
Russian Fed.	28	41	41	69	1.3
Hong Kong-China	37	45	52	51	9.2
Portugal	35	27	47	69	1.9
Macao-China	34	35	45	43	4.2
New Zealand	35	41	39	56	1.3
Switzerland	24	41	52	60	1.2
Poland	40	30	40	54	2.5
Greece	46	27	44	50	6.7
Liechtenstein	22	41	52	54	0.1
Sweden	49	30	35	53	8.4
Italy	31	28	47	60	1.0
Latvia	26	22	41	55	1.8
Germany	21	40	43	55	1.4
France	31	24	47	67	4.9
United States	32	40	34	51	0.7
Slovak Republic	27	34	33	58	1.2
Australia	28	37	36	51	3.5
Canada	31	34	36	52	5.8
Ireland	29	32	33	48	3.8
Serbia	29	20	35	48	0.2
Spain	32	20	37	61	5.1
Iceland	33	24	38	49	8.6
Korea	29	22	31	44	15.5
Belgium	23	23	33	54	1.9
Norway	26	29	34	50	16.2
Czech Republic	10	30	31	40	3.9
Netherlands	20	20	35	46	2.1
Hungary	18	24	27	40	0.9
Finland	18	20	25	45	11.2
Luxembourg	21	30	33	43	0.6
Austria	20	31	28	41	1.0
Japan	13	26	26	32	7.9
OECD average	*31*	*31*	*38*	*53*	*1.5*
United Kingdom[1]	30	35	34	49	1.9



1. Response rate too low to ensure comparability (see Annex A3).
Source: OECD PISA 2003 database, Table 3.1.

countries when other learner characteristics are accounted for. However, whatever the nature of this relationship, a positive disposition towards mathematics remains an important educational goal in its own right.

It is of concern that in most countries males are statistically significantly more interested in mathematics than females, and in half of the countries this difference is very substantial.

While the preceding chapter showed that differences in the mathematics performance of males and females in at least two of the four mathematics scales tend to be small or moderate, it is noteworthy that, with the exception of Iceland, Ireland, Portugal, Spain and the partner countries the Russian Federation and Thailand, males express significantly higher interest in and enjoyment of mathematics than females, and particularly so in Austria, Germany, Switzerland and the partner country Liechtenstein (Table 3.1). As an example, on average across OECD countries, 37 per cent of males (compared with 25 per cent of females) agree or strongly agree with the statement that they enjoy reading about mathematics. As an even more extreme example, in Switzerland 33 per cent of males compared with just 13 per cent of females report enjoying reading about mathematics (for data see *www.pisa.oecd.org*). When gender differences on the PISA index of interest in and enjoyment of mathematics are converted into effect sizes (Figure 3.14 and Table 3.16), 21 of the 41 countries participating in PISA show effect sizes equal to or greater than 0.20, which can be interpreted as relevant to educational policy (Box 3.3). In contrast, gender differences in mathematics performance that exceed effect sizes of 0.20 only exist in Greece, Korea and the Slovak Republic and in the partner countries Liechtenstein and Macao-China (Table 3.16, Box 3.3).

This is of concern for policy as these data reveal inequalities between the genders in the effectiveness with which schools and societies promote motivation and interest in mathematics.

Instrumental motivation

Most students believe that success in mathematics will help them in their future work and study…

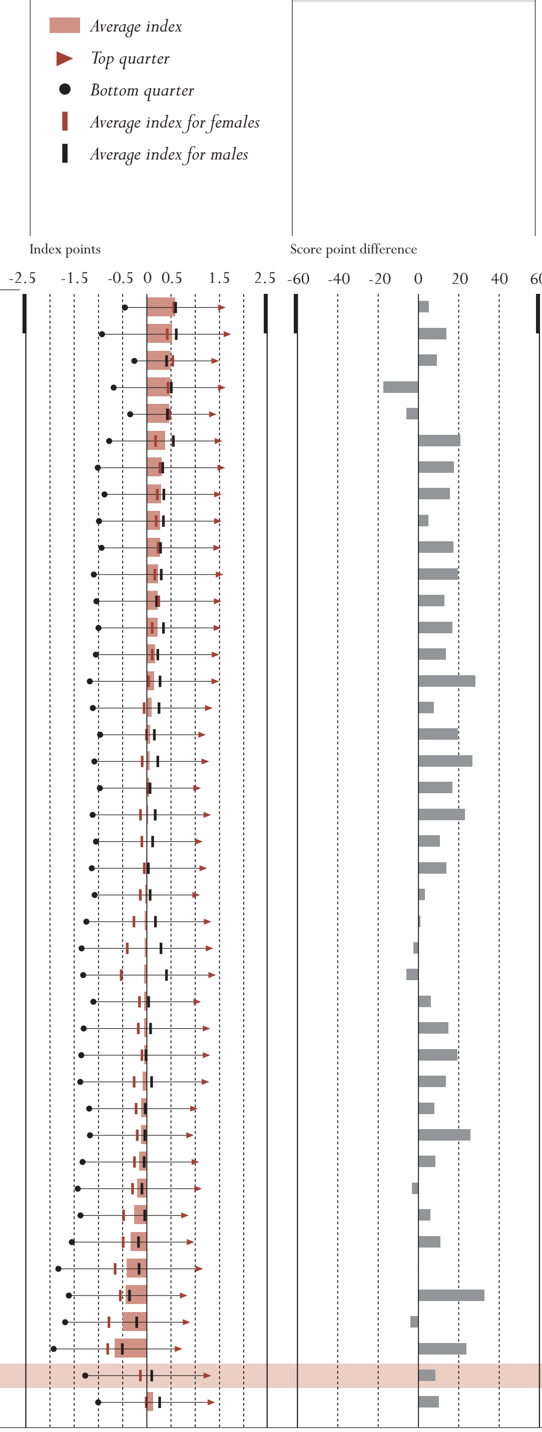
Beyond a general interest in mathematics, how do 15-year-olds assess the relevance of mathematics to their own life and what role does such external motivation play with regard to their mathematics performance? Among OECD countries 75 per cent of 15-year-olds agree or strongly agree with the statements that making an effort in mathematics is worth it because it will help them in the work that they want to do later on. Seventy-eight per cent of 15-year-olds agree or strongly agree that learning mathematics is important because it will help them with the subjects that they want to study further on in school. Sixty-six per cent of them agree or strongly agree that mathematics is an important subject because they need it for what they want to study later on. And 70 per cent agree or strongly agree that they will learn many things in mathematics that will help them get a job (see first panel of Figure 3.3a).

…but in some countries only half have such attitudes, a notable finding despite difficulties with comparability.

Nevertheless, significant proportions of students disagree or disagree strongly with such statements. There is also considerable cross-country variation in self-reported instrumental motivation. Only half of the students in Japan and Luxembourg agree or strongly agree that making an effort in mathematics is

Figure 3.3a ■ Students' instrumental motivation in mathematics

	Percentage of students agreeing or strongly agreeing with the following statements: Making an effort in mathematics is worth it because it will help me in the work that I want to do later.	Learning mathematics is important because it will help me with the subjects that I want to study further on in school.	Mathematics is an important subject for me because I need it for what I want to study later on.	I will learn many things in mathematics that will help me get a job.	Percentage of explained variance in student performance
Mexico	95	94	82	91	0.3
Tunisia	84	82	82	81	3.1
Thailand	96	93	94	93	0.6
Brazil	89	86	81	88	2.4
Indonesia	94	90	95	89	0.3
Denmark	91	88	75	83	4.3
Iceland	83	85	79	78	4.0
New Zealand	85	89	77	82	2.2
Uruguay	83	83	71	84	0.2
Portugal	82	89	80	80	3.5
Canada	80	87	73	79	5.4
Turkey	81	86	79	66	1.5
Australia	83	87	74	79	3.0
United States	81	82	73	83	2.0
Norway	82	82	75	73	10.1
Ireland	80	85	66	75	0.7
Latvia	82	84	68	79	3.6
Finland	73	87	74	76	8.5
Poland	79	87	79	79	2.4
Sweden	71	86	67	73	5.3
Czech Republic	74	81	74	77	1.0
Russian Fed.	77	70	68	72	1.9
Macao-China	79	85	71	65	0.1
Germany	73	79	48	72	0.0
Switzerland	76	75	52	66	0.1
Liechtenstein	77	70	51	59	0.4
Slovak Republic	76	81	64	77	0.3
Greece	74	72	63	70	2.6
Spain	76	79	63	68	5.1
France	73	74	65	62	2.4
Hungary	79	71	69	67	0.5
Hong Kong-China	74	82	70	63	4.9
Italy	69	76	66	65	0.7
Serbia	73	73	54	60	0.1
Netherlands	70	71	63	61	0.4
Belgium	66	65	56	57	1.1
Luxembourg	52	61	51	53	0.0
Korea	57	60	58	46	12.0
Austria	64	51	36	56	0.2
Japan	49	43	41	47	6.2
OECD average	*75*	*78*	*66*	*70*	*0.7*
United Kingdom[1]	83	87	65	77	1.1



1. Response rate too low to ensure comparability (see Annex A3).
Source: OECD PISA 2003 database, Table 3.2a.

worth it, because it will help them in the work they want to do (Figure 3.3a). Similarly, the percentage of students that agree or strongly agree that they will learn many things in mathematics that will help them get a job is only around 46 per cent in Japan and Korea and also less than 60 per cent in Austria, Belgium and Luxembourg (it is 70 per cent on average across the OECD). Among the partner countries, this figure is equal to or more than 60 per cent. While the difficulties of comparing student responses on this index across cultures are acknowledged, the magnitude of these observed differences warrants attention.

While the links between instrumental motivation and mathematics performance are often weak…

As in the case of interest in and enjoyment of mathematics, countries can be compared on an index that summarises the different questions about instrumental motivation in mathematics (see *www.pisa.oecd.org* for the item map and Table 3.2a and Figure 3.3a for data). The third panel of Figure 3.3a shows the relationship between student instrumental motivation in mathematics and mathematics performance, measured in terms of the increase in mathematics performance associated with a one unit (one standard deviation) increase on the PISA index of instrumental motivation (Table 3.2a).

… in some countries students who are instrumentally motivated typically expect to stay in education for longer, and it is noteworthy…

Although the results show that the relationship between performance and instrumental motivation is much weaker than with intrinsic motivation (*i.e.,* interest in and enjoyment of mathematics), instrumental or extrinsic motivation has been found to be an important predictor for course selection, career choice and performance (Eccles, 1994).

Obviously, the choices that the 15-year-olds assessed in PISA 2003 will make in their future lives cannot be known. However, PISA asked 15-year-olds what education level they expect to attain. In most countries, levels of instrumental motivation are higher among students aspiring to at least completing educational programmes that provide access to tertiary education. This relationship is stronger still if the students expect to complete a tertiary programme, as is shown in the first panel of Figure 3.3b (Table 3.2b). However, this pattern is not universal, as shown in the second panel of the same figure.

…that in countries where female 15-year-olds show the lowest levels of instrumental motivation, relatively fewer women graduate from university with degrees in mathematics or computer science.

Last but not least, it is also noteworthy that in the countries where the difference in instrumental motivation between males and females is largest, namely in Austria, Germany, the Netherlands and Switzerland, the share of women graduating from university-level tertiary programmes in mathematics or computer science is below the OECD average and in some of these countries it is significantly below this benchmark (OECD, 2004a).[6] This observation supports the hypothesis that instrumental motivation in different subject matter areas, combined with other influences, is predictive of the future labour market and career choice of students. These differences are even more striking as Table 3.3 shows that, overall, females have higher expectation toward their future occupations than males. In the combined OECD area, 89 per cent of females, but only 76 per cent of males expect to hold a white-collar occupation by the age of 30.

Figure 3.3b ■ **Students' instrumental motivation in mathematics and their educational expectations**

Females ▲ Mean index of intrumental motivation in mathematics for females expecting to complete a university-level programme (ISCED Level 5A and 6)

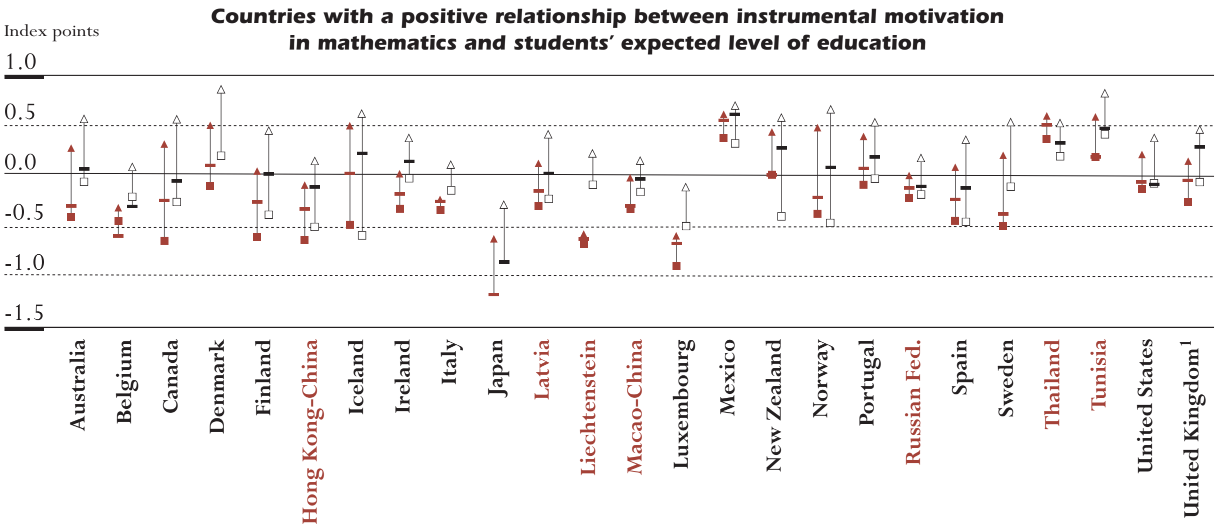
▬ Mean index of intrumental motivation in mathematics for females expecting to complete an upper secondary programme providing access to university-level programmes (ISCED 3A and 4)

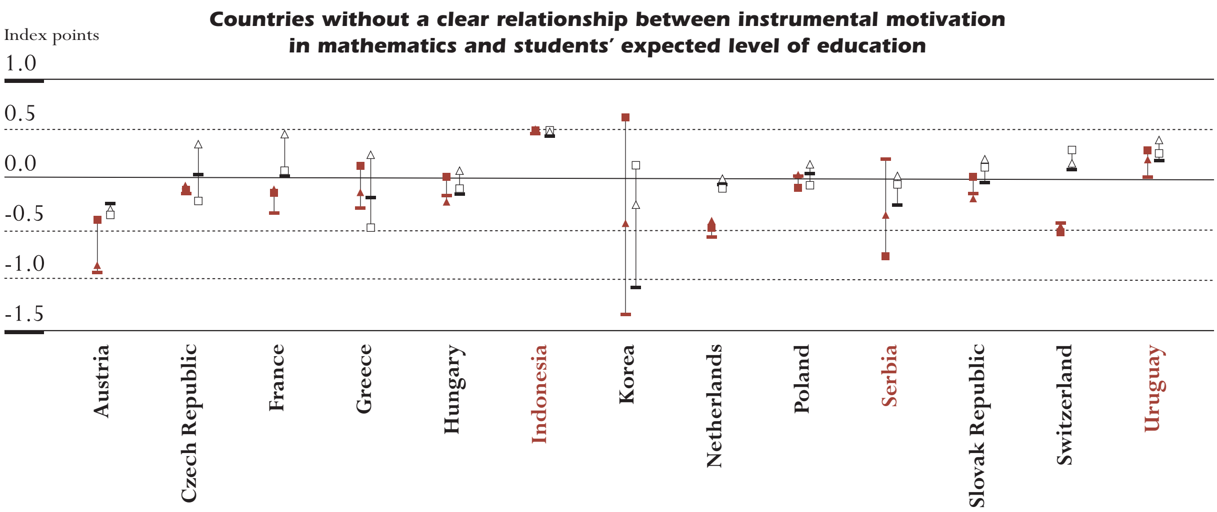
■ Mean index of intrumental motivation in mathematics for females expecting to complete lower secondary education (ISCED Level 2)

Males △ Mean index of intrumental motivation in mathematics for males expecting to complete a university-level programme (ISCED Level 5A and 6)

▬ Mean index of intrumental motivation in mathematics for males expecting to complete an upper secondary programme providing access to university-level programmes (ISCED 3A and 4)

□ Mean index of intrumental motivation in mathematics for males expecting to complete lower secondary education (ISCED Level 2)





1. Response rate too low to ensure comparability (see Annex A3).
Source: OECD PISA 2003 database, Table 3.2b.

Students' perception of how well school has prepared them for life

In general, most students think that school has prepared them well for life…

All education systems aspire not just to transmit subject knowledge but also to prepare students well for life in general. The views of the majority of 15-year-olds suggest that education systems are quite successful in this respect. Typical students in the OECD area disagree with the statement that school has done little to prepare them for adult life when they leave school. They also disagree or strongly disagree that school has been a waste of time. In contrast, they agree that school helped give them confidence to make decisions and agree that school has taught them things which could be useful in a job.

…but nevertheless substantial minorities disagree.

Nevertheless, a significant minority of students, 8 per cent on average across OECD countries, consider school a waste of time and an average of 32 per cent consider that school has done little to prepare them for life. In Germany, Hungary, Luxembourg, Mexico, Turkey and, among the partner countries, in Hong Kong-China, Liechtenstein, Macao-China and Uruguay, those agreeing or strongly agreeing that school has done little to prepare them for life exceeds 40 per cent (see first panel of Figure 3.4). This suggests that there is room for improvement in general attitudes towards schooling for 15-year-olds.

As in the case of interest in and enjoyment of mathematics, an index summarises results in different countries for the questions about attitudes towards school (see *www.pisa.oecd.org* for the item map and Table 3.4 for data).

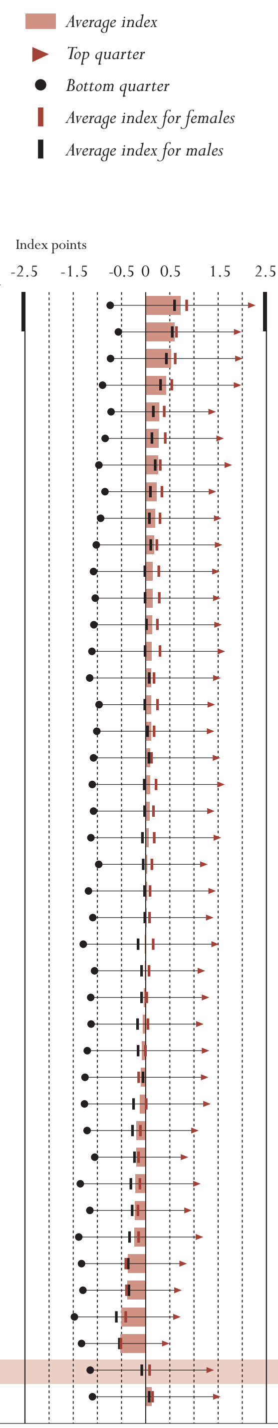
Although in each school some students feel let down, in certain schools much more of them do than in others…

To what extent are the attitudes of students towards school an attribute of the educational programmes or the schools that they attend? This question is difficult to answer. However, the last two columns in Figure 3.4 show that, in some countries at least, students' attitudes vary greatly from one school to another. The first of these two columns shows the average level of students' attitudes towards schools in one of the schools with the lowest such attitudes, defined as the school below which only 5 per cent of schools report more negative attitudes. The last column shows the average level of students' attitudes towards school in a school where attitudes are higher than in 95 per cent of the other schools. Together, the two columns thus provide an indication of the range of student attitudes among schools. While differences in these attitudes among students within schools tend to be much larger than differences across schools, the latter are nonetheless significant. In most countries, attitudes in schools where they are most positive tend to be around a standard deviation higher than where they are the most negative. Hence, although students within schools differ far more than schools do in this respect, there are considerable differences between schools in many countries. This is most notably the case in Austria, Greece, Hungary, Iceland, Italy, Mexico, Turkey and the United States as well as in the partner countries Brazil and the Russian Federation.

…but no school can be complacent…

In contrast, schools in Finland, Japan, Korea, the Netherlands and the partner country Hong Kong-China differ less with regard to attitudes towards school.

Figure 3.4 ■ Students' attitudes towards school



	Percentage of students agreeing or strongly agreeing with the following statements: School has done little to prepare me for adult life when I leave school.	School has been a waste of time.	School helped give me confidence to make decisions.	School has taught me things which could be useful in a job.	Percentage of explained variance in student performance	Attitudes towards school in one of the schools with the most negative attitudes[1]	Attitudes towards school in one of the schools with the most positive attitudes[2]
Tunisia	25	6	90	90	1.4	0.2	1.2
Indonesia	18	2	95	95	0.5	0.1	1.2
Brazil	30	2	90	90	0.0	-0.2	1.5
Mexico	45	5	93	93	7.6	-0.9	1.1
Thailand	39	5	95	95	1.0	-0.8	1.3
Portugal	26	4	86	86	1.1	-0.5	0.7
Australia	23	6	84	84	2.4	-0.2	0.7
Latvia	17	4	83	83	1.0	-0.1	0.9
Russian Fed.	19	5	86	86	0.3	-0.3	1.1
Serbia	27	7	82	82	0.1	-0.3	0.8
France	25	7	68	68	0.6	m	m
Spain	33	7	79	79	0.2	-0.4	0.6
Ireland	26	7	79	79	0.7	-0.3	0.5
Turkey	44	8	84	84	0.1	-1.0	0.9
Austria	29	8	64	64	0.1	-0.5	1.5
Finland	21	7	79	79	2.0	-0.2	0.5
Uruguay	41	6	87	87	0.0	-0.4	0.8
New Zealand	30	8	81	81	2.3	-0.7	0.6
United States	31	10	79	79	0.6	-0.7	0.8
Greece	39	6	78	78	1.5	-0.3	1.1
Canada	26	9	74	74	0.8	-0.6	0.7
Slovak Republic	28	6	78	78	1.0	-0.4	0.6
Switzerland	37	9	65	65	0.0	-0.5	0.6
Sweden	31	7	66	66	2.2	-0.5	0.7
Iceland	27	10	63	63	3.4	-0.6	0.8
Czech Republic	31	6	73	73	0.1	-0.5	0.6
Denmark	32	7	72	72	0.5	-0.6	0.5
Italy	34	6	74	74	0.3	-0.7	0.9
Germany	43	7	56	56	0.9	-0.5	0.4
Liechtenstein	43	9	62	62	0.9	c	c
Poland	32	11	76	76	0.1	-0.8	0.4
Belgium	32	11	63	63	0.1	-0.7	0.3
Netherlands	23	11	65	65	0.1	-0.6	0.2
Norway	37	11	64	64	2.9	-0.7	0.5
Hungary	46	6	66	66	0.3	-1.0	0.8
Luxembourg	49	10	53	53	1.0	-0.7	0.2
Korea	28	10	66	66	0.0	-0.6	0.1
Macao-China	46	9	70	70	0.1	-0.7	0.4
Japan	33	10	52	52	0.1	-1.0	-0.2
Hong Kong-China	53	13	66	66	1.1	-0.8	-0.1
OECD average	*32*	*8*	*72*	*72*	*0.0*	*-0.6*	*0.7*
United Kingdom[3]	26	6	78	78	1.9	-0.5	0.6

1. This is the school at the 5th percentile. In only 5% of schools are attitudes towards school more negative.
2. This is the school at the 95th percentile. Attitudes towards school are more positive than in 95% of the other schools.
3. Response rate too low to ensure comparability (see Annex A3).
Source: OECD PISA 2003 database, Table 3.4.

However, what is equally clear from the analysis is that poor attitudes towards school are not confined to a small number of schools. Indeed, there are few schools in any country in which this cannot be considered an issue. In two countries, Japan and the partner country Hong Kong-China, even in the 5 per cent of schools with the most positive student attitudes towards school, school means fall below the OECD average.

...as poor attitudes towards school are not confined to a small number of schools.

A relationship between students' attitude to school and student achievement is not evident from the data. Nonetheless, the promotion of positive attitudes to school is worthwhile given that it has been shown to relate to other important outcomes relevant to learning for life.

Gender differences in attitude to school are statistically significant in all countries except in Korea and New Zealand and in the partner countries Hong Kong-China, Liechtenstein and Macao-China. Females generally report far more positive attitudes towards school.

Attitudes to school are generally more positive among female students.

Students' sense of belonging at school

Beyond students' perception of how well school has prepared them for life, their overall sense of belonging at school is also important. For most students, school is central to their daily life. They view schooling as essential to their long-term well-being, and this attitude is reflected in their participation in academic and non-academic pursuits. These students tend to have good relations with school staff and with other students – they feel that they belong at school. However, some youths do not share this sense of belonging, and do not believe that academic success will have a strong bearing on their future. These feelings and attitudes may result in their becoming disaffected with school (Finn, 1989; Jenkins, 1995). They may withdraw from school activities, and in some cases participate in disruptive behaviour and display negative attitudes towards teachers and other students. Meeting the needs of students who have become disaffected from school is a major challenge facing teachers and school administrators.

Students who feel they do not belong at school face serious risks...

Much of the research on students' sense of belonging at school has been concerned with its relationship to student performance. This chapter also examines this issue. However, in addition, students' sense of belonging at school can be seen as a disposition towards learning, working with others and functioning in a social institution. It is known that students who have behavioural problems tend to be disaffected with school (Offord and Waters, 1983). In some countries, longitudinal studies that have followed young people with behavioural problems into adulthood have found that nearly one-half of them continue to suffer from psychological and social difficulties as adults (Offord and Bennett, 1994). Thus, the sense of belonging at school can be, for some students, indicative of economic or educational success and long-term health and well-being. As such, this perception deserves to be treated alongside academic performance as an important outcome of schooling. Moreover, the sense of belonging at school should not be considered an unalterable trait of individuals, stemming

...and this can affect not just academic performance but other aspects of students' lives as well.

solely from students' experiences at home, but as entailing perceptions that can be affected by teachers and parents, as well as shaped by school policy and practice.

Typically, students in OECD countries have a positive sense of belonging at school…

Students' sense of belonging at school was measured by asking them about their feelings about school as a place. Overall, students in the OECD report a positive sense of belonging at their school. On average across OECD countries, 81 per cent of the students agree or strongly agree that their school is a place where they feel like they belong. Eighty-nine per cent agree or strongly agree that their school is a place where they make friends easily. Ninety per cent disagree or strongly disagree that they feel awkward and out of place, and 93 per cent disagree or strongly disagree that school is a place where they feel like an outsider or left out of things (Figure 3.5).

…but in some countries, relatively large numbers have a low sense of belonging at school…

Nevertheless, there is considerable variation across countries, which is most readily apparent when student views are summarised on an index (see *www.pisa.oecd.org* for the item map and Table 3.5a for data). Students in Austria, Germany, Iceland, Luxembourg, Norway, Spain, Sweden and Switzerland and in the partner countries Liechtenstein and Uruguay report the highest sense of belonging at school. In contrast, the lowest sense of belonging at school is reported by students in Belgium, the Czech Republic, France, Japan, Korea, Poland, the Slovak Republic and Turkey, and in the partner countries Hong Kong-China, Indonesia, Latvia, Macao-China, the Russian Federation and Thailand. For example, while in Sweden 5 per cent of students report that school is a place where they feel awkward and out of place, more than three times this proportion report that feeling in Belgium, Japan and the partner country Tunisia (Figure 3.5).

…and even in some countries where overall students have a high sense of belonging at school, significant proportions feel negative.

Within countries, there is still more variation with regard to students' sense of belonging at school than between countries. It is noteworthy that in some of the countries where students, overall, express a strong sense of belonging at school, including Austria, Germany, Luxembourg, Norway and Sweden, this is not because there are exceptionally few students reporting a low sense of belonging at school. Rather, this is because the quarter of students at the top end report a particularly strong sense of belonging at school.

In 20 of the 41 participating countries, males and females report similar levels of sense of belonging at school. However, there are some notable exceptions, with females in Australia, Belgium, Canada, Hungary, Ireland, Japan, Mexico, Poland and Turkey and in the partner countries in Hong Kong-China, Indonesia, Latvia, the Russian Federation and Thailand, reporting a higher sense of belonging at school. In contrast, the reverse is true in Finland, Korea, Spain, Sweden and the partner country Uruguay.

Students' answers are, of course, likely to depend on their cultural context, their own social confidence and their feelings about school. However, analyses of the PISA data (mentioned in the introduction) support the use of the overall

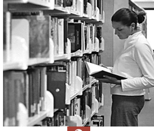
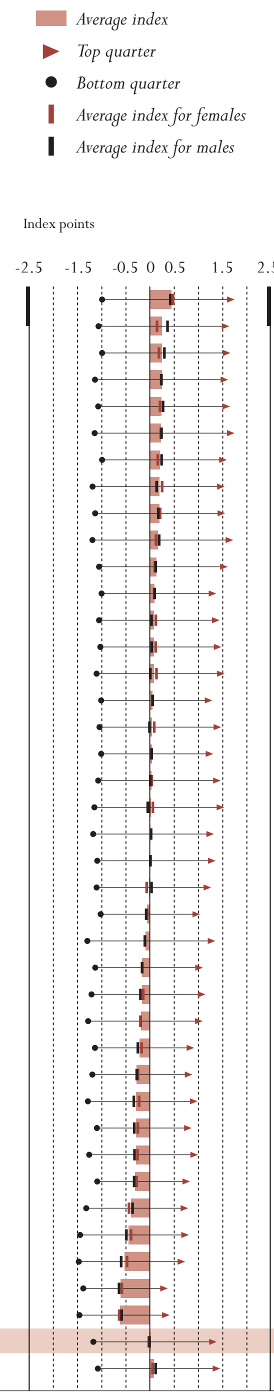


Figure 3.5 ■ Students' sense of belonging at school



	Percentage of students agreeing or strongly agreeing with the following statements — School is a place where: I feel like an outsider (or left out of things).	I make friends easily.	I feel like I belong.	I feel awkward and out of place.	Other students seem to like me.	I feel lonely.	Percentage of explained variance in student performance	Students' sense of belonging in one of the schools with the lowest levels[1]	Students' sense of belonging in one of the schools with the highest levels[2]
Austria	6	90	89	9	78	7	0.1	-0.3	1.3
Sweden	5	88	81	5	91	7	0.0	-0.5	0.8
Uruguay	7	90	93	7	93	7	0.1	-0.3	0.9
Germany	6	86	87	12	70	6	0.0	-0.3	0.7
Norway	6	90	85	9	91	7	0.0	-0.3	1.0
Luxembourg	8	89	73	10	91	7	0.5	-0.2	0.5
Spain	4	91	85	9	92	5	0.1	-0.3	0.6
Liechtenstein	7	86	91	11	70	8	1.0	c	c
Switzerland	7	88	82	12	78	6	0.8	-0.4	0.9
Iceland	10	85	89	11	90	10	0.0	-0.4	0.7
Brazil	7	91	92	11	92	7	0.3	-0.4	0.7
Portugal	6	93	93	12	91	5	2.8	-0.5	0.5
Hungary	9	88	91	7	89	7	1.1	-1.1	0.8
Ireland	6	91	88	8	95	5	0.4	-0.3	0.4
Mexico	10	88	92	10	89	11	2.6	-0.9	1.0
Italy	5	92	85	6	91	6	0.1	-0.8	1.0
Australia	8	91	88	9	95	6	0.1	-0.6	0.4
Greece	6	91	91	8	92	7	0.3	-0.6	0.5
Serbia	10	93	88	10	92	8	0.0	-0.3	0.5
Canada	9	90	81	11	94	8	0.0	-0.5	0.6
Denmark	5	88	69	12	92	6	0.1	-0.5	0.8
New Zealand	8	91	86	11	94	7	0.1	-0.4	0.5
Finland	6	88	89	9	87	6	0.0	-0.3	0.3
Netherlands	4	92	77	8	93	3	0.4	-0.4	0.3
Tunisia	10	88	58	18	89	11	0.2	-0.4	0.3
Slovak Republic	8	92	85	12	91	7	0.1	-0.6	0.5
Poland	8	88	76	10	93	8	0.6	-0.6	0.3
France	8	92	45	13	93	7	0.0	m	m
Latvia	5	89	92	9	72	9	1.5	-0.7	0.1
Czech Republic	10	89	77	7	87	7	1.3	-0.7	0.3
Belgium	8	89	56	16	92	6	0.3	-0.8	0.1
Thailand	6	95	95	15	80	11	1.6	-1.0	0.7
Russian Fed.	6	88	92	15	51	9	1.2	-0.8	0.4
Indonesia	4	98	68	11	83	7	0.3	-0.7	0.1
Korea	8	79	76	9	45	7	1.0	-0.8	0.4
Turkey	14	88	75	11	41	25	3.1	-1.2	-0.2
Japan	6	77	80	18	69	30	1.3	-1.0	-0.2
Hong Kong-China	18	88	68	10	77	12	1.3	-0.9	-0.3
Macao-China	16	84	65	14	72	15	0.3	-0.9	-0.3
OECD average	*7*	*89*	*81*	*10*	*86*	*8*	*0.1*	*-0.7*	*0.6*
United Kingdom[3]	7	91	85	9	95	6	0.0	-0.3	0.6

1. This is the school at the 5th percentile. In only 5% of schools is students' sense of belonging at school lower.
2. This is the school at the 95th percentile. Students' sense of belonging at school is higher than in 95% of the other schools.
3. Response rate too low to ensure comparability (see Annex A3).
Source: OECD PISA 2003 database, Table 3.5a.

response to these questions as an indicator of whether students feel that they belong in the school environment. Thus, unlike in the case of previous indicators reported in this chapter, students' reports of their sense of belonging at school produce an indicator that can be validly compared across countries.

To what extent are students who feel that they do not belong concentrated in particular schools within each country? This question is important for education policy, since it helps establish the extent to which disaffection is associated with features of the school system itself or the way it interacts with students and schools in particular circumstances.

Most variation in the sense of belonging at school is found within schools…

The last two columns of Figure 3.5 give some indication of the between-school differences in each country by showing the range of school averages of students' sense of belonging at school. The first of these two columns shows the average sense of belonging in a school where such attitudes are among the lowest, defined as a school below which students' sense of belonging is lower only in 5 per cent of other schools. The last column shows the school average where students' sense of belonging at school is higher than in 95 per cent of other schools.

…suggesting that strategies only targeted at certain schools will not be able to address the problem fully.

Differences in the sense of belonging at school among students within schools – as shown by the range from the 5^{th} to the 95^{th} percentiles – tend to be much larger than differences among schools (in most countries, between-school differences explain only around 4 per cent of the overall variation). Therefore, no school is immune from this problem, and a strategy that is only targeted at certain schools will not be able to address the problem fully. However, in countries such as Austria, Denmark, Hungary, Italy, Mexico, Norway, Switzerland, and the partner countries Liechtenstein and Thailand, students' sense of belonging at school differs considerably between schools. By contrast, between-school differences in students' sense of belonging at school are negligible in Finland, Ireland, Japan, and the Netherlands and in the partner countries Hong Kong-China and Macao-China.

As with attitudes to school, a low sense of belonging at school is thus not confined to small numbers of schools in each country. In Japan and Turkey and in the partner countries Hong Kong-China and Macao-China even in the 5 per cent of schools with the most positive student perception of sense of belonging at school, school means fall below the OECD average.

In some countries students in vocational streams seem to feel they belong at school less than those in general streams.

Determining the extent of this variation across schools is important for at least two reasons. In countries where there is considerable variation among schools, it may be more efficient to target certain schools for intervention, whereas if the prevalence is fairly uniform across most schools in a country, then more universal policies are likely to be more effective. The second reason is that if there is considerable variation among schools in the prevalence of disaffected students, then it may be possible to discern whether particular school factors are related to students' sense of belonging at school, thereby providing some direction for what kinds of interventions might be most effective. It is beyond

the scope of this initial report to examine such school factors but one issue worth noting is significant variation in students' sense of belonging at school between different types of school programmes in some countries (Table 3.5b). For example, in Austria and the Netherlands and in the partner countries Indonesia and Serbia students' sense of belonging at school is considerably weaker in programmes geared towards vocational studies than in academically oriented programmes. Similarly, students' sense of belonging at school in programmes designed to provide direct access to the labour market, tends to be lower than in academically oriented programmes, most notably in Belgium, the Czech Republic, Greece, Hungary, Japan, Korea and the Netherlands and in the partner country Serbia.

The relationship between students' sense of belonging at school and their performance can be interpreted differently …

While, as noted above, students' sense of belonging at school is an important outcome of schooling, it is also important to examine how it relates to their performance. A common explanation of engagement is that it precedes academic outcomes, and that when students become disengaged from school, their academic performance begins to suffer. This may be the case for some students. However, an equally plausible model is that a failure to succeed in academic work at school results in student disaffection and the withdrawal from school activities. A third model is that a range of other factors, including individual, family and school factors, jointly influence both engagement and academic outcomes. It may also be that the causal relationships differ, depending on students' academic ability and family and school contexts. In addition, these explanations are not incompatible with one another. An understanding of the causal mechanisms associated with engagement and academic achievement is central to educational policy in that it affects decisions about when and how to intervene.

…but the fact that the strongest associations with performance are for whole schools rather than for individuals suggests that influences operate at the school level.

PISA cannot determine the causal relationships underlying students' sense of belonging at school and their performance (or vice versa). However, it can provide an indication of how strong the relationships are at age 15. The relationship between sense of belonging at school and mathematics performance can be examined both at the level of individual students and at the level of schools (Table 3.5c). At the student level, the relationship tends to be weak, which suggests that performance and sense of belonging at school are markedly different outcome measures. By contrast, in most countries, the sense of belonging at school that students have in particular schools tends to be more closely related to the average performance level of that school. In particular, in Japan, Mexico and Turkey and in the partner country Hong Kong-China, schools with high average levels of sense of belonging at school also tend to have high average levels of performance.

Students' sense of belonging at the school level – mirroring students' shared experience – is more likely to reflect features of the school that are relevant for students' sense of belonging at school. Thus, schools that provide the basis for students to feel engaged and to experience a sense of belonging at school tend to have better overall performance than schools where students on average feel awkward and out of place.

This may indicate that it is not just underachieving students who may need help…

This finding has a number of implications for educational policy and practice. The weak correlations at the student level suggest that teachers and guidance counsellors are likely to encounter students who have a very low sense of belonging at school but whose performance in academic subjects is average or above average.

…and that schools that focus on helping students fit in are not doing so at the expense of academic performance.

The moderately strong school-level correlations between students' sense of belonging at school and their mathematics performance mean that schools where students tend to have a strong sense of belonging also tend to have high levels of academic performance. The design of PISA does not allow the inference that efforts to increase students' sense of belonging at school are likely to lead to better academic performance. However, the results suggest that efforts to increase students' sense of belonging at school will not usually be harmful to academic performance, and *vice versa*. In fact, the relationship might be mutually reinforcing.

STUDENTS' BELIEFS ABOUT THEMSELVES

PISA also looked at students' belief in their abilities, at their ability to tackle difficult tasks and at their anxiety in mathematics.

Autonomous learning requires both a critical and a realistic judgement of the difficulty of a task as well as the ability to invest enough energy to accomplish it. Learners form views about their own competences and learning characteristics. These views have been shown to have considerable impact on the way they set goals, the strategies they use and their performance. Two ways of defining these beliefs are in terms of students' beliefs in their own academic abilities (self-concept) and of how much students believe in their own ability to handle tasks effectively and overcome difficulties (self-efficacy). A third dimension relates to emotional factors, such as feelings of helplessness and emotional stress when dealing with mathematics. All three dimensions were investigated by PISA.

This section examines these three aspects of students' beliefs about themselves as learners in mathematics. It then analyses how these aspects relate to performance in mathematics.

Students' self-concept in mathematics

Students who believe in their abilities make successful learners…

Students' academic self-concept is both an important outcome of education and a powerful predictor of student success. Belief in one's own abilities is highly relevant to successful learning (Marsh, 1986). It can also affect other factors such as well-being and personality development, factors that are especially important for students from less advantaged backgrounds.

… but two-thirds of students find some of their mathematics work too difficult and half say they do not learn mathematics quickly…

When 15-year-olds are asked about their views of their mathematical abilities, the picture that emerges is, however, less positive than students' self-concept in reading, which was examined in PISA 2000 (OECD, 2001a). On average across OECD countries, 67 per cent of students disagree or strongly disagree that in their mathematics class, they understand even the most difficult work. Countries vary with respect to the response patterns. For example, for the aforementioned question, percentages disagreeing or strongly disagreeing range from around 84 per cent or more in Japan and Korea to 57 per cent or less in Canada, Mexico, Sweden and the United States. Similarly, on average across OECD countries, roughly half of the students disagree or strongly disagree that they learn mathematics quickly. But while in Japan and Korea, as well as in the partner country Thailand, more than 62 per cent of students disagree or strongly disagree, the proportion is only around 40 per cent of students in Denmark and Sweden (Figure 3.6, but note that results are reported in terms of students' agreement with the respective statements rather than disagreement, as in this text).

...while a third of males and half of females think they are no good at mathematics.

For most of these questions, comparatively large gender differences are apparent. For example, while on average across OECD countries, 36 per cent of males agree or strongly agree that they are simply not good at mathematics, the average for females is 47 per cent. In Italy, Japan, Korea, Norway, Poland, Portugal and Spain and in the partner countries Brazil, Hong Kong-China, Indonesia, Macao-China, Thailand, Tunisia and Turkey, between 50 and 70 per cent of females agree or strongly agree with this statement (for data, see *www.pisa.oecd.org*).

Self-concept in mathematics is summarised in a cross-nationally comparable index...

Countries can be compared on an index that summarises the different questions about students' self-concept in mathematics. As before, the index is constructed with the average score across OECD countries set at 0 and two-thirds scoring between 1 and -1 (see *www.pisa.oecd.org* for the item map). Results for individual countries are displayed in the second panel of Figure 3.6. Countries are here ranked by their mean levels of self-concept in mathematics, with lines connecting the mean of the bottom and top quarters of the distribution in each country. The mean index by gender is shown in this figure as well as in Table 3.6.

...showing country differences together with considerable gender differences in each country...

The comparison shows that students in Canada, Denmark, Germany, Mexico, New Zealand, the United States and the partner country Tunisia have the greatest confidence in their mathematics abilities. Students in Japan and Korea and in the partner country Hong Kong-China have the lowest self-concept. In almost all countries, there is considerable variation between males and females and in all countries males tend to show statistically significantly higher levels of self-concept in mathematics than females. This is particularly so in Denmark, Germany, Luxembourg, the Netherlands and Switzerland and in the partner country Liechtenstein (Table 3.6). Nevertheless, some caution is warranted when comparing index values on this measure across countries.

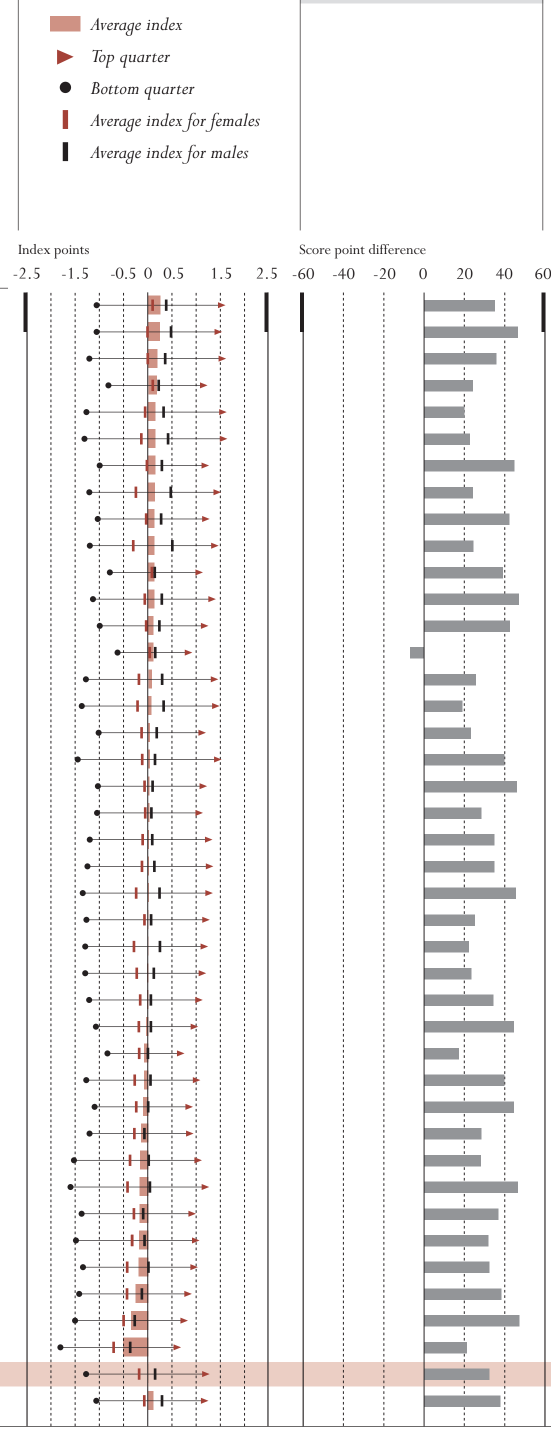
...and substantial differences in performance among students who are more and less confident in their mathematics abilities.

The third panel of Figure 3.6 also shows that, within countries, students' self-concept in mathematics is closely related to their performance on the PISA 2003 mathematics assessment. An increase of one index point on the scale of self-concept in mathematics corresponds, on average across OECD countries, to 32 score points on the mathematics performance scale, which is about half a proficiency level (Table 3.6).

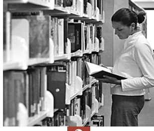
Besides a moderately strong association between individual students' performance and their self-concept in mathematics, it is perhaps even more important that the

Figure 3.6 ■ Students' self-concept in mathematics

	Percentage of students agreeing or strongly agreeing with the following statements:					Index of self-concept in mathematics	Change in mathematics performance per unit of the index of self-concept in mathematics	
	I am just not good at mathematics.	I get good marks in mathematics.	I learn mathematics quickly.	I have always believed that mathematics is one of my best subjects.	In my mathematics class, I understand even the most difficult work.			Percentage of explained variance in student performance
United States	36	72	58	44	44			14.6
Denmark	30	70	60	48	34			27.6
Canada	34	63	58	41	43			19.9
Mexico	48	65	50	44	45			5.4
Tunisia	52	53	54	54	39			7.6
Germany	36	59	57	36	42			7.1
New Zealand	33	71	56	40	38			17.0
Switzerland	34	61	57	37	40			6.9
Australia	32	65	56	38	38			16.8
Liechtenstein	35	65	59	35	41			6.5
Russian Fed.	37	50	46	42	42			10.5
Sweden	34	59	60	31	44			24.4
Greece	43	63	59	44	24			16.6
Indonesia	68	64	47	57	36			0.3
Austria	36	59	55	33	39			8.9
Luxembourg	38	61	55	35	37			5.3
Brazil	51	61	48	33	41			4.3
Iceland	46	55	55	41	39			26.4
Poland	52	59	50	37	31			21.6
Serbia	37	45	55	38	27			8.9
Turkey	59	53	55	46	30			11.0
Uruguay	46	55	50	40	32			12.9
Finland	40	56	54	33	38			33.0
Italy	50	56	51	36	40			7.1
Netherlands	38	62	54	33	29			6.1
Belgium	38	62	51	30	28			4.8
Ireland	38	60	49	32	29			14.1
Slovak Republic	44	58	48	28	26			16.1
Thailand	68	44	38	45	35			1.8
Czech Republic	38	55	46	30	21			15.8
Latvia	39	44	46	24	25			16.7
Hungary	45	42	42	33	24			6.6
France	39	48	47	26	28			10.3
Norway	45	48	47	31	30			31.6
Portugal	53	47	46	27	32			15.4
Spain	51	47	45	31	31			13.2
Macao-China	50	29	45	26	28			11.7
Hong Kong-China	57	25	45	32	30			12.1
Korea	62	36	34	30	16			21.4
Japan	53	28	25	27	10			4.1
OECD average	*42*	*57*	*51*	*35*	*33*			*10.8*
United Kingdom[1]	34	68	53	38	38			14.4



1. Response rate too low to ensure comparability (see Annex A3).
Source: OECD PISA 2003 database, Table 3.6.



data reveal a similarly strong association at school levels. This suggests that schools in which students tend to have a strong self-concept in mathematics also tend to have high levels of mathematics performance. Note, however, that countries with high average self-concept in mathematics are not necessarily countries with high mean mathematics scores.

At one level, it is not surprising that students who perform well in PISA also tend to have high opinions of their abilities. However, as explained in Box 3.4, self-concept must be seen as much more than simply a mirror of student performance. Rather, it can have a decisive influence on the learning process. Whether students choose to pursue a particular learning goal is dependent on their appraisal of their abilities and potential in a subject area and on their confidence in being able to achieve this goal even in the face of difficulties. The latter aspect of self-related beliefs is the subject of the following section.

This is not just because able students are more confident, but also because confident students are more likely to adopt certain learning goals.

Box 3.4 ■ Do students' beliefs about their abilities simply mirror their performance?

One issue that arises when asking students what they think of their own abilities, especially in terms of whether they can perform verbal and mathematical tasks (which are also assessed directly in PISA), is whether this adds anything of importance to what we know about their abilities from the assessment. In fact, both prior research and the PISA results give strong reasons for assuming that confidence helps to drive learning success, rather than simply reflecting it. In particular:

- Research about the learning process has shown that students need to believe in their own capacities before making necessary investments in learning strategies that will help them to higher performance (Zimmerman, 1999). This finding is also supported by PISA: Figure 3.7 suggests that the belief in one's efficacy is a particularly strong predictor of whether a student will control his or her learning.
- Much more of the observed variation in student levels of self-related beliefs occurs within countries, within schools and within classes than would be the case if self-confidence merely mirrored performance. That is to say, in any group of peers, even those with very low levels of mathematics performance, the stronger performers are likely to have relatively high self-confidence, indicating that they base this on the norms they observe around them. This illustrates the importance of one's immediate environment in fostering the self-confidence that students need in order to develop as effective learners.
- PISA 2000 showed that students reporting that they are good at verbal tasks do not necessarily also believe that they are good at mathematical tasks, despite the fact that PISA 2000 revealed a high correlation between performance on these two scales. Indeed, in most countries there was, at most, a weak and in some cases negative correlation between verbal and mathematical self-concept (OECD, 2003b). This can again be explained by the assertion that students' ability judgements are made in relation to subjective standards which are in turn based on the contexts they are in. Thus, some students who are confident in reading may be less confident in mathematics partly because it is a *relative* weak point in relation to their own overall abilities and partly because they are more likely than weak readers to have peers who are good mathematicians.

The picture remains, of course, largely descriptive and it will require further analysis to examine to what extent self-related beliefs in general, and self-concept in mathematics in particular, are related to factors such as instructional practices and teacher feedback.

Students' confidence in overcoming difficulties in mathematics

Successful learners are not only confident of their abilities, They also believe that investment in learning can make a difference and help them to overcome difficulties.

Successful learners are not only confident of their abilities. They also believe that investment in learning can make a difference and help them to overcome difficulties – that is, they have a strong sense of their own efficacy. By contrast, students who lack confidence in their ability to learn what they judge to be important and to overcome difficulties are exposed to failure, not only at school, but also in their adult lives. Self-efficacy goes beyond how good students think they are in subjects such as mathematics. It is more concerned with the kind of confidence that is needed for them to successfully master specific learning tasks. It is therefore not simply a reflection of a student's abilities and performance, but has also been shown to enhance learning activity, which in turn improves student performance.

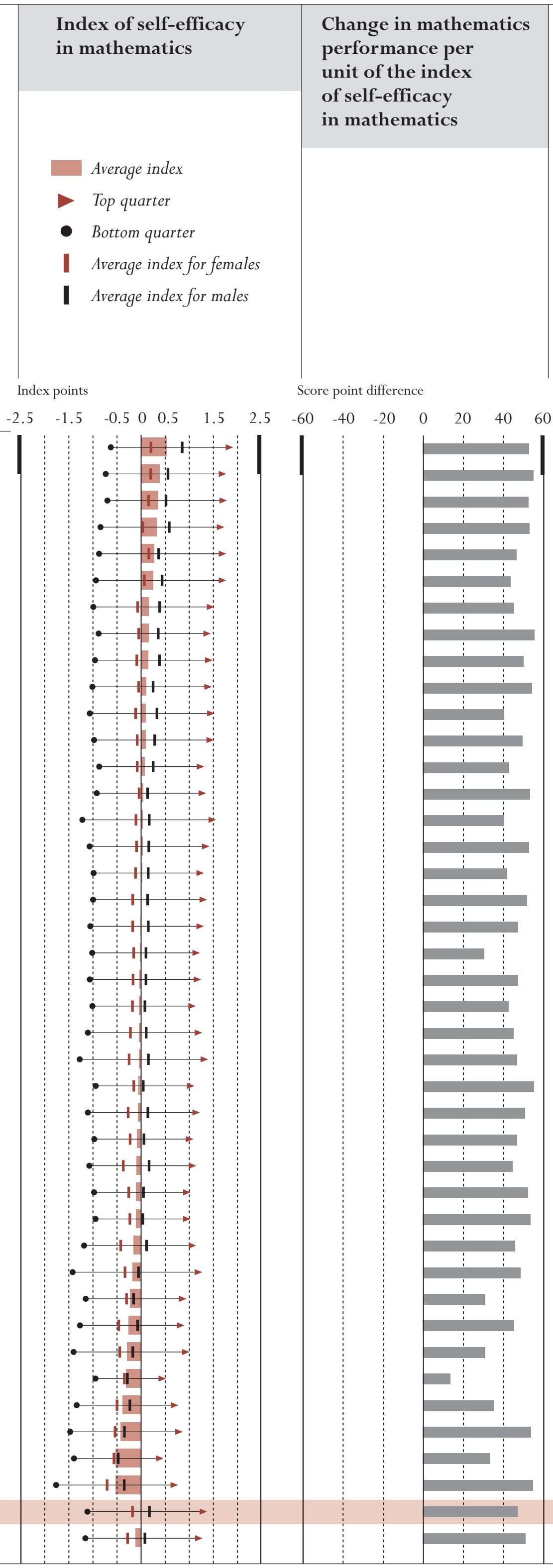
Such self-efficacy can be described by a cross-nationally comparable index, that reveals differences between and within countries.

Students' confidence in overcoming difficulties in particular mathematics tasks can be compared through an index of self-efficacy in mathematics. This summarises the different questions about students' confidence in solving certain calculations in mathematics. The index is constructed, with the average score across OECD countries set at 0 and with two-thirds scoring between 1 and -1 (*i.e.,* a standard deviation of 1) (see *www.pisa.oecd.org* for the item map). Evidence from PISA 2000 and PISA 2003 suggests that the index values of self-efficacy in mathematics can be reasonably compared across countries (OECD, 2003b). Results for individual countries are displayed in the first panel of Figure 3.7, where countries are ranked by their mean levels of self-efficacy in mathematics, with lines connecting the mean of the bottom and top quarters of the distribution in each country. On average, students in Greece, Japan, Korea and Mexico and in the partner countries Brazil, Indonesia, Thailand and Tunisia express the least self-efficacy in mathematics whereas students in Canada, Hungary, the Slovak Republic, Switzerland and the United States express comparatively stronger degrees of self-efficacy. However, within each country there is considerable variation, with the top quarter of students in most countries expressing strong confidence in handling specific tasks related to mathematics. Variation is particularly large in Canada, Iceland, Luxembourg, Norway, Switzerland, Turkey and the United States as seen by the difference between the mean index for the top and the bottom quarters.

The link between self-efficacy and performance in mathematics is particularly strong…

Figure 3.7 shows that students' self-efficacy in mathematics is even more closely related to student performance on the PISA 2003 mathematics assessment than self-concept in mathematics. In fact, self-efficacy is one of the strongest predictors of student performance, explaining, on average across OECD countries, 23 per cent of the variance in mathematics performance, and more than 30 per cent in the Czech Republic, Hungary, Japan, Korea, Norway, the Slovak Republic, Sweden and the partner country Hong Kong-China. Even when accounting for other learner characteristics, such as anxiety in mathematics, interest in and

Figure 3.7 ■ Students' self-efficacy in mathematics



	Percentage of explained variance in student performance
Liechtenstein	28.0
Slovak Republic	34.8
Hungary	31.0
Switzerland	29.8
United States	27.4
Canada	28.9
Austria	24.6
Czech Republic	31.0
Germany	25.8
Hong Kong-China	31.0
Luxembourg	21.8
Australia	27.3
Macao-China	19.3
Poland	29.9
Iceland	25.3
Sweden	31.8
Uruguay	15.8
New Zealand	27.1
France	25.4
Serbia	11.4
Ireland	28.0
Spain	19.4
Belgium	17.7
Norway	30.4
Portugal	28.1
Denmark	27.4
Russian Fed.	19.0
Netherlands	20.8
Italy	20.8
Latvia	24.8
Finland	27.5
Turkey	25.7
Mexico	9.5
Greece	18.4
Tunisia	13.7
Indonesia	1.1
Brazil	9.4
Korea	33.2
Thailand	10.2
Japan	34.3
OECD average	*22.7*
United Kingdom[1]	30.1

1. Response rate too low to ensure comparability (see Annex A3).
Source: OECD PISA 2003 database, Table 3.7.

enjoyment of mathematics or the use of control strategies, sizeable effects sizes remain for virtually all countries (Table 3.12).

...and in no country does the quarter of students with the least efficacy in mathematics reach the OECD average level of performance.

Looked at differently, an OECD average increase of one index point on the scale of self-efficacy in mathematics corresponds to 47 score points – just over the equivalent of one school year – in mathematics performance (Table 3.7 and Box 2.2). Not even in the best-performing OECD countries does the quarter of students who believe least in their own learning efficacy perform at or above the OECD average mathematics score. In contrast, in all but five OECD countries, students in the third quarter on the index of self-efficacy in mathematics score above the OECD average, while students in the top quarter score above the average performance of Finland, the highest scoring OECD country overall, in all but six OECD countries (Table 3.7). In fact, in some of the best performing countries, including the Czech Republic, Japan, Korea and Switzerland, the quarter of students with least self-efficacy face a three to four times higher probability of performing in the bottom quarter on the mathematics assessment than students reporting average self-efficacy.

Much of the difference between schools' performances is associated with the differing self-efficacy of their students...

The association between mathematics efficacy and mathematics performance is not only strong at the student level. In most countries there is also a clear tendency for students in lower performing schools to have less confidence in their abilities to overcome difficulties. In fact, across the OECD, 23 per cent of the mathematics performance differences among schools can be explained by the average levels of students' self-efficacy in mathematics at school (Figure 3.7). This indicates that further research, perhaps with longitudinal studies, is warranted to identify the school and student factors associated with high efficacy, and to investigate whether attempts to increase efficacy also result in increases in achievement.

...and not least, self-efficacy in mathematics is a positive outcome in itself, beyond its effect on performance.

Finally, and as stated above, students' views about their abilities to handle challenges in mathematics effectively should not only be considered a predictor of student performance. These views should be considered an important outcome in their own right, having as they do a key impact on students' motivation and use of control strategies (Table 3.13).

STUDENTS' ANXIETY IN MATHEMATICS

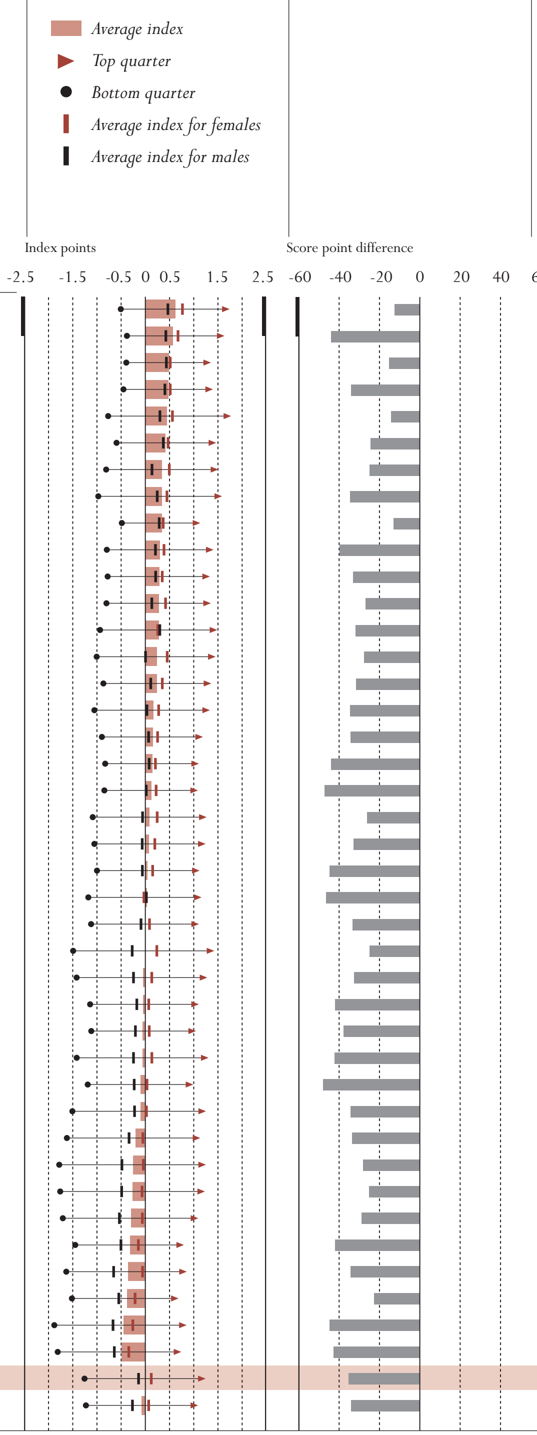
Most 15-year-olds worry to a certain extent about having difficulties in mathematics, although only a minority get very nervous when doing mathematics problems...

Some students' less favourable disposition towards mathematics may be a consequence of earlier failures. Indeed, a considerable proportion of 15-year-olds in PISA report feelings of helplessness and emotional stress when dealing with mathematics (Table 3.8 and Figure 3.8). On average among OECD countries, half of 15-year-old males and more than 60 per cent of females report that they often worry that they will find mathematics classes difficult and that they will get poor marks (for data see *www.pisa.oecd.org*). On the other hand, fewer than 30 per cent of students across the OECD agree or strongly agree with statements indicating that they get very nervous doing mathematics problems, get very tense when they have to do mathematics homework or feel helpless when doing a mathematics problem (see first panel in Figure 3.8).

Figure 3.8 ■ Students' anxiety in mathematics

	Percentage of students agreeing or strongly agreeing with the following statements:							
	I often worry that it will be difficult for me in mathematics classes.	I get very tense when I have to do mathematics homework.	I get very nervous doing mathematics problems.	I feel helpless when doing a mathematics problem.	I worry that I will get poor marks in mathematics.	Percentage of explained variance in student performance	Students' anxiety in mathematics in one of the schools with the lowest levels[1]	Students' anxiety in mathematics in one of the schools with the highest levels[2]
Tunisia	80	65	48	39	79	1.8	0.3	1.0
Brazil	70	45	48	43	90	12.1	0.2	1.2
Thailand	64	54	67	45	75	1.6	-0.5	0.8
Mexico	77	45	49	27	87	8.6	-0.2	0.9
Japan	69	52	42	35	66	2.1	-0.1	0.8
Korea	79	33	44	44	78	4.8	-0.1	0.8
France	61	53	39	37	75	6.4	m	m
Turkey	64	50	41	46	68	11.7	-0.6	1.0
Indonesia	79	39	48	37	66	1.1	0.0	0.7
Uruguay	64	36	38	26	83	12.7	-0.2	0.8
Italy	70	28	44	44	72	8.6	-0.1	0.9
Spain	66	36	40	31	77	6.9	-0.1	0.7
Serbia	63	45	43	32	63	13.7	-0.4	0.8
Macao-China	68	32	39	37	63	9.7	-0.3	0.7
Hong Kong-China	68	29	33	35	72	7.9	-0.2	0.6
Greece	69	35	44	38	52	12.4	-0.2	0.9
Portugal	75	22	30	35	67	10.7	-0.2	0.8
Russian Fed.	58	39	32	24	72	14.4	-0.3	0.6
Latvia	62	33	26	24	73	17.6	-0.3	0.5
Belgium	57	28	32	29	69	5.6	-0.3	0.7
Ireland	60	30	26	26	60	13.2	-0.3	0.5
Slovak Republic	58	25	40	28	53	16.7	-0.6	0.5
Poland	61	30	35	31	57	24.0	-0.7	0.4
Hungary	62	19	22	29	62	10.1	-0.7	1.0
Luxembourg	58	29	32	30	61	9.8	-0.5	0.4
Canada	54	32	26	24	58	16.0	-0.6	0.5
Czech Republic	52	20	32	29	51	16.8	-0.6	0.5
Australia	53	28	22	20	58	12.4	-0.3	0.3
Norway	47	37	20	31	58	24.5	-1.2	0.9
New Zealand	52	24	21	21	56	19.2	-0.6	0.5
United States	56	34	26	23	47	15.7	-0.5	0.7
Iceland	50	19	17	28	59	15.9	-0.7	0.5
Germany	53	30	24	23	47	11.6	-0.7	0.3
Austria	56	30	22	24	44	9.8	-1.3	0.5
Switzerland	48	26	19	25	47	10.1	-0.9	0.3
Finland	50	7	15	26	51	19.7	-0.6	0.0
Liechtenstein	47	19	13	22	51	11.0	c	c
Netherlands	36	7	16	17	44	4.9	-0.8	0.0
Denmark	34	26	15	17	41	26.5	-1.1	0.2
Sweden	32	14	11	17	46	19.9	-0.9	0.1
OECD average	*57*	*29*	*29*	*29*	*59*	*12.7*	*-0.7*	*0.7*
United Kingdom[3]	47	28	25	22	58	11.8	-0.6	0.4

Index of anxiety in mathematics — **Change in mathematics performance per unit of the index of anxiety in mathematics**



1. This is the school at the 5th percentile. In only 5% of schools is students' anxiety in mathematics lower.
2. This is the school at the 95th percentile. Students' anxiety in mathematics is higher than in 95% of the other schools.
3. Response rate too low to ensure comparability (see Annex A3).
Source: OECD PISA 2003 database, Table 3.8.

...but country-differences are great: for example, half of students in some countries but only a few in others get tense when doing mathematics homework.

There is considerable cross-country variation in the degree to which students feel anxiety when dealing with mathematics, with students in France, Italy, Japan, Korea, Mexico, Spain, and Turkey reporting feeling most concerned and students in Denmark, Finland, the Netherlands and Sweden least concerned (see second panel in Figure 3.8). For example, more than half of the students in France and Japan report that they get very tense when they have to do mathematics homework, but only 7 per cent of students in Finland and the Netherlands report this. It is noteworthy that Finland and the Netherlands are also two of the top performing countries.

More than two-thirds of the students in Greece, Italy, Japan, Korea, Mexico and Portugal report that they often worry that it will be difficult for them in mathematics classes, whereas only about one-third of students in Denmark or Sweden fall into this category. Among the participating partner countries, students in Brazil, Indonesia, Thailand, Tunisia and Uruguay report feeling more anxiety in dealing with mathematics, with students in Liechtenstein feeling the least anxiety. For example, more than half of students in Thailand and Tunisia report that they get very tense when they have to do mathematics homework. More than two-thirds of the students in Brazil, Hong Kong-China, Indonesia, Macao-China and Tunisia report that they often worry that they will find mathematics classes difficult.

Students with high levels of mathematics anxiety tend to perform worse in mathematics...

As is to be expected, anxiety in mathematics is negatively related to student performance. A one-point increase on the PISA index of anxiety in mathematics corresponds, on average across OECD countries, to a 35-point drop in the mathematics score, which is just over half a proficiency level (see the third panel in Figure 3.8 and Table 3.8). Students in the bottom quarter of the index of anxiety in mathematics are half as likely to be among the bottom quarter of performers compared to the average student. This negative association remains even if other learner characteristics – such as students' interest in and enjoyment of mathematics, self-efficacy in mathematics and use of control strategies – are accounted for (Table 3.12).

...and students in lower-performing schools tend to be more anxious.

As was the case with self-efficacy, the association between anxiety in mathematics and mathematics performance is not only strong at student levels. In most countries, there is also a clear tendency for students in lower performing schools to report higher levels of anxiety in mathematics (Table 3.15), with 7 per cent of the performance variance among schools explained by the average levels of students' anxiety in mathematics at school.

The fact that males are less anxious about mathematics than females, and students in some countries less anxious than in others, suggests that this is a problem that can be addressed.

The statistically significantly higher levels of anxiety in mathematics reported among females (apparent in all countries except Poland) are of particular concern for education policy, most notably in Austria, Canada, Denmark, Finland, France, Germany, Luxembourg, the Netherlands, Norway and Switzerland. Females also reported higher levels of anxiety in mathematics than males in all partner countries except Serbia (Table 3.8 and Figure 3.8).

The importance of further research in this area is underlined by the strong prevalence of anxiety in mathematics among 15-year-olds in general, and females in particular, coupled with the finding that in countries such as Denmark, Sweden and the Netherlands students report much lower levels of anxiety in mathematics. The positive experiences of the latter group of countries, which also perform well in mathematics overall, suggest that the issue can be managed successfully and raise questions about how these countries are addressing the issue through the organisation of schooling and instructional delivery.

STUDENTS' LEARNING STRATEGIES

As students are active participants in the learning process, constructing meaning in ways shaped by their own prior knowledge and new experiences…

Students do not passively receive and process information. They are active participants in the learning process, constructing meaning in ways shaped by their own prior knowledge and new experiences. Students with a well-developed ability to manage their own learning are able to choose appropriate learning goals, to use their existing knowledge and skills to direct their learning, and to select learning strategies appropriate to the task in hand. While the development of these skills and attitudes has not always been an explicit focus of teaching in schools, it is increasingly being explicitly identified as a major goal of schooling and should, therefore, also be regarded as a significant outcome of the learning process. This is particularly so as, once students leave school, they need to manage most of their learning for themselves. To do this they must be able to establish goals, persevere, monitor their progress, adjust their learning strategies as necessary and overcome difficulties in learning. Therefore, while understanding and developing strategies that will best enhance their learning will be a benefit for students at school, even larger benefits are likely to accrue when they learn with less support in adult life.

…PISA also sought to capture different types of learning strategy.

This section describes three constructs collected from students in PISA 2003 that are related to the control of learning strategies in general (metacognitive strategies that involve planning, monitoring and regulation); memorisation strategies (*e.g.,* learning key terms or repeated learning of material); and elaboration strategies (*e.g.,* making connections to related areas or thinking about alternative solutions).

Controlling the learning process

Effective learners monitor their own learning by checking that they are meeting their learning goals…

Good learners can manage their own learning and apply an arsenal of learning strategies in an effective manner. Conversely, students who have problems learning on their own often have no access to effective strategies to facilitate and monitor their learning, or fail to select a strategy appropriate to the task in hand. Control strategies through which students can monitor their learning by, for example, checking what they have learned and working out what they still need to learn, form an important component of effective approaches to learning as they help learners to adapt their learning as needed.

…and most students say they do this to some degree…

When asked questions about their approaches to monitoring their learning in mathematics and relating this to their learning goals, 87 per cent of the 15-year-olds

in the OECD countries agree or strongly agree that when they study for a mathematics test they try to work out what are the most important parts to learn. Seventy-three per cent of them agree or strongly agree that when they study mathematics they make themselves check to see if they remembered the work they had already done. Eighty-six per cent agree or strongly agree that when they study mathematics they try to figure out which concept they still have not understood properly. Sixty-nine per cent agree or strongly agree that when they cannot understand something in mathematics they always search for more information to clarify the problem. And 75 per cent of 15-year-olds agree that when they study mathematics they start by working out exactly what they need to learn (Figure 3.9).

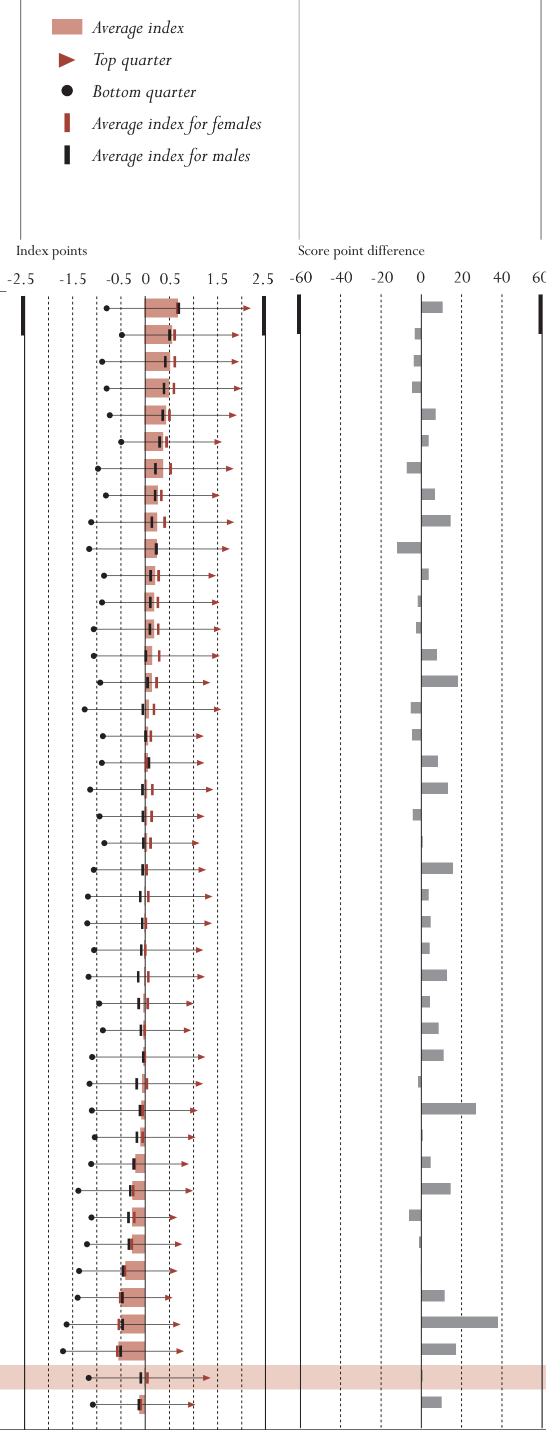
Students can be compared on an index that summarises the different questions about the use of control strategies (see *www.pisa.oecd.org* for the item map and Table 3.9 for data). However, analyses of the PISA 2000 data suggest that absolute values of countries on this index cannot be easily compared because of cultural differences in student response behaviour. Nevertheless, it is legitimate to compare how closely student control strategies relate to student performance in each country and how differences between males and females (or other groups) within each country vary across countries (Table 3.9). It is also noteworthy that females report significantly more use of control strategies in mathematics than males in 22 of 30 OECD countries.

...but the association with performance, though substantial in some countries, tends to be weak overall.

The relationship between the reported use of control strategies and student performance in mathematics tends to be relatively weak, with one unit on the index corresponding to around 6 score points on the mathematics scale, on average across OECD countries (Table 3.9). This is different from the case of reading in PISA 2000, where the use of control strategies was strongly related to reading performance, with one unit on the index corresponding to a reading performance difference of 16 score points (Table 4.5 and OECD, 2001a). As suggested later in this chapter, students who are anxious about mathematics may use control strategies to help them more than those who are confident, so that while such strategies help individuals raise their performance, they are not on average used more by people who perform better. For these reasons, schools may still need to give more explicit attention to allowing students to manage and control their learning, with the aim to help them develop effective strategies, not only to support their learning at school but also to provide them with the tools to manage their learning later in life.

It is also noteworthy that the relationship between the use of control strategies in mathematics and mathematics performance varies widely between countries. In Korea, for example, which has a comparatively low mean score on the control strategies index (-0.49), the relationship between the index and student performance is strong, with one unit on the index corresponding to 38 score points on the mathematics scale. In Australia, Japan, Norway, Portugal, Turkey and the partner country Hong Kong-China, one unit corresponds to between 14 and 27 score points. In contrast, in other countries the relationship is not statistically significant or even slightly negative.

Figure 3.9 ■ Effective learning: Control strategies

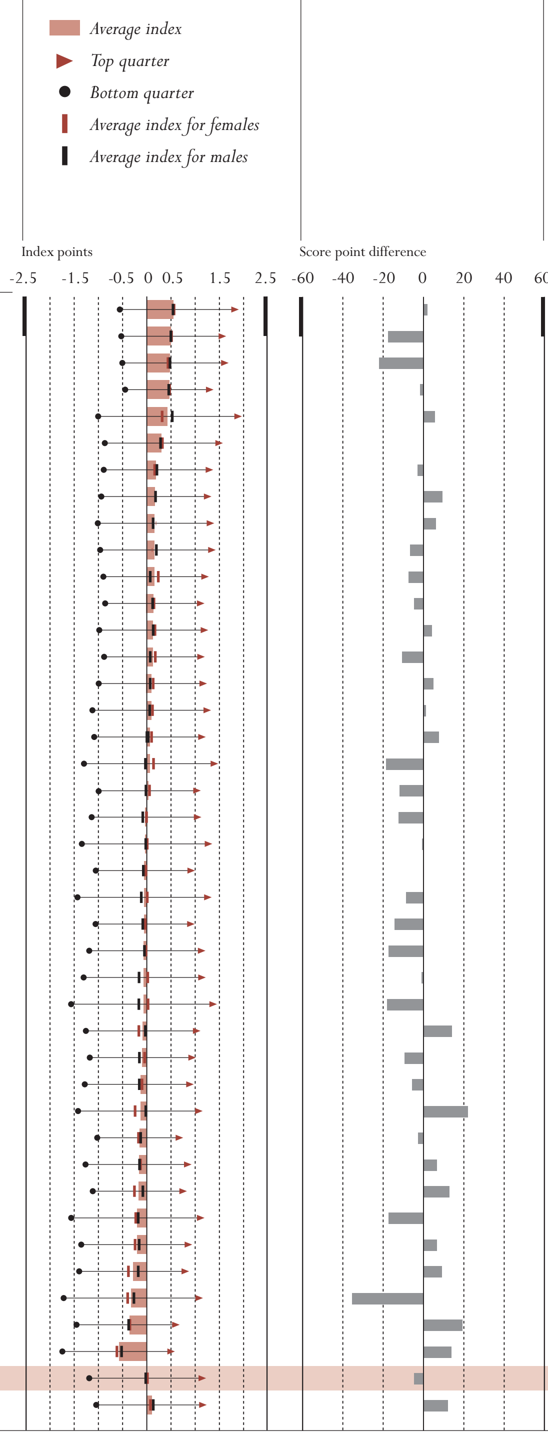


	Percentage of students agreeing or strongly agreeing with the following statements:					
	When I study for a mathematics test, I try to work out what are the most important parts to learn.	When I study mathematics, I make myself check to see if I remember the work I have already done.	When I study mathematics, I try to figure out which concepts I still have not understood properly.	When I cannot understand something in mathematics, I always search for more information to clarify the problem.	When I study mathematics, I start by working out exactly what I need to learn.	Percentage of explained variance in student performance
Tunisia	91	80	86	88	83	2.3
Brazil	93	92	91	91	86	0.1
Austria	86	81	91	70	84	0.2
Serbia	90	83	90	87	85	0.4
Mexico	95	83	93	80	85	0.7
Indonesia	95	96	91	88	89	0.1
Germany	90	71	89	66	88	0.7
Greece	89	85	90	79	79	0.5
Turkey	88	85	85	61	86	2.7
Liechtenstein	85	60	89	72	81	2.1
Italy	90	76	91	83	85	0.1
Uruguay	91	79	88	72	78	0.0
Switzerland	89	63	89	72	80	0.1
France	91	72	87	78	78	0.8
Portugal	91	86	85	77	88	3.8
Luxembourg	83	78	84	66	71	0.4
Slovak Republic	91	79	90	78	83	0.2
Macao-China	87	77	91	65	89	0.7
Canada	87	75	87	74	77	2.4
Hungary	90	76	88	76	78	0.2
Czech Republic	84	82	93	80	80	0.0
Australia	89	77	86	69	79	2.4
United States	86	72	83	74	79	0.1
Iceland	89	73	84	58	76	0.3
Ireland	90	75	86	69	76	0.2
Spain	84	79	84	66	82	2.0
Poland	91	80	86	75	79	0.2
Thailand	94	82	85	74	76	0.6
New Zealand	88	77	86	69	73	1.1
Belgium	85	71	85	67	80	0.0
Hong Kong-China	87	76	89	64	82	6.0
Russian Fed.	87	74	86	71	71	0.0
Denmark	84	68	86	78	57	0.2
Norway	87	61	78	66	59	2.3
Latvia	84	67	84	71	66	0.3
Netherlands	86	59	82	58	81	0.0
Sweden	79	57	84	72	41	0.0
Finland	88	46	82	48	59	1.2
Korea	75	60	75	56	47	16.0
Japan	81	65	76	50	26	3.2
OECD average	*87*	*73*	*86*	*69*	*75*	*0.0*
United Kingdom[1]	89	77	86	65	75	0.9

1. Response rate too low to ensure comparability (see Annex A3).
Source: OECD PISA 2003 database, Table 3.9.

Figure 3.10 ■ Effective learning: Memorisation strategies

	Percentage of students agreeing or strongly agreeing with the following statements: I go over some problems in mathematics so often that I feel as if I could solve them in my sleep.	When I study mathematics, I try to learn the answers to problems off by heart.	In order to remember the method for solving a mathematics problem, I go through examples again and again.	To learn mathematics, I try to remember every step in a procedure.	Percentage of explained variance in student performance
Mexico	41	82	68	92	0.1
Indonesia	68	52	88	79	3.6
Brazil	30	62	88	88	4.1
Thailand	48	90	71	85	0.0
Tunisia	43	52	81	78	0.7
United States	42	67	70	83	0.0
Greece	29	60	75	81	0.1
Australia	30	64	71	80	0.9
Canada	33	58	70	83	0.5
Uruguay	46	42	82	62	0.4
Hungary	44	30	74	89	0.5
Poland	36	62	71	78	0.2
New Zealand	31	66	70	74	0.2
Slovak Republic	60	32	59	82	0.9
Ireland	28	57	77	75	0.3
Turkey	44	30	78	75	0.0
Spain	31	40	76	85	0.7
Austria	43	29	70	78	5.1
Italy	30	32	79	84	1.2
Macao-China	36	55	69	53	1.8
Iceland	26	55	62	72	0.0
Russian Fed.	24	50	63	71	0.0
Luxembourg	42	27	72	73	1.1
Czech Republic	40	34	62	75	1.7
Serbia	33	24	84	68	4.3
France	25	37	70	82	0.0
Germany	42	34	61	68	5.1
Sweden	33	56	63	61	2.2
Belgium	28	36	71	76	0.7
Portugal	27	43	66	74	0.4
Norway	31	41	61	79	6.7
Latvia	19	40	71	74	0.0
Hong Kong-China	34	47	64	56	0.4
Netherlands	41	34	61	61	1.4
Switzerland	32	33	54	74	3.9
Finland	26	44	54	72	0.6
Denmark	19	45	50	69	0.9
Liechtenstein	36	27	50	61	17.7
Korea	30	34	61	52	3.6
Japan	21	27	45	62	1.9
OECD average	*34*	*45*	*66*	*75*	*0.2*
United Kingdom[1]	30	63	70	76	1.6



1.Response rate too low to ensure comparability (see Annex A3).
Source: OECD PISA 2003 database, Table 3.10.

Memorisation and elaboration strategies

Memorisation strategies (*e.g.,* learning of facts or rehearsal of examples) are important in many tasks, but they commonly only lead to verbatim representations of knowledge, with new information being stored in the memory with little further processing. Where the learner's goal is to be able to retrieve the information as presented, memorisation is an appropriate strategy. But such learning by rote rarely leads to deep understanding. In order to achieve understanding, new information must be integrated into a learner's prior knowledge base. Elaboration strategies (*e.g.,* exploring how the material relates to things one has learned in other contexts, or asking how the information might be applied in other contexts) can be used to reach this goal.

Students may need to memorise information, but only where this is integrated with prior knowledge does this bring deeper understanding…

Students in PISA 2003 were asked separate questions on their use of memorisation and elaboration strategies in the field of mathematics. On the basis of their responses, indices were created for each of these learning strategies. As ever, any conclusions need to be drawn with reference to the cultural and educational contexts and analyses in both PISA 2000 and PISA 2003. This suggests that it remains difficult to compare absolute values on both of these indices across countries and cultures (Table 3.10 and Table 3.11).

…so PISA looked at memorisation and elaboration strategies.

With regard to the use of memorisation strategies in the OECD countries, 66 per cent of the 15-year-old students agree or strongly agree that in order to remember the method for solving a mathematics problem they go through examples repeatedly. Seventy-five per cent of them agree or strongly agree that to learn mathematics they try to remember every step in a procedure. However, 65 per cent disagree or strongly disagree that when they study for mathematics they try to learn the answers to problems by heart (Figure 3.10).

Most students memorise procedures but report to not simply learn answers by heart…

With regard to the use of elaboration strategies in OECD countries, 53 per cent of 15-year-olds agree or strongly agree that they think how the mathematics they have learnt can be used in everyday life. Sixty-four per cent agree or strongly agree that they try to understand new concepts in mathematics by relating them to things they already know. Sixty per cent disagree or strongly disagree that when they are solving a mathematics problem they often think about how the solution might be applied to other interesting questions. And 56 per cent of 15-year-olds disagree or strongly disagree that when learning mathematics they try to relate the work to things they have learnt in other subjects.

…and most relate new concepts to what they know, but do not reflect on them more widely.

HOW LEARNER CHARACTERISTICS RELATE TO EACH OTHER AND INFLUENCE PERFORMANCE

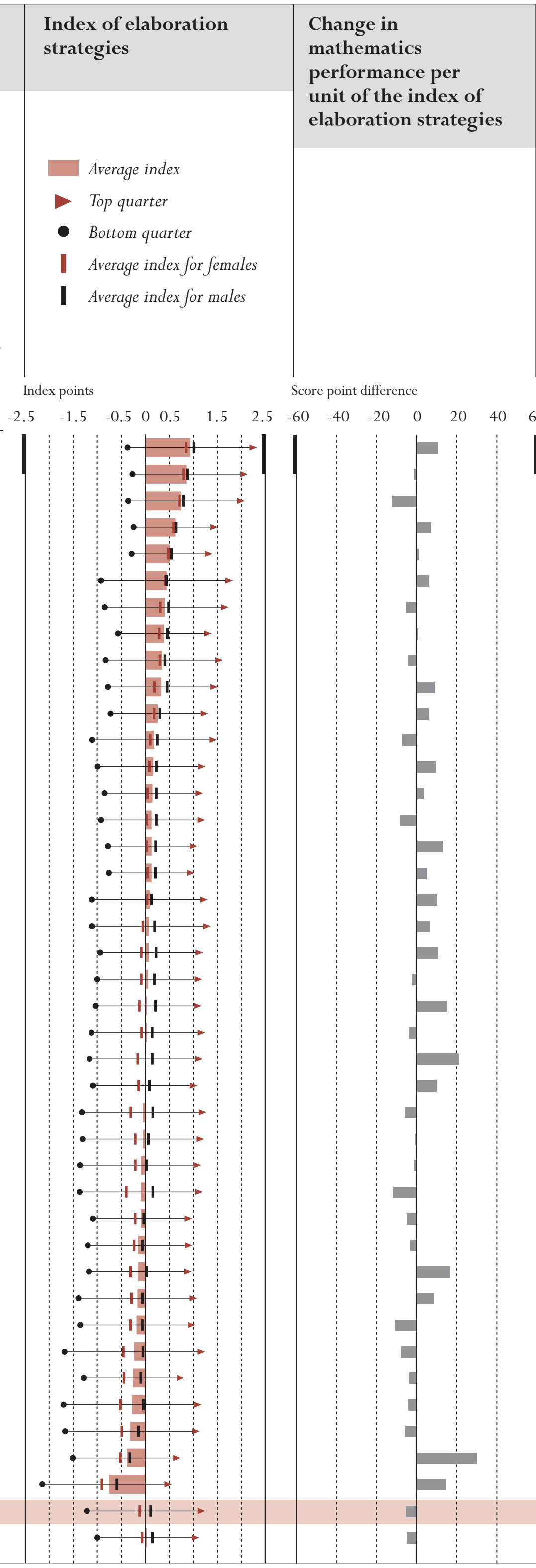
Previous sections in this chapter have examined different learner characteristics individually. This section now considers how different learner characteristics interrelate and how each of these learner characteristics relate to student performance, after accounting for the effect of the others.

Examining these learner characteristics together…

Figure 3.11 ■ Effective learning: Elaboration strategies

Percentage of students agreeing or strongly agreeing with the following statements:

	When I am solving mathematics problems, I often think of new ways to get the answer.	I think how the mathematics I have learned can be used in everyday life.	I try to understand new concepts in mathematics by relating them to things I already know.	When I am solving a mathematics problem, I often think about how the solution might be applied to other interesting questions.	When learning mathematics, I try to relate the work to things I have learnt in other subjects.	Percentage of explained variance in student performance
Tunisia	74	79	78	85	72	1.8
Mexico	78	89	84	67	71	0.0
Brazil	78	83	85	68	57	1.3
Thailand	64	90	81	74	75	0.3
Indonesia	74	86	82	71	43	0.0
Turkey	68	60	72	57	68	0.4
Serbia	60	62	78	62	54	0.4
Slovak Republic	65	69	80	43	67	0.0
Uruguay	64	66	72	52	52	0.2
Greece	50	75	71	56	52	0.8
Poland	52	64	80	46	59	0.3
United States	56	55	70	48	52	0.6
Portugal	64	53	73	60	41	0.9
Russian Fed.	32	68	68	48	57	0.1
New Zealand	54	60	67	43	47	0.5
Czech Republic	33	77	76	38	49	1.1
Latvia	44	72	75	38	49	0.2
Spain	55	63	63	44	44	1.3
Canada	53	52	64	43	47	0.5
Denmark	47	57	66	42	47	1.0
Australia	53	55	65	41	44	0.0
Macao-China	56	54	65	40	38	2.4
Italy	54	51	64	43	44	0.2
Hong Kong-China	58	51	63	43	40	4.1
Sweden	48	61	64	33	41	0.9
Switzerland	44	47	66	37	45	0.4
Iceland	38	57	65	38	38	0.0
France	45	47	52	48	44	0.0
Liechtenstein	44	44	70	35	41	1.4
Hungary	34	56	65	31	38	0.2
Ireland	41	49	60	33	36	0.1
Finland	43	51	62	27	40	3.1
Norway	35	59	58	35	37	0.8
Belgium	44	36	58	40	40	1.0
Luxembourg	54	40	44	37	34	1.0
Netherlands	40	27	56	36	41	0.1
Austria	41	41	60	29	40	0.3
Germany	36	42	56	27	36	0.4
Korea	40	34	55	27	21	9.1
Japan	42	12	52	21	15	2.4
OECD average	*49*	*53*	*64*	*40*	*44*	*0.3*
United Kingdom[1]	52	52	67	38	47	0.2



1. Response rate too low to ensure comparability (see Annex A3).
Source: OECD PISA 2003 database, Table 3.11.

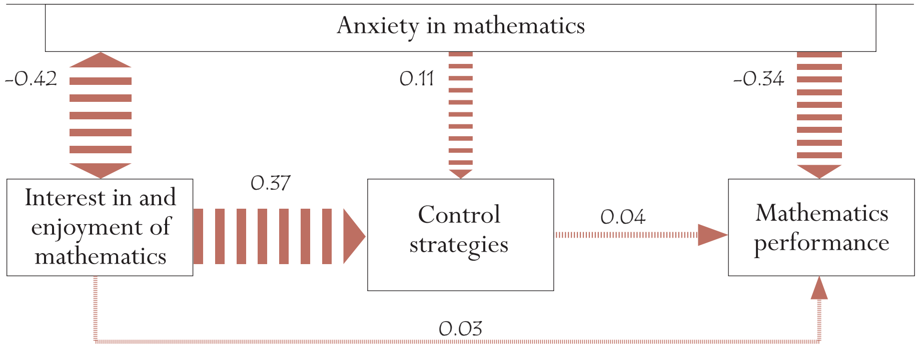
Associations between different student characteristics make it difficult to separate out the effect of any single one of them when it comes to predicting performance. For example, students who say that they are interested in mathematics are also more likely to perform well, to believe in their own efficacy and to exert effort and persistence, factors that have also been shown to be associated with strong performance. To what extent is being interested in mathematics a predictor, in itself, of good performance and to what extent can the high performance of students who are interested in mathematics be explained by the fact that they also tend to have these other positive attributes? By building a model of the multiple interactions among these variables, it is possible to separate out the impact of each – effectively looking at the association between, say, mathematics interest and performance while controlling for other measured characteristics. This makes it possible to distinguish a separate effect for each variable (Figure 3.11).

...makes it possible to distinguish the separate influence of each on performance.

The model used here to analyse these effects considers a selection of the measures used by PISA to measure students' interest in mathematics and their anxiety in mathematics, alongside students' use of control strategies and their mathematics performance.[7] The model operates on the basis that students' interest in mathematics and low levels of anxiety are drivers which initiate investment in learning activity, with the adoption of particular strategies, represented in the model by students' tendency to control their own learning. The model then seeks to predict students' performance in mathematics from students' interest in mathematics, their absence of anxiety in mathematics and the frequency with which students report the use of control strategies.

Figure 3.12 shows the measured average degree of association for each of the relationships, with results for individual countries shown in Table 3.12.[8] These are different from the individual associations between the various characteristics

Figure 3.12 ■ **Individual factors associated with control strategies and performance, when accounting for other factors**



Note: The width of each arrow is proportional to the regression coefficient, shown in each box, a measure of the association between the factors (however, the proportion of explained variance cannot be calculated from the coefficient for a single variable, since several variables are looked at simultaneously). The directions of the arrows in this diagram indicate a suggested effect, rather than a demonstrated causal link.

Source: OECD PISA 2003 database, Tables 3.12, 3.13 and 3.14.

and performance shown in previous sections because they now separate out the specific effect by accounting for interrelationships with the other variables. The following results emerge from this analysis.

This analysis shows that students who are less anxious perform better regardless of other characteristics…

First, the various aspects of student anxiety in mathematics closely affect performance, over and above associations with other learner characteristics. The strength of the influence is shown by the width of each arrow. The results show that students with an absence of anxiety about mathematics perform strongly in mathematics, regardless of other aspects of their attitudes or behaviour. When other factors are taken into account, students' interest in and enjoyment of mathematics have on average no clear association with performance.

…that anxiety and interest in and enjoyment of mathematics are closely interrelated…

This does not mean, however, that interest in and enjoyment of mathematics do not matter: the fact that students with these characteristics are more likely to use effective learning strategies clearly contradicts such an interpretation. Rather, the strong negative association between interest in and enjoyment of mathematics and anxiety in mathematics suggests that these two factors work together: As indicated by the associations between anxiety in mathematics and interest in and enjoyment of mathematics in Figure 3.12, students who are anxious about doing mathematics tend not to be interested in or enjoy mathematics. The associations between the two learner characteristics on the left side of the model are rather consistent across countries (Table 3.14) and thus seem to illustrate a universal pattern of relationships.

… that while control strategies are not directly associated with performance, they are linked to interest and anxiety…

An impact of control strategies on performance, once other learner characteristics are accounted for, is not measurable. This is not because controlling one's learning does not help performance, but rather because a large amount of the variation in the degree to which students control their learning is associated with variation in their interest in and enjoyment of mathematics as well as in their anxiety in mathematics.

…and that students often seem to use control strategies as a response to anxiety.

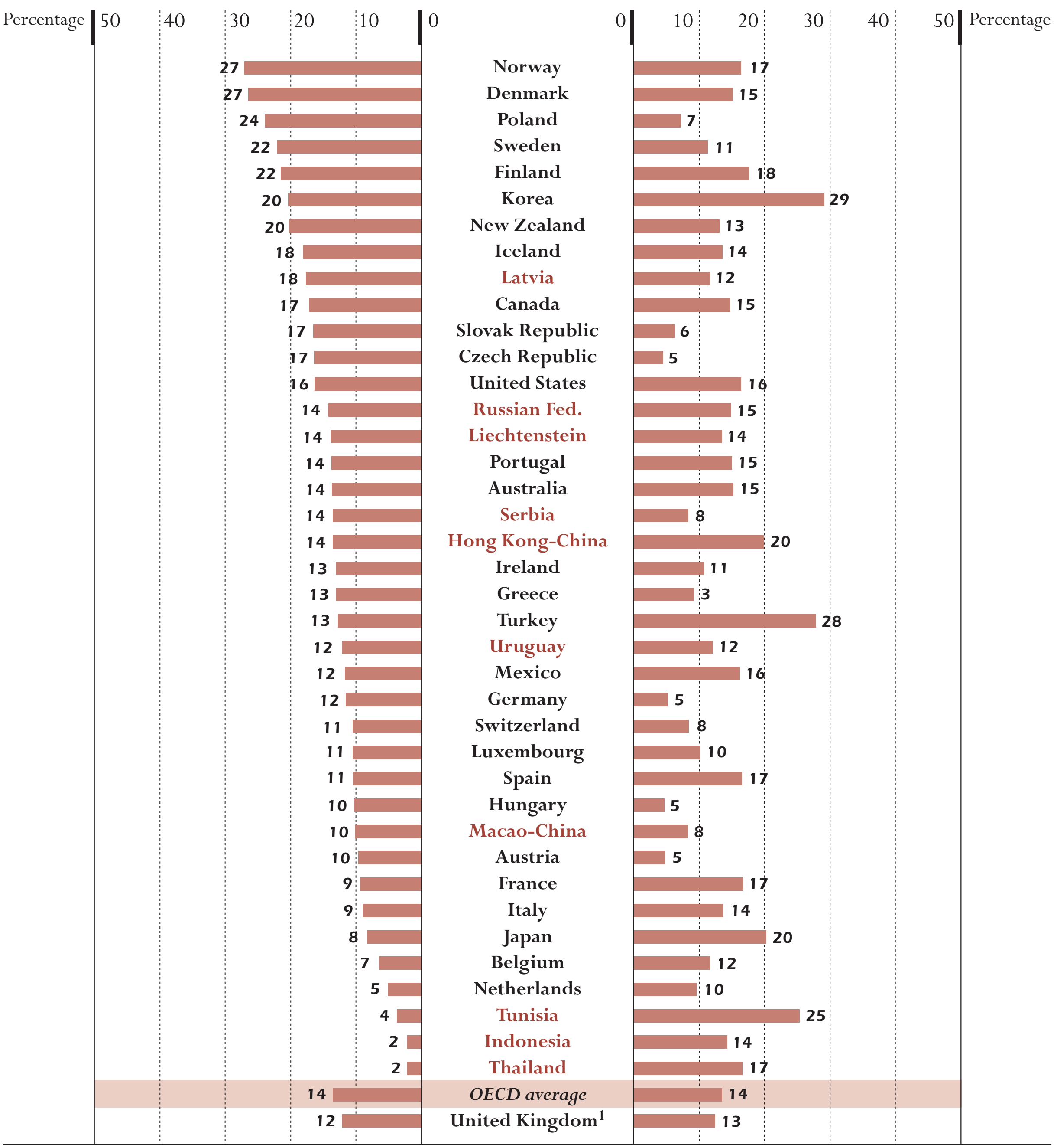
It is clear from the above that while the separate effects of individual student characteristics on student performance and on the use of control strategies are not always large, measurement of the overall effect is different from the sum of these individual associations, because several factors may combine to have an influence. The modelling process allows the combined effect of several characteristics to be measured by considering the percentage of variation in, for example, student performance that could be explained by the combined association with related factors. These results are shown in Figure 3.13.

Additionally, the low but positive association between students' anxiety in mathematics and their self-reported control strategies – most obvious in Belgium, Luxembourg, the Netherlands and Spain as well as in Latvia and Liechtenstein among the partner countries (Table 3.13) – shows that control strategies are not only used by students who are highly motivated, but also used by students who are anxious about mathematics. Students who are anxious (and often low performing as indicated by the negative effect on mathematic performance)

Figure 3.13 ■ **The combined explanatory power of student learning characteristics on mathematics performance and control stategies**

(A)
Percentage of variance in student performance in mathematics that is explained by the combined effect of:
- interest in and enjoyment of mathematics
- anxiety in mathematics
- control strategies

(B)
Percentage of variance in student use of control strategies that is explained by the combined effect of:
- interest in and enjoyment of mathematics
- anxiety in mathematics



1. Response rate too low to ensure comparability (see Annex A3).
Source: OECD PISA 2003 database.

seem to regulate their learning by an increased use of control strategies, which can be a highly effective approach given their specific needs. On the other hand, students who are more capable might not need such deliberate self-control, since information processing happens smoothly and thus they report using these to use strategies less frequently. Looking at the overall picture, as shown in Figure 3.12, such a differential (but adaptive) use of strategies can help explain why students who use control strategies most do not necessarily have higher than average performance, even though such strategies can help individuals with particular needs to perform better.

This analysis shows strong interrelationships between learner characteristics and mathematics performance.

Overall, Figure 3.13 shows strong interrelationships between learner characteristics and mathematics performance. Similarly, when looking at the amount of explained variance for students' use of control strategies, the two predictors, namely interest in and enjoyment of mathematics and anxiety in mathematics, explain around 30 per cent of the variance in Korea and Turkey and the partner country Tunisia (OECD average 14 per cent). Although the PISA index of control strategies may also capture other learner characteristics, control over the learning process is an important outcome in its own right, particularly in a lifelong learning context where autonomous learning is becoming increasingly important. It suggests that in all countries, adopting an effective learning strategy depends not just on having cognitive tools (knowing how to learn) but also on having certain attitudes and dispositions (wanting to learn).

HOW LEARNER CHARACTERISTICS VARY ACROSS SCHOOLS

PISA shows fewer differences among schools in learner characteristics than in performance…

How do the overall patterns in learner characteristics vary among schools? A high degree of variation between schools within countries would indicate that certain schools stand out and suggest that it is possible to influence the development of students' approaches to learning through schooling and targeted interventions. Table 3.15 examines the relative proportions of variation between schools in several of the learner characteristics reported in this chapter.

The results suggest that differences between schools in students' reported characteristics are far less pronounced than the differences within schools. For the eight characteristics considered in Table 3.15, on average across OECD countries, variation among schools accounts for less than 15 per cent of the overall variation among students. This may suggest that, in most countries, comparatively few schools stand out as being particularly likely to have students who report being well-motivated, confident and using effective learning strategies.

…but this may be because students describe their characteristics relative to those of their peers.

Such results must be interpreted with caution, though, given that they are based on self-reports and that students' judgements about themselves can be strongly influenced by reference to their peers. In the case of some characteristics, this might disguise important between-school differences in students' real approaches to learning. For example, it is possible that some students with hard-working classmates understate the amount of effort and persistence they put in, compared to students with less hard-working classmates, even though

it is the absolute amount of effort that matters to school success. This makes it hard to identify schools with relatively hard-working pupils overall. On the other hand, in other respects, students' perceptions relative to their peers are an important part of the picture. For example, even if students' perceptions of not being good at mathematics are linked to the high mathematics abilities of others in the school, rather than to an absolute weakness in the subject, this lack of confidence is still an important aspect of their approach to learning that may hold them back.

Nevertheless, the high variation within each school shows that even successful schools have issues to address.

The finding that individual schools do not vary greatly in the profile of students' self-reported approaches to learning has, nevertheless, important implications, even if it does *not* imply that all schools are similar with regard to the learner characteristics of their intake. What it does highlight is the large variation in learner characteristics among students within schools. The large proportion of within-school variation underlines the importance for teachers to be able to engage constructively with heterogeneity not only in student abilities but also in their approaches to learning. Even in schools that are performing well there are students who lack confidence and motivation and who are not inclined to set and monitor their own learning goals.

A SUMMARY PICTURE OF GENDER DIFFERENCES IN LEARNER CHARACTERISTICS

Various gender differences can be compared in standardised form…

Previous sections of this chapter have examined gender differences separately for the various learner characteristics. Figure 3.14 summarises the information on gender differences for student attitudes, anxiety, strategies and cognitions related to mathematics and relates the results to the observed performance differences in mathematics. All results are expressed as effect sizes, so that results can be compared across the different measures and across countries, with an effect size of 0.20 used as a criterion to establish differences that warrant attention by policy makers (Box 3.3).

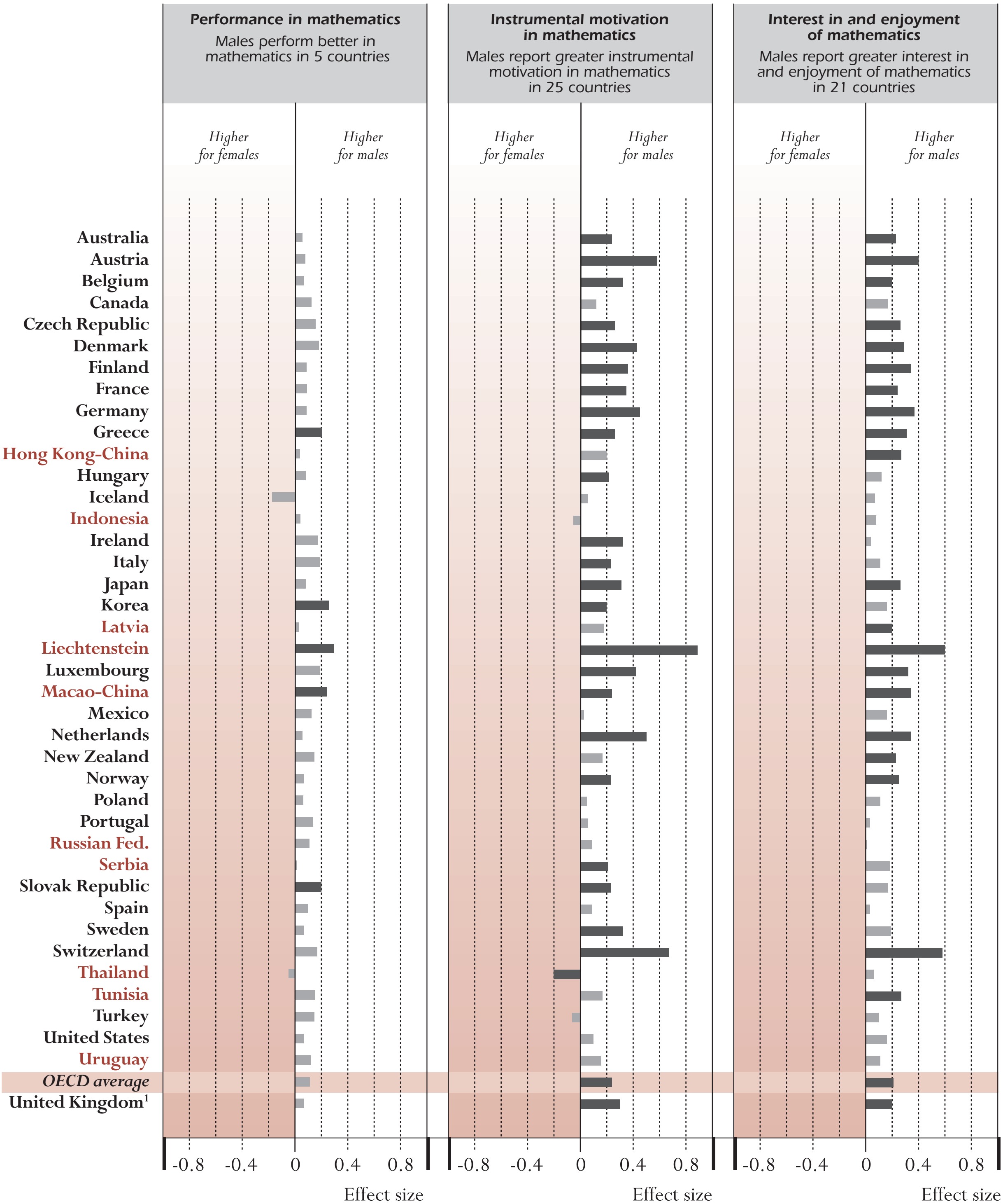
…showing that males and females approach the learning of mathematics differently…

A first striking finding is that while gender differences in student performance tend to be modest (see first bar in Figure 3.14) there are marked differences between males and females in their interest in and enjoyment of mathematics as well as in their self-related beliefs, emotions and learning strategies related to mathematics.

…with males showing higher motivation, particularly in some countries.

Figure 3.14 shows that in 21 countries males express stronger levels of interest in and enjoyment of mathematics than females, with an average effect size of 0.21, and with effect sizes greater than 0.50 in Switzerland as well as in the partner country Liechtenstein. Gender differences in instrumental motivation in mathematics tend to be even greater (the average effect size is 0.24) than in interest in mathematics, suggesting that males may be more motivated to learn because they believe that mathematics will help them in their later careers.

Figure 3.14 ■ **Gender differences in mathematics and other learning characteristics as measured by effect sizes**

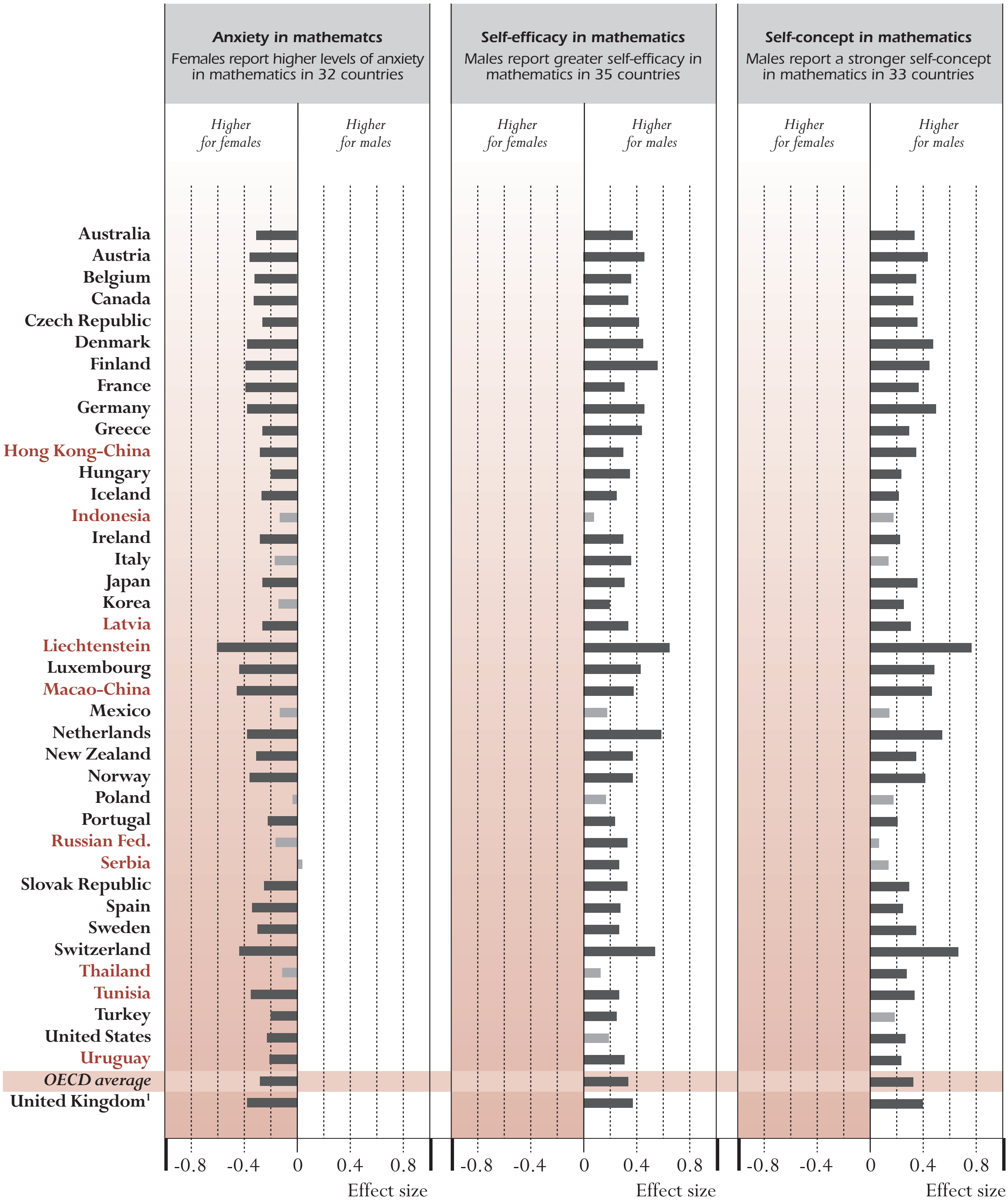


Note: Effect sizes equal to or greater than 0.20 are marked in darker colour (see Annex A4).

1. Response rate too low to ensure comparability (see Annex A3).

Source: OECD PISA 2003 database, Table 3.16.

Figure 3.14 (continued-1) ■ **Gender differences in mathematics and other learning characteristics as measured by effect sizes**

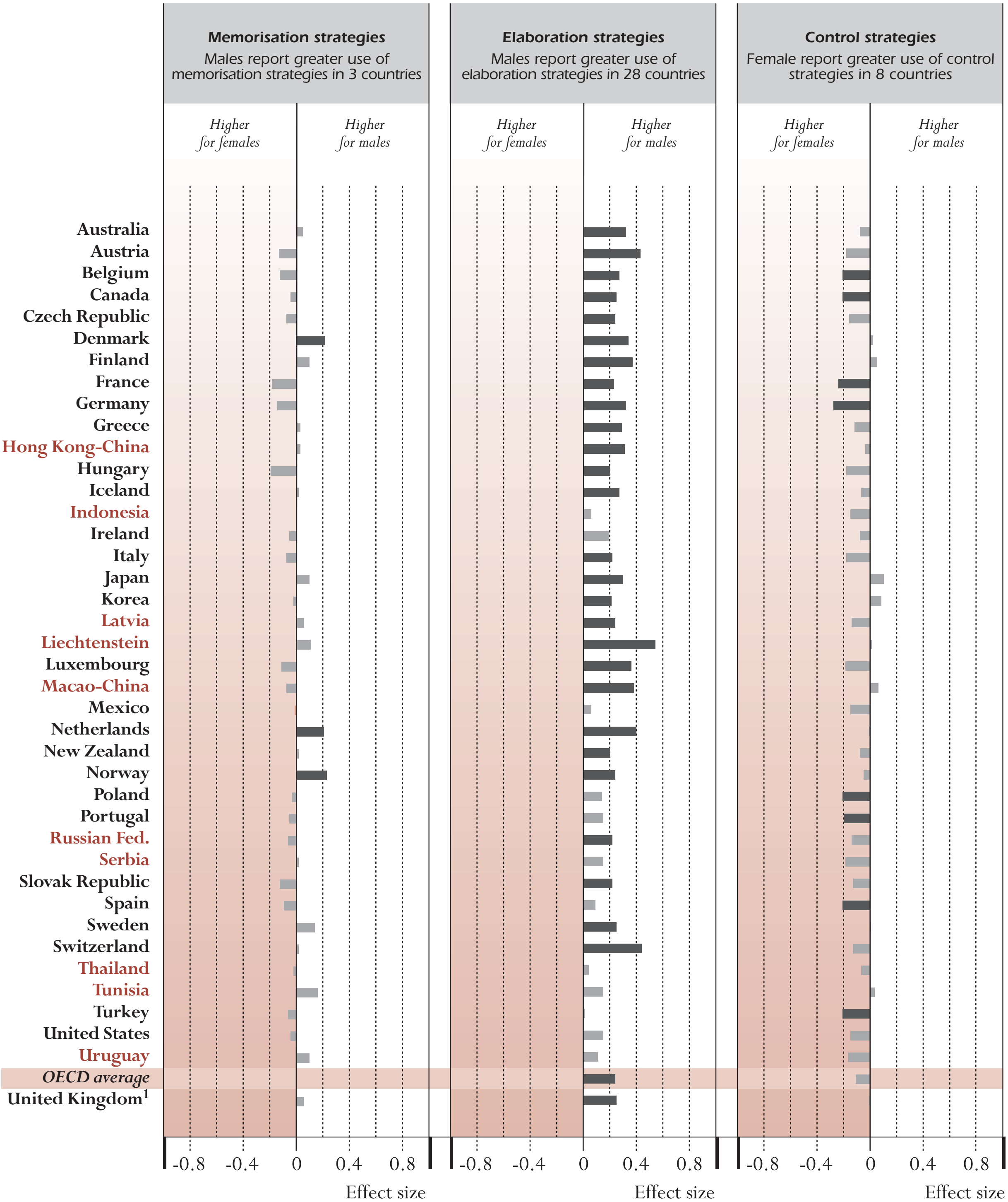


Note: Effect sizes equal to or greater than 0.20 are marked in darker colour (see Annex A4).

1. Response rate too low to ensure comparability (see Annex A3).

Source: OECD PISA 2003 database, Table 3.16.

Figure 3.14 (continued-2) ■ **Gender differences in mathematics and other learning characteristics as measured by effect sizes**



Note: Effect sizes equal to or greater than 0.20 are marked in darker colour (see Annex A4).

1. Response rate too low to ensure comparability (see Annex A3).

Source: OECD PISA 2003 database, Table 3.16.

Males also show greater confidence in mathematics, relative to females, than one might expect from relatively small differences in performance…

Beyond the observed discrepancy between gender difference in actual performance (which are comparatively small) and gender differences in student intrinsic and extrinsic motivation (which tend to be much larger), a similar picture also emerges also when looking at students' mathematics-related self-efficacy beliefs, self-concepts and anxiety. Again, although females often do not perform at a level much lower than males, they tend to report lower mathematics-related self-efficacy than males in almost all countries, with the strongest effects in Finland, the Netherlands, and Switzerland, as well as in the partner country Liechtenstein. Similar results emerge for students' self-concept in mathematics, where males tend to have a more positive view of their abilities than do females in most countries.

…while in most countries females feel more anxious.

Finally, females experience significantly more feelings of anxiety, helplessness and stress in mathematics classes than males in 32 of 40 countries. There are statistically significantly higher levels of anxiety among females in Austria, Denmark, Finland, France, Germany, Luxembourg, the Netherlands, Norway, Spain and Switzerland, as well as in the partner countries Liechtenstein, Macao-China and Tunisia.

This suggests that schools need to promote interest in and confidence about mathematics among females.

Taken together, the difference between males and females in performance in mathematics, on the one hand, and anxiety and attitudes towards the subject, on the other, are highly relevant for policy makers, as these data reveal inequalities between the genders in the effectiveness with which schools and societies promote motivation and interest. The data also reveal a difference in the level of anxiety in mathematics. The results raise questions as to how the gender gap can be reduced and how to reach a high level of overall performance through the organization of schooling and instructional delivery.

In some countries, females are more likely to control their learning and males to elaborate new knowledge.

With respect to students' use of learning strategies, gender differences are less pronounced. Nevertheless, while gender patterns in the use of memorisation strategies are not widely apparent,[9] in 28 of the 40 countries with available data, males consistently report using elaboration strategies more often than females. Conversely, in 8 countries, females report using control strategies more often than males. This suggests that females are more likely to adopt a self-evaluating perspective during the learning process. Females might benefit from training in the use of elaboration strategies, while males, on the other hand, might benefit from more general assistance in planning, organising and structuring learning activities. Similar results have been reported on the basis of the PISA 2000 data, where the same learning strategies were measured for reading (OECD, 2003b).

These gender differences are relevant for students' futures, not just their performance at school.

Although these data reflect the attitudes and behaviour of 15-year-olds, the patterns observed may well be predictive of those appearing later in their educational and occupational careers. As mentioned before, significant progress has been achieved in reducing the gender gap in formal educational qualifications over the last generation and university-level graduation rates for women now equal or exceed those for men in 21 of the 27 OECD countries for which

comparable data exist (OECD, 2004a). However, in mathematics and computer science, gender differences in tertiary qualifications remain persistently high: the proportion of women among university graduates in mathematics and computer science is only 30 per cent, on average, among OECD countries, and in Austria, Belgium, Germany, Hungary, Iceland, the Netherlands, Norway, the Slovak Republic and Switzerland it is only between 9 and 25 per cent.

IMPLICATIONS FOR POLICY

The results from this chapter suggest that students are most likely to initiate high quality learning, using various strategies, if they are well motivated, not anxious about their learning and believe in their own capacities.

Well-motivated and confident students invest well in their own learning…

Students' motivation, their positive self-related beliefs as well as their emotions also affect their use of learning strategies. There are good grounds for this: high quality learning is time and effort-intensive. It involves control of the learning process as well as the explicit checking of relations between previously acquired knowledge and new information, the formulation of hypotheses about possible connections and the testing of these hypotheses against the background of the new material. Learners are only willing to invest such effort if they have a strong interest in a subject or if there is a considerable benefit, in terms of high performance, with learners motivated by the external reward of performing well. Thus, students need to be willing to learn how to learn. From the perspective of teaching this implies that effective ways of learning – including goal setting, strategy selection and the control and evaluation of the learning process – can and should be fostered by the educational setting and by teachers.

…and teachers can help those with weaker approaches to adopt effective learning strategies…

Research on ways of instructing students in learning strategies has shown that the development of learning expertise is dependent not only on the existence of a repertoire of cognitive and metacognitive information-processing abilities but also on the readiness of individuals to define their own goals, to be proactive, to interpret success and failure appropriately, to translate wishes into intentions and plans and to shield learning from competing intentions. A repertoire of strategies combined with other attributes that foster learning develops gradually through the practices of teachers who model learning behaviour, through activities aimed at building a scaffolding structure of learning for the student and through analysis of the reasons for academic success and failure. During the process of becoming effective and self-regulated learners, students need assistance and feedback, not only on the results of their learning, but also on the learning process itself. In particular, the students with the weakest approaches to learning need professional assistance to become effective and self-regulated learners.

…which requires a building of their motivation and confidence.

The links between students' self-related beliefs in mathematics and learning behaviours in mathematics suggest that motivation and self-confidence are indispensable to outcomes that will foster lifelong learning. The combined effect of motivation and self-confidence on control strategies suggests that teaching

a student how to learn autonomously is unlikely to work without strong motivation and self-confidence as a basis.

The finding that the profile of students' self-reported approaches to learning varies much more within schools than among schools also has policy implications, even if it does not imply that all schools are similar with regard to the learner characteristics of their intake. What it does highlight is the large variation in learner characteristics among students in each school. This underlines the importance for schools and teachers to be able to engage constructively with heterogeneity not only in student abilities but also in their characteristics as learners and their approaches to learning. It will not be sufficient to operate on the principle that a rising tide raises all ships, since even in well-performing schools there are students who lack confidence and motivation and who are not inclined to set and monitor their own learning goals.

Teachers in all schools, not just low-performing ones, need to help students become stronger learners…

Another striking finding of the analysis is that while females generally do not perform much below males in mathematics, they consistently report much lower interest in and enjoyment of mathematics, lower self-related beliefs and much higher levels of helplessness and stress in mathematics classes. This finding is highly relevant for policy makers, as it reveals inequalities between the genders in the effectiveness with which schools and societies promote motivation and interest and – to an even greater extent – help students overcome anxiety towards different subject areas. These patterns may well be predictive of gender differences appearing later in the educational and occupational careers of males and females. They raise questions as to how the gender gap can be reduced and a high level of overall performance reached through the organisation of schooling and instructional delivery.

…and should pay particular attention to females, whose lack of self-confidence and motivation in mathematics exceeds their lower performance.

Overall, the results suggest that education systems need to invest in approaches that address aspects of attitudes and learning behaviours and to consider this as a goal that is as central to the mission of education systems as cognitive instruction. This may have implications for the initial training of teachers, as well as for the continuous professional development of teachers.

Thus, schools must not just instruct students but also address their learning approaches.

Notes

1. This research is summarised in Box 3.1 below and further described in OECD (2003b).
2. The other two categories related to the interactive use of tools in the widest possible sense and social skills, defined in terms of successful participation in socially heterogeneous groups.
3. For the country Serbia and Montenegro, data for Montenegro are not available. The latter accounts for 7.9 per cent of the national population. The name "Serbia" is used as a shorthand for the Serbian part of Serbia and Montenegro.
4. To illustrate the meaning of the international scores on the index, question-by-score maps have been constructed that relate the index value to typical student responses to the questions that were asked. These question-by-score maps can be found at *www.pisa.oecd.org*.
5. See Box 2.2 in Chapter 2 for an explanation of how scores are translated into years of schooling.
6. The share of females completing a university-level qualification (tertiary Type A) in mathematics or computer science in 2002 was 30 per cent on average across OECD countries with available data and 19 per cent in Austria, 23 per cent in Germany, 16 per cent in the Netherlands and 19 per cent in Switzerland. Luxembourg also shows large gender differences in instrumental motivation but since tertiary institutions awarding Type A qualifications in mathematics and science do not exist in Luxembourg, no comparison about gender differences can be made (OECD, 2004a).
7. The variables selected for the purpose of this model are as follows: The use of *control strategies in mathematics* is used to illustrate how learning strategies are associated with performance. Thinking about what one needs to learn and relating this to learning goals is a particularly important aspect of regulating one's own learning, which prior research has shown to have a particularly close association with performance. The link between motivation and performance is illustrated *by interest in and enjoyment of mathematics*, one of the motivational characteristics measured. *Anxiety in mathematics* or students' feelings of helplessness and stress when dealing with mathematics has been shown to have a negative effect on performance. Instead of processing task relevant cognitions, students with a high degree of anxiety are often occupied by task-irrelevant cognitions and emotional stress. Both lead to reduced capacity for actually dealing with the tasks at hand and therefore to lower performance.
8. The degree of association is measured by the multiple regression coefficients in the model. These coefficients vary between 1 or -1 (indicating a perfect positive or negative relationship) and 0 (indicating that there is no relationship)
9. Effect sizes exceed 0.2 only in Denmark, the Netherlands and Norway.