5

The Role of Teachers and Schools in Shaping Students' Engagement, Drive and Self-Beliefs

This chapter discusses how students' engagement with and at school, their drive and their self-beliefs are influenced by policies and practices at school. Experience with mathematics problems at school, teachers' practices, teacher-student relations, and disciplinary climate in the classroom are discussed in relation to students' dispositions towards learning. The chapter also analyses the effect on these dispositions when students compare their performance to that of other students in the same school, and examines trends in the relationship between students' engagement, motivation and self-belief and the schools they attend.

Chapters 2, 3 and 4 map the extent to which students have high levels of engagement with and at school, drive and motivation to learn, and how they view themselves as mathematics learners. They also reveal the strong association between mathematics performance and students' engagement, drive, motivation and self-beliefs. This chapter looks at the role schools and teachers can play in fostering students' engagement with school, mathematics and learning, and also studies the concentration in schools of students with these dispositions. The learning environment examined by PISA may only partially reflect students' experience in education, particularly in school systems where students attend different educational institutions as they progress through pre-primary, primary, lower secondary and upper secondary education. To the extent that students' current learning environment differs from that of their earlier school years, the contextual data collected by PISA are an imperfect proxy for students' learning environments up until they reach the age of 15, and the effects of those environments on learning outcomes is likely to be underestimated. In most cases, 15-year-old students have been in their current school for only two to three years. This means that much of their academic development took place earlier, in other schools, which may have little or no connection with the present school.

What the data tell us

- Some 47% of students in OECD countries are in schools where between one in four and one in two students arrived late for school at least once in the two weeks prior to the PISA test, and 21% are in schools where more than half of students arrived late.
- In all countries and economies except Turkey, Liechtenstein, Indonesia, Hong Kong-China and Malaysia, among students with equal performance and similar socio-economic status, students who attend schools with better teacher-student relations are less likely to report that they had arrived late during the two weeks before the PISA test.
- In most countries students' intrinsic motivation to learn mathematics is positively associated not only with how well they perform in mathematics, but also with how much better these students perform compared to other students in their school.
- On average across OECD countries, students who reported that their teacher uses cognitive-activation strategies and teacher-directed instruction reported particularly high levels of perseverance and openness to problem solving, are more likely to favour mathematics as a field of study over other subjects, and to see mathematics as more necessary to their careers than other subjects compared with students who perform as well but whose teachers do not use these strategies.

This chapter first examines the concentration of students with low levels of engagement, drive, motivation and self-beliefs across schools. There are large variations between countries in the extent to which students reported low levels of engagement with and at school, drive and motivation and mathematics self-beliefs. But are these students concentrated in some schools? The findings suggest that in some schools students are especially likely to have low levels of engagement. However, students' drive, motivation and self-beliefs tend to be similar across schools.

The chapter then examines the processes and policies applied in schools that are related to the observed outcomes. To a large extent, students' dispositions and self-beliefs are influenced by their peers; but the teaching practices, and the material teachers present to students can also influence students' drive, motivation and self-beliefs, and teaching practices can vary widely, even within the same school. What role does experience with mathematics problems play in the formation of students' drive and motivation to learn mathematics, and mathematics self-beliefs? Do teachers' behaviours and teaching practices help students develop drive, motivation and positive self-beliefs? The chapter concludes by examining other school practices and interventions that could promote these dispositions.

The associations between school factors and education policies on the one hand and students' engagement, drive, motivation and self-beliefs on the other are examined by comparing all students and by comparing students with similar levels of proficiency in mathematics. Because teachers' behaviour, opportunities to learn, school factors and education policies can all influence mathematics performance (see Volumes I and IV of this report), and students' engagement, drive, motivation and self-beliefs are strongly associated with mathematics performance (see Chapters 2, 3 and 4 of this volume), examining these relationships among students with similar performance reveals the specific role school factors and education policies can play in promoting students' engagement, drive, motivation and self-beliefs.[1]

THE ASSOCIATION BETWEEN SCHOOL CLIMATE AND DISPOSITIONS TO LEARN

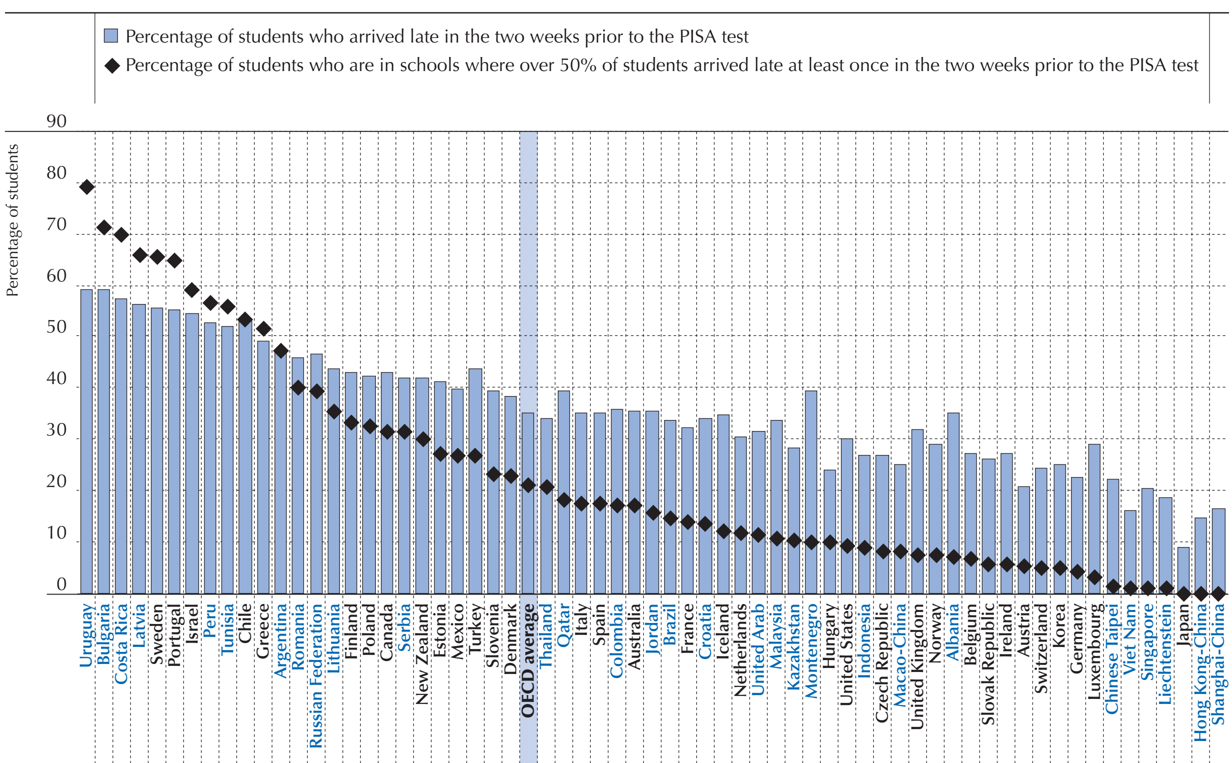
A high concentration of students with low levels of engagement, drive, motivation and self-beliefs might be particularly challenging for schools since students who, for example, arrive late or skip classes or days of school, disrupt the learning environment for all other students and the teaching staff, and could contribute to a climate where academic proficiency is not valued. Teachers and school principals might be particularly hard-pressed to ensure that students put effort into their studies and value learning when many of the students' peers don't.

Table III.5.1a shows that, across OECD countries, 8% of students are in schools where at most 10% of students reported to have arrived late for school in the two weeks prior to the PISA test, 24% are in schools where more than one in ten students but fewer than one in four students arrived late at least once during the same period. By contrast, 47% of students are in schools where between one in four and one in two students arrived late for school, and 21% are in schools where more than half of students reported to have arrived late for school at least once in the two weeks prior to the PISA test. However, the OECD average masks large variations in the extent to which a lack of punctuality is concentrated in some schools. Figure III.5.1 shows that in Bulgaria, Costa Rica and Uruguay more than 70% of students attend schools where more than one in two students reported having arrived late for school at least once in the two weeks prior to the PISA test. These are also countries where arriving late for school is relatively common.

Similarly, across OECD countries, an average of 27% of students are in schools where one in ten students or fewer reported having skipped classes or days of school in the two weeks prior to the PISA test; 31% are in schools where between one in ten and one in four students reported to have done so at least once; 30% are in schools where between a quarter and half of students reported to have done so; and 13% are in schools where more than half the students reported to have done so. In Argentina, Latvia and Turkey over 80% of students attend schools where more than half the students reported to have skipped a day of school or a class at least once in the two weeks prior to the assessment (Table III.5.2a).

▪ Figure III.5.1 ▪

Concentration of students who arrive late for school



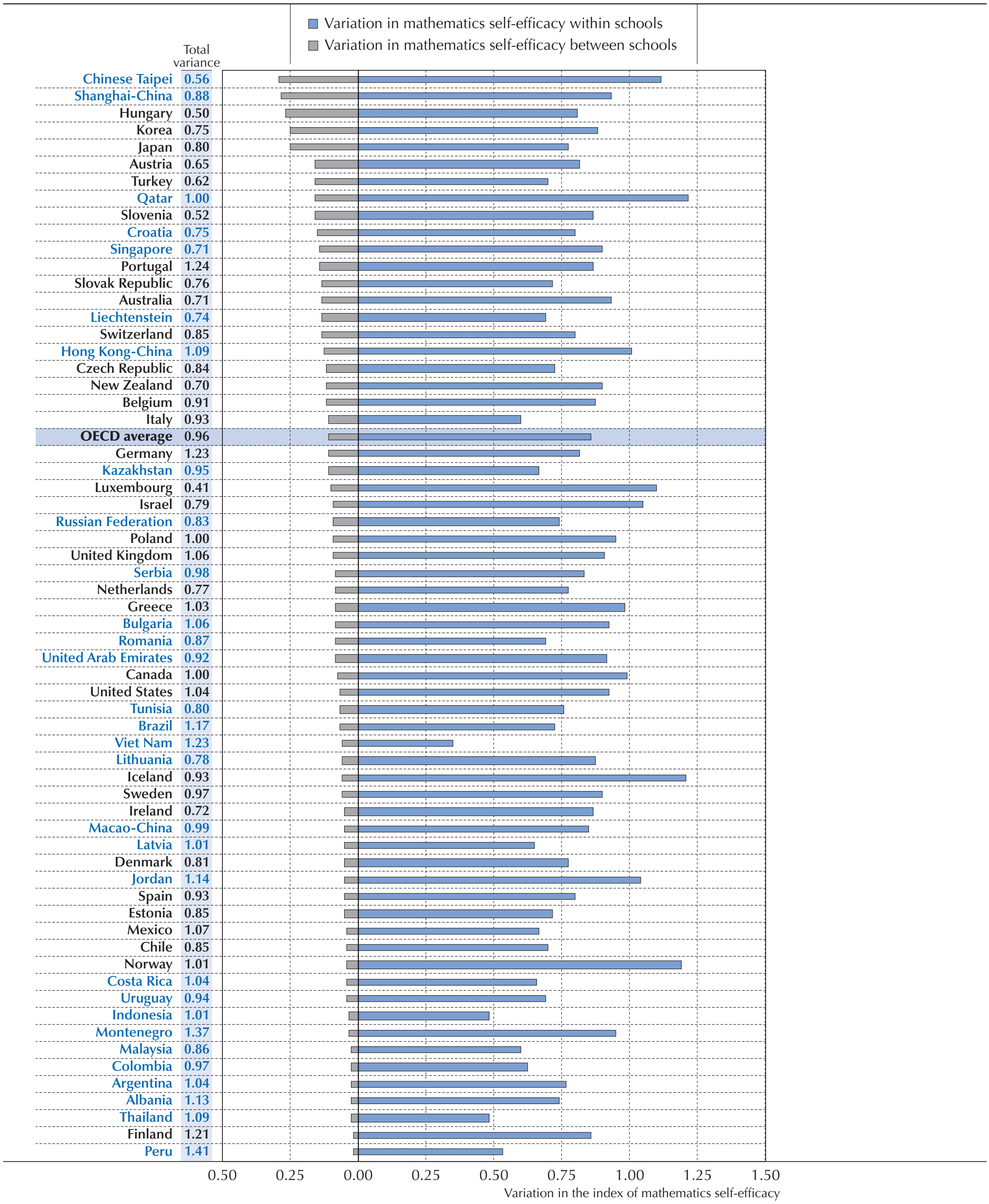
Countries and economies are ranked in descending order of the percentage of students who are in schools where over 50% of students arrived late at least once in the two weeks prior to the PISA test.

Source: OECD, PISA 2012 Database, Table III.5.1a.

StatLink http://dx.doi.org/10.1787/888932964015

▪ Figure III.5.2 ▪

Within- and between-school differences in mathematics self-efficacy



Notes: The total variation in mathematics self-efficacy is calculated from the square of the standard deviation for the students used in the analysis. The statistical variation in mathematics self-efficacy and not the standard deviation is used for this comparison to allow for the decomposition.

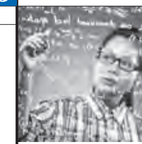
The sum of the between- and within-school variation components, as an estimate from a sample, does not necessarily add up to the total.

In some countries, sub-units within schools were sampled instead of schools; this may affect the estimation of the between-school variation components (see Annex A3).

Countries and economies are ranked in descending order of the variation in mathematics self-efficacy between schools.

Source: OECD, PISA 2012 Database, Table III.5.7a.

StatLink http://dx.doi.org/10.1787/888932964015



The proportion of 15-year-old students who reported having skipped classes or days of school varies across schools. However, in some systems, students who reported skipping classes or days of school are concentrated in certain schools, while in other systems students who reported having skipped classes or days of school are distributed more evenly among all schools. The high concentration of students who have low levels of engagement with school, as indicated by a lack of punctuality and the unauthorised non-attendance of classes indicates that learning in certain schools in some countries might be severely hampered by a negative climate.

On average across OECD countries, around 11% of the overall variation in mathematics self-efficacy lies between schools (Table III.5.7a). In some countries and economies, most notably Chinese Taipei, Hungary, Japan, Korea and Shanghai-China more than 20% of the overall variation in students' reported levels of mathematics self-efficacy lie between schools. This means that while it is possible to find in the same school both students who feel very confident and students who do not feel so confident about solving a series of mathematics, in some schools students tend to share high levels of self-efficacy while in other schools students tend to feel less efficacious.

By contrast, on average across OECD countries, only a very small part of the overall variation in students' drive, motivation and self-beliefs lies between schools: 2% of the overall variation in perseverance (Table III.5.4a); 5% of the overall variation in intrinsic motivation and 4% of the overall variation in instrumental motivation to learn mathematics (Tables III.5.5a and III.5.6a); 3% of the variation in mathematics self-concept (Table III.5.8a); and 3% of the overall variation in mathematics anxiety lie between schools (Table III.5.9a). These results mean that, while two students selected at random from two different schools will tend to share similar self-reported levels of drive, motivation, self-concept and mathematics anxiety, there are large differences in the levels of these dispositions among students who attend the same school. In some countries between-school variations are more pronounced. For example, in Italy, Indonesia, Kazakhstan and Peru, and more than 10% of the overall variation in intrinsic motivation to learn mathematics lies between schools (Table III.5.5a); and in Indonesia, Kazakhstan and Latvia more than 7% of the overall variation in students' perseverance lies between schools (Table III.5.4a). Across countries and economies that took part in PISA 2012, it is rare to encounter schools where students have generally high levels of intrinsic motivation to learn mathematics and schools where students do not, or schools where students report feeling anxious about mathematics and schools where students do not.

One of the possible reasons why in most countries there is little between-school variation in students' intrinsic and instrumental motivation to learn mathematics, perseverance and anxiety (as compared to self-efficacy) is not that the influence of schools on student dispositions and self-beliefs is weak, but rather that each and every school has a powerful influence on their students' feelings and perceptions about themselves as mathematics learners that acts differently from one student to the next. Students use information from both their own performance and from how their performance compares to others in their immediate environment (i.e. their classmates) in determining their perceptions of their skills and performance in mathematics (Festinger, 1954; Ruble, 1983; Wigfield, Eccles and Pintrich, 1996).

A second explanation is that students' drive, motivation and self-beliefs are closely associated with classroom practices. Because PISA does not gather information at the classroom level (15-year-olds in the same school often attend different classes), the large within-school variation might be due to the different teachers students work with, each of whom might adopt his or her own teaching and assessment strategies and expose their students to a different mix of pure and applied mathematics topics. Even though in some schools teachers may follow a common project and collaborate by sharing material, practices and experiences, teachers inevitably adapt to classroom dynamics and the composition of the class. Results from the OECD Teaching and Learning International Study (TALIS) confirm that that teacher attitudes, behaviours and practices show small between school variations and mostly between school variations (OECD, 2009).

THE ROLE OF SOCIAL COMPARISONS

Students around the world spend a significant part of their days in school; for most 15-year-olds, schools are an important social, as well as learning, environment. Through interactions with their peers at school students gather information about their standing on a range of measures, from how proficient they are in mathematics to whether they have similar tastes in music or admire the same sports champions and movie stars. Students shape their own preferences for school subjects or pursuits through a combination of observing their own abilities and how well they perform compared to others (Ruble, 1983; Wigfield, Byrnes and Eccles, 2006). For example, across the countries and economies that participated in PISA 2012, students who perform at higher levels in mathematics tend to enjoy mathematics more, are less anxious about mathematics, feel more competent in mathematics in general, and in solving specific mathematics problems (see Chapters 3 and 4 of this volume). However, their level of interest in mathematics and their mathematics self-beliefs also depend on whether they perform better or worse than their peers. Students who perform equally well in mathematics but who attend schools where other students perform at higher levels than they do, on average, tend to enjoy mathematics less, feel more anxious about mathematics, and feel less competent in mathematics. Results presented in Tables III.5.5c, III.5.8c and III.5.9c indicate that student A, who attends a school where all students are highly proficient in mathematics, will report lower levels of intrinsic motivation to learn mathematics, greater mathematics anxiety, and lower levels of mathematics self-concept than student B, who performs similarly to student A, but attends a school where students perform at low levels, on average.

▪ Figure III.5.3 ▪

Relative performance and student engagement, drive and self-beliefs

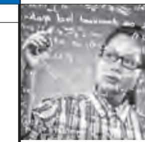
Association between how much better (or worse) students perform compared to the average student in their school and …[1]		Country/economy with smallest statistically significant association		OECD average	Country/economy with largest statistically significant association	
Arriving late for school	(Change in percentage)	Poland	**-9.3**	**0.8**	Macao-China	**13.5**
Skipping classes or days of school	(Change in percentage)	Malaysia	**-11.1**	0.5	Croatia	**9.9**
Sense of belonging	(Change in mean index)	Lithuania	**-0.3**	**-0.1**	Malaysia	**0.2**
Perseverance	(Change in mean index)	Singapore	**0.1**	**0.2**	Germany	**0.4**
Intrinsic motivation to learn	(Change in mean index)	Viet Nam	**0.1**	**0.2**	Germany	**0.5**
Instrumental motivation to learn	(Change in mean index)	Korea	**-0.1**	**0.2**	Liechtenstein	**0.7**
Mathematics self efficacy	(Change in mean index)	Japan	**-0.1**	**0.1**	Argentina	**0.3**
Mathematics self-concept	(Change in mean index)	Viet Nam	**0.1**	**0.4**	Germany	**0.7**
Mathematics anxiety	(Change in mean index)	Liechtenstein	**-0.6**	**-0.2**	Singapore	**-0.1**

Note: Values that are statistically significant are indicated in bold (see Annex A3).
1. The figure represents the association between relative performance (defined as the difference between individual student performance and the mean performance of students attending the same school) and selected indicators of engagement, drive, motivation and self-beliefs. The reported coefficient refers to a difference in performance of 100 score points.
Source: OECD, PISA 2012 Database, Tables III.5.1b, III.5.2b, III.5.3c, III.5.4b, III.5.5c, III.5.6c, III.5.7c, III.5.8c and III.5.9c.

Within the classroom, one of the most important tools teachers have to guide the behaviour of students are school marks. Teachers use marks as a diagnostic tool as well as to communicate expectations and foster motivation in their students (Jussim, Robustelli and Cain, 2009; Stiggins and Conklin, 1992); students react to marks by modifying their behaviour (Bonesrønning, 1999). Marks as a mode of communication and a source of incentives influence student interest in school and in the subject matter, self-efficacy, motivation, and future performance (Brookhart, 2009; Docan, 2006; Guskey, 2004). Used effectively, marks can motivate students to put forth more effort and change their behaviours and attitudes in a way that is beneficial for learning. Marks can, however, also potentially discourage and alienate some students (Covington, 1984, 2009; Kohn, 1993; Deci and Ryan, 2002).

Students who attend higher-achieving schools tend to have lower levels of academic self-concepts and receive lower marks (Espenshade et al., 2005; Kelly, 2008; Marsh and Hau, 2003; Marsh and O'Mara, 2008). Marsh and colleagues have called this the "Little Fish Big Pond Effect": when one is in a high-performing school, many students do well and therefore it can be more difficult to maintain a positive sense of one's ability. PISA 2009 indicated that in some countries, students with similar performance receive marks that are almost one standard deviation lower than those in schools that perform 100 score points higher on the PISA reading assessment (OECD, 2012). In general, in the context of PISA 2009, in the majority of countries and economies, students who attended higher-achieving schools receive lower marks when compared to students who perform similarly and have similar learning habits but who attend poorer-performing schools. Research on effective marking practices strongly advises against normative grading,[2] as it creates incentives for unhealthy competition among students and reduces the motivation to excel.

Normative marking practices reflect the value particular teachers, and a school system as a whole, give to relative performance rather than to absolute performance. The most important information normative grading gives to students is that what matters for the teacher and for the school system is students' relative standing, not their absolute level of achievement. Students who participated in PISA 2012 were not asked about the school marks they received. Still, an indication of whether different school systems value relative standing more than absolute performance can be obtained by seeing how using students' reports on their motivation and self-beliefs vary when students' performance in mathematics is examined relative to that of other students attending the same school. While students who perform at higher levels in mathematics are inherently more likely to enjoy mathematics, if the analysis shows that peer comparisons and relative standing are closely tied with how much students enjoy a subject, this can then be an indicator that the school system is more likely to be structured on competitive pressures.



In general, students' feelings of competence depend on their relative standing among their school peers (Marsh and Parker, 1984; Marsh, 2005; Marsh and Hau, 2003; Marsh and Craven, 2002), at least in classrooms and schools that emphasise social comparison and competition among students (Deci and Ryan, 2002; Wigfield, Byrnes and Eccles, 2006). The focus on relative standing can adversely affect students' intrinsic motivation and interest as well (Deci and Ryan, 2002; Ryan and Deci, 2009; Wigfield, Byrnes and Eccles, 2006). In some countries students are more strongly and negatively affected by their relative standing than in others. In some school systems, students' success is measured by their ability to outperform their peers and therefore education is perceived as a zero-sum game. This can happen, for example, in school systems where there is excess demand for access to universities, academic programmes or particular schools, or where there is large between-school variation in achievement. When only the best, rather than all, students who meet specified standards have access to and can benefit from specific opportunities, a school system will promote competition between students and relative standing will become an important source of motivation for them (Covington, 2009).

Across the countries and economies that took part in PISA 2012, students' own performance is positively associated with higher levels of intrinsic motivation to learn mathematics, a greater belief that mathematics will be important for their future studies or careers, a belief that they learn mathematics quickly, are less likely to report feeling tense about having to do mathematics homework, and less likely give up easily when confronted with a problem when they perform at higher levels. However, the better their schoolmates' performance, the less likely these students are to express high levels of intrinsic and instrumental motivation to learn mathematics, the lower their levels of self-concept, the less likely they are to report being perseverant, and the more likely they are to express feelings of anxiety towards mathematics (Tables III.5.4b, III.5.5c, III.5.6c, III.5.8c and III.5.9c).

In all countries except Belgium, Croatia, Finland, Korea and Romania students' intrinsic motivation to learn mathematics is positively associated with how much better students perform compared to other students in their schools (Table III.5.5c). As Figure III.5.4a and Figure III.5.4b show, on average across OECD countries, when comparing two students with equal performance, a student who scores 100 points higher in mathematics than the average student in his or her school has a value on the *index of intrinsic motivation to learn mathematics* that is one-fifth of a standard deviation higher than a student who performs at the same level as the average student in his or her school. Students in Germany, Liechtenstein, Peru, Israel, Argentina and the United States are particularly likely to report enjoying mathematics when they have higher relative standing compared to other students in their school (Table III.5.5c).

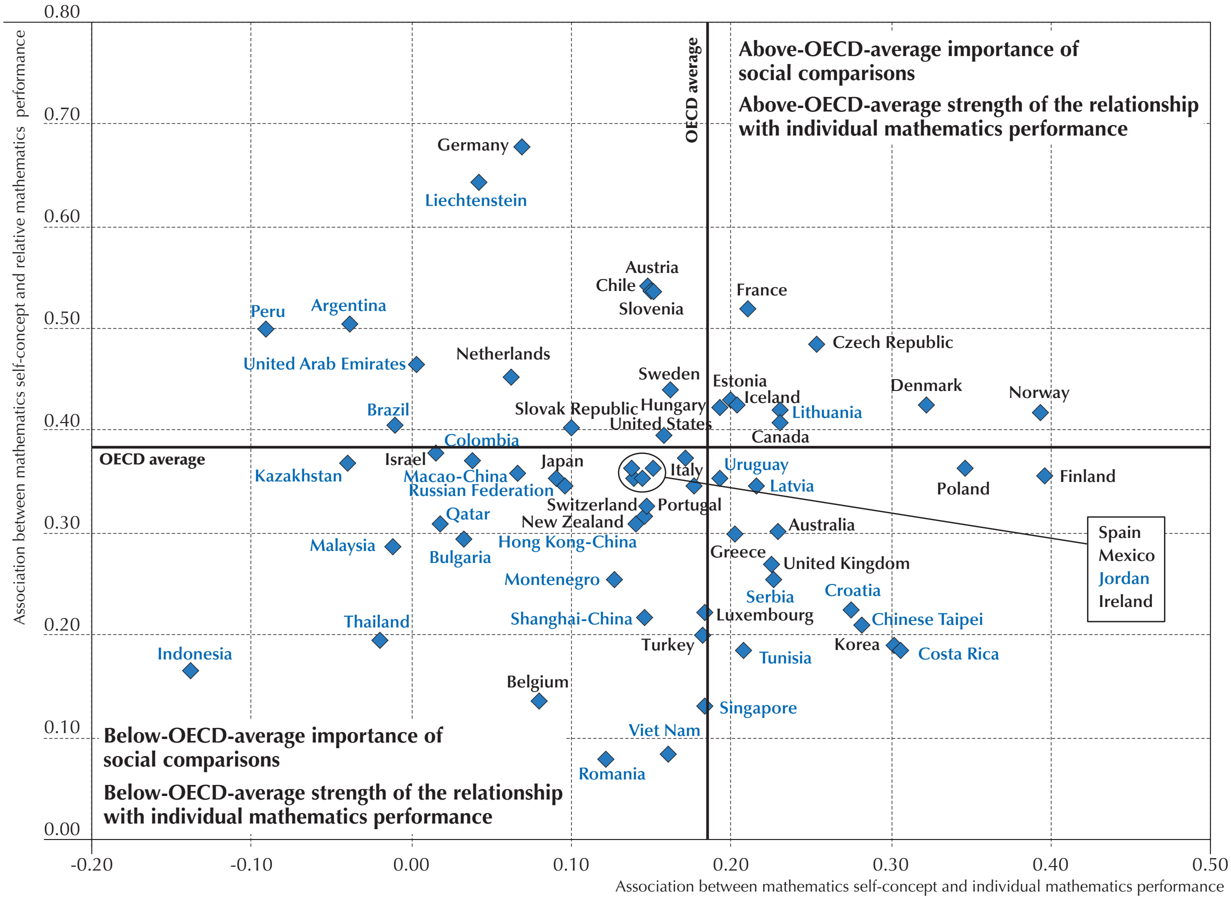
Students' self-reported level of mathematics self-concept is also highly dependent on how well they perform in mathematics relative to other students in their school (Table III.5.8c). As Figure III.5.4a and Figure III.5.4b show, on average across OECD countries, when comparing two students with equal performance, a student who scores 100 points higher in mathematics than the average student in his or her school has a value on the *index of mathematics self-concept* that is two-fifths of a standard deviation higher than a student who performs at the same level as the average student in his or her school. Relative standing is particularly strongly associated with mathematics self-concept in Argentina, Austria, Chile, France, Germany, Liechtenstein, Slovenia and Peru. In all these countries, when students score 100 points higher than the average student in their school, their value on the *index of mathematics self-concept* is at least half a standard deviation higher (Table III.5.8c).

Students' reports of mathematics anxiety also depend on how well they perform compared to other students in their school (Table III.5.9c). On average across OECD countries, when comparing two students with equal performance, a student who performs 100 points higher in mathematics than the average student in his or her school has a value on the *index of mathematics anxiety* that is one-quarter of a standard deviation lower than a student who performs at the same level as the average student in his or her school. Mathematics anxiety is not associated with students' relative performance in New Zealand, the United Kingdom, Israel, Belgium, Jordan, Costa Rica, Tunisia and Romania while the association is strongest in Liechtenstein, Germany, Slovenia, Austria, the Czech Republic, Japan, Canada, the Netherlands and France. In this latter group of countries, when students score 100 score points higher in mathematics compared to the average student in their school, their levels of mathematics anxiety are one-third of a standard deviation less than those of students with similar absolute performance levels, but are in schools where the average student performs as well as they do (see Table III.5.9c).

Results presented in Tables III.5.1b, III.5.2b and III.5.3c provide further validity to the fact that social comparisons are part of students' development of drive, motivation and mathematics self-beliefs. When mathematics performance is unlikely to be the frame of reference for students, as in the case of engagement with and at school, the relative performance indicator does not appear to have the same impact. Relative performance is not associated with students' sense of belonging, lack of punctuality and unauthorised non-attendance of classes or days of school.[3] In fact, in some countries, students who attend schools where other students perform at higher levels than they do are less, rather than more, likely to report having arrived late and having skipped classes or days of school, and are more likely to have a strong sense of belonging. These findings may indicate that a sense of belonging in school is based on much more than on social comparisons alone. Social connections, and the broader environment in schools, for example, are likely to be more important in these cases (Voelkl, 2012; Wentzel, 2009). Similarly, social comparisons are not strongly associated with students' feelings of competency in solving specific mathematics problems (mathematics self-efficacy) (Table III.5.7c). This is perhaps because self-efficacy has been relatively firmly established by the age of 15 and so may not be that strongly associated with feelings of competency in solving specific problems, and because it entails students' perceptions against a clear benchmark: a specific mathematics problem rather than a comparison with other students.

▪ Figure III.5.4a ▪

Relationship between absolute and relative performance and mathematics self-concept



Source: OECD, PISA 2012 Database, Table III.5.8c.

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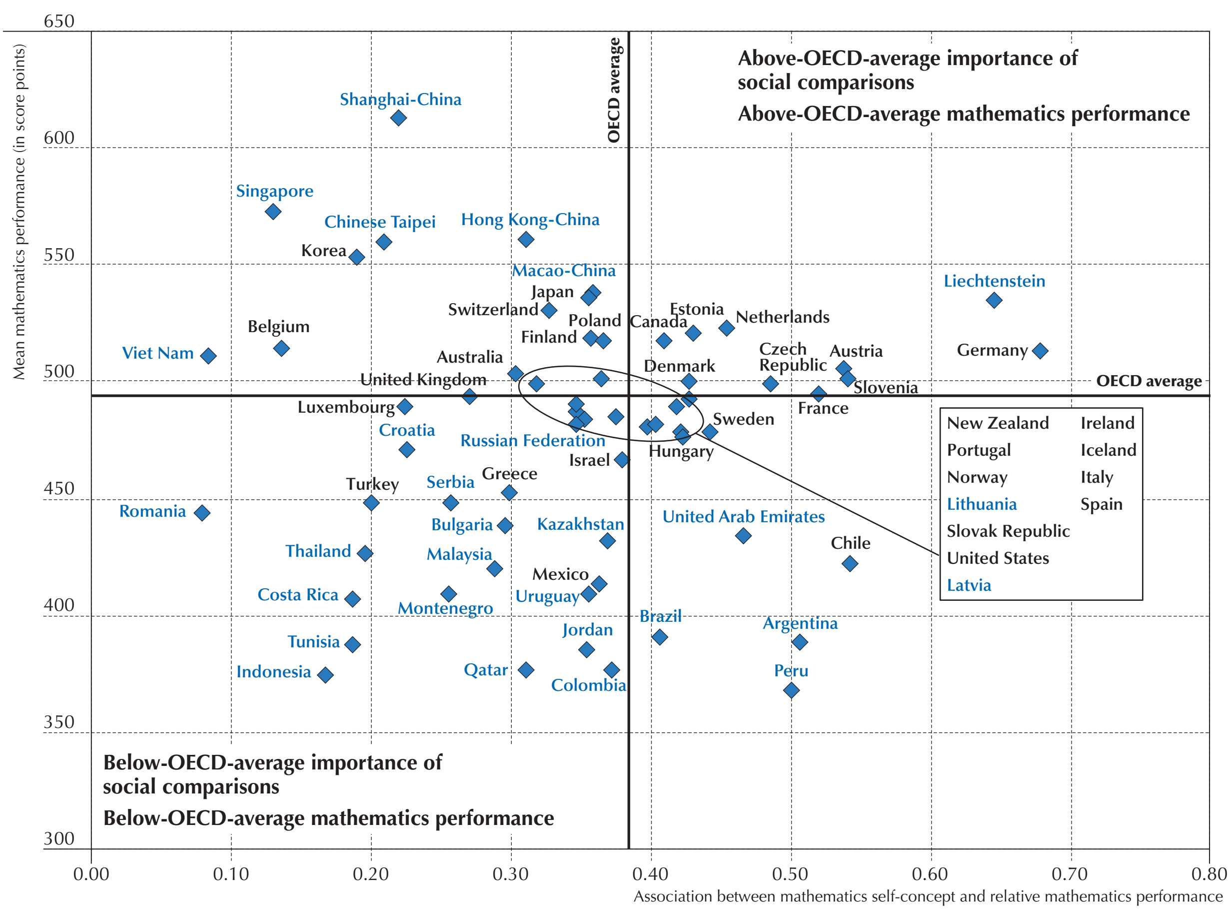
▪ Figure III.5.4b ▪

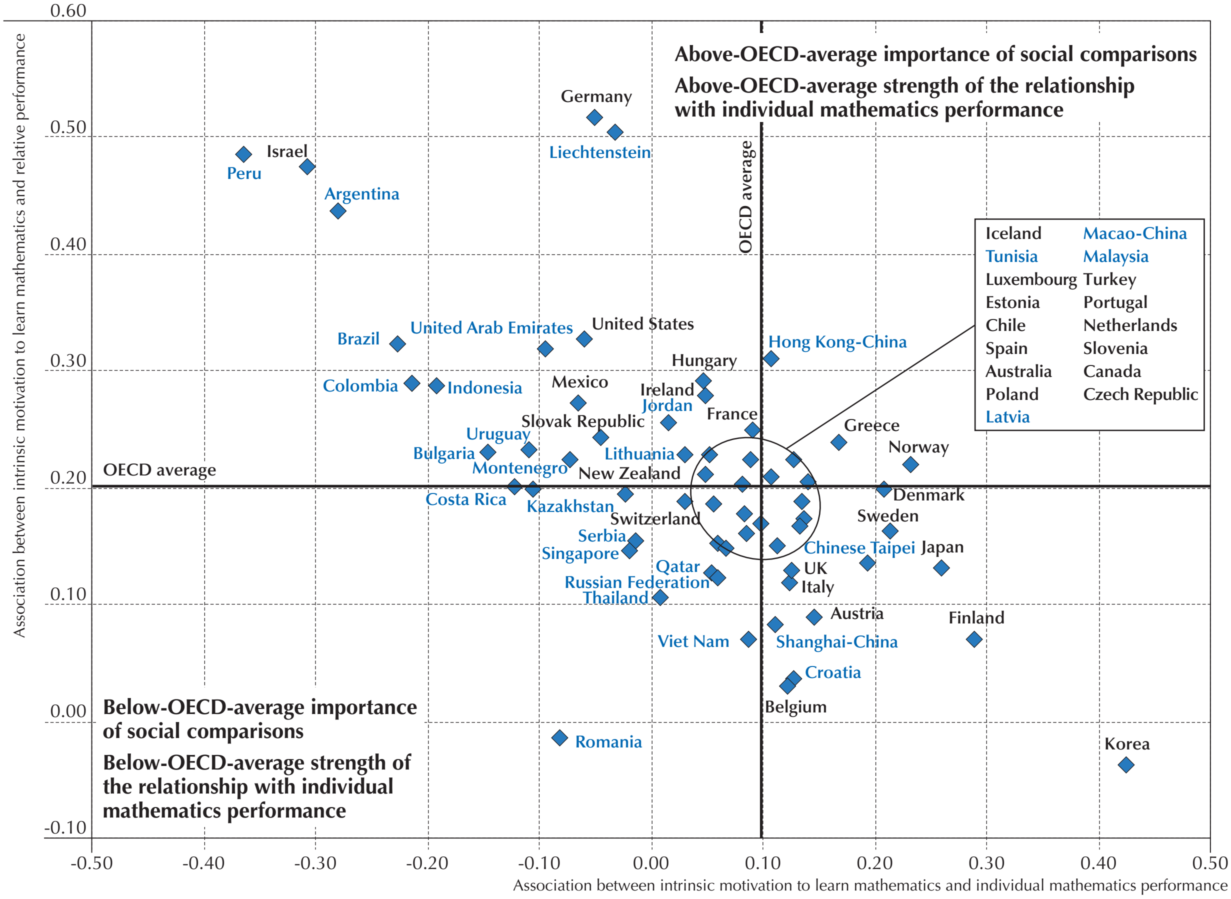
Relationship between relative performance and mathematics self-concept and mean mathematics performance



Source: OECD, PISA 2012 Database, Tables III.5.8c and I.2.3a.
StatLink http://dx.doi.org/10.1787/888932964015

■ Figure III.5.5a ■

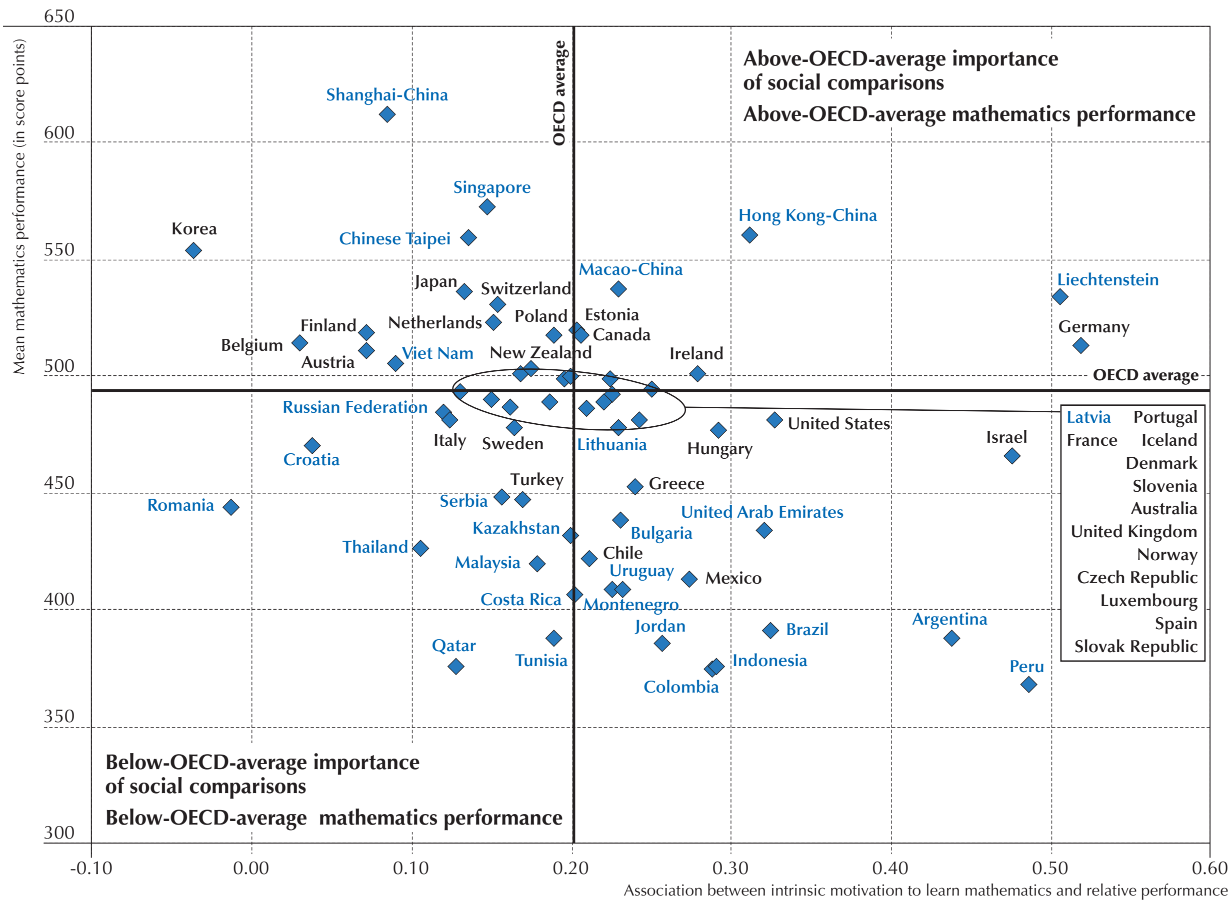
Relationship between absolute and relative performance and intrinsic motivation to learn mathematics



Source: OECD, PISA 2012 Database, Table III.5.5c.
StatLink http://dx.doi.org/10.1787/888932964015

▪ Figure III.5.5b ▪

Relationship between relative performance and intrinsic motivation to learn mathematics and mean mathematics performance



Source: OECD, PISA 2012 Database, Tables III.5.5c and I.2.3a.

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THE RELATIONSHIP BETWEEN WHAT HAPPENS IN THE CLASSROOM AND STUDENT ENGAGEMENT, DRIVE AND MOTIVATION, AND MATHEMATICS SELF-BELIEFS

The previous section examines how 15-year-olds across PISA 2012 participating countries and economies tend to develop motivation and self-beliefs depending on their relative standing among their peers. Schools can also contribute significantly to the formation of students' dispositions and self-beliefs and promote greater engagement with school and learning through the strategies and practices teachers adopt in their classrooms (Hipkins, 2012; Wigfield, Cambria and Eccles, 2012). For example, teachers who expose their students not only to abstract mathematics concepts, but also to applied mathematics, might be more effective in nurturing student engagement. Some 15-year-olds might find the connection with real-world situations more interesting than learning abstract concepts without seeing their practical applications (Guthrie, Wigfield and Klauda, 2012). Results discussed in Volume I, *What Students Know and Can Do*, indicate that opportunities to learn are crucial for acquiring skills – and ultimately proficiency – in mathematics. Previous research has shown a relationship between students' exposure to subject content in school, what is known as "opportunity to learn", and student performance (Schmidt et al., 2001).

Box III.5.1. **Students' reports on teachers' behaviours in class**

Building on previous measures of opportunity to learn (Carroll, 1963; Wiley and Harnischfeger, 1974; Sykes, Schneider and Planck, 2009; Schmidt et al., 2001), the PISA 2012 assessment included questions to students on the mathematics theories, concepts and content to which they had been exposed in school, and the amount of class time devoted to different types of problems and subjects. Some of the students who took part in the PISA 2012 study* were first asked to report how confident they felt about having to do a series of mathematics tasks, and, after a series of other questions, were also asked to report how frequently they had encountered similar tasks. Student reports on their exposure to pure mathematics problems – for example, a linear or a quadratic equation – as well as applied mathematics problems – such as, for example, calculating how many square metres of tiles are needed to cover a floor, calculating the petrol consumption rate of a car, or calculating how much cheaper a TV would be after a 30% discount – were used to develop two indices: the *index of experience with applied mathematics problems* and the *index of experience with pure mathematics problems* (Tables III.5.10a and III.5.10c).

Students were asked to think about the mathematics teacher who taught their last mathematics class and to report the frequency with which the following eight situations happened: the teacher asks questions that make students reflect on the problem; the teacher gives problems that require students to think for an extended time; the teacher asks students to decide, on their own, procedures for solving complex problems; the teacher presents problems in different contexts so that students know whether they have understood the concepts; the teacher helps students to learn from mistakes they have made; the teacher asks students to explain how they solved a problem; the teacher presents problems that require students to apply what they have learned in new contexts; and the teacher gives problems that can be solved in different ways. Students were asked to report whether these behaviours and situations occur always or almost always, often, sometimes or never or rarely. Student responses were used to develop the *index of teachers' use of cognitive activation strategies*, which was standardised to have a mean of 0 and a standard deviation of 1 across OECD countries. Higher values on the index suggest that students reported that their most recent mathematics teacher more frequently used cognitive-activation strategies than the most recent mathematics teacher of the average student in OECD countries. Figure III.5.6 shows the extent to which students in PISA 2012 participating countries and economies reported that their teachers always, almost always or often use different cognitive-activation strategies.

Students were also asked to report how often a series of situations happen during their mathematics lessons. Students' reports on whether different things happen in every lesson, in most lessons, in some lessons, or never or hardly ever were used to develop three indices reflecting teacher's use of different strategies to foster student learning: the *index of teacher-directed instruction,* the *index of teachers' student orientation,* and the *index of teachers' use of formative assessment*. The *index of teacher-directed instruction* was constructed using students' reports on the frequency with which, in mathematics lessons, the teacher sets clear goals for student learning; the teacher asks students to present their thinking or reasoning at some length; the teacher asks questions to check whether students understood what was taught; and the teacher tells students what they have to learn. The *index of teachers' student orientation* was constructed using students' reports on the frequency with which, in mathematics lessons, the teacher gives students different work to classmates who have difficulties learning and/or to those who can advance faster; the teacher assigns projects that require at least one week to complete; the teacher has students work in small groups to come up with a joint solution to a problem or task; and the teacher asks students to help plan classroom activities or topics. The *index of teachers' use of formative assessment* was constructed using students' reports on the frequency with which, in mathematics lessons, the teacher tells students how well they are doing in mathematics class; the teacher gives students feedback on their strengths and weaknesses in mathematics; and the teacher tells students what they need to do to become better in mathematics. Figure III.5.7 shows the extent to which students in PISA 2012 participating countries and economies reported that these different things happen in their mathematics classes.

* One-third of students in each participating school were asked to fill "form A" of the student background questionnaire which contained questions related to mathematics self-beliefs and opportunity-to-learn constructs.

...

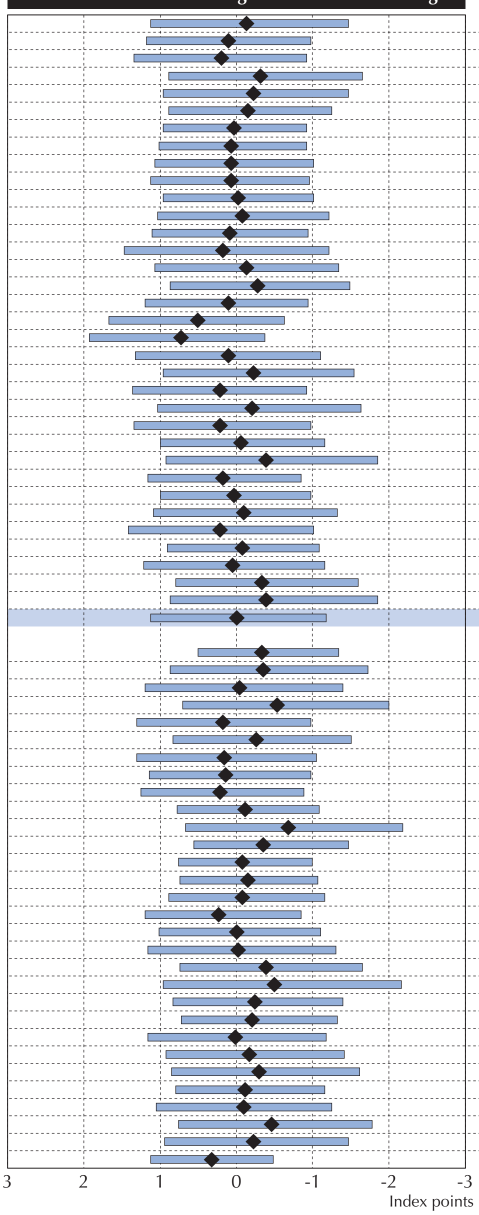
■ Figure III.5.6 ■

Index of teachers’ use of cognitive-activation strategies

Range between top and bottom quarters
◆ Average index

- **A** The teacher asks questions that make us reflect on the problem
- **B** The teacher gives problems that require us to think for an extended time
- **C** The teacher asks us to decide on our own procedures for solving complex problems
- **D** The teacher presents problems for which there is no immediately obvious method of solution
- **E** The teacher presents problems in different contexts so that students know whether they have understood the concepts
- **F** The teacher helps us to learn from mistakes we have made
- **G** The teacher asks us to explain how we have solved a problem
- **H** The teacher presents problems that require students to apply what they have learned to new contexts
- **I** The teacher gives problems that can be solved in several different ways

Index of teachers’ use of cognitive-activation strategies



OECD	A	B	C	D	E	F	G	H	I
Australia	62	62	39	53	65	69	70	70	60
Austria	50	61	48	46	54	52	67	60	60
Belgium	58	45	31	44	52	57	66	61	57
Canada	65	66	48	60	72	69	73	75	69
Chile	66	61	50	49	70	72	71	59	65
Czech Republic	71	53	53	70	62	51	67	68	64
Denmark	59	57	32	43	58	61	76	72	57
Estonia	60	44	41	39	59	61	68	60	65
Finland	57	53	41	48	45	60	75	59	58
France	63	47	31	56	64	48	74	60	62
Germany	49	62	48	45	61	57	81	71	55
Greece	72	43	46	60	58	63	75	58	62
Hungary	69	58	41	43	62	51	70	55	62
Iceland	52	44	34	43	55	66	54	55	56
Ireland	71	63	31	50	59	72	79	68	59
Israel	71	68	48	49	62	69	78	66	70
Italy	59	49	41	44	53	58	70	68	55
Japan	40	37	29	26	51	50	52	48	31
Korea	28	23	18	13	53	40	45	40	46
Luxembourg	53	59	49	48	55	53	70	59	54
Mexico	64	53	47	44	66	67	73	64	67
Netherlands	66	49	28	43	47	59	69	53	48
New Zealand	60	66	46	55	63	68	72	69	64
Norway	42	37	47	41	51	55	67	62	49
Poland	70	56	47	59	52	52	74	58	68
Portugal	67	66	52	67	71	71	73	74	70
Slovak Republic	61	52	26	44	61	44	66	43	61
Slovenia	61	44	59	49	53	53	66	59	63
Spain	62	57	42	45	63	68	65	69	66
Sweden	46	33	40	34	48	57	73	49	62
Switzerland	58	62	49	55	65	60	73	67	61
Turkey	52	42	42	27	61	61	75	66	65
United Kingdom	68	71	46	59	67	78	82	73	66
United States	69	70	47	55	68	73	77	76	69
OECD average	59	53	41	47	59	60	70	62	60
Partners									
Albania	81	48	45	35	67	88	89	77	76
Argentina	63	63	51	50	69	74	71	73	69
Brazil	64	58	50	38	59	65	55	55	63
Bulgaria	83	71	59	60	67	72	80	68	76
Chinese Taipei	48	61	34	28	53	65	50	49	69
Colombia	61	53	52	40	70	72	74	67	72
Costa Rica	49	41	30	38	61	68	55	51	59
Croatia	56	42	32	44	50	49	68	58	61
Hong Kong-China	46	49	42	26	54	59	54	54	60
Indonesia	84	54	42	35	62	86	77	67	80
Jordan	82	77	66	63	75	79	80	77	78
Kazakhstan	79	62	54	29	69	85	87	77	78
Latvia	74	46	29	46	64	66	79	68	72
Liechtenstein	62	71	59	48	67	66	80	70	59
Lithuania	67	58	30	60	53	62	71	66	70
Macao-China	43	64	41	37	36	59	54	40	62
Malaysia	58	40	31	36	65	81	64	56	66
Montenegro	53	47	48	55	57	67	71	52	62
Peru	66	62	55	43	68	75	75	67	68
Qatar	74	68	59	57	72	73	73	72	71
Romania	68	53	46	47	67	67	74	73	69
Russian Federation	61	53	30	38	70	72	84	78	74
Serbia	57	45	51	40	58	57	66	64	67
Shanghai-China	66	31	42	48	65	74	69	70	66
Singapore	59	64	47	57	71	82	68	77	70
Thailand	46	55	49	39	60	70	69	68	75
Tunisia	54	50	46	57	65	61	63	65	66
United Arab Emirates	73	70	54	48	74	77	77	75	76
Uruguay	68	59	45	47	66	72	73	68	67
Viet Nam	67	25	23	16	60	70	64	45	61

Note: Higher values on the index indicate greater teachers’ use of cognitive-activation strategies.
Source: OECD, PISA 2012 Database, Table III.5.10e.
StatLink http://dx.doi.org/10.1787/888932964015

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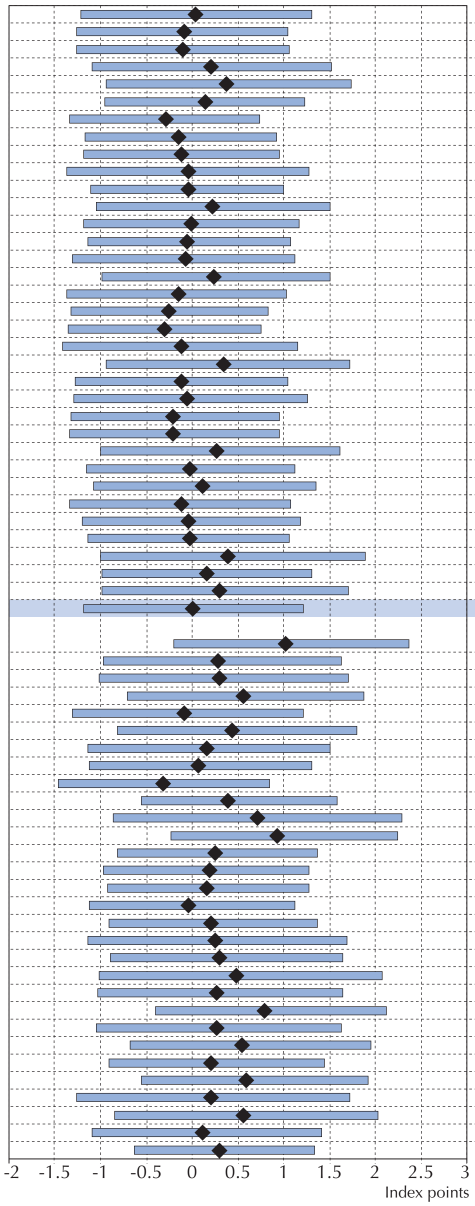
▪ Figure III.5.7 ▪
Index of teacher-directed instruction

Range between top and bottom quarters
◆ Average index

- **A** The teacher sets clear goals for our learning
- **B** The teacher asks me or my classmates to present our thinking or reasoning at some length
- **C** The teacher asks questions to check whether we have understood what was taught
- **D** At the beginning of a lesson, the teacher presents a short summary of the previous lesson
- **E** The teacher tells us what we have to learn

Index of teacher-directed instruction at school



	A	B	C	D	E
OECD					
Australia	68	56	73	41	85
Austria	65	60	64	40	80
Belgium	61	47	68	42	83
Canada	71	59	76	56	82
Chile	82	53	82	54	84
Czech Republic	74	60	75	54	78
Denmark	67	31	76	30	75
Estonia	75	36	68	28	88
Finland	67	62	60	44	78
France	61	53	65	49	79
Germany	67	68	70	34	80
Greece	76	61	78	45	81
Hungary	61	55	72	44	85
Iceland	80	39	71	31	89
Ireland	59	57	75	29	84
Israel	74	68	72	41	87
Italy	68	47	71	35	75
Japan	58	48	63	40	74
Korea	60	30	59	48	76
Luxembourg	57	59	63	34	85
Mexico	82	61	79	54	73
Netherlands	67	72	60	30	77
New Zealand	57	54	69	40	84
Norway	64	61	64	27	76
Poland	69	43	66	27	81
Portugal	78	75	78	47	80
Slovak Republic	74	44	70	45	79
Slovenia	71	64	68	50	81
Spain	73	46	72	38	66
Sweden	67	71	68	34	77
Switzerland	70	67	68	39	76
Turkey	69	77	76	56	79
United Kingdom	75	57	80	39	87
United States	74	65	80	49	83
OECD average	69	56	71	41	80
Partners					
Albania	87	79	91	75	89
Argentina	75	53	84	52	76
Brazil	81	60	77	49	80
Bulgaria	82	62	84	70	86
Chinese Taipei	63	49	70	46	74
Colombia	75	63	86	55	77
Costa Rica	78	47	81	46	70
Croatia	79	40	68	54	78
Hong Kong-China	49	43	63	43	69
Indonesia	82	66	88	69	87
Jordan	84	72	81	73	81
Kazakhstan	87	74	91	84	92
Latvia	77	71	78	42	89
Liechtenstein	80	79	76	41	75
Lithuania	78	42	74	58	88
Macao-China	65	45	67	57	73
Malaysia	74	39	80	60	81
Montenegro	82	64	72	47	80
Peru	77	57	80	49	77
Qatar	81	66	80	63	79
Romania	75	53	74	56	75
Russian Federation	87	66	87	73	93
Serbia	78	51	72	61	83
Shanghai-China	78	70	77	70	86
Singapore	71	59	82	50	88
Thailand	83	67	84	74	81
Tunisia	72	55	71	56	72
United Arab Emirates	79	62	84	65	84
Uruguay	75	51	74	55	66
Viet Nam	90	40	79	65	81

Note: Higher values on the index indicate greater teachers' use of teacher-directed instruction at school.
Source: OECD, PISA 2012 Database, Table III.5.10l.
StatLink http://dx.doi.org/10.1787/888932964015

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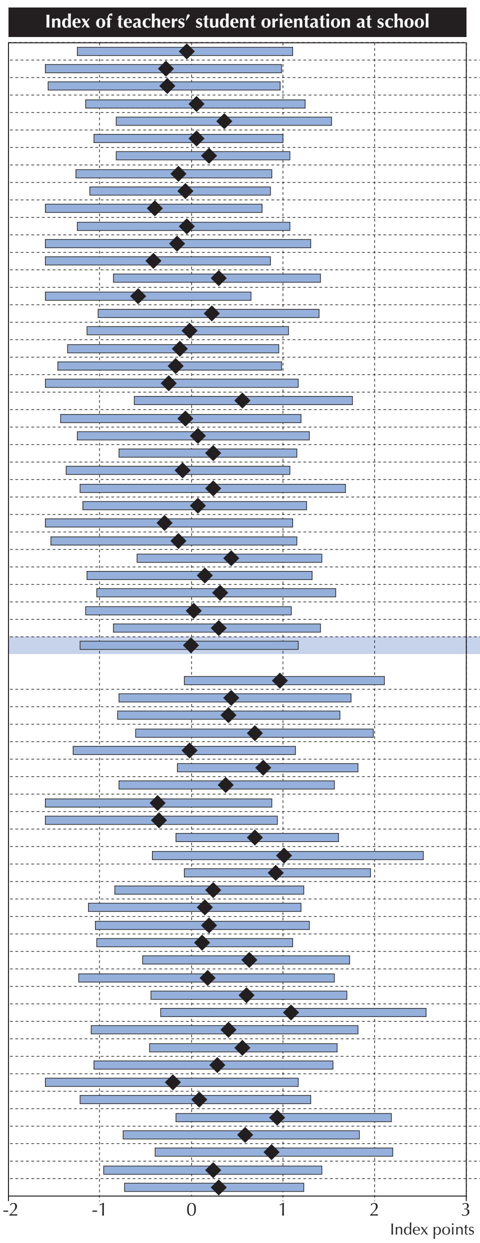
■ Figure III.5.8 ■

Index of teachers' student orientation

■ Range between top and bottom quarters
◆ Average index

A The teacher gives different work to classmates who have difficulties learning and/or to those who can advance faster
B The teacher assigns projects that require at least one week to complete
C The teacher has us work in small groups to come up with joint solutions to a problem or task
D The teacher asks us to help plan classroom activities or topics



OECD	A	B	C	D
Australia	27	23	17	11
Austria	21	11	21	14
Belgium	21	12	14	16
Canada	22	17	37	13
Chile	26	31	42	21
Czech Republic	26	8	13	37
Denmark	29	13	30	12
Estonia	33	6	9	11
Finland	56	6	11	5
France	13	13	16	9
Germany	25	12	27	14
Greece	16	16	18	26
Hungary	22	8	12	9
Iceland	47	30	22	11
Ireland	16	7	12	6
Israel	39	28	20	19
Italy	13	10	15	46
Japan	32	13	14	15
Korea	16	11	14	21
Luxembourg	24	14	19	16
Mexico	30	29	52	27
Netherlands	25	17	23	18
New Zealand	37	20	24	13
Norway	58	11	21	11
Poland	28	13	19	10
Portugal	37	22	36	26
Slovak Republic	33	15	16	26
Slovenia	25	15	14	17
Spain	22	17	17	18
Sweden	62	19	33	13
Switzerland	34	19	37	18
Turkey	37	23	25	27
United Kingdom	34	21	20	8
United States	19	30	50	17
OECD average	30	17	23	17
Partners				
Albania	58	30	44	53
Argentina	28	31	41	30
Brazil	35	29	46	19
Bulgaria	50	29	33	51
Chinese Taipei	22	17	16	23
Colombia	37	37	65	27
Costa Rica	29	31	46	18
Croatia	25	8	12	9
Hong Kong-China	15	11	15	11
Indonesia	31	32	58	37
Jordan	58	47	50	52
Kazakhstan	63	34	50	36
Latvia	38	15	21	16
Liechtenstein	34	17	44	16
Lithuania	43	19	21	15
Macao-China	26	20	22	12
Malaysia	24	39	53	38
Montenegro	49	21	21	20
Peru	28	33	52	26
Qatar	54	49	61	53
Romania	38	27	36	32
Russian Federation	65	20	32	17
Serbia	45	17	19	38
Shanghai-China	18	10	24	15
Singapore	28	17	26	18
Thailand	49	38	53	41
Tunisia	47	30	37	41
United Arab Emirates	51	38	52	46
Uruguay	24	25	41	14
Viet Nam	27	12	32	15

Note: Higher values on the index greater teachers' student orientation at school.
Source: OECD, PISA 2012 Database, Table III.5.10j.
StatLink http://dx.doi.org/10.1787/888932964015

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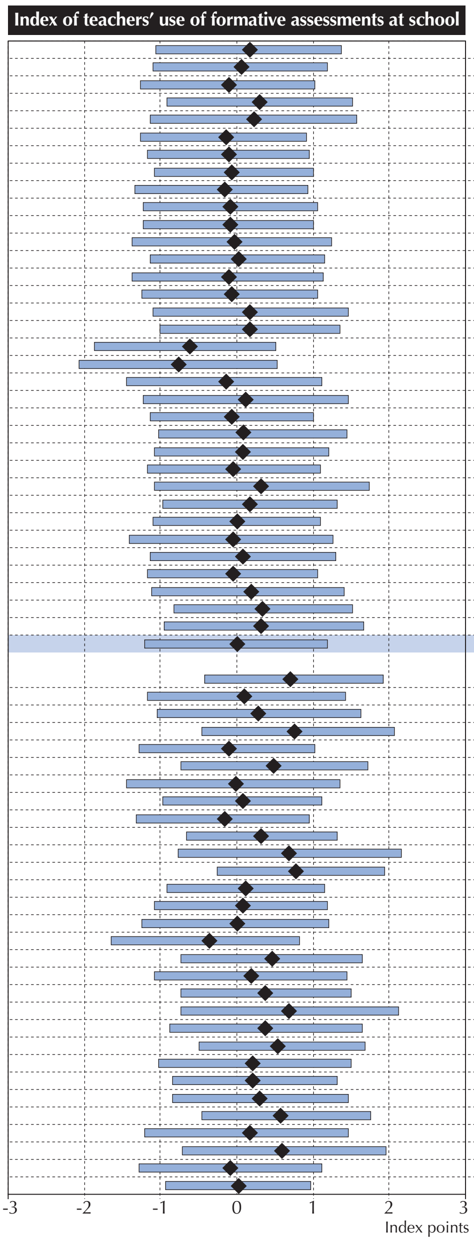
■ Figure III.5.9 ■

Index of teachers' use of formative assessments

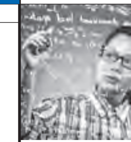
Range between top and bottom quarters
◆ Average index

A The teacher tells me about how well I am doing in my mathematics class
B The teacher gives me feedback on my strengths and weaknesses in mathematics
C The teachers tells us what is expected of us when we get a test, quiz or assignment
D The teacher tells me what I need to do to become better in mathematics



OECD	A	B	C	D
Australia	33	33	71	52
Austria	30	30	65	48
Belgium	34	18	63	38
Canada	43	32	76	52
Chile	45	28	63	60
Czech Republic	23	22	61	38
Denmark	26	26	50	36
Estonia	15	23	73	41
Finland	28	19	56	37
France	26	15	70	40
Germany	26	25	54	47
Greece	34	28	56	44
Hungary	22	26	69	49
Iceland	43	17	51	44
Ireland	22	24	64	45
Israel	34	28	76	52
Italy	40	33	62	49
Japan	8	11	42	40
Korea	15	12	25	29
Luxembourg	26	24	58	44
Mexico	43	27	49	57
Netherlands	29	22	68	38
New Zealand	34	34	71	52
Norway	34	28	63	44
Poland	27	20	68	42
Portugal	51	38	54	67
Slovak Republic	36	36	57	52
Slovenia	24	26	69	48
Spain	42	27	43	46
Sweden	35	26	64	48
Switzerland	26	21	69	42
Turkey	27	39	60	62
United Kingdom	42	38	70	60
United States	46	33	74	51
OECD average	31	26	61	47
Partners				
Albania	51	61	63	74
Argentina	34	25	53	61
Brazil	45	31	62	65
Bulgaria	53	55	75	76
Chinese Taipei	15	32	44	60
Colombia	49	41	59	70
Costa Rica	41	21	50	54
Croatia	21	24	76	49
Hong Kong-China	18	23	48	54
Indonesia	37	39	63	72
Jordan	57	57	69	68
Kazakhstan	57	53	72	80
Latvia	28	25	69	54
Liechtenstein	31	23	74	53
Lithuania	33	29	58	47
Macao-China	19	21	36	37
Malaysia	36	53	64	68
Montenegro	33	28	70	58
Peru	41	31	63	65
Qatar	62	57	69	67
Romania	47	36	63	62
Russian Federation	43	41	81	66
Serbia	30	36	71	54
Shanghai-China	19	36	61	72
Singapore	35	35	74	60
Thailand	38	54	71	72
Tunisia	46	33	54	58
United Arab Emirates	53	52	71	67
Uruguay	31	18	47	50
Viet Nam	17	32	35	58

Note: Higher values on the index indicate greater teachers' use of formative assessments at school.
Source: OECD, PISA 2012 Database, Table III.5.10g.
StatLink http://dx.doi.org/10.1787/888932964015



Tables III.5.10a to III.5.10m and Figure III.5.10 suggest that, across the countries and economies that participated in PISA 2012, there is a large within-school variation in the extent to which students who attend the same school are exposed to different teaching strategies, teacher behaviours and mathematics content. On average across OECD countries, only 3% of the overall variation in students' reported experience with applied mathematics tasks lies between schools, as does 5% of the overall variation in students' reports that their teachers use cognitive-activation strategies. The between-school variation in students' reported exposure to pure mathematics tasks, use of formative assessments, and application of teachers' student orientation is higher: 7% of the overall variation in teachers' use of formative assessment, 9% of the overall variation in student exposure to pure mathematics tasks, and 13% of the overall variation in teachers' student orientation lies between schools.

The proportion of the overall variation in students' reported exposure to applied mathematics topics in school is generally small: on average, across OECD countries the overall variation is 3% and is as high as 8% in Kazakhstan and 9% in the Czech Republic (Table III.5.10b); but in 21 countries and economies, that proportion is higher than 10% in the case of students' reported exposure to pure mathematics topics (Table III.5.10d). More than 10% of the overall variation in students' reports that their teachers use cognitive-activation strategies lie between schools only in Japan and Estonia (Table III.5.10f). Similarly, in only 4 countries and economies more than 10% of the overall variation in students' reports that their teachers use formative assessments lie between schools (Table III.5.10h), while in 38 countries and economies the same proportion applies to students reports that their teachers use student orientation (Table III.5.10k), and it applies to student reports that teachers use teacher-directed instruction only in Estonia and Latvia (Table III.5.10m). A comparatively large between-school variation could be due, for example, to how the schooling is organised and handles heterogeneity in student performance.

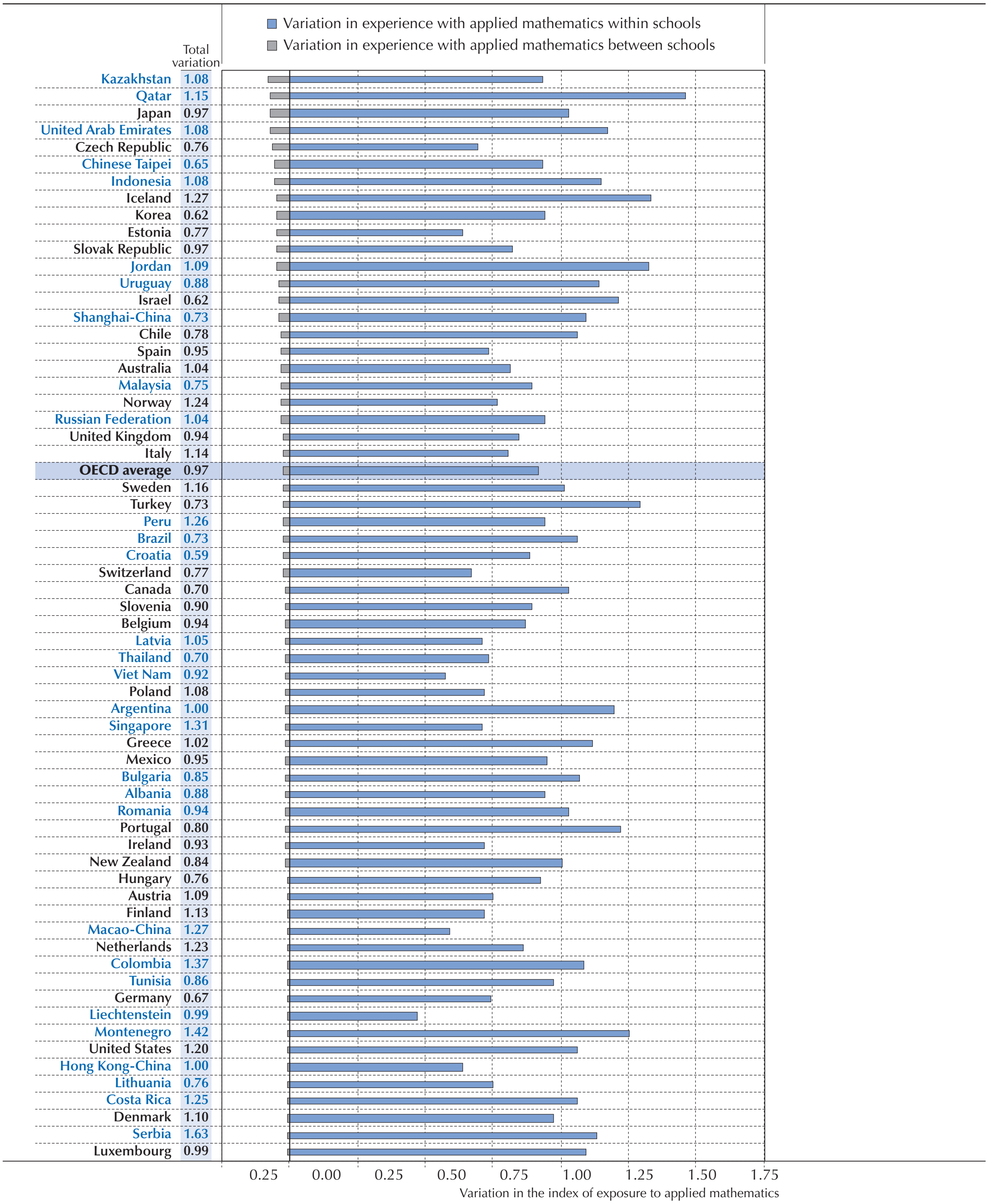
Experience with pure and applied mathematics

The previous section establishes that most of the variation in students' reported experience with pure and applied mathematics tasks occurs within schools. This section examines the relationship between students' exposure to pure and applied mathematics problems and student engagement, drive and motivation, and mathematics self-beliefs. Volume I illustrates how experience with applied, but especially with pure, mathematics problems is positively associated with performance in mathematics. Differences in exposure to pure and applied mathematics topics could therefore reflect differences in mathematics performance between students related to individual teaching practices or ability grouping. For example, teachers might only present applied mathematics problems to students who have mastered abstract mathematics concepts, because in the absence of such knowledge students would not be able to solve applied mathematics tasks. Other teachers might use applied mathematics problems as a way to spark interest and motivation among lower-achieving students. PISA data cannot be used to define exactly the direct and indirect relationships between students' experience with pure and applied mathematics problems, their mathematics performance, and their engagement, drive, motivation and self-beliefs. However, PISA data do allow for a detailed examination of the relationship between experience with pure and applied mathematics problems and students' levels of engagement, drive, motivation and self-beliefs among all students and among students who perform similarly in mathematics. Table III.5.11 shows two sets of results on the association between students' experience with pure and applied mathematics problems and student engagement, drive, motivation and self-beliefs. The first set represents the difference in engagement, drive, motivation and self-beliefs that is associated with students' exposure to different mathematics problems when the students share similar socio-economic status and gender, but differ in performance. The second set is calculated when comparing students with similar performance in mathematics.

The first set of results presented in Table III.5.11, which shows associations among all students, regardless of their performance in mathematics, indicates that students who reported having been more frequently exposed to pure mathematics problems reported a greater sense of belonging, more positive attitudes towards school, more perseverance, greater openness to problem solving, greater intrinsic and instrumental motivation to learn mathematics, greater mathematics self-efficacy, a higher self-concept, and lower mathematics anxiety. The relationship between experience with applied mathematics problems and students' engagement, drive, motivation and self-beliefs is positive, but weaker than that estimated between experience with pure mathematics problems and students' engagement, drive, motivation and self-beliefs.

■ Figure III.5.10 ■

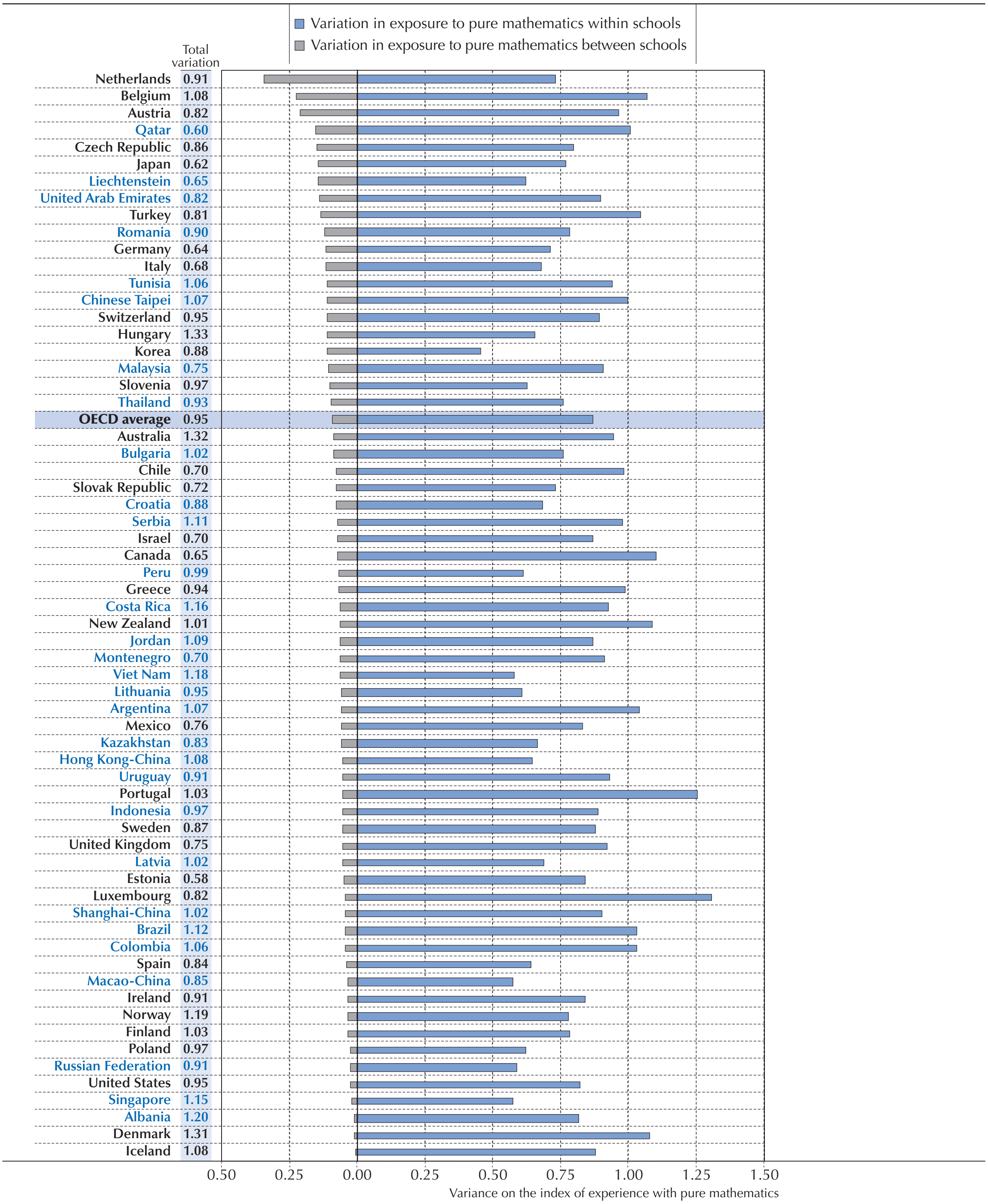
Within- and between-school differences in students' experience with applied mathematics tasks



Notes: The total variation in the index of applied mathematics is calculated from the square of the standard deviation for the students used in the analysis. The statistical variation in the index of applied mathematics and not the standard deviation is used for this comparison to allow for the decomposition. The sum of the between- and within-school variation components, as an estimate from a sample, does not necessarily add up to the total.
In some countries, sub-units within schools were sampled instead of schools; this may affect the estimation of the between-school variation components (see Annex A3).
Countries and economies are ranked in descending order of the between-school variation in experience with applied mathematics tasks.
Source: OECD, PISA 2012 Database, Table III.5.10b.
StatLink http://dx.doi.org/10.1787/888932964015

■ Figure III.5.11 ■

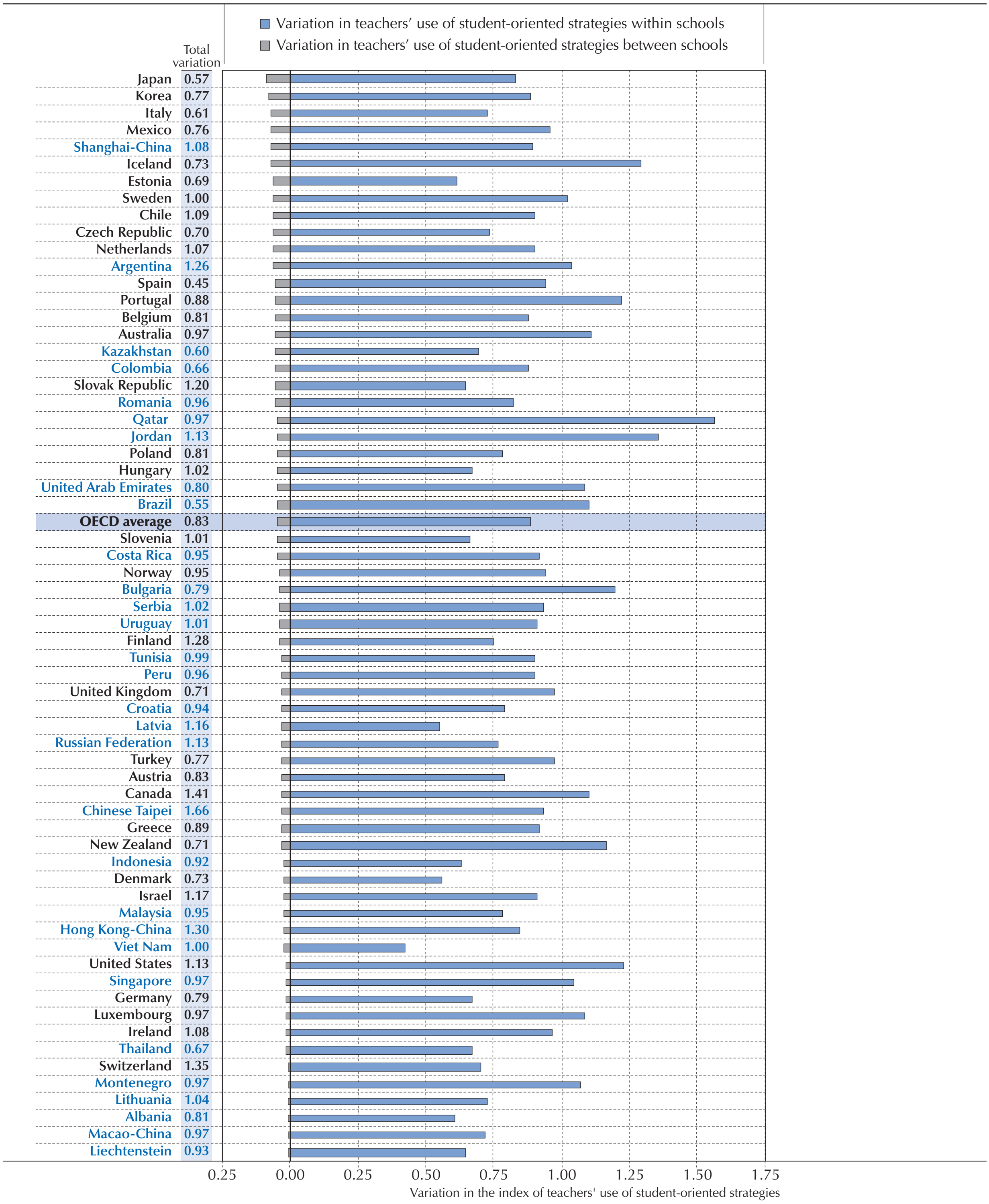
Within- and between-school differences in students' experience with pure mathematics tasks



Notes: The total variation in the index of pure mathematics is calculated from the square of the standard deviation for the students used in the analysis. The statistical variation in the index of pure mathematics and not the standard deviation is used for this comparison to allow for the decomposition.
The sum of the between- and within-school variation components, as an estimate from a sample, does not necessarily add up to the total.
In some countries, sub-units within schools were sampled instead of schools; this may affect the estimation of the between-school variation components (see Annex A3).
Countries and economies are ranked in descending order of the between-school variation in experience with pure mathematics.
Source: OECD, PISA 2012 Database, Table III.5.10d.
StatLink http://dx.doi.org/10.1787/888932964015

■ Figure III.5.12 ■

Within- and between-school differences in teachers' use of student-oriented strategies



Notes: The total variation in the index of teachers' use of student-oriented strategies is calculated from the square of the standard deviation for the students used in the analysis. The statistical variation in the index of teachers' use of student-oriented strategies and not the standard deviation is used for this comparison to allow for the decomposition.

The sum of the between- and within-school variation components, as an estimate from a sample, does not necessarily add up to the total.

In some countries, sub-units within schools were sampled instead of schools; this may affect the estimation of the between-school variation components (see Annex A3).

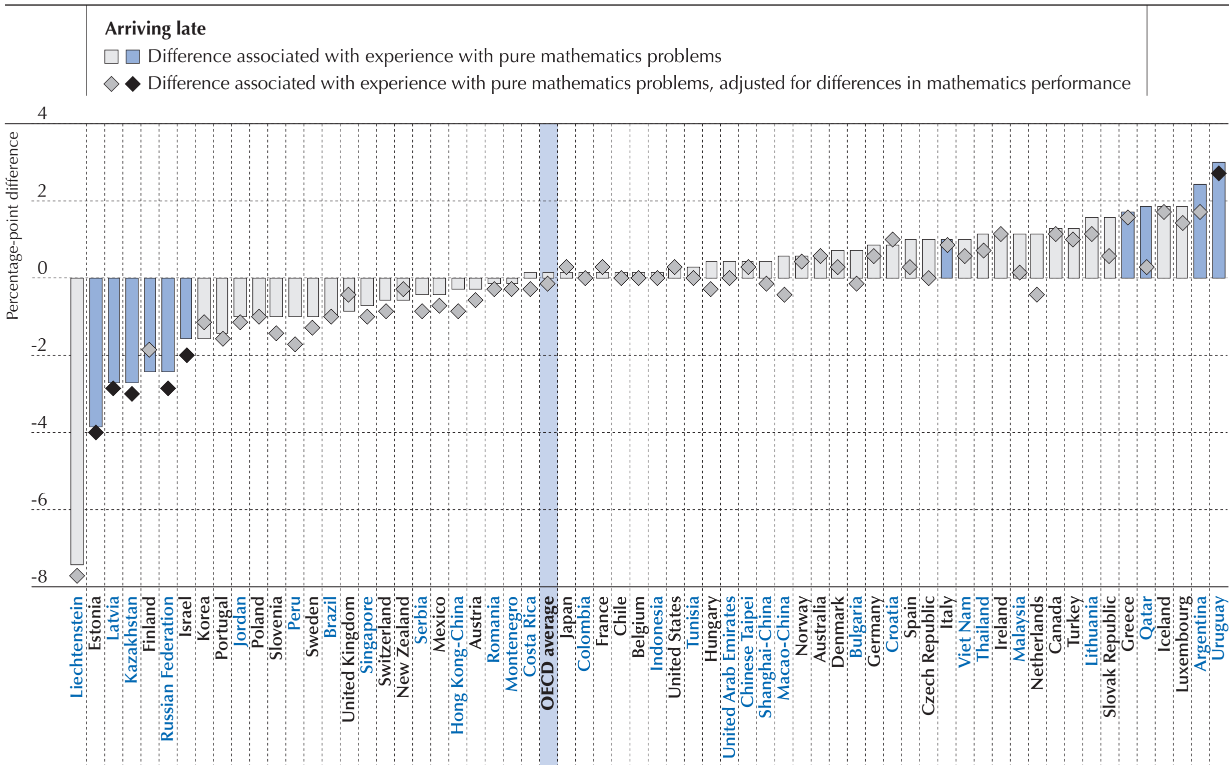
Countries and economies are ranked in descending order of the variation in teachers' use of student-oriented strategies between schools.

Source: OECD, PISA 2012 Database, Table III.5.10f.

StatLink http://dx.doi.org/10.1787/888932964015

▪ Figure III.5.13 ▪

Relationship between experience with pure mathematics problems and students' lack of punctuality



Note: Statistically significant percentage-point changes at the 5% level ($p < 0.05$) are marked in a darker tone.
Countries and economies are ranked in descending order of the unadjusted percentage difference in mathematics performance associated with arriving late.
Source: OECD, PISA 2012 Database, Tables III.5.11.
StatLink http://dx.doi.org/10.1787/888932964015

However, the second set of results presented in Table III.5.11, where relationships are presented when comparing students with similar mathematics performance, reveals that experience with applied mathematics problems is strongly associated with students' drive, motivation and self-beliefs. While the association between experience with applied mathematics problems and students' drive, motivation and self-beliefs is stronger among students with similar proficiency in mathematics, the relationship between experience with pure mathematics problems and students' drive, motivation and self-beliefs is weaker, and in many cases not present, in this latter group. While findings in the first sets of results in Table III.5.11 can be interpreted as the "overall association" between experience with pure and applied mathematics topics, the second sets of results reveals the differences in the engagement, drive motivation and self-beliefs among students who reported different levels of exposure to pure and applied mathematics topics, but who perform similarly in mathematics.

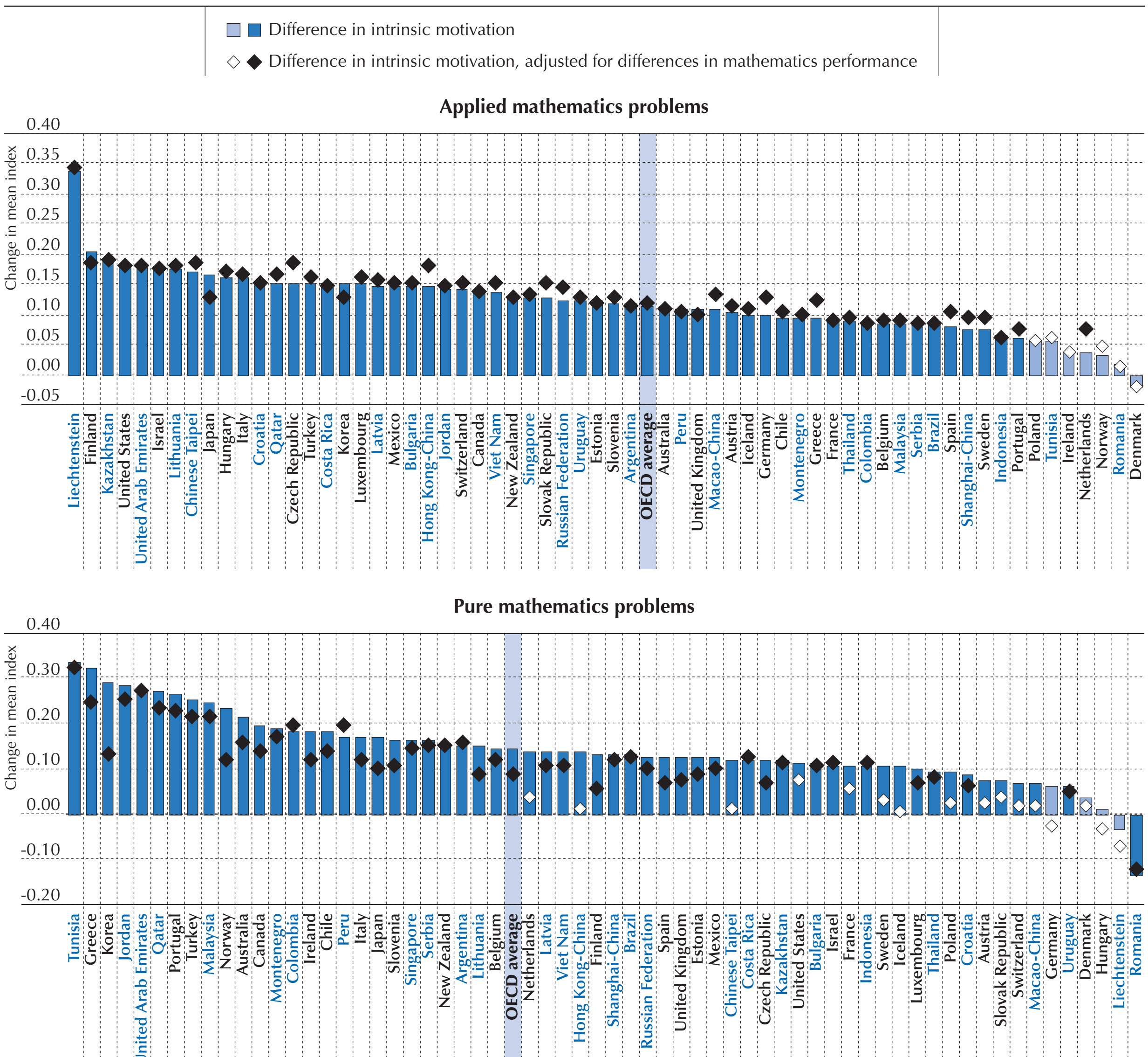
Students' mathematics self-efficacy is also strongly and consistently associated with exposure to applied mathematics problems. In all countries and economies except Denmark and Liechtenstein, a change in one unit in the *index of applied mathematics problems* is positively associated with mathematics self-efficacy; and across OECD countries, a change in one unit in the *index of exposure to applied mathematics problems* is associated with a difference of almost one-fifth of a standard deviation in the *index of mathematics self-efficacy*. Experience with pure mathematics problems is also strongly and positively associated with mathematics self-efficacy, although the association is much weaker when examining differences among students who perform similarly in mathematics than when examining differences across students at all proficiency levels. This is because exposure to pure mathematics problems is very strongly and positively associated with how well students do in mathematics, while exposure to applied mathematics problems is less strongly associated with mathematics performance. Experience with pure mathematics problems is positively associated with mathematics self-efficacy in all countries and economies except Poland, Germany, Sweden, Denmark, Norway, Hong Kong-China, Macao-China, Liechtenstein, Iceland and Shanghai-China, and a difference of one unit on the *index of exposure to pure mathematics problems* is associated with a difference of one-tenth of a standard deviation in the *index of mathematics self-efficacy* among students with equal performance.

Results on the association between students' reported experience with pure and applied mathematics problems, mathematics performance, and engagement, drive, motivation and self-beliefs suggest that students who are frequently exposed to pure and applied mathematics problems fare particularly well: they perform at higher levels in mathematics and enjoy greater drive, motivation and more positive self-beliefs.

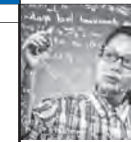
In all but six countries and economies, exposure to applied mathematics problems among students of equal performance is positively associated with intrinsic motivation to learn mathematics. Similarly, in all but 16 countries and economies, exposure to pure mathematics problems is associated with intrinsic motivation to learn mathematics among students with equal mathematics performance. Across OECD countries, exposure to pure and applied mathematics problems is similarly associated with intrinsic motivation to learn mathematics: a difference of one standard deviation in both indices

▪ Figure III.5.14 ▪

Relationship between students' experience with pure and applied mathematics tasks and intrinsic motivation to learn mathematics



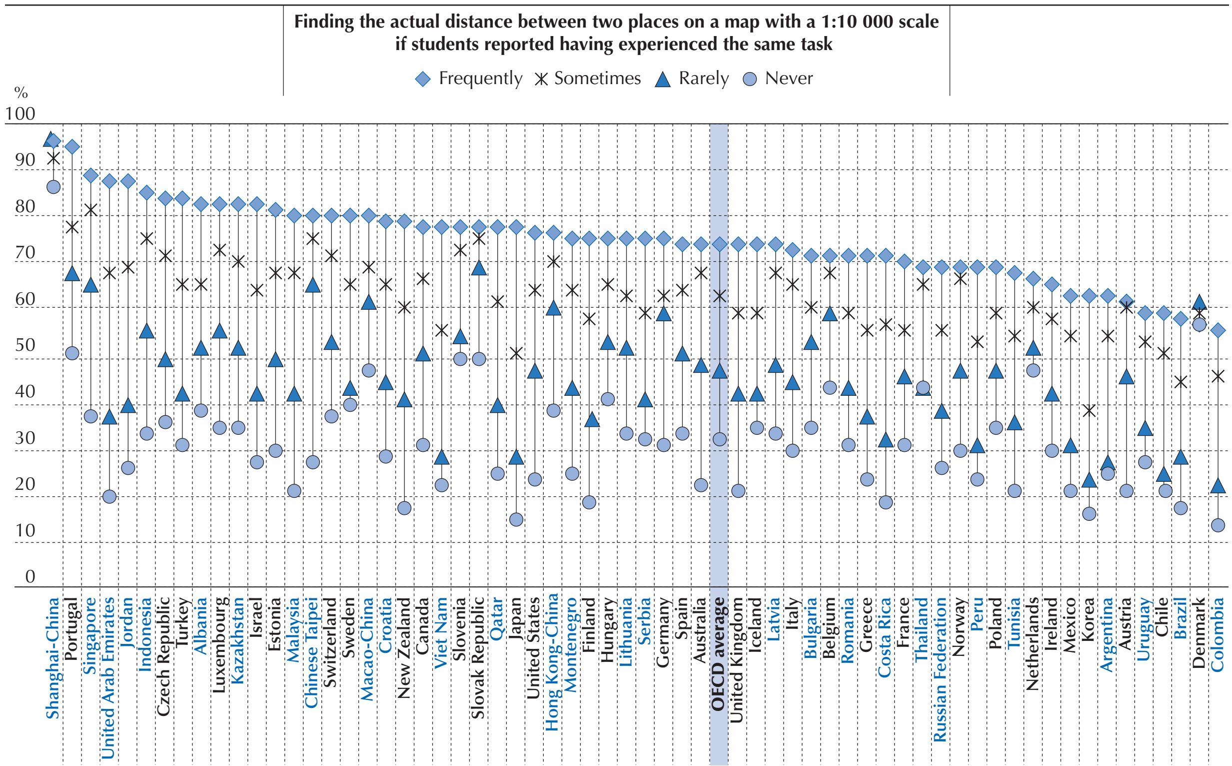
Note: Statistically significant score-point changes at the 5% level ($p < 0.05$) are marked in a darker tone.
Countries and economies are ranked in descending order of the unadjusted change in the mean index of applied mathematics problems *and* index of pure mathematics problems*, respectively.*
Source: OECD, PISA 2012 Database, Tables III.5.11.
StatLink http://dx.doi.org/10.1787/888932964015



is associated with a tenth of a standard deviation difference in intrinsic motivation. Similarly, in all but 8 countries and economies exposure to applied mathematics problems, and in 13 countries and economies, exposure to pure mathematics problems, is positively associated with instrumental motivation to learn mathematics, with a difference of around one-tenth of a standard deviation in instrumental motivation being associated with a difference in one unit in the two indices.

■ Figure III.5.15 ■

Students' confidence in solving an applied mathematics task as a function of frequency of experience with that task



Countries and economies are ranked in descending order of the percentage of students who reported being confident or very confident about having to "find the actual distance between two places on a map with a 1:10 000 scale" when they frequently experienced the same problem.
Source: OECD, PISA 2012 Database, Table III.5.12.
StatLink http://dx.doi.org/10.1787/888932964015

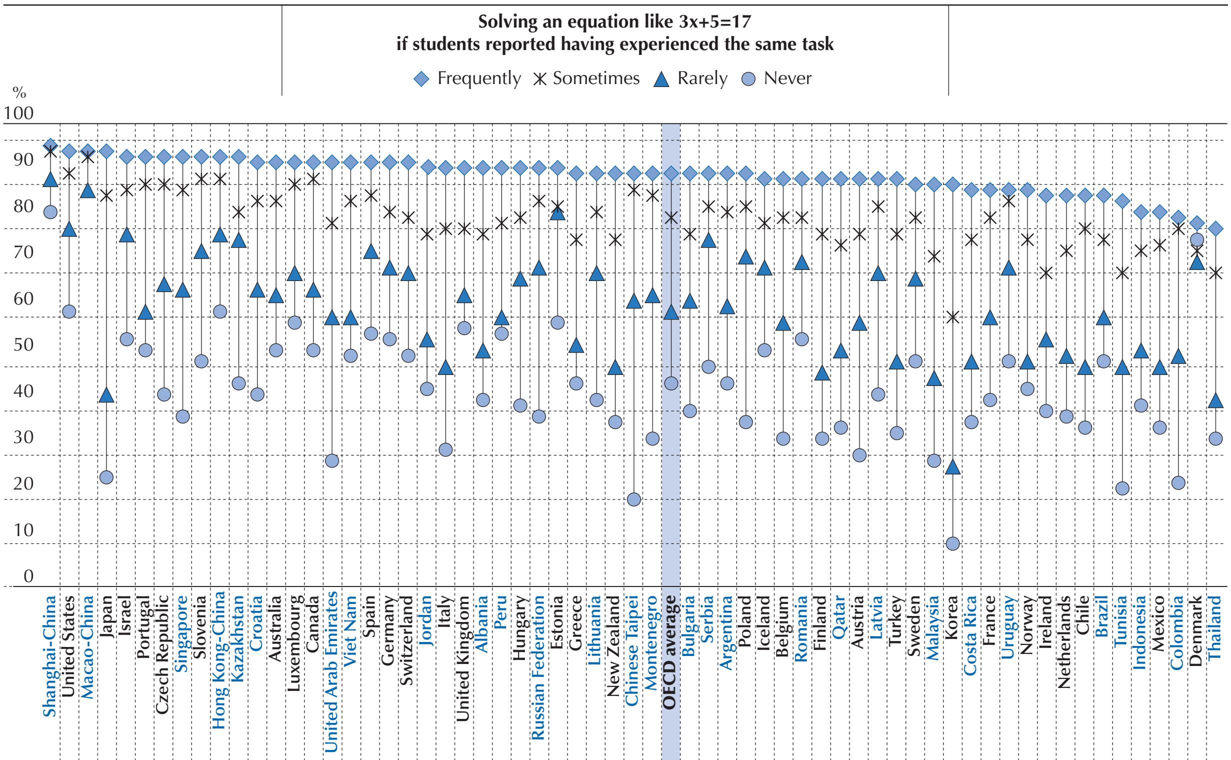
Student exposure to mathematics problems and mathematics self-efficacy

Chapter 4 highlights the strong association between students' feelings of confidence as expressed by mathematics self-efficacy and mathematics performance. This section examines in detail the connection between how confident students feel about being able to solve specific pure and applied mathematics problems, and whether they were exposed to similar or different problem sets in class.

Figure III.5.16 illustrates the proportion of students who feel confident or very confident about finding the actual distance between two places on a map with a 1:10 000 scale, depending on whether they reported having encountered the same mathematics task at school frequently, sometimes, rarely or never. On average across OECD countries, 56% of students feel confident or very confident about having to do such task (Table III.4.1a). However this percentage varies greatly depending on whether students reported having encountered the problem frequently, sometimes, rarely or never. For example, 74% of students who reported having frequently encountered the problem reported feeling confident about having to solve it; 63% of those who reported having sometimes encountered the problem reported feeling confident or very confident about having to solve it; 47% of those who reported having only rarely encountered the problem reported feeling confident or very confident, and 32% of those who reported never having encountered the problem felt confident or very confident about having to solve it.

■ Figure III.5.16 ■

Students' confidence in solving a pure mathematics task as a function of frequency of experience with that task



Countries and economies are ranked in descending order of the percentage of students who reported being confident or very confident about having to "[solve] an equation like 3x+5=17" when they frequently experienced the same problem.
Source: OECD, PISA 2012 Database, Table III.5.12.
StatLink http://dx.doi.org/10.1787/888932964015

In contrast, Figure III.5.17 shows that many more students feel confident or very confident about solving a linear equation, such as 3x+5=17, and that virtually all students who reported having frequently encountered the same linear equation reported feeling confident or very confident about solving it (93% across OECD countries). However, fewer than half of those who reported never to have seen such an equation also reported being confident or very confident about solving it (Table III.5.12). The difference in the percentage of students who feel confident or very confident about solving a linear equation when they reported having frequently encountered, rather than having never encountered, a linear equation is larger than 50 percentage points in 28 countries and economies; it is larger than 70 percentage points in Korea, Chinese Taipei and Japan, and smaller than 30 percentage points in Shanghai-China and Denmark.

In general, almost all students who reported having frequently encountered pure mathematics tasks feel confident about having to solve such tasks. However, feelings of confidence about having to solve applied mathematics problems are much lower even when students reported having frequently encountered such problems. One possibility is that applied mathematics problems are, by their very nature, more ambiguous. A second possibility is that solving applied mathematics problems generally requires both a good understanding of an underlying abstract problem as well as a good understanding of the context in which such a problem is set. Results presented in Figure III.5.16 and Figure III.5.17 suggest that exposure matters for students' mathematics self-efficacy: the more frequently students are exposed to a very specific problem set, according to their self-reports, the more confident they feel about solving that problem. But is the relationship between exposure and feelings of self-efficacy wide or narrow, i.e. does exposure to pure mathematics problems help students to feel more confident about having to solve applied mathematics problems? And does exposure to one type of applied mathematics problem help to foster feelings of confidence about being able to solve other types of applied mathematics problems?

▪ Figure III.5.17 ▪

Students' confidence as a function of experience with different problems, OECD average

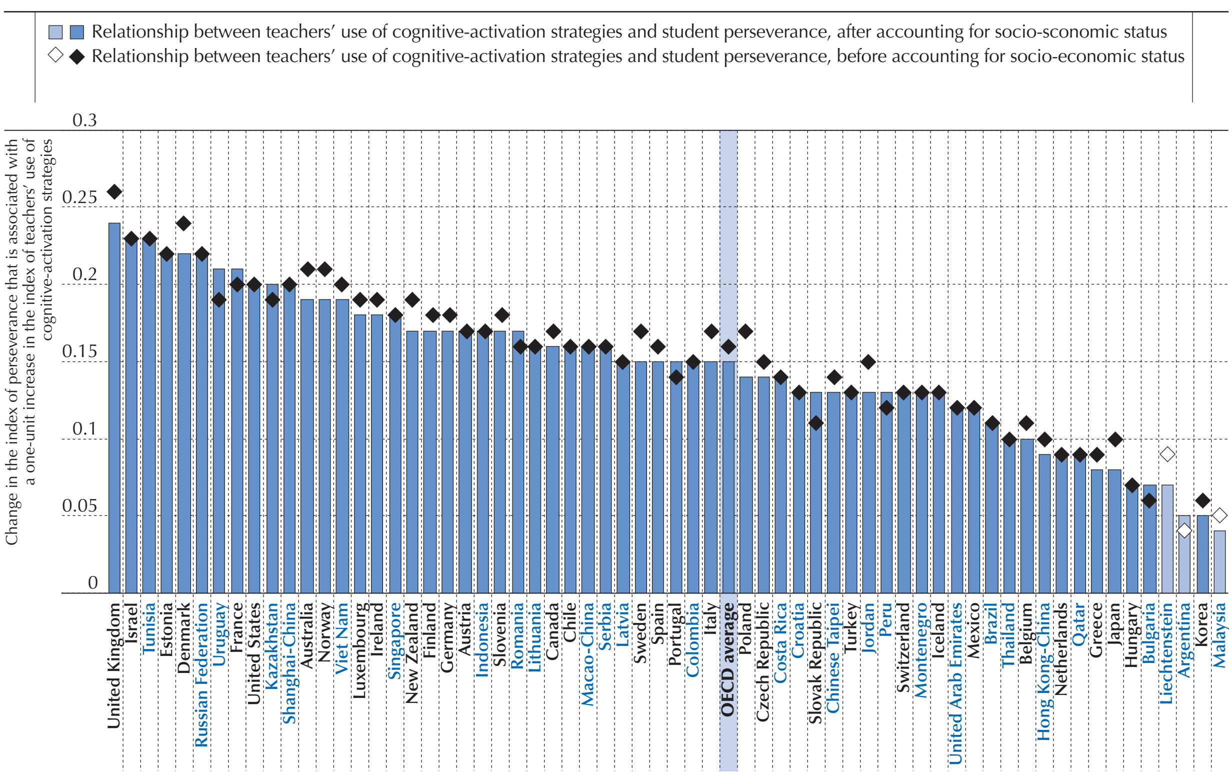
Note: Statistically significant score-point changes at the 5% level ($p < 0.05$) are marked in a darker tone.
Source: OECD, PISA 2012 Database, Tables III.5.13c, f, g and h (available on line).
StatLink http://dx.doi.org/10.1787/888932964015

Tables III.5.13a to III.5.13h show the percentage-point difference in whether students reported feeling confident or very confident about solving a specific mathematics problem depending on how frequently they reported having seen the same or a very similar problem. Results illustrate whether students' feelings of confidence about solving a set of problems are strictly related to having been exposed to very similar problem sets[4] or whether they are more generally associated with having been presented with pure or applied mathematics problems.

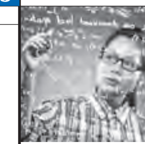
Figure III.5.18 shows that students are much more likely to report feeling confident or very confident about being able to solve a series of various applied and pure mathematics problems when they are exposed to the same problem set; being exposed to different problems sets is only weakly associated or not associated at all with self-reported confidence levels. For example, on average, students in OECD countries who reported having been rarely exposed to the problem "how many square metres of tiles would you need to cover a floor", were nine percentage points more likely to report feeling confident or very confident about solving such a task than students who reported that they were never exposed to such tasks. This reflects the difference in confidence associated with exposure to mathematics problems when comparing students of the same gender, socio-economic status and with similar levels of exposure to otherwise similar materials. Students who were frequently exposed to a problem asking them to calculate the power consumption, per week, of an electronic appliance were six percentage points more likely to feel confident or very confident about having to calculate a car's petrol consumption rate. Experience with other problems, such as calculating how much more expensive a computer would be after adding tax, finding the actual distance between two places on a map with a 1:10 000 scale, and solving an equation like 2(x+3)=(x+3)(x-3) was also positively associated with feelings of confidence but much less so. These results support findings in the literature that self-efficacy beliefs are based on performance and exposure to specific tasks (Schunk and Pajares, 2009).

▪ Figure III.5.18 ▪

Relationship between teachers' use of cognitive-activation strategies and student perseverance



Note: Statistically significant index-point changes at the 5% level ($p < 0.05$) are marked in a darker tone.
Countries and economies are ranked in descending order of the change in the index *of perseverance that is associated with a one-unit increase in the* index of teachers' use of cognitive-activation strategies, *after accounting for gender and socio-economic status.*
Source: OECD, PISA 2012 Database, Table III.5.14.
StatLink http://dx.doi.org/10.1787/888932964015



Solving an applied mathematics problem requires students to see through the surface structure of the problem (for example, in the case of two sets of problems presented in PISA 2012, the student first needs recognise that "this is a problem about cars" and "this is a problem about purchasing a TV set"), see the building blocks that define the problem (if a TV costs x before it is sold with a 30% discount, the discount is $y=0.3x$ or the TV set after the discount will cost $y=x-[0.3x]$), and apply abstract principles to solve it (solve the equation when, for example, $x=100$). Does the framing of the problem affect students' ability to solve the problem and their feelings of confidence about solving it? Does the fact that a problem is framed in terms of a car's petrol consumption rate mean that students who do not have an interest in cars (or less of an interest in cars than other students do, which might be the case, for example, for 15-year-old girls compared to 15-year-old boys) will feel less confident about being able to solve such a problem?

PISA data cannot be used to determine exactly whether framing matters, but results presented in Tables III.5.13a to III.5.13h and Figure III.5.18 show that students who are exposed to a variety of applied mathematics problems and therefore a variety of contexts in which these problems are set feel more confident about solving a greater number of such problems than students who have little or only a narrow exposure. These findings are in line with empirical evidence that suggests that framing does matter: students perform at higher levels when they are familiar with the context used to present a particular problem set (Chiesi, Spilich and Voss, 1979; Alexander, 1992; Alexander and Judy, 1988; Alexander, Kulikowich and Schulze, 1994; Geary et al., 2011). Although the findings presented in this section refer to students' feelings of self-efficacy, they have important implications for students' mathematics performance more generally. A large body of evidence indicates that how individuals perform on a given task depends, crucially, on how capable they feel of solving it. Academic achievement is significantly influenced by self-stereotyping and, implicitly, by individuals' attitudes and beliefs about their own ability (see Steen, 1987; Aronson, 2002; Benbow, 1988; Eccles, 2009; Hedges and Nowell, 1995; Shih, Pittinsky and Ambady, 1999; Levy, 1996).

Only students who have developed a wide and extensive knowledge of mathematical concepts and processes can solve complex real-life problems that they have not encountered before. Learning new things and solving new, complex problems, depend on previously acquired knowledge; the more background knowledge students have stored in long-term memory, the easier it is for them to learn new, related material and to solve problems. The more knowledge students have acquired, the more new problems appear as *related* instead of *unrelated* to them. When students possess a complex web of memorised information, they will be more likely to be able to find relations in the structure of the new problem, the meaning and content of the problem, or the purpose of the problem, and in so going will be able to solve the problem faster and will find the problem easier.

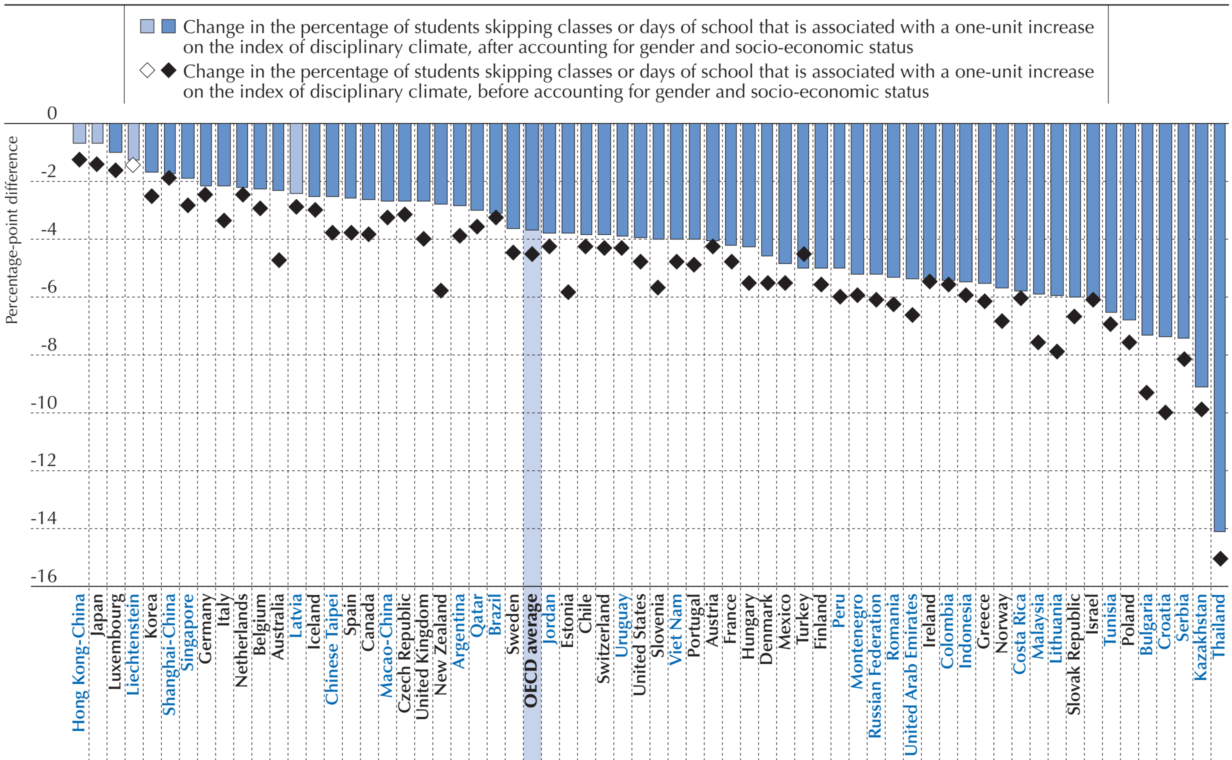
STUDENTS' DRIVE, MOTIVATION AND SELF-BELIEFS AND SCHOOL PRACTICES: TEACHER BEHAVIOUR IN CLASS AND SCHOOL CLIMATE

Previous sections in this chapter illustrate the role of social comparisons and the association between the material students encounter in class and their drive, motivation and self-beliefs. This section examines the association between students' reports of what behaviour and practices their mathematics teacher adopts in class and their level of engagement, drive, motivation and self-beliefs and the association between students' reports of disciplinary climate in the school and of teacher student relations.

Table III.5.14 indicates that students who reported that their teacher uses cognitive-activation strategies reported particularly high levels of perseverance and openness to problem solving, are more likely to favour mathematics as a field of study over other subjects or to see mathematics as more necessary than other subjects to their careers. Teachers' use of cognitive-activation strategies is also positively associated with students' engagement with and at school, intrinsic motivation to learn mathematics and mathematics self-beliefs. However, in all these cases the relationship is weaker and is less pervasive. In many countries there is no association between teachers' use of cognitive-activation strategies and students' engagement, motivation and self-beliefs. As Figure III.5.19 shows, on average across OECD countries, students who reported that their teachers use a large variety of cognitive-activations strategies relatively frequently (as indicated by a value of 1 on the relative index) also reported greater perseverance (values on the index of perseverance that are 0.16 higher) than that reported by students whose teachers use cognitive-activations strategies at around the OECD average frequency. In 12 countries and economies the difference in the *index of perseverance* that is associated with a change of one standard deviation in the *index of teachers' use of cognitive-activation strategies* is larger than one-fifth of a standard deviation. Results are not driven by differences in how well students perform in mathematics; the relationship between teachers' use of cognitive-activation strategies and engagement, drive, motivation and self-beliefs among students who show similar mathematics performance is much like that observed among students with varying levels of proficiency in mathematics (Table III.5.14).

■ Figure III.5.19 ■

Relationship between disciplinary climate and students' skipping classes or days of school



Note: Statistically significant percentage-point changes at the 5% level ($p < 0.05$) are marked in a darker tone.
Countries and economies are ranked in descending order of the change in the percentage of students skipping classes or days of school that is associated with a one-unit increase on the index of disciplinary climate, *after accounting for gender and socio-economic status.*
Source: OECD, PISA 2012 Database, Table III.5.18.
StatLink http://dx.doi.org/10.1787/888932964015

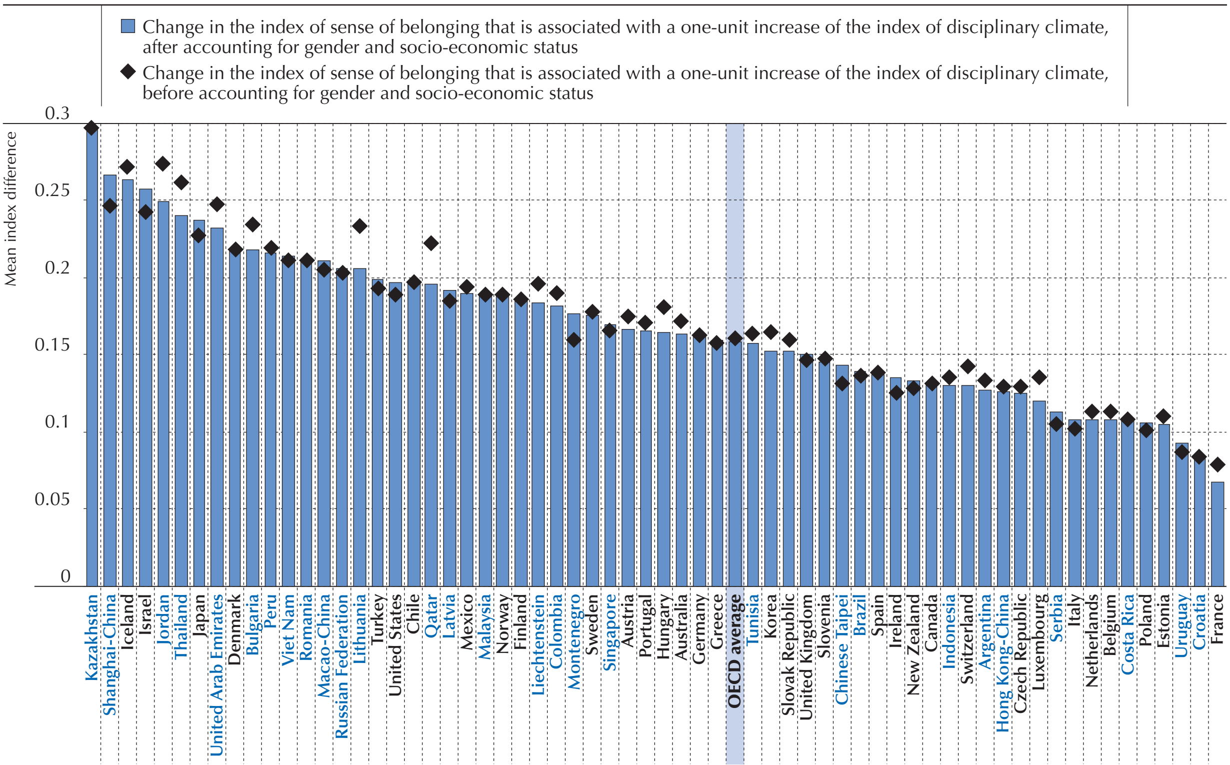
Tables III.5.15 and III.5.16 indicate that students who reported that in their mathematics lessons teachers use teacher-directed instruction and formative assessments also reported particularly high levels of perseverance, openness to problem solving and students' intentions to pursue mathematics as a career or a field of study and, to a lesser extent, higher levels of engagement with and at school, intrinsic motivation to learn mathematics and mathematics self-beliefs. The relationship is weaker and less pervasive in the case of teachers' use of student-orientation strategies (Table III.5.17).

Table III.5.18 indicates that disciplinary climate is strongly associated with students' engagement with and at school, students' intrinsic motivation to learn mathematics, and how anxious students reported to be about solving mathematics problems. However, disciplinary climate is only weakly associated with students' self-reported perseverance, openness to problem solving, mathematics self-efficacy and mathematics self-concept. On average across OECD countries, students who attend schools with better disciplinary climate are 5% less likely to report having arrived late and having skipped classes or days of school during the two weeks before the PISA test. They also have much more positive values on the *index of sense of belonging* (0.16 higher values), *index of intrinsic motivation to learn mathematics* (0.17 higher values) and *index of mathematics self-efficacy* (0.12 higher values). Table III.5.18 reveals that the strong association between disciplinary climate and engagement with and at school is not the result of a positive association between disciplinary climate and mathematics performance.

Figure III.5.20 and Figure III.5.21 show, for example, that among students with similar mathematics performance, those who attend schools with better disciplinary climate report fewer incidents of unauthorised non-attendance of classes and days of school and a stronger sense of belonging. On average across OECD countries, a difference of one unit in the *index of disciplinary climate* is associated with a difference of four percentage points in the probability that students will report having skipped classes or days of school. This difference is largest, at more than six percentage points, in Thailand, Kazakhstan, Croatia, Serbia, Bulgaria, Poland, Tunisia, Israel and the Slovak Republic; by contrast, in Latvia, Liechtenstein, Japan and Hong Kong-China, there is no difference in the probability that students with equal performance

▪ Figure III.5.20 ▪

Relationship between disciplinary climate and students' sense of belonging



Note: All changes in the index of sense of belonging that are associated with a one-unit increase in the index of disciplinary climate are statistically significant.
Countries and economies are ranked in descending order of the change in the index of sense of belonging *that is associated with a one-unit increase in the* index of disciplinary climate*, after accounting for gender and socio-economic status.*
Source: OECD, PISA 2012 Database, Table III.5.18.
StatLink http://dx.doi.org/10.1787/888932964015

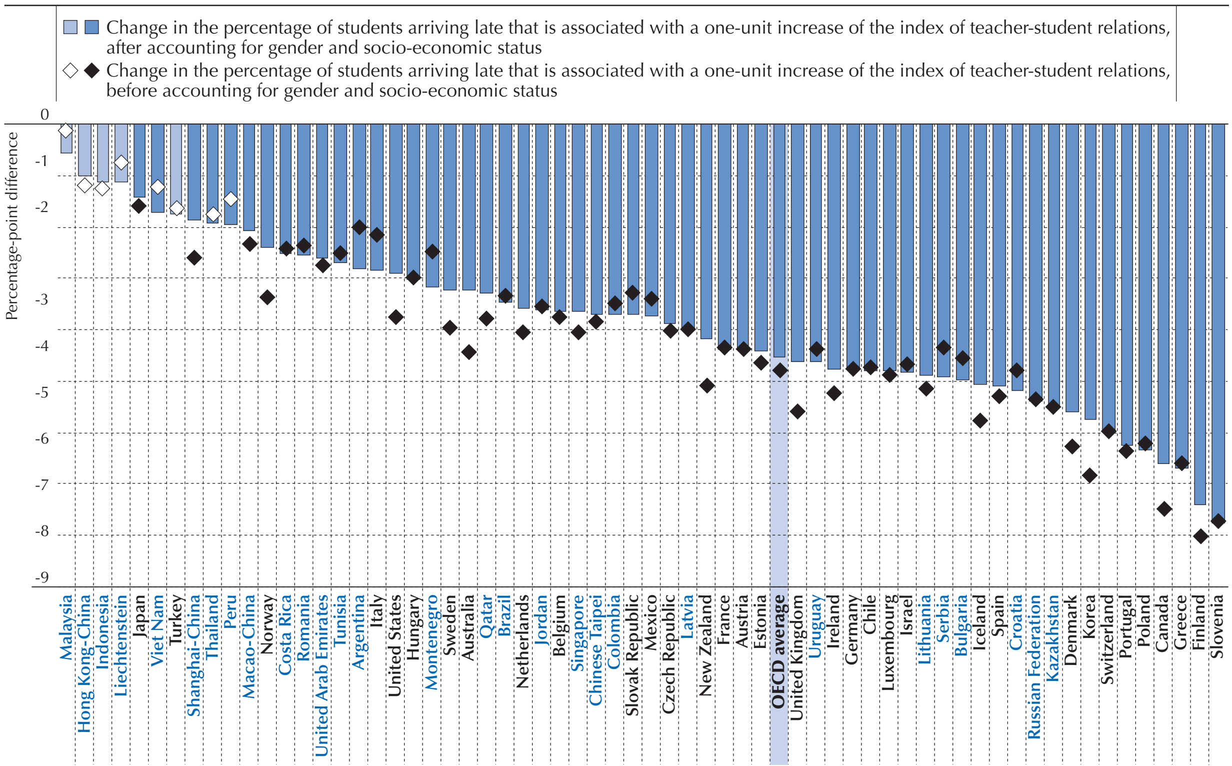
will report having skipped classes or days of school when they attend schools with different disciplinary climates. Figure III.5.21 also indicates that the difference in the sense of belonging between students with similar performance in mathematics, but who attend schools with different disciplinary climates, varies greatly across countries. This difference is largest, at one-quarter of a standard deviation or more, in Kazakhstan, Shanghai-China, Iceland and Israel and lowest, at less than one-tenth of a standard deviation, in France, Croatia and Uruguay.

Teacher-student relations are also strongly associated with students' engagement with and at school. The relationship between teacher-student relations and students' lack of punctuality, skipping classes or days of school, and a sense of belonging is strong in virtually all countries and economies (Table III.5.19). When comparing students with similar performance in mathematics, on average across OECD countries, students who reported that, for example, they get along with most of their teachers, that most teachers are interested in their well-being, that most teachers really listen to what they have to say, that they will receive extra help from their teachers, if needed, and that most teachers treat them fairly, are five percentage points less likely to report having arrived late for school and four percentage points less likely to report having skipped classes or days of school during the two weeks prior to the PISA test. They also have values on the *index of sense of belonging* that are almost two-fifth of a standard deviation higher than students who attend schools with poorer teacher-student relations.

Not surprisingly, Figure III.5.22 shows that in all countries and economies except Turkey, Liechtenstein, Indonesia, Hong Kong-China and Malaysia, among students with equal performance and similar socio-economic status, students who attend schools with better teacher-student relations are less likely to report having arrived late during the two weeks before the PISA test. In Slovenia, Finland, Greece, Canada, Poland, Portugal, Switzerland, Korea, Denmark, Korea, Kazakhstan, the Russian Federation, Spain, Croatia and Iceland this difference is particularly large – five percentage points or more. Similarly, Figure III.5.23 shows that in all countries and economies among students with equal

■ Figure III.5.21 ■

Relationship between teacher-student relations and students' lack of punctuality



Note: Statistically significant percentage-point changes at the 5% level ($p < 0.05$) are marked in a darker tone.
Countries and economies are ranked in descending order of the change in the percentage of students arriving late that is associated with a one-unit increase in the index of *teacher-student relations, after accounting for gender and socio-economic status.*
Source: OECD, PISA 2012 Database, Table III.5.19.
StatLink http://dx.doi.org/10.1787/888932964015

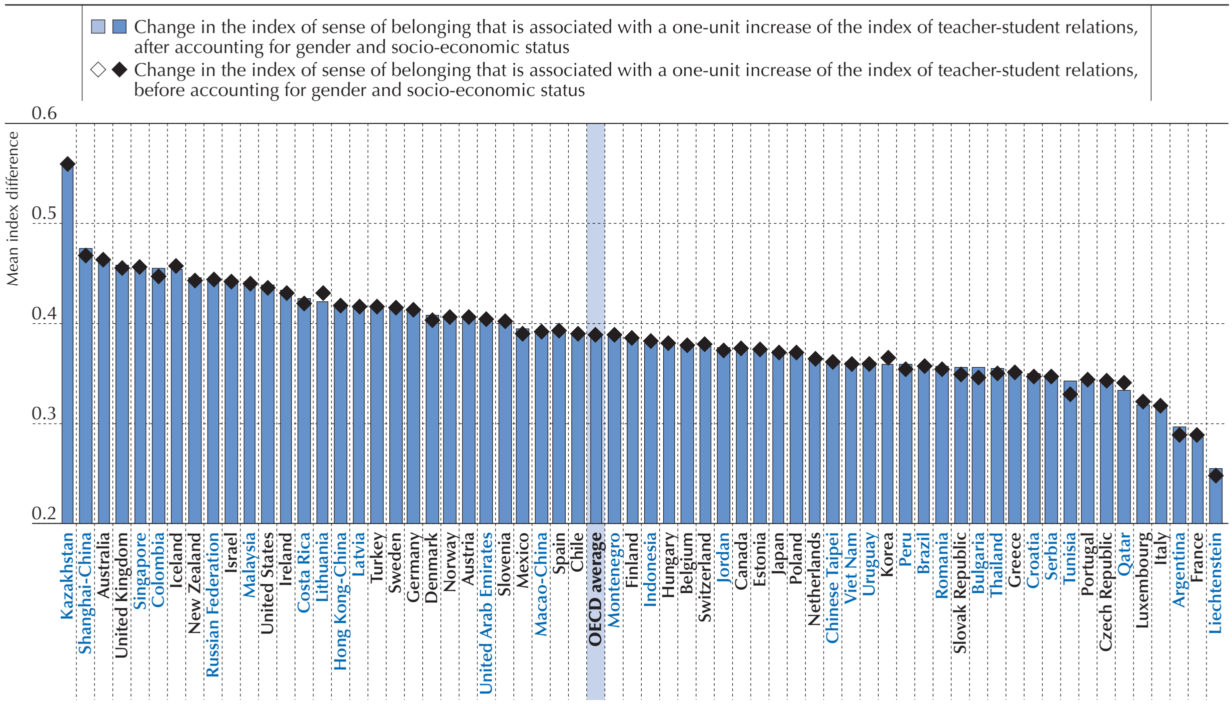
performance and similar socio-economic status, students who attend schools with better teacher-student relations report a stronger sense of belonging. This difference is very large: in all countries and economies, the change in a sense of belonging that is associated with a one-unit difference in the *index of teacher-student relations* is larger than one-quarter of a standard deviation and it is larger than 0.4 in 25 countries and economies.

Table III.5.19 shows that positive teacher-student relations are also positively and strongly associated with students' intrinsic motivation to learn mathematics. With the exception of Romania and Liechtenstein, the *index of teacher-student relations* is positively associated with intrinsic motivation to learn mathematics in all countries and economies when controlling for students' socio-economic status and mathematics performance. On average across OECD countries, a difference of one unit on the *index of teacher-student relations* corresponds to a one-quarter of a standard deviation difference on the *index of intrinsic motivation to learn mathematics*. Positive teacher-student relations are positively associated with students' mathematics self-efficacy. Teacher-student relations are positively associated with mathematics self-efficacy in all countries and economies, except Liechtenstein. On average across OECD countries, a one-unit difference on the *index of teacher-student relations* is associated with a 0.16 difference on the *index of mathematics self-efficacy* among students of similar socio-economic status and with similar mathematics performance. Teacher-student relations are also positively associated with students' mathematics self-concept in all countries and economies (Table III.5.19).

Students who report having repeated a grade tend to have lower performance in mathematics than students who report not having repeated a grade. Results presented in Table III.5.21 suggest that grade repetition is also associated with worse outcomes for students: students of similar economic condition who reported having repeated a grade are more likely to report having arrived late and having skipped classes during the two weeks before the PISA test, to have a lower sense of belonging lower mathematics self-efficacy and self-concept, higher levels of mathematics anxiety and less openness to problem solving. However most of these differences reflect the lower performance of students who repeat a grade.

■ Figure III.5.22 ■

Relationship between teacher-student relations and students' sense of belonging



Note: All changes in the *index of sense of belonging* that are associated with a one-unit increase of the index of teacher-student relations are statistically significant.
Countries and economies are ranked in descending order of the change in the index of sense of belonging *that is associated with a one-unit increase in the* index of teacher-student relations*, after accounting for gender and socio-economic status.*
Source: OECD, PISA 2012 Database, Table III.5.19.
StatLink http://dx.doi.org/10.1787/888932964015

When comparing students of similar performance in mathematics and of similar socio-economic status, students who reported having repeated a grade are more likely to report having skipped classes or days of school, but when comparing students of similar socio-economic condition and mathematics performance, the relationship is weakened considerably. Grade repetition is also associated with more negative mathematics self-beliefs among students but those differences mostly reflect the lower performance of students who repeated a grade. When comparing students of similar performance in mathematics and similar socio-economic condition, in some countries, grade repetition is associated with slightly higher levels of mathematics self-efficacy, mathematics self-concept, lower mathematics anxiety and a higher propensity of students to report intending pursuing mathematics courses, degrees or careers rather than courses, careers or degrees requiring other subjects (Table III.5.21).

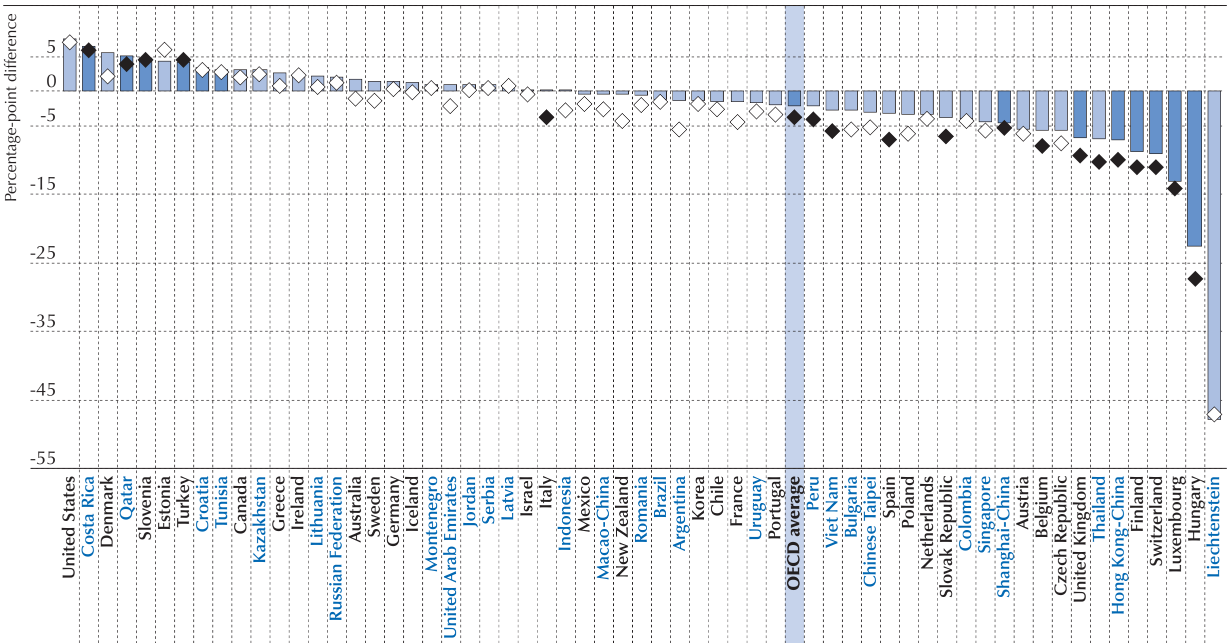
In general, there is only a weak association between learning time in mathematics and student engagement, drive, motivation and self-beliefs. Results shown in Table III.5.22 suggest that the most significant relationships are those between the reported amount of time students study mathematics at school and levels of mathematics self-efficacy and intrinsic motivation. For each additional 100 minutes students spend studying mathematics, students reported levels of mathematics self-efficacy and intrinsic motivation to learn mathematics that are roughly one-tenth of a standard deviation higher. This association reflects, to some extent, the better mathematics performance among students who spend more time studying mathematics, whether because higher-achieving students opt for more and more demanding mathematics courses or because time spent studying mathematics improves performance. In 23 countries and economies, learning time in mathematics is positively associated with intrinsic motivation to learn mathematics; in 22 countries and economies it is positively associated with mathematics self-efficacy. Macao-China and Romania represent notable exceptions because in these countries, among students who perform equally well, those who spend more time learning mathematics reported lower levels of intrinsic motivation to learn the subject. Similarly, Table III.5.23 indicates that the association between overall learning time in school and students' engagement, drive, motivation and self-beliefs, even when statistically significant, is quantitatively not important.

▪ Figure III.5.23 ▪

Relationship between repeating a grade and skipping classes or days of school

Change in the percentage of students skipping classes or days of school that is associated with repeating a grade, after accounting for gender and socio-economic status

Change in the percentage of students skipping classes or days of school that is associated with repeating a grade, before accounting for gender and socio-economic status



Note: Statistically significant percentage-point changes at the 5% level ($p < 0.05$) are marked in a darker tone.

Countries and economies are ranked in descending order of the change in the percentage of students skipping classes or days of school that is associated with repeating a grade, after accounting for gender and socio-economic status.

Source: OECD, PISA 2012 Database, Table III.5.20.

StatLink http://dx.doi.org/10.1787/888932964015

Other school characteristics, such as the use of ability grouping, the availability of creative extracurricular activities or extracurricular mathematics activities, class size and school size, are also not strongly associated with students' engagement, drive, motivation and self-beliefs (Tables III.5.24, III.5.25, III.5.26, III.5.27 and III.5.28).

At a first glance, students who attend more socio-economically advantaged schools do not appear to report levels of drive and motivation that are different from those reported by students who attend less-advantaged schools (Table III.5.29). However, when comparing students of similar performance who attend more- and less-advantaged schools, a different picture emerges: students who attend more advantaged schools reported much lower levels of perseverance, intrinsic motivation to learn mathematics and lower levels of openness to problem solving, and are less likely to report intending to engage in mathematics-related careers or coursework than students who perform similarly but who attend less-advantaged schools. For example, on average across OECD countries, students who attend more advantaged schools reported levels of intrinsic motivation to learn mathematics and openness to problem solving that are one-fifth of a standard deviation lower than students who attend less-advantaged schools, even if all these students share similar socio-economic status and performance in mathematics; when considering perseverance, the difference between the two groups of students is 0.16 of a standard deviation.

On the other hand, students who attend schools that are more advantaged tended to report much higher levels of mathematics self-efficacy and lower levels of mathematics anxiety (Table III.5.29). On average across OECD countries, a difference of one unit on the *PISA index of economic, social and cultural status* is associated with a difference of one-third of a standard deviation on the *index of mathematics self-efficacy* and one-tenth of a standard deviation on the *index of mathematics anxiety*. However, these differences simply reflect the better performance of students who attend advantaged schools.

These results confirm findings illustrated in previous sections of this chapter: social comparisons matter; and because advantaged schools tend to be schools where performance is generally better, students attending these schools, will tend to report lower levels of drive, motivation and self-beliefs.

Trends in the relationship between students' engagement, motivation and dispositions and the schools they attend

The proportion of students who attend schools in which their peers often arrive late decreased between 2003 and 2012. In 2012 and on average across OECD countries, compared with 2003 there were fewer 15-year-olds enrolled in schools where more than 25% of students reported arriving late at least once in the two weeks prior to the PISA test. The decrease in the proportion of students in these types of schools is notable in Luxembourg and Indonesia. In Luxembourg, for example, the proportion of students in schools where between one in four and one in two students reported arriving late shrank by 26 percentage points between 2003 and 2012. Decreases are also observed in Hong Kong-China, Japan, Hungary, Australia, the Netherlands, Spain, Denmark, Norway, Liechtenstein, Italy and Iceland. In the Russian Federation, Tunisia, Sweden, Turkey, the Czech Republic, Latvia, Uruguay, Poland and Macao-China, more students attended schools with a high concentration of late arrivers in 2012 than in 2003 (Table III.5.1c).

In general, there are no large differences between advantaged and disadvantaged schools, private and public schools, upper and lower secondary programmes, schools in urban and rural settings, or large and small schools in the share of students who reported arriving late for school. Nor have these differences changed substantially between 2003 and 2012. The share of students in large schools who arrived late shrank in 15 countries and economies, particularly in Mexico, Switzerland, Luxembourg, Norway and Iceland where, among students who attend large schools, the share of students who arrived late decreased by more than 10 percentage points during the period. In Latvia, Luxembourg and Iceland students in advantaged schools were more likely to have arrived late in 2003, but by 2012 this difference was no longer observed. In Mexico there was a reduction in the share of students in disadvantaged schools who arrived late, but no such change among students in advantaged schools (Table III.5.1d).

Students' self-reported motivation and dispositions towards school and mathematics are defined by comparisons with their peers at school (Festinger, 1954; Marsh et al., 2008). In line with this logic of social comparison, the variation of sense of belonging, instrumental and intrinsic motivation to learn mathematics, mathematics self-concept and anxiety towards mathematics varies mostly within schools. That is, in most schools there are students with high and low levels of these attitudes and dispositions and it is relatively uncommon to find, in any of PISA-participating countries and economies, schools that have exclusively high levels of intrinsic motivation to learn mathematics or anxiety towards mathematics, for example. In 2003, in all countries and economies, more than 93% of the variation in engagement, motivation and dispositions was observed within schools; by 2012, little had changed: Thailand was the only country in which more than 7% of the variation in students' sense of belonging and anxiety towards mathematics was related to different schools. Comparisons of overall levels of these dispositions across school types – and trends in these levels by school type – should not distract policy makers from the fact that policies and practices to improve these dispositions should be adopted within individual schools, targeting those students with little or no sense of belonging and high anxiety towards mathematics; the same can be said for motivation (intrinsic and instrumental motivation). Although a relatively larger proportion of the variation in mathematics self-beliefs is observed between schools, most of the variation is observed within schools as it has been since 2003 (Tables III.5.3b, III.5.5b, III.5.6b, III.5.7b, III.5.8b and III.5.9b).

Notes

1. Because of the positive and reciprocal association between mathematics performance and students' drive, motivation and self-beliefs, estimates of the relationship between these and school factors and education policies after controlling for mathematics performance represent the lower limit of this relationship. Upper-limit estimates are represented by relationships observed when not controlling for mathematics performance. In practice, the relationship between school factors and education policies and students' drive, motivation and self-beliefs lies between the lower- and upper-limit estimates.

2. Marks are used normatively when students are evaluated in the context of their peers' achievement. This means that, when marks are used normatively, students tend to be graded based on the distribution of performance within the school, so that, had they attended a poorer-performing school and maintained their performance levels, they would have obtained substantially better marks.

3. Models estimating changes in the probability that students reported having arrived late for school at least once in the two weeks prior to the PISA test and in the probability that they reported having skipped classes or days of school in the same period were estimated using Linear Probability Models (see Angrist and Pischke, 2008).

4. The assumption underlying the results presented in the tables is that the association between students' confidence and frequency of exposure is linear. In practice, the linearity assumption means that the difference in the probability that students will report feeling confident or very confident about solving a specific mathematics task is likely to be the same between, for example, having rarely seen vs. having sometimes seen a mathematics problem and having seen a problem frequently vs. sometimes. This assumption appears reasonable given the distributions illustrated in Tables III.5.13a to III.5.13h and the robustness checks, fitted using a quadratic specification that identified decreasing marginal returns to experience in a small subset of countries. In virtually all cases where the marginal returns to experience were observed to be decreasing, they remained positive up until the end of the measured scale (frequently). The linearity assumption therefore means that, in a small subset of countries and for some indicators, the marginal contribution of experience to confidence levels is higher than the estimates presented in Tables III.5.13a to III.5.13h, between having never seen and having rarely seen a problem set, and smaller than the estimates presented in Tables III.5.13a and III.5.13h between having sometimes seen to having frequently seen a problem set.

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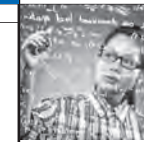

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