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INSIGHTS FROM THE TALIS-PISA LINK DATA

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TEACHING STRATEGIES FOR INSTRUCTIONAL QUALITY: INSIGHTS FROM THE TALIS-PISA LINK DATA

OECD Education Working Paper No. 148

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ABSTRACT

This report explores the relationships between mathematics teachers' teaching strategies and student learning outcomes in eight countries, using information from the TALIS-PISA link database. First, the study seeks to understand the shaping of teaching strategies by examining the way teachers use different classroom practices and the prevalence of these strategies among teachers across schools and countries. As a result of this exploration, three teaching strategies are put forward: active learning, cognitive activation and teacher-directed instruction. Second, the report aims at identifying the teaching strategies that are positively associated with student skill acquisition. Third and finally, it analyses the contributions of the school and the classroom settings, the teacher background and beliefs, to the implementation of the teaching strategies found to be positively related to student learning outcomes. Results show that cognitive activation strategies and, to a lesser extent, active learning strategies, have a strong association with students' achievement in mathematics. However, this association seems to be weaker in schools with socio-economically disadvantaged students. Also, teachers from the same school tend to share the same approach to teaching, which indicates that these teaching strategies are part of a "teaching culture" within the school. Teacher self-efficacy and teacher collaboration are shown to be the factors more often associated with the implementation of cognitive activation strategies and active learning. Following on from these findings, the paper concludes with a series of policy recommendations.

RÉSUMÉ

Ce rapport explore les relations entre les stratégies pédagogiques des enseignants de mathématique et les résultats d'apprentissage des élèves à partir d'information de la base de données de l'option « lien TALIS-PISA » dans 8 pays. Tout d'abord, l'enquête cherche à comprendre comment s'élaborent les stratégies pédagogiques en examinant la façon dont les enseignants emploient des pratiques scolaires différentes et la prévalence de ces stratégies parmi les enseignants, dans les établissements et les pays. Trois stratégies pédagogiques en sont ressorties : l'apprentissage actif, l'activation cognitive et l'enseignement direct. Le rapport a pour but d'identifier les stratégies qui sont associées de manière positive à l'acquisition de compétences chez l'élève. Finalement, il analyse les contributions des établissements et des caractéristiques des classes, de la formation et des croyances de l'enseignant, à la mise en œuvre de stratégies pédagogiques considérées comme participant de manière positive aux résultats d'apprentissage de l'élève. Les résultats montrent que les stratégies d'activation cognitives et, dans une moindre proportion, les stratégies d'apprentissage actif, sont très fortement associées à la réussite de l'étudiant en mathématiques. Cependant, cette corrélation semble être plus faible dans les établissements où se trouvent des élèves désavantagés sur les plans économique et social. En outre, les enseignants provenant de la même école ont tendance à utiliser la même approche, ce qui indique que ces stratégies font partie d'une « culture d'enseignement » au sein de l'établissement. L'efficacité personnelle et la collaboration entre enseignants sont les facteurs qui sont le plus souvent associés à la mise en œuvre de stratégies d'activation cognitive et d'apprentissage actif. Sur la base de ces résultats, le rapport présente une série de recommandations.

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EXECUTIVE SUMMARY

Teachers are the most important ingredient of quality education. Although the importance of teaching quality might be deeply ingrained in the policy debate, no action will be possible until policy makers are able to identify how quality of instructions can be improved. How can policies support teachers in the adoption of instructional practices associated with better outcomes, and how can policies be tailored to better meet the needs of different schools or students?

In this respect, this report aims to provide some answers to two crucial questions. Which teaching strategies are associated with better student outcomes? Which characteristics of teachers, students, and schools are associated with the regular use of teaching practices strongly associated with student outcomes?

The TALIS-PISA-linked dataset is the ideal tool to answer these questions. It is a unique dataset that links the rich data surrounding mathematics teachers' practices collected by TALIS 2013 (Teacher and Learning International Survey) with the data collected by PISA 2012 (Programme for International Student Assessment) on the mathematics proficiency and non-cognitive skills of 15-year-old students, as well as information on their family and school background. Eight countries decided to participate in the TALIS-PISA link option of the TALIS 2013 study: Australia, Finland, Latvia, Mexico, Portugal, Romania, Singapore and Spain.

An important limitation of the study is that the link between the TALIS and the PISA surveys operates at the school level and not at the classroom level. This means that no direct relation can be drawn between a teacher and his/her students. What is measured by the aggregation of teacher or student individual data at the school level relates to a school's overall context and needs to be interpreted accordingly. Therefore, the reported analyses may be fairly conservative, to the extent that an association between teachers' practice aggregated at the school level and individual student outcomes might not be significant, while a teacher's practice might truly contribute to individual student outcomes.

Finally, it is important to take into account that this study was based on the findings of only eight countries and, thus, inferences regarding frequencies and associations to other national contexts should be made carefully. These findings should be considered as tentative correlations that should be explored further in larger scale studies.

What are the most common teaching strategies?

The analysis of mathematics teachers' classroom practices explored in the TALIS 2013 survey has highlighted the existence of three underlying teaching strategies referred to as active learning, cognitive activation and teacher-directed instruction.

Active learning strategies consist of promoting the engagement of students in their own learning. It typically includes practices such as group work, use of information and communication technology, or student self-assessment. Cognitive activation consists of practices capable of challenging students in order to motivate them and stimulate higher-order skills, such as critical thinking, problem solving and decision making. Teacher-directed instruction encompasses practices based on lecturing, memorisation and repetition, where the teacher is the main actor responsible for transmitting knowledge to receptive students.

Results show that teacher-directed instruction is the most frequently used strategy. This means that, across participating countries, the most common teaching practices by mathematics teachers include presenting a summary of the lesson content, stating the learning goals of the instruction, or asking short, fact-based questions.

A possible explanation for the widespread use of teacher-directed instruction is that this type of strategy is less time-consuming than active learning and cognitive activation and requires less commitment from disengaged students. At the same time, active learning and cognitive activation feed from more sophisticated practices than teacher-directed instruction.

Schools' teaching culture

Overall, teachers working in the same schools tend to adopt teaching approaches more similar to those of their colleagues than to those of teachers from different schools. Teachers collaborate, talk and discuss their teaching practices, so it should not be uncommon to observe that teachers from the same school "share" their practices. The effect of this "teaching culture" on classroom practices is observed for each teaching strategy. This has important implications for the design of induction and professional development programmes: these training initiatives need to take into consideration the contexts in which teachers work.

Since teachers within the same school seem to have teaching strategies that are more similar to those of their colleagues than to those of teachers from different schools, a school-embedded approach to professional development, i.e. participating in professional networks, participating in mentoring or coaching programmes and working with teachers to ensure common standards could, therefore, be recommended. Teachers that have been trained or gain experience in effective practice can engage with other teachers from their schools through these embedded professional development activities. School-embedded professional development can re-inforce professional development communities in the school and facilitate the "sharing" of effective practices. Thus, school leaders should seek to foster the collaboration of their staff in order to promote encourage and promote good teaching strategies.

Which teaching strategies are associated with better achievement?

The findings show that, overall, a frequent use of the cognitive activation strategy, which stimulates students' critical thinking, problem-solving and decision making, is associated with higher mathematics performances. This type of practice encourages students to solve problems in more than one way, explain their thinking on complex tasks and be innovative in their work. Active learning strategies also showed a positive association with mathematics achievement, but only in Mexico, Romania and Spain.

Does the relationship between teaching strategies and students' achievement vary according to the characteristics of the school, such as the composition of the student body? Overall, the contributions of the three teaching strategies to student mathematics performance seem more pronounced in socio-economically advantaged schools than in disadvantaged ones. For example, the positive association found between the cognitive activation strategy and student mathematics achievement is stronger in socio-economically advantaged schools than in disadvantaged ones. Results from previous TALIS and PISA studies have shown that resources are not equally distributed across schools with different socio-economic compositions. Thus, a possible explanation for why teaching strategies seem to have a more pronounced association in schools with socio-economically advantaged students is that teachers in those schools have access to a support structure, such as professional networks and occasional professional development that could help boost the effectiveness of these strategies. More research is needed to understand the enablers and limitations of teaching strategies across schools of different socio-economic composition.

What factors linked with active learning and cognitive activation strategies?

Cognitive activation and, to a lesser extent, active learning strategies had the strongest association with student achievement. In addition, these strategies are not as frequently used as teacher-directed strategies. Thus, it is important to understand which factors determine the adoption of these strategies.

Teacher self-efficacy is the only factor that is associated with a more frequent use of both strategies in *all* participating countries. A teacher needs to be confident in her/his capability to manage a classroom and deliver quality instruction in order to implement teaching practices. Also, in almost all participating counties, results show that the more a teacher co-operates with other teachers in the school, the more he or she tends to regularly use cognitive activation and active learning strategies. This suggests that exchanging ideas and experience about teaching with other teachers, observing each other's classrooms, or providing mutual support increases the likelihood of implementing these teaching strategies.

A disciplined climate in the classroom is also positively associated with a more regular use of cognitive activation in most countries. This type of strategy is usually time-consuming and demanding of student's attention and, thus, is less likely to be implemented in disruptive classrooms. Teachers holding constructivist beliefs about their role as a teacher, by putting the student at the centre of their learning, are also more likely to implement cognitive strategies.

Final policy recommendations

Teacher training and professional development can play an important role in the acquisition of teaching practices. Among other attributes, it is important that these training programmes build upon a school-embedded and context-sensitive approach, since the positive associations of these strategies with student outcomes varies depending on the school's and classroom's settings.

The findings of this report highlight a further key ingredient of policies that aim at increasing students' learning through improved teaching quality: the development and support of teacher co-operation. Thus, the promotion of professional learning communities that encourage teachers to work and teach jointly, exchange teaching materials with colleagues, engage in discussions about the learning development of their students, observe other teachers' classes and provide feedback are likely to foster the adoption of good and well-suited teaching strategies. Teachers who have participated in training in good classroom practices could work as mentors to other teachers and share their experience, since the results from the TALIS-PISA link data have shown there is a strong sharing of practices within schools. These initiatives cannot be carried if the teachers do not have a support structure providing orientation on their objectives and goals. Thus, principals and school leaders have a crucial role in developing and consolidating professional learning communities that foster teachers' co-operation, professional development and self-efficacy.

1. CONCEPTUALISING TEACHING STRATEGIES

Introduction

This report explores the relationships between mathematics teachers' teaching strategies and student learning outcomes: student performances, as well as student attitudes towards learning. First, the study seeks to understand the shaping of teaching strategies by examining the way teachers use different classroom practices and the prevalence of these strategies among teachers, across schools and countries. From this exploration, three teaching strategies are put forward: active learning, cognitive activation and teacher-directed instruction. Second, the report aims at identifying the teaching strategies that can positively contribute to student skill acquisition. Third and finally, it analyses the contributions of the school and the classroom settings, the teacher background and beliefs, to the implementation of the teaching strategies found to be positively related to student learning outcomes.

The TALIS-PISA link dataset presents itself as a unique platform for conducting this analysis. It combines the school, principal, teacher and student data from the Programme for International Student Assessment (PISA) 2012 and the Teaching and Learning International Survey (TALIS) 2013. By gathering an unprecedented amount of data from multiple education stakeholders and from various institutional levels (individual, classroom, school, country) in eight countries, this linked dataset is ideal for analysing the factors enabling and resulting from the use of teaching practices by mathematics teachers.

Background

Teachers are the most important school factor affecting student outcomes. Students who are exposed to a "good teacher" tend to perform significantly higher that students exposed to an "average teacher" (Rivkin, Hanushek and Kain, 2005). Also, students coming from a disadvantaged background benefit the most under effective teachers while reducing the achievement gap with students coming from more privileged backgrounds (Sanders and Rivers, 1996). Furthermore, the difference in teacher quality can have important consequences for a nation's economic growth (Hanushek and Woessmann, 2011). Investing in the development of teachers "…is vital for improving student achievement, and is perhaps the policy direction most likely to lead to substantial gains in school performance." (OECD, 2005: 27) Thus, it is necessary to identify the key areas for improving teacher quality.

This is no easy task, since there is no consensus about the exact characteristics, attributes, and practices that make a "good teacher" (Echazarra et al., 2016; OECD, 2005). Evidence showing the correlation between teaching attributes – such as a teacher's experience, certification and educational attainment – with student outcomes has been mixed (Akiba, LeTendre and Scribner et al., 2007; Goldhaber and Anthony, 2007; Rivkin, Hanushek and Kain, 2005).

A more promising area of exploration has been the study of what the teacher actually does in the classroom. Indeed, teachers' actions such as "…to convey ideas in clear and convincing ways; to create effective learning environments for different types of students; to foster productive teacher-student relationships; to be enthusiastic and creative; and to work effectively with colleagues and parents." (OECD, 2005: 27) could be crucial elements for student learning. The set of practices capable of improving student outcomes has been identified as "instructional quality" (Creemers and Kyriakides, 2008; Klieme, Pauli and Reusser, 2009; Kunter et al., 2013).

What can instructional quality achieve?

In *Teachers Matter: Attracting, Developing and Retaining Effective Teachers* (OECD, 2005), the OECD signalled the development of effective teaching strategies as one of the fundamental dimensions for the constitution of a quality teaching workforce. The report showed that, given the relevance of teaching strategies, a growing number of countries were developing standards and profiles of teachers modelled by instructional quality components. Annex C provides policy examples from the TALIS-PISA link countries.

The most recent International Summit on the Teaching Profession (ISTP) (Asia Society, 2016) echoed the importance given to instructional quality, by discussing the connections between pedagogical knowledge and the implementation of effective teaching strategies. During this meeting, government officials and union representatives from a myriad of different educational systems conveyed their view of what were considered the best practices to implement in the classroom.

The ISTP reached a consensus about the importance of not limiting the influence of instructional quality to just academic outcomes. Instead, teaching practices should foster what has been called “21st century competencies”. This name signals the necessary skills to be developed under “…the vastly changed context into which the current generation of students will graduate when they leave school.” (Asia Society 2016: 10-11) Thus, besides the development of the students’ cognitive skills, teachers’ practices should also foster socio-emotional skills, such as good intra-personal relationships, motivation, confidence and attitudes towards learning. Evidence has shown that the development of these socio-emotional components can have an important influence on educational attainment, employment and health status in adulthood (Almlund, 2011; Asia Society, 2016).

Although the relevance of instructional quality might be deeply ingrained in the policy debate, no action will be possible until policy makers are able to identify which are the areas necessary to invest in, in order to modify or improve teaching practices. The results of TALIS 2013 show that a high proportion of teachers need more “active” practices (OECD, 2014b). However, the most frequent practices reported by teachers are based on memorisation, repetition and practice. Results from PISA 2012 show that only one-third of the students are exposed to the type of teaching practices that could foster 21st century cognitive skills (Echazarra et al., 2016). Thus, there seems to be barriers to teachers fulfilling their instructional quality needs, and the necessary policy and school mechanisms to enable these types of practices seem to be missing.

The purpose of this report is not only to identify what works for improving the 21st century skills of students, but also to identify the key areas of investment in order to enable these practices.

Research and policy questions

For the eight countries that participated in the TALIS-PISA link option, the study first identifies mathematics teachers’ main teaching strategies based on teachers’ self-reported classroom practices. It then analyses the relationships between the frequency with which teachers adopt each of the teaching strategies and each key student outcomes (student mathematics achievement and attitudes towards mathematics and learning). While tackling these questions, attention is brought to cross-country differences in the relationships between teachers’ teaching strategies and students’ outcomes, as well as to school socio-economic composition, which is likely to moderate the identified these associations.

Finally, the report examines several factors that may enable the use of teaching strategies found to be positively correlated with student learning. Thus, the questions guiding this research are the following:

1. Teaching strategies: what are the most commons teaching strategies used by mathematics teachers and to what extent do they vary within and between schools?

2. Teaching strategies and student outcomes: how do teachers' teaching strategies contribute to student mathematics performances and their attitudes towards learning?

3. Factors associated with the use of teaching strategies: how do the school, the classroom and the teacher characteristics relate to the implementation of teaching strategies?

The TALIS-PISA link database

This report explores the relationships between the school context, classroom teaching practices, and students' outcomes using the TALIS-PISA link database. One of the options under the implementation of the Teaching and Learning International Survey (TALIS) in 2013 was to invite those countries and economies that participated in the OECD's 2012 Programme for International Student Assessment (PISA) to implement TALIS questionnaires in a sub-sample of schools that participated in PISA (OECD, 2014c) (see Box 1.1). The purpose was to give participants the option of linking relevant teacher-related factors (TALIS data) with student outcomes (PISA data).

TALIS provides substantial data regarding the background, beliefs and practices of lower secondary teachers from representative national samples. It is the largest international survey that focuses on the working conditions of teachers and the learning environment in their schools. TALIS aims to provide valid, timely and comparable information to help countries review and define policies for developing a high quality teaching profession. It is an opportunity for teachers and school leaders to provide input into educational policy analysis and development in key areas of their work.

PISA delivers insights into the family and school background, attitudes and cognitive and non-cognitive skills of 15-years-old students. It assesses to what extent children near the end of compulsory education have acquired the knowledge and skills needed in modern societies. PISA includes a survey of students that can be used as contextual information in TALIS. The survey collects rich information on students and schools, which can be translated into information about the important elements of a teacher's working environment.

TALIS offers data on several dimensions of teachers' and principals' work that contextualise and frame students' performance and their attitudes towards learning. Thus, the possibility of linking PISA with TALIS allows for the creation of a rich dataset where student, principal and teacher data across countries can be connected in several ways. For example, it allows for the establishment of relationships between teaching strategies and characteristics of the school, the students and the teachers themselves.

Another additional advantage of this dataset is its international component. Most of the studies surrounding instructional quality are done in one specific country with little possibility of exploring whether these findings also hold for other national contexts. The TALIS-PISA link has information on eight countries from four continents that allow policy makers and researchers to test whether the relationships put forward in specific national contexts hold in other countries.

In TALIS 2013, participating countries and economies had the option of applying TALIS questionnaires to a PISA 2012 sub-sample with the purpose of linking schools', teachers' and students' data (Box 1). Eight countries decided to take part in this option: Australia, Finland, Latvia, Mexico, Portugal, Romania, Singapore and Spain.

Box 1.1 The TALIS-PISA link

The design of the TALIS-PISA Link:

- Participating countries: Australia, Finland, Latvia, Mexico, Portugal, Romania, Singapore and Spain.
- International target population: Teachers in schools that participated in PISA 2012.
- Representative samples of schools, teachers, and 15-year-old students within schools with a target sample size of 150 schools per country, 1 school principal, 35 students and 20 teachers in each school, including all eligible mathematics teachers.
- Target response rates: 75% of the sampled schools, together with a 75% response rate from all sampled teachers in the country. A school is considered to have responded if 50% of sampled teachers responded.
- TALIS questionnaires for teachers and school principals, with a special, additional questionnaire for mathematics teachers (i.e. the mathematics module), were available on paper and on line.
- PISA questionnaires, including, in particular, student and school questionnaires, as well as student assessments in mathematics, reading and science.
- Survey windows:
  - For PISA 2012: March-May 2012 for countries in the northern hemisphere (Finland, Latvia, Mexico, Portugal, Romania, Spain) and May-August 2012 for countries in the southern hemisphere (Australia, Singapore).
  - For TALIS 2013: September-December 2012 for countries in the southern hemisphere and February-June 2013 for countries in the northern hemisphere.

Teachers and school principals were given the TALIS teacher and principal questionnaires, which require between 45 and 60 minutes to complete. Teachers answered questions about the teaching practices they used in their first class after 11 a.m. on the previous Tuesday. Sampled mathematics teachers were also given an additional short questionnaire asking them about the mathematics classes they teach. Mathematics teachers were asked in more detail about the teaching practices they used in this particular class and their beliefs about teaching and learning mathematics. Further details about the sample for all target populations and about the TALIS questionnaires can be found in the *TALIS 2013 Technical Report* (OECD, 2014b).

A proper examination of teachers' classroom practices and the school-, teacher- and student-level factors associated with their use requires careful selection of the teacher sample under study. Given that the administration of the TALIS teacher and principal questionnaires occurred several months after the administration of the PISA study (see Box 1.2), it was decided to restrict the teacher sample to teachers teaching in the participating school at the time of the PISA 2012 administration. In the analyses, teachers' self-reports about their background, practices and beliefs in 2013 are thus used as a proxy for teachers' self-reports about the same issues in 2012. This sample restriction also presents the advantage of retaining only teachers who have some experience teaching in the surveyed schools and discarding teachers who very recently started teaching in a school and who were still adjusting to a new school environment. This decision was based on evidence showing the strong association between teaching experience and student achievement and the weak relationship between new teachers and students' learning (Rockoff et al., 2008).

Box 1.2 Teacher sample used in this study

Teachers presenting the following characteristics were retained in the study sample:

- Teachers who were teaching in the school at the time of the PISA 2012 administration: i.e. having taught for at least a year in the surveyed school in the southern hemisphere countries and for at least two years in the northern hemisphere countries.
- Teachers teaching mathematics to 15-year-old students.
- Teachers whose target class falls into mathematics.
- Teachers who answered the teacher mathematics module.
- Teachers who responded to the 24 items about classroom practices considered for this study.

Across the eight participating countries, the resulting sample comprises 3 390 teachers from 1 111 schools.

In order to best examine the factors associated with the use of specific classroom practices, it is preferable to confine the analyses to one school subject, as teaching practices vary to a great extent across subjects. As mathematics is the major domain of the PISA 2012 assessment and consequently student performance measures are more accurate and reliable for mathematics than the other assessment domains, this report focuses on teachers teaching mathematics to PISA-eligible students. Box 1.2 lists all the selection criteria for the teacher sample used in the analyses presented in this report.

The specific survey design of the TALIS-PISA link data has important implications for the interpretation of the results presented in this report. First, as the link between the TALIS and the PISA surveys operates at the school level and not at the classroom level, TALIS individual teacher data cannot directly be linked to PISA individual student data. While analysing the data, two types of links can be established between the TALIS and PISA data:

- individual student data can be merged with TALIS data aggregated at the school level
- individual teacher data can be merged with PISA data aggregated at the school level.

This means that no direct relation can be drawn between a teacher and his/her students. Only the overall relationships between a teacher and a school's students or between a student and a school's teachers can be studied. What is measured by the aggregation of teacher or student individual data at the school level relates to a school's overall context and needs to be interpreted accordingly. This applies, in particular, to the study of teachers' teaching strategies, which are the focus of this report. Therefore, the reported analyses may be fairly conservative, to the extent that an association between teachers' practice aggregated at the school level and individual student outcomes might not be significant, while a teacher's practice might truly contribute to individual student outcomes.

Second, both the TALIS and the PISA studies are cross-sectional, i.e. they measure student, teacher and school characteristics in many countries, but at a single date. The absence of a longitudinal design prevents causal interpretation of the reported analyses being made. Also, understanding the conditions for educational quality is a complex phenomenon where teachers and their practice is one crucial component with a set of important factors associated with student achievement. Although the analysis takes into account additional factors, this does not mean that a causal interpretation is possible. All the results presented here are correlational and should be interpreted accordingly. The associations between teachers' teaching strategies and school-, teacher- and student-level factors highlighted in this report need to be cautiously interpreted and do not allow drawing any conclusions about teacher effectiveness.

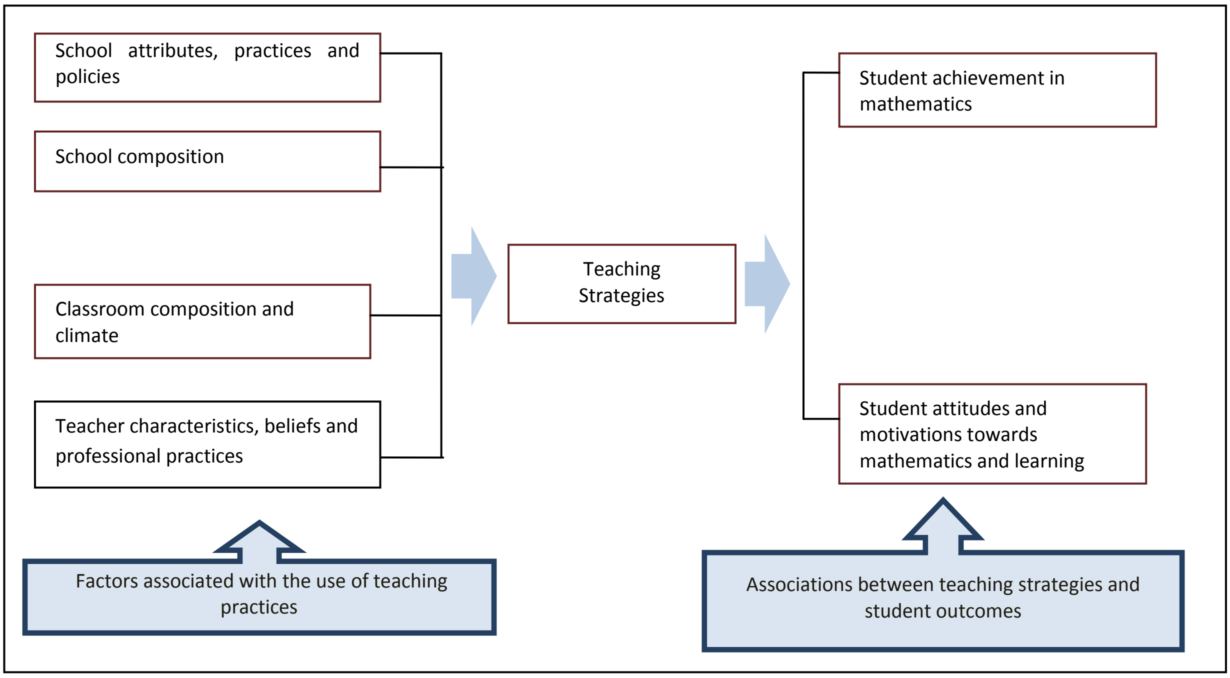
Student achievement is considered in this study as the overall performance of students in the PISA 2012 mathematics tests. Since it does not present detailed information on specific mathematics items, it consists of a rough estimate of the students' skills in mathematics. As such, the association of teaching strategy with the overall achievement of students in mathematics should be interpreted cautiously.[1]

Finally, it is important to consider that this study is based on the data of only eight countries. In previous TALIS and PISA studies, the possibility of having a pool of 30+ countries and economies allowed the identification of general trends concerning the frequency of practices and the association between school and student outcomes. In the case of this report, due to the limited sample of countries, care should be taken when considering the applicability to other national contexts of the results found in this study. As such, frequencies and associations are reported by country and not by international averages.

Conceptual framework

As previously mentioned in the research objectives, the report has the purpose of: 1) identifying teaching strategies; 2) exploring the association of teaching strategies with student outcomes and; 3) determining the factors associated with the use of teaching strategies. The conceptual framework has the task of articulating these research objectives by mapping and establishing the associations explored in this report.

Figure 1.1 Conceptual framework



1 . Previous research conducted with PISA data has been able to provide additional information by analysing the likelihood of the students to respond to mathematics items of different levels of difficulty (Echazarra et al., 2016).

Teaching strategies

School effectiveness studies have identified several layers associated with student outcomes, such as national/regional educational policies, educational environment, school policy, evaluation of school policy and instructional quality (Creemers and Kyriakides, 2008; Hattie, 2009). This last item, instructional quality, refers to the set of classroom strategies found to improve student outcomes. As such, the variables of interest – teaching strategies – can be observed at the centre of the conceptual framework.

There is a consensus in the research community that the teaching strategies embodying instructional quality are multidimensional and their efficiency depends on the context in which they are applied. In other words, there is no single teaching strategy that guaranties the improvement of educational outcomes. Instead, it is the combination of techniques and practices that seems to be the best approach for instructional quality (Hattie, 2009).

A series of meta-analysis reviews conducted over the years have been able to identify a group of practices that are constantly highlighted as effective approaches towards learning. Thus, practices such as strong classroom management, clarity of the instruction and learning, providing students with support, providing a meaningful engagement with the learning content and apply a formative style of assessment, have been identified as crucial practices for improving student learning (Creemers and Kyriakides, 2008; Hattie, 2009; Marzano, Pickering and Pollock, 2001; Seidel and Shavelson, 2007).

These meta-analyses informed the TALIS conceptual framework and item development. The TALIS study purposely incorporated a series of items covering a wide range of teaching practices. According to the framework of the 2013 cycle of the study, "…when teachers have opportunities to expand and develop their own teaching repertoires, they are more likely to provide an increased range of learning opportunities for students." (OECD, 2013b: 35).

Particularly helpful is the conceptualisation of instructional quality elaborated by Klieme, Pauli and Reusser (2009), identifying three "basic dimensions of instructional quality": cognitive activation, classroom management, and supportive climate. Cognitive action refers to those teaching practices that place "higher cognitive demands" on students with the purpose of engaging them in "co-constructive and reflective higher-level thinking" (Klieme, Pauli and Reusser, 2009: 140-141). These higher-order thinking practices involve thinking critically about content and relationship and applying it to problem-solving or decision making.

At the same time, supportive climate refers to practices aiming at providing student support and feedback in order to improve their learning efforts and motivation. As Klieme, Pauli and Reusser (2009) state, this dimension relates to "…supportive teacher-student relationships, positive and constructive teacher feedback, a positive approach to student errors and misconceptions, individual learner support and caring teacher behaviour." (p. 141). Finally, classroom management refers to the teacher's ability to construct an orderly classroom environment and provide clear instructions.

For the 2013 cycle of the TALIS study, formative assessment was also identified as key practice for instructional quality. Formative assessment is understood as evaluation that provides meaningful feedback and strong and tailored support to the students. Research has shown that these types of assessment can have important associations with student achievement, especially in mathematics (National Centre for Education Statistics, 2003).

Items reflecting all the teaching practices mentioned above were included in the TALIS 2013 teacher questionnaires. Section 2 will show the results of an exploratory factor analysis evidencing the teaching strategies behind these practices.

Relationships between teaching strategies and student outcomes

As can be observed in the mapping of Figure 1 and as discussed in previous sections, one of the purposes of the study is to explore the association between instructional quality and different sets of student outcomes, such as academic achievement, as well as students' interest in, attitude towards and confidence in mathematics.

Research exploring these associations has usually used two broad terms for signalling effective practices. Traditional or transmission strategies emphasise the inculcation of knowledge and skills through lectures, practice and repetition. Among other student-centred approaches, modern or constructivist approaches promote the development of a student's analytical and critical thought, reasoning process, self-inquiry, peer-collaboration, and problem-solving (Echazarra et al., 2016).

Each set of practices seems to be strongly associated with different learning tasks. Evidence shows that traditional practices, such as lecturing, have a positive association with repetitive tasks, while modern approaches are linked with the successful completion of high level problem-solving tasks (Bietenbeck, 2014; Echazarra et al., 2016). Analyses based on PISA 2012 showed that students exposed to cognitive activation strategies have higher odds of success for more difficult items, while being exposed to teacher-directed instruction moderately improves the odds of success on less difficult items.

The nature of the associations also seems to differ, depending on the characteristics of the student's population. Previous research has shown that students coming from disadvantaged backgrounds benefit more from teacher-directed instruction than students coming from advantaged backgrounds (Lavy, 2011; Scheerens, 1992; Slavin, 1996). Thus, when this association is explored in this report, the socio-economic composition of the school will also be taken into consideration.

Furthermore, teacher practices are not only related to students' cognitive outcomes, but also to student attitudes towards learning, motivation, absenteeism, suspensions and grades. Results from PISA 2012 show that, constructivist strategies, such as studying mathematics by "…seeking alternative solutions and making connection with prior knowledge and real-life experience…" (Echazarra et al., 2016: 81) are associated with positive attitudes of students towards mathematics (Echazarra et al., 2016). Thus, in order to incorporate how instructional quality is related to the development of socio-emotional characteristics, the report will explore the association of teaching strategies with students' interest in, attitude towards and confidence in mathematics.

Factors associated with the use of teaching strategies

Finally, Figure 1 shows that the intention is to identify those factors that are related to the implementation of instructional quality. As expressed earlier, this exploration is considered to be of vital importance for policy making, since it can highlight those elements more likely to influence teaching practices.

The overall effectiveness of teaching strategies largely depends on the context in which they are implemented. Indeed, the school socio-economic and socio-demographic composition, the school and classroom climate (Scheerens, 1992), the students' level of achievement (Echazarra et al., 2016), among other features, can play a crucial role in shaping these types of practices (Muijs et al., 2004).

In this study, four dimensions of the context that research has shown to influence teaching strategies have been identified. *School attributes, practices and policies* refer to the type of school administration (i.e. private or public) and policies that could affect teaching practices, such as ability grouping and the school's level of teacher autonomy. Dividing classrooms according to the academic ability of students has implications for teachers' planning and also for their practices. The level of decision making that a teacher can have in a school is associated with their job satisfaction and sense of self-efficacy, so it is relevant to explore how it is related to the implementation of teaching practices (Echazarra, et al., 2016).

The second contextual dimension, *school composition and climate,* acknowledges that the composition of the school's student body may relate to what teaching strategies are being implemented. Both the school and teacher might be likely to modify their teaching strategies due to the characteristics of the students that they have in front of them. School climate is a multidimensional concept concerning the relations between the school's stakeholders, student engagement towards learning and the overall institutional environment in a given school. Research has shown that school climate may have important implications for the implementation of teaching strategies (Thapa et al., 2013).

Classroom composition and climate takes into consideration the characteristics of the students in the classroom and the teacher's perception of the classroom disciplinary climate. Results from PISA 2012 have shown that an orderly class environment and positive teacher-student relationships are strongly correlated with both teacher-directed and cognitive activation practices (Echazarra et al., 2016).

Finally, the last dimension includes *teacher characteristics, beliefs and professional practices*. Undoubtedly, a teacher's background – e.g. their gender, experience or educational attainment – can influence teaching practices. However, their beliefs about what they consider are the best practices to improve students learning might also shape instructional quality (Pajares and Schunk, 2001; Richardson, 1996). "Professional practices" refer to the action that teachers take in order to improve the quality of their instruction. Teacher co-operation is a key element consisting of the engagement in discussion, collaboration and feedback with other teachers in the school, and evidence has shown its association with the development of teaching practices (Desimone, 2009).

Outline of the report

As mentioned previously, teachers' teaching approaches can vary considerably, depending on the context. Section 2 seeks to explore whether the 24 classroom practices analysed in this report can be grouped in different teaching strategies and observe how predominant these strategies are across the participating countries.

Empirical research has also shown that different types of practices can have different effects on students' outcomes, depending on the school setting. Section 3 examines the relationships between teachers' teaching strategies and two sets of student outcomes: student achievement in mathematics and student attitudes and motivation towards mathematics and learning. Furthermore, Section 3 explores how these relationships change depending on the school's socio-economic composition. In this section, TALIS variables, in particular teachers' teaching strategies, are aggregated at the school level to analyse PISA outcomes, i.e. student mathematics achievement and attitudes towards learning.

One of the aims of Section 3 is to identify which teaching strategies are positively related to student learning outcomes. Section 4 will then explore which school, classroom and teacher characteristics are related to the teaching approaches that show the strongest association with students' outcomes. In Section 4, PISA variables are aggregated at the school level to analyse the frequency with which promising teaching strategies are implemented by mathematics teachers.

Finally, Section 5 presents a summary of the main findings, discusses its policy implications and suggests recommendations for the promotion of teaching and learning best practices.

2. MATHEMATICS TEACHERS' TEACHING STRATEGIES

Introduction

This section seeks to describe mathematics teachers' classroom practices by identifying and describing the teaching strategies in the TALIS-PISA link dataset. On this basis, it then attempts to describe the prevalence of these teaching strategies across countries, and across schools within countries. Finally, it draws conclusions regarding the degree of similarity between teachers from the same schools in their teaching, i.e. about the existence and size of a "teaching culture" with regard to the way teachers teach mathematics.

Teaching practices in the TALIS-PISA link study

A distinctive characteristic of TALIS (Teaching and Learning International Survey) and consequently of the TALIS-PISA (Programme for International Student Assessment) link study is that it asks teachers about their use of a wide range of classroom practices that have been identified by the research literature as indicators of instructional quality (OECD, 2013b; for more information, see the conceptual framework in Section 1).

In TALIS 2013, teachers were asked several questions about their teaching and educational approaches. For this study, 24 practices, stemming from two questions included in the Teacher Questionnaire and one question from the Mathematics Module, were selected: they cover both instructional and assessment practices. The three questions ask teachers about their practices when they teach a particular class referred to as the "target class".[2] Box 2.1 presents the detailed description of each selected question with their corresponding items.

Box 2.1 TALIS questions and items about classroom practices

24 items were selected from the TALIS survey in order to explore teaching strategies. These items were extracted from two questions in the main TALIS Teacher Questionnaire and one from the TALIS Teacher Mathematics Module:

1. How often does each of the following happen in the <target class> throughout the school year? (TALIS Teacher Questionnaire)

   - I present a summary of recently learned content.
   - Students work in small groups to come up with a joint solution to a problem or task.
   - I give different work to the students who have difficulties learning and/or to those who can advance faster.
   - I refer to a problem from everyday life or work to demonstrate why new knowledge is useful.
   - I let students practice similar tasks until I know that every student has understood the subject matter.

2. Following sampling deliberation on how to identify a class that the teacher teaches, a "target class" is defined as the first class attended by 15-year-old students that teachers taught in the school year after 11 a.m. on the last Tuesday preceding the survey. For more information, see the *TALIS 2013 Technical Report* (2014).

Box 2.1 TALIS questions and items about classroom practices *(continued)*

- I check my students’ exercise books or homework.
- Students work on projects that require at least one week to complete.
- Students use ICT (information and communication technology) for projects or class work.

2. How often do you use the following methods of assessing student learning in the <target class>? (TALIS Teacher Questionnaire)

- I develop and administer my own assessment.
- I administer a standardised test.
- I have individual students answer questions in front of the class.
- I provide written feedback on student work in addition to a <mark, i.e. numeric score or letter grade>.
- I let students evaluate their own progress.
- I observe students when working on particular tasks and provide immediate feedback.

3. How often do you employ the following teaching practices in the <target class>? (TALIS Mathematics Module)

- I explicitly state learning goals.
- I ask short, fact-based questions.
- I expect students to explain their thinking on complex problems.

I give students a choice of problems to solve.

- I connect mathematics concepts I teach to uses of those concepts outside of school.
- I encourage students to solve problems in more than one way.
- I require students to provide written explanations of how they solve problems.
- I require students to work on mathematics projects that take more than a single class period to complete.
- I go over homework problems that students were not able to solve.
- I encourage students to work together to solve problems.

All 24 items measure how frequently teachers use a particular practice. Frequency is measured through four ordered response options: “Never or almost never”, “Occasionally”, “Frequently “and “In all or nearly all lessons”.

Identification of teachers' teaching strategies

Purpose and method

A practice item by itself can only show a limited picture of a mathematics teacher's overall teaching approach. Instructional quality is a complex and multidimensional process that involves the implementation of a diverse range of practices. Thus, the first objective is to identify the possible teaching strategies underlying the more or less frequent uses of each of these 24 practices.

In order to identify teachers' underlying teaching strategies, an exploratory factor analysis (EFA) was conducted, with the purpose of investigating the possible underlying structure of a set of 24 classroom practices (see Annex A for further detail). EFA could be described as orderly simplification of interrelated practices. It is used here to explore the possible underlying structure of a set of 24 interrelated practices without imposing any preconceived structure on the outcome. It thus groups the practices into a reduced number of sub-groups, which each one relating to a single underlying (i.e. latent) factor. Several criteria are considered in order to identify and select the appropriate number of latent factors and the set of items retained to define each extracted factor. For this study, three latent factors explaining more than the 10% of the total variance in teachers' teaching practices were extracted. Each of these latent factors shows good statistical reliability in each of the participating countries; this means that these factors make sense in each of the national contexts (see Table A.1. in Annex A). The analysis was carried out on a restricted sample of mathematics teachers (see Box 1.2 in Section 1 for more details).

Three underlying teaching strategies

Three underlying strategies were selected out of the 24 classroom practices analysed by means of the EFA. Box 2.2 lists the practices that contribute the most to each latent construct or teaching strategy, based on the EFA results. In order to conceptually interpret each of the three latent groups, existing classifications of teaching strategies derived from TALIS data are particularly insightful. The interpretation of the three constructs is partially informed by previous studies (Echazarra et al., 2016) and yields to the identification of three underlying teaching strategies referred to as active learning, cognitive activation and teacher-directed instruction.

Box 2.2 TALIS-PISA link: Three teaching strategies[1]

Items retained to define the first underlying teaching strategy: active learning

- Students work on projects that require at least one week to complete.
- Students use ICT (information and communication technology) for projects or class work.
- I require students to work on mathematics projects that take more than a single class period to complete.
- I let students evaluate their own progress.
- Students work in small groups to come up with a joint solution to a problem or task.

Items retained to define the second underlying teaching strategy: cognitive activation

- I expect students to explain their thinking on complex problems.

Box 2.2 TALIS-PISA link: Three teaching strategies *(continued)*

- I encourage students to solve problems in more than one way.
- I require students to provide written explanations of how they solve problems.
- I encourage students to work together to solve problems.
- I connect mathematics concepts I teach to uses of those concepts outside of school.
- I go over homework problems that students were not able to solve.

Items retained to define the third teaching strategy: teacher-directed instruction

- I explicitly state learning goals.
- I let students practice similar tasks until I know that every student has understood the subject matter.
- I observe students when working on particular tasks and provide immediate feedback.
- I ask short, fact-based questions.
- I present a summary of recently learned content.
- I give different work to the students who have difficulties learning and/or to those who can advance faster.
- I refer to a problem from everyday life or work to demonstrate why new knowledge is useful.

1. In 2016, the OECD published a working paper focusing on teaching strategies and their association with students' achievement in mathematics. The research draws on data from the PISA 2012 and the TALIS-PISA link database and presents a classification of practices similar to the one presented in Box 2.2. However, it is important to state that the Echazarra et al. (2016) study used students' responses, while the present study is based on teachers' responses. Furthermore, Echazarra et al. uses a conceptual approach for defining the items in each teaching strategy, while this study used an empirical approach based on an EFA. Despite these differences in classification and approaches, the studies share common results. Please see Box 3.2 in Echazarra et al., (2016) to see the difference in the classification of practices.

Active learning

Active learning consists of promoting the engagement of students in their own learning. Under this strategy, students' discussions, group work, co-operation, reflection and the necessary support to foster these activities plays a central role (Adesope and Nesbit, 2013; Orlich et al., 2013). Furthermore, the inclusion and use of information and communication technologies (ICT) in the classroom can help to foster an interactive and individual learning environment. Evidence has shown that the implementation of these types of practice might lead to an improvement on student learning (Dunlosky et al., 2013; Johnson and Johnson, 2009). However, results from TALIS 2013 showed that mathematics teachers in particular use active learning practices less often than teachers from other disciplines (Austin et al., 2015).

Cognitive activation

Cognitive activation refers to the use of practices capable of challenging students in order to motivate them and stimulate higher-order skills, such as critical thinking, problem solving and decision making. This type of practice not only encourages students to find creative and alternative ways to solve problems, but enables them to communicate their thinking processes and results with their peers and teachers. Results from PISA 2012, show that cognitive activation practices has a positive association with student achievement in mathematics across the OECD countries (Echazarra et al., 2016). More specifically, students exposed to cognitive activation strategies have higher odds of success for more difficult items in the PISA mathematics test.

Teacher-directed instruction

Teacher-directed instruction refers to teaching practices that rely, to a great extent, on a teacher's ability to deliver orderly and clear lessons. Making explicit the learning goals, providing a summary of previous lessons or asking short fact-based questions are examples of practices that help to structure lessons. According to TALIS 2013, teacher-directed instruction is the strategy that is the most used by teachers across participating countries and economies (TALIS 2014b). In addition, students exposed to this type of strategy are more likely to succeed in less difficult items on the PISA mathematics tests (Echazarra et al., 2016). This could be explained by the fact that teacher-directed instruction is associated with accumulation of knowledge and resolving routine problems (Bientenbeck, 2014).

Three indices were derived from the three teaching strategies identified above. Each index is computed as the simple mean of the practice items that are key contributors to the corresponding teaching strategy. Each practice item and, consequently by construction, each index, is measured on a scale ranging from 1 ("never or almost never") to 4 ("in all or nearly all lessons"). Higher values for an index therefore denote higher frequencies at which teachers use a teaching strategy and its corresponding practices.

Prevalence of the teaching strategies across and within countries

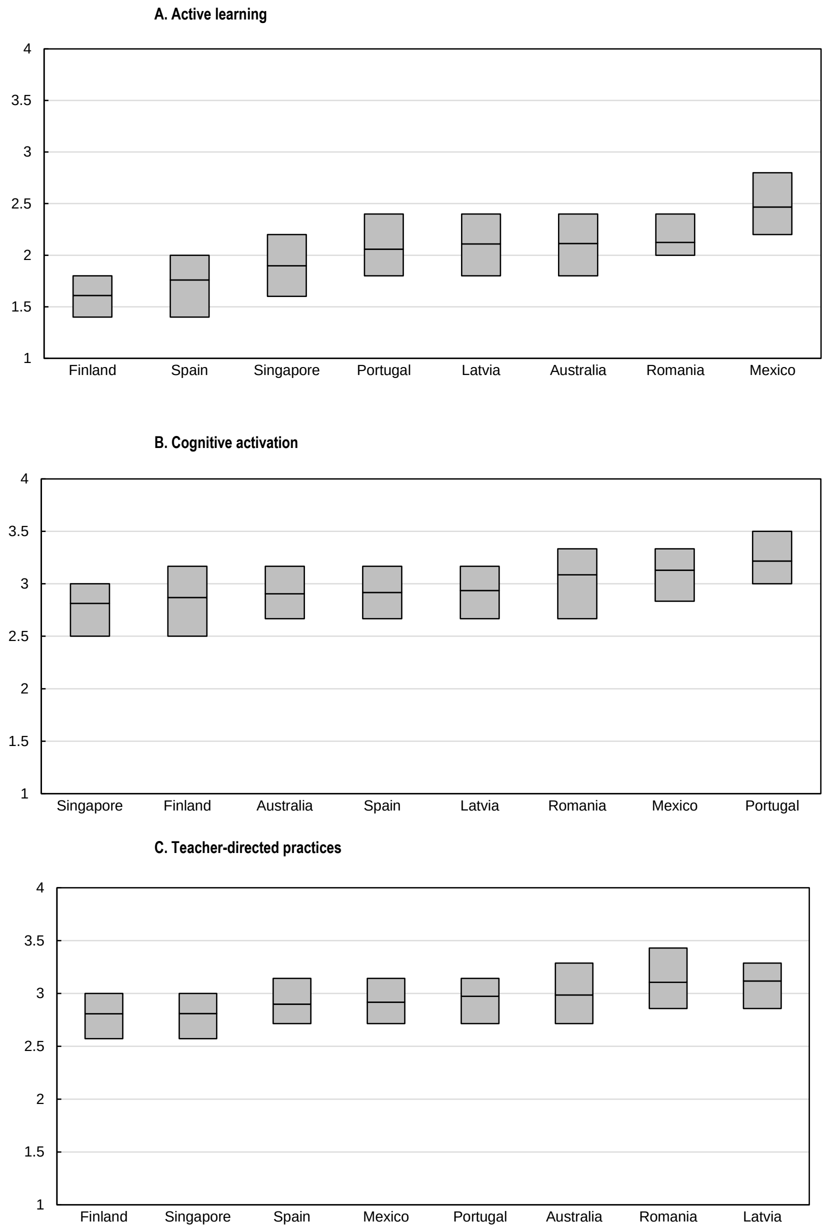
Now that the three teaching strategies explored in this report have been defined, the prevalence of these strategies within and between countries can be examined. With which frequency do teachers use each of the identified strategies? Are some strategies more common than others? Do teachers of the same schools tend to teach alike? Do the answers to these questions vary across countries? These are the few questions that the remaining of this section intends to address.

Figure 2.1, below, shows the prevalence and distribution of each teaching strategy in each participating country. It indicates the average frequency with which mathematics teachers use a given approach (the horizontal line inside a grey box). It also shows the differences between users in the frequency of use of the strategy.

This figure shows that, in every country, the active learning strategy is, on average, less often used than the other two teaching strategies (cognitive activation and teacher-directed instruction). Indeed, while most mathematics teachers report that they use active learning practices only occasionally (which corresponds to a value of 2 on the y-axis), they usually report using cognitive activation and teacher-directed practices frequently (which corresponds to a value of 3).

Figure 2.1 Frequency with which teachers use active learning, cognitive activation and teacher-directed instruction strategies

Scale from 1 to 4, where 1 represents "never or almost never" and 4 "in all or nearly all lessons"



Countries are ranked in ascending order of the average frequency with which mathematics teachers use the teaching strategy of interest.

Note: The line inside a grey box denotes the average frequency with which mathematics teachers use a given teaching strategy in a given country. The top of a grey box represents the frequency with which a teacher located at the third quartile of the distribution uses a teaching strategy. The bottom of a grey box represents the frequency with which a teacher located at the first quartile of the distribution uses a teaching strategy.

Sources: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database,* www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013a), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Cross-country differences are more pronounced when looking at the use of active learning than at the other two teaching strategies. Teachers declare using the active learning strategy more regularly in Mexico than in Finland or Spain. While the cognitive activation strategy is widely adopted by teachers in all participating countries, but it is more frequently used in Portugal, Mexico and Romania. A previous study looking at PISA students report on classroom practices, also found that comparatively Singapore and Finland are the countries with the lowest frequency use of cognitive active strategies (Echazarra et al., 2016) Teacher-directed instruction is also a widespread teaching strategy among teachers in every country. This strategy is also the most common practice across all the countries and economies participating in PISA 2012 when looking at student data (Echazarra et al., 2016: 43). It can also be seen in Figure 2.1 that, within countries, teachers do not differ substantially in the degree to which they implement this teaching strategy (the grey boxes in panel C of Figure 2.1 are less extended than in the other two panels). Practices such as stating learning goals, presenting a summary or asking short, fact-based questions can be considered common initiatives adopted by teachers regardless of their country of origin, which would explain the small between-country variance in teacher-directed strategies.

An interesting finding is that teachers in high achieving educational systems, such as Singapore and Finland, engage in these types of strategies much less often than teachers from other countries participating in the study. The same result is observed by looking at most of the practices under each teaching strategy (Annex D). Although much more study is needed to explain this situation, there is a potential hypothesis. Due to the self-reporting nature of the TALIS survey, teachers may tend to over- or understate their engagement in particular teaching practices based on a notion of social-desirability. In other words, teachers may tend to answer following cultural patterns of what is desirable or expected of them. Nevertheless, a deeper exploration of this issue is needed to understand this scenario.

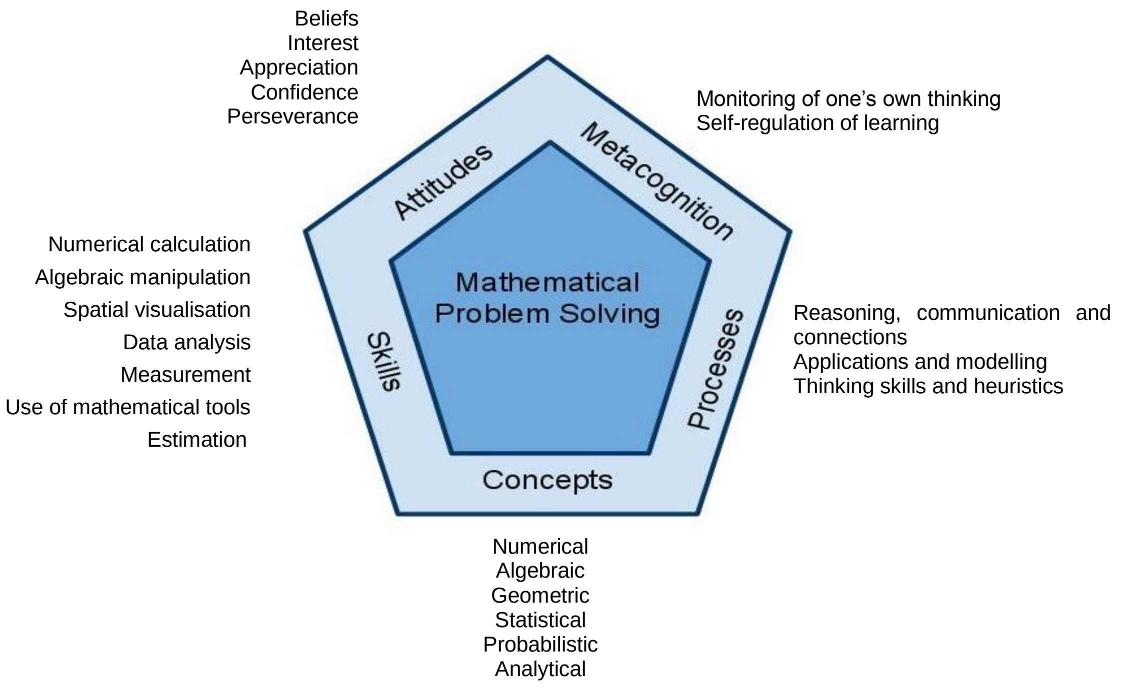
Thus, do teachers tend to employ one strategy exclusively, or a combination of the three identified strategies? It is important to keep in mind that these teaching strategies are not mutually exclusive; a teacher can present a summary of recent learned content (teacher directed-strategies), encourage students to work in small groups to come up with a joint solution to a problem or task (active learning strategies) and expect students to explain their thinking on complex problems (cognitive-activations strategies) with different frequencies.

The correlations between the frequency with which teachers use each of these teaching strategies are significantly positive, but moderate: across all countries, the linear correlation coefficients between the pairs of teaching strategies range from 0.30 to 0.56 (see Table B.1, Annex B). For most of the countries, the lowest correlations observed are between the use of active learning and that of teacher-directed instruction (most of the linear correlation coefficients are below 0.40), while the highest correlations observed are between the use of cognitive activation and teacher-directed instruction (most of the linear correlation coefficients are above 0.40). The correlation between the use of cognitive activation and teacher-directed instruction was also observed in the student data (Echazarra et al., 2016: 48). The stronger association found between cognitive activation and teacher-directed strategies may be explained by the need to have an orderly learning environment in order for a teacher to implement more challenging and advanced teaching strategies (Wolfolk, 2010). As Echazarra et al., (2016) explains, there is a "…compatibility of well-structured practices with demanding and thoughtful questions posed to students." (p. 48). Box 2.3 shows how the mathematics curriculum in Singapore promotes a myriad of good teaching practices.

Box 2.3 Teaching and learning strategies for mathematics in Singapore

The objective of the mathematics curriculum in Singapore is to develop students' ability to apply mathematics to solve problems by developing their mathematics skills, helping them acquire key mathematics concepts, fostering positive attitudes towards mathematics and encouraging them to think about the way they learn. To accomplish this objective, teachers use a variety of teaching strategies in their approach to mathematics. Teachers typically provide a real-world context that demonstrates the importance of mathematical concepts to students (thereby answering the all-too-common question: "Why do I have to learn this?"). Teachers then explain the concepts, demonstrate problem-solving approaches, and facilitate activities in class. They use various assessment practices to provide students with individualised feedback on their learning.

Singapore mathematics curriculum framework



Students are also exposed to a wide range of problems to solve during their study of mathematics. In this way, students learn to apply mathematics to solve problems, appreciate the value of mathematics, and develop important skills that will support their future learning and their ability to deal with new problems.

Source: OECD (2016a), *Ten Questions for Mathematics Teachers… and How PISA Can Help Answer Them*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264265387-en.

Active learning seems to be both a less common strategy and, when it is used, a more exclusive strategy. Since this strategy consists of a set of practices aiming at supporting students' learning, its disconnection with other strategies could be a source of concern. Particularly, what these results might be hinting, is that when teachers focus more often on presenting clear learning objectives (teacher-directed instruction) there may be fewer opportunities for attention to individual student needs (active learning).

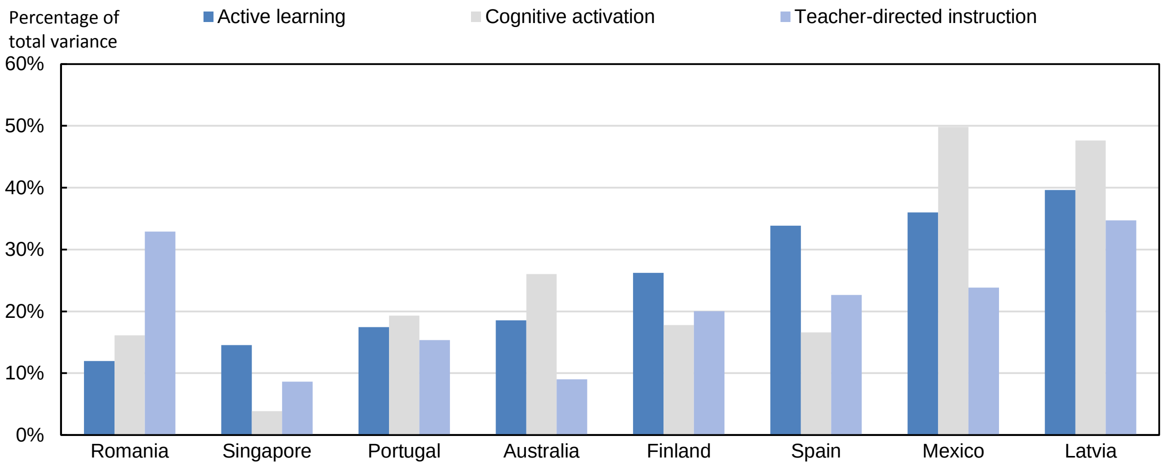
For more detailed information about the distribution of each strategy and practice, please the teaching strategies country profiles in Annex D.

Teachers' teaching strategies: Is there a school "teaching culture"?

There are some substantial differences across and within countries in the frequency with which teachers adopt one or other of the teaching strategies. How do teachers' teaching practices vary within and between schools? If the between-school variation of teaching strategies is high, this might indicate that there are school related factors – such as policies, practices or a particular learning environment – that encourage the implementation of these strategies. On the other hand, if the between-school variation is low, this could mean that teacher attributes – such as demographic characteristics, credentials – are the most likely source encouraging the implementation of certain types of strategies. This between-school variation would indicate that teachers in the same school approach learning in the same way, thus fostering a school "teaching culture" (Echazarra et al., 2016). This question has important implications for policy discussion, since it identifies at which level (school or teacher) to invest in order to change teaching practices.

To address this issue, the total variation in teachers' use of each teaching strategy has been broken down into two components, for each country: the variation between teachers within schools and the variation (within-school variation) between the average teachers of each school (between-school variation). The second component, also referred to as "between-school variance", provides information on the degree of similarity between teachers of the same schools with regard to their teaching. Figure 2.2 shows the between-school variation in teachers' use of each teaching strategy, expressed as a percentage of the total variation in teachers' use of each teaching strategy (also known as the intra-class correlation coefficient).

Figure 2.2 Between-school variations in teachers' use of teaching strategies



Countries are ranked in ascending order of the intra-class correlation coefficient estimated for active learning.

Note: the reported intra-class correlation coefficients measure the percentage of total variance in the frequency with which teachers use a teacher strategy that lies between schools in a given country.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013a), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Do teachers from the same school tend to have more similarity in their teaching practices than teachers in different schools? Overall, across countries, teachers from the same schools tend to use the active learning strategy with similar frequency levels than teachers from different schools (see Figure 2.2). The existence of a school effect with respect to active learning is indeed confirmed for all but two out of the eight participating countries – Romania and Singapore (where the estimated intra-class correlation coefficients account respectively for 12% and 15% of the total variance, but are not statistically significant). The size of the school effect varies across countries: it is rather moderate in Portugal, Australia and Finland and stronger in Latvia, Mexico and Spain, where the between-school variation in teachers' use of active learning accounts for more than 30% of the total variance.

Figure 2.2 also confirms the tendency for teachers from the same schools to use cognitive activation practices with a more similar frequency than teachers from different schools. This school effect is significant in all participating countries except Singapore. It is particularly strong in Mexico and Latvia, where the intra-class correlation coefficients amount to more than 40% of the total variance in teachers' use of cognitive activation.

Finally, Figure 2.2 also shows that, in general, teachers from the same school tend to employ teacher-directed practices at a more similar pace than teachers from different schools. However, there are some cross-country variations in the degree of similarity between teachers from the same school in their use of teacher-directed strategy. While in Singapore and Australia the school effect with regard to teacher-directed instruction is not significant (the intra-class correlation coefficients account for 9% of the total variance, but are not statistically significant), it is significant and moderate in most other countries. For more detail on the between school variance, see Annex B (Table B.2).

To summarise, teachers from the same school tend to adopt more similar teaching approaches than teachers from different schools. But, overall, there are substantial cross-country differences in the size of these "school effects". Latvia and Mexico are the countries where the degree of similarity between teachers of the same school is the strongest, while Singapore is the only country where no school effect has been identified with regard to any teaching strategy. This might indicate that, in Singapore, the implementation of teaching strategies does not rely heavily on the school, but on other teacher- or classroom-level factors.

Echazarra et al. (2016, p. 16) examined the between-school variation of similar teaching strategies, but from the perspective of students. The authors found variation levels similar to the ones calculated from teacher responses. In other words, teaching strategies as reported by students are more similar within a school than between schools. Like the discussion in this report of the "school effect", Echazarra et al. argue that these results are indicative of a "teaching culture" that predominates the school.

These findings have some implications for the type of policies to design when targeting teachers' teaching practices. Since there is an important school effect in some countries, policies targeting schools, such as school-embedded professional development activities, would likely be well-suited to changing teachers' teaching methods in these countries. The professional development opportunities that pull teachers away from their context and isolate the teacher from his or her school colleagues may not have an extended impact on the teaching strategies. On the contrary, professional development involving participation in learning communities, co-operation and peer observation has been reported by teachers to have a positive impact on their practice (Opfer, 2016). Systems that require teachers to carry out their professional development outside of the school could ask teachers to participate in mentoring programmes in order to effectively share what they learn with their colleagues and, in this way, support professional development communities.

These types of initiatives would require a support structure in the school. A recent OECD report (OECD, 2016b) showed that instructional leadership can foster professional networks and teacher co-operation that enables teachers to share and discuss their practice. Furthermore, instructional-oriented school leadership has been shown to be a crucial factor in fostering professional networks and teacher co-operation. As such, within this support structure, the principal or school leader role is a crucial component.

3. TEACHERS' TEACHING STRATEGIES AND STUDENT LEARNING AND ATTITUDES

Section 2 identified and described a set of three teaching strategies – active learning, cognitive activation and teacher-directed instruction – variably adopted by teachers from the eight countries that participated in this study. Section 3 aims to analyse to what extent and how these different teaching strategies contribute to student achievement and attitudes towards learning.

Background

Research seeking to identify which elements of classroom teaching practices are related to student performance is vast (Hattie, 2009; Marzano, Pickering and Pollock, 2001; Wayne and Youngs, 2003). For example, using primary and middle school data from Israel, Lavy (2011) found strong evidence that two important elements of teaching cause student achievement to improve: teaching practices emphasising the instilment of knowledge and comprehension, and the endowment of analytical and critical skills, also referred as typical elements of "modern" teaching. However, not all elements of "modern" teaching are found to be associated with an improvement of student performance: the instilment of the capacity for individual study, as well as transparency, fairness and proper feedback in teacher behaviour towards their students, are elements that are not significantly, or only slightly positively related to student learning gain.

On an international scale, Echazarra et al. (2016) studied the relationship between student performance at the PISA mathematics test and exposure to specific teaching approaches. They found that, on average across OECD countries, lower-performing students in mathematics are more frequently exposed to practices pertaining to student-oriented, formative assessment, and teacher-directed instruction, while higher-achieving students reported being more often exposed to cognitive-activation instruction.

Another body of research has shown that different teaching practices contribute to the development of different skills. Based on the TIMSS data, Bietenbeck (2014) showed that traditional teaching practices increase student factual knowledge and competency in solving routine problems, but have no significant effect on reasoning skills. Modern teaching practices have the exact opposite effects: they foster reasoning skills.

Some studies have also analysed the relationship between teaching practices and student non-cognitive outcomes, such as effort to achieve, quality of relationships, psychological health, or social capital. For example, Algan, Cahuc and Shleifer (2011) found that teaching practices, such as having the students copy from the board versus working on projects together, are strongly related to various dimensions of social capital, ranging from beliefs about co-operation with each other and with teachers to involvement in civic life.

Overall, there is some evidence that many teaching practices play a role in and outside the classroom. The set of practices capable of improving student outcomes has been identified as "instructional quality" (Creemers and Kyriakides, 2008; Klieme, Pauli and Reusser, 2009; Kunter et al., 2013). They are also found to be bound to the context, particularly the school setting, in which they are implemented (Chang and Lee, 2010; Johnson and Johnson, 2009; Parsons, Dodman and Burrowbridge, 2013; Prince, 2004; Schmidt et al., 2009).

Research and policy questions

In light of the extant body of research, the analyses presented in this section examine the contribution of teachers' teaching strategies – active learning, cognitive activation and teacher-directed instruction – to student mathematics achievement and attitudes towards learning in an effort to assess if these strategies can be considered within the set of instructional quality. Are the different teaching strategies differently related to student mathematics performance? Are they associated with student interest, beliefs, attitudes towards mathematics and school?

While tackling these questions, attention will be brought to cross-country differences in the relationships between teachers' teaching strategies and student outcomes, as well as to contextual factors that are likely to moderate the identified relations.

Analytical and methodological approach

For each country, using the TALIS-PISA link dataset, a two-level regression model (schools, students) is estimated to test the relationship between a student outcome variable and teachers' use of each of the three teaching strategies identified in Section 2 – active learning, cognitive activation and teacher-directed instruction. The regression model is fitted on each student outcome of interest – student mathematics performance at the PISA test and two attitude variables derived from the PISA Student Questionnaire.

As explained in Section 1, a limitation of the design of the TALIS-PISA link dataset is that it does not allow testing the relationship between a student's outcome and a teacher's teaching strategies; it only allows for connecting the student's outcome and the typical teaching strategies of the mathematics teachers in a school.

A set of control variables – known to be correlated with student academic performance and/or teachers' classroom practices (Echazarra et al., 2016) – is also introduced in order to estimate the relationship between teachers' teaching strategies and student outcomes, net of their relationship with other key factors. Box 3.1 details the list of control variables introduced in the model. Technical details about the two-level model can be found in Annex A and the regression tables can be found in Annex B (Tables B.4, B.5, B.6, B.7 and B.8).

Box 3.1 Control variables included in the regression model estimating the relationship between teaching strategies and student outcomes

In addition to the three key explanatory variables of teaching strategies, a set of control variables is introduced in the model. The first subset of controls includes student-level variables known to be correlated with student learning outcomes: student index of economic, social and cultural status (ESCS), and student gender and immigration background. School-level variables drawn from the PISA dataset are also added: school sector, school practices regarding student ability grouping and school socio-economic composition measured as the mean value of the student ESCS index in the school. Two school-level variables derived from TALIS data are also included: the mean values of the indices of teacher co-operation and teacher constructivist beliefs (both indices are averaged across the mathematics teachers of a school). When the dependent variable of the model is a student non-cognitive outcome, student mathematics performance is added as an additional control variable.

How teachers' teaching strategies are measured

It is of interest to test the relationship between a student learning outcome and teachers' use of specific teaching strategies. While the outcome variable varies depending on the focus of the analyses (mathematics performance, attitude towards learning, etc.), it is systematically measured at the student level and derived from the PISA Student Questionnaire. As TALIS and PISA data can only be linked at the school level, teacher data derived from TALIS need to be aggregated in some way at the school level to be merged with student and school PISA data. Therefore each index of teaching strategy (presented in Box 2.2, Section 2) is averaged at the school level to be linked to individual student outcomes. More specifically, the three following variables are introduced in the regression of student outcomes:

- teacher index of active learning averaged across the school's mathematics teachers
- teacher index of cognitive activation averaged across the school's mathematics teachers
- teacher index of teacher-directed instruction averaged across the school's mathematics teachers.

Each of these variables provides information regarding the average frequency with which mathematics teachers of the same school engage in a given teaching strategy. The implications these measures have for the interpretation of the results are presented in Annex A.

Finally, as previously stated in Section 1, due to the limited set of countries included in this analysis, it is not possible to identify worldwide general trends. Thus, the findings of this report should be interpreted carefully. Frequency and associations are reported by country.

Teaching strategies and student achievement and attitudes

How teachers' teaching strategies contribute to student mathematics performances?

Focus is first on the relationships between teachers' teaching strategies and student mathematics performances. Figure 3.1 shows the estimated associations between each teaching strategy and student mathematics scores by country.

The relationship between the use of an active learning strategy and student mathematics performance presents a mixed pattern across countries. In other words, a frequent use of active learning practices, such as having students work on week-long projects, use ICT for projects or class work, work in small groups, or evaluate their own progress, is positively related to student mathematics skills in Mexico, Romania and Spain, but negatively in Australia and Portugal. Since active learning practices consist mainly of supporting student learning, it is possible that in Australia and Portugal these practices are more often used in schools with high concentrations of low-performing students, which would explain the negative association with performance. In Finland, Latvia and Singapore, active learning does not significantly contribute to student performance. The mixed results found for the use of active learning are consistent with the findings of other studies (e.g. Echazarra et al., 2016).

There is a positive association between the use of cognitive activation and student performance in six out of eight countries and it is strong and significant in four of them – in Australia, Latvia, Portugal and Romania. This suggests that practices involving students' reflection on problems, various ways of solving them, and connecting problems to real-life situations can positively contribute to student skill acquisition in mathematics.

Conversely, teacher-directed instruction is found to be non-significant or negatively related to student mathematics performance, with a moderate but significant association in four countries – Australia, Portugal, Romania and Spain. A possible explanation for this result is that teachers tend to use this teaching strategy even more often when they teach low-performing students (Echazarra et al., 2016). At the same time, the association of teacher-directed instruction is not significant for Finland, Latvia, Mexico and

Singapore. However, judgement should not be rushed on the use of teacher-directed practice, as using overall student achievement in mathematics can be a rough estimation of student performance in mathematics. In fact, Echazarra et al. (2016) breakdown mathematics achievement by the likelihood of students responding correctly to mathematics items of different difficulty. Results showed that students exposed to teacher-directed practices were more likely to answer easy mathematics items. Please see Box 3.2 for a discussion on this topic.

Despite some trends across the eight countries, results showed that, depending on the country, each teaching strategy presents mixed results regarding their association with students' maths achievement. What could be the explanation for this? A preliminary response concerns the limitation of a self-reporting survey. Although teachers' attest to the frequency with which they engage in a particular practice, the TALIS-PISA link study does not have data on "how" teachers engage in these practices. For example, Latvian teachers organising students in small groups may be doing it a different way than Australian teachers would, but teachers from both of these countries report a similar degree of engagement (see Annex D). This study is lacking the data that only capturing practices through classroom observations could allow and could explain why, depending on the context, the same type of practices have different outcomes.

Box 3.2 Understanding the role of teacher-directed practices on students' learning: A dialogue between PISA and TALIS

The recent PISA publication *Ten Questions for Mathematics Teachers ... and How PISA Can Help Answer Them* (2016) explores the association of "teacher-directed" practices, as identified by student accounts, with the likelihood of correctly answering mathematics items of different ranges of difficulty. The results show that students exposed to teacher-directed instruction are more likely to solve the easiest mathematics problems in PISA. However, as the difficulty of the item increases, this association becomes non-significant. Although the overall association is moderate, the evidence suggests that teacher-directed strategies seem to be more conducive to solving easier tasks than more complex ones.

The report also looks at the overall association between cognitive activation practices, as identified by student accounts, and mathematics achievement. Similarly to the results presented in this paper, the results show that cognitive activation practices are positively associated with student performance.

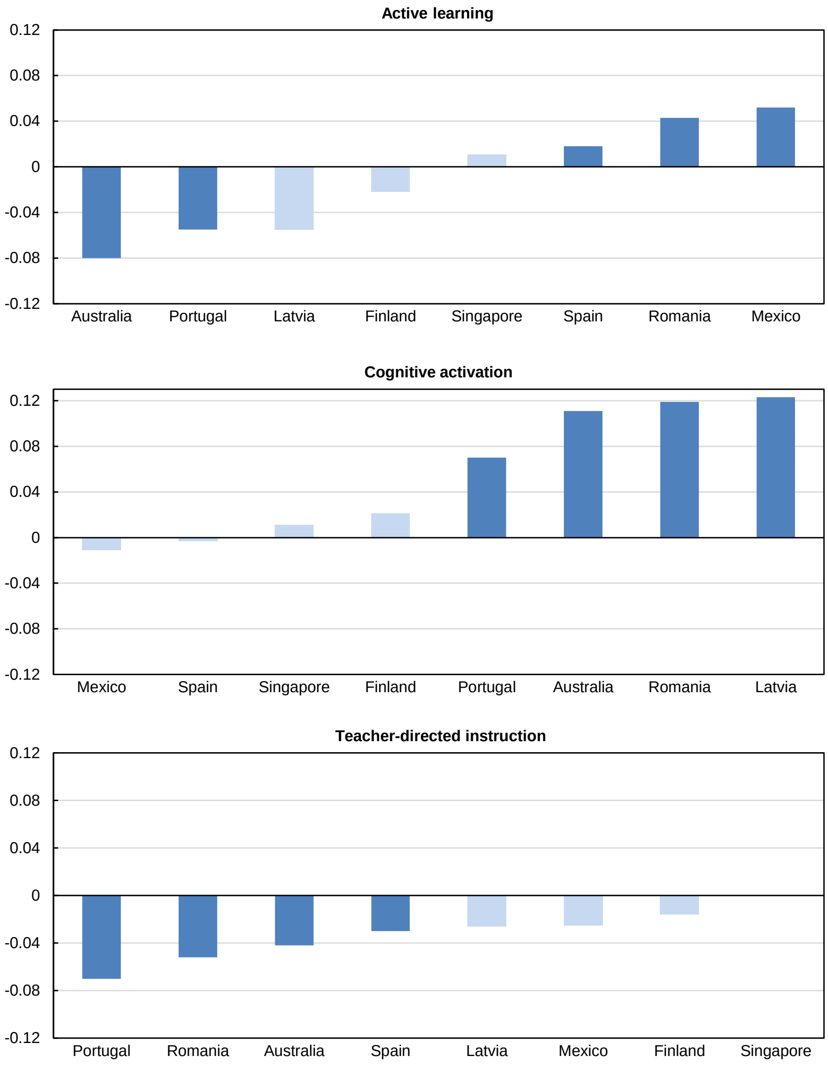
Thus, teacher-directed strategies can help students succeed on easier tasks, but they may not be the most promising strategy in the long run to prepare students for more complex tasks and to raise performance across the board.

Source: OECD (2016), *Ten Questions for Mathematics Teachers… and How PISA Can Help Answer Them*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264265387-en.

An interesting finding is that top performing countries, such as Finland and Singapore, do not show a significant association between any teaching strategy and students' mathematics outcomes. Furthermore, results from Section 2 showed that Finnish and Singaporean teachers engage in these strategies less often than teachers from other countries participating in the study. At the same time, Romania and Mexico are the countries that more frequently engage in these teaching strategies and exhibit a positive association with student outcomes when applying active learning strategies (both Mexico and Romania) and cognitive activation strategies (Romania only). This poses the question: why are Mexico and Romania not among the top performing systems? One possibility is that, although teaching strategies are a crucial element for improving student outcomes, they are not the only variable that matters in this association. Student outcomes are a complex product of student, teacher and school factors. This analysis has isolated a single variable – teaching strategies – but there may be other factors not taken into account by the model used here that may overshadow the overall contribution of teaching strategies in the aforementioned countries.

In summary, the analyses show that different teaching strategies are differently related to student mathematics achievement. While cognitive activation is, overall, positively related to student mathematics performance in six of the eight countries (significant in four of them), there is no positive association between teacher-directed instruction and student performance and there is a mixed pattern of results regarding the use of active learning.

Figure 3.1 Associations between teachers' teaching strategies and student mathematics performances



Countries are ranked in ascending order of the standardised regression coefficient associated with the teaching strategy of interest.

Note: The bars represent the regression coefficients associated with the school index of a given teaching strategy. The darker bars indicate regression coefficients that are significant at the 5% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

The role of the school socio-economic composition

Does the contribution of teachers' teaching strategies to student achievement vary according to the school setting? Research has shown that the degree of impact of teaching strategies might depend on factors such as the school socio-demographic and socio-economic composition (Muijs et al., 2004). After carrying out several additional analyses, it has become clear that the relationships observed between teaching strategies and student performances vary according to the school's socio-economic background.

Figure 3.2 shows the results of additional estimations run on two sub-populations of students: on students enrolled in the half of the schools that are most socio-economically disadvantaged and on students enrolled in the half of the schools that are most socio-economically advantaged. The grey bars represent the estimated associations between the use of a given teaching strategy and student mathematics performance for the advantaged schools, while the blue bars represent those for the disadvantaged ones.

Comparing the findings for those two sub-populations (Figure 3.2) along with those of the whole student population (Figure 3.1) proves to be quite instructive. In the previous section, the use of an active learning strategy was found to be positively related to student mathematics performance in several countries. Figure 3.2 allows fine-tuning the understanding of the observed relationships for the whole student population. In Romania and Spain, the use of active learning is positively associated with student mathematics performance only for students enrolled in disadvantaged schools, while in Mexico and Singapore the positive relationship is only found for students enrolled in advantaged schools. It was also observed that, in Australia and Finland, the use of active learning is negatively associated with student mathematics performance, regardless of the school's socio-economic composition. Results regarding the use of an active learning strategy are, thus, not only mixed from a cross-national perspective, but also when compared with the results for students enrolled in schools from a variety of socio-economic backgrounds. This may suggest that the usefulness of this teaching strategy is highly dependent on the conditions under which it is adopted.

While an overall positive association between the use of cognitive activation and student mathematics performance was previously found, Figure 3.2 further shows that this association is, in general, even more positive and stronger for students enrolled in advantaged schools than for students in disadvantaged ones. This may indicate that cognitive activation practices, such as having students reflect on problems, finding various ways of solving problems, and connecting problems to real-life situations, are particularly efficient with advantaged students. Yet, Mexico is the perfect example to the contrary, as it is the only country where cognitive activation is found to be negatively related to mathematics achievement for students enrolled in advantaged schools.

Similar conclusions are reached when turning to teacher-directed instruction. While an overall negative relationship between the use of teacher-directed instruction and student mathematics performance was previously found, the bottom part of Figure 3.2 also shows that this relationship is, in general, only significantly negative for students enrolled in advantaged schools and non-significant for students in disadvantaged schools. This may imply that a too frequent use of teacher-directed strategies is only detrimental to the performance of advantaged students, while it does not negatively affect disadvantaged students' skill acquisition. In any case, the findings in this report are relatively consistent with previous research showing that students coming from disadvantaged backgrounds benefit more from teacher-directed instruction than students coming from advantaged ones (Lavy, 2011; Scheerens, 1992; Slavin, 1996).

Overall, the contributions of teachers' teaching strategies to student mathematics performance seem more pronounced in advantaged schools than in disadvantaged ones. This could suggest that students enrolled in schools with a more advantaged background are more sensitive to teachers' teaching strategies than those of students in disadvantaged schools. Results from TALIS 2013 (OECD, 2014b) have shown that, in schools with a higher concentration of students coming from a disadvantaged background, teachers are more likely to experience disruptive behaviours in their classrooms and struggle with keeping an orderly learning environment. Thus, it may be argued that, in those school contexts, elaborating suitable and efficient teaching strategies is more complicated.

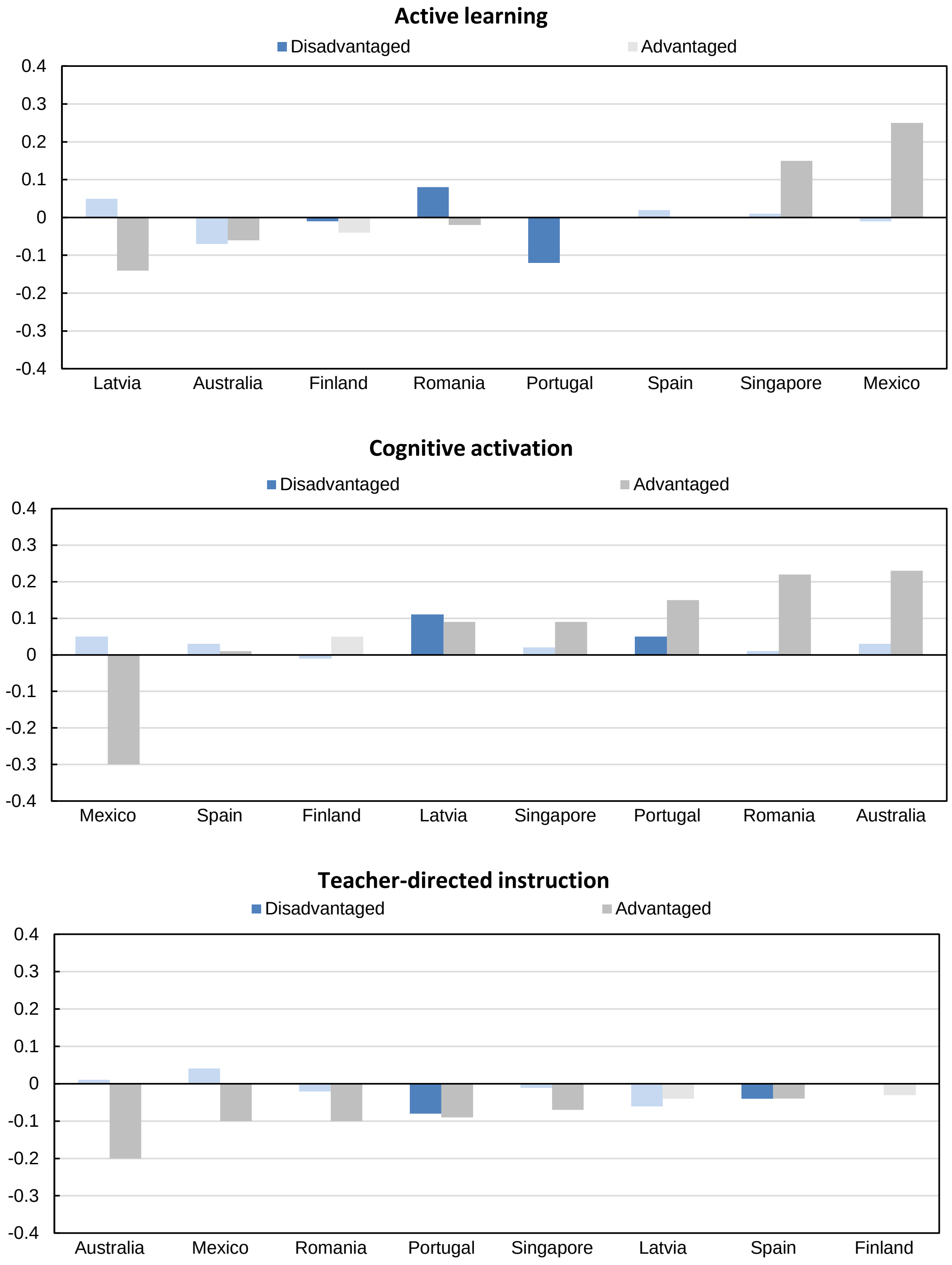
Given that different educational strategies can have different outcomes depending on the student context in which they are applied, the identification of student needs becomes imperative in order to adapt teaching strategies. In some education systems, special needs teachers are appointed to correctly identify those students that most need help. Box 3.3 briefly describes how this takes place in the Finnish system.

Box 3.3 Finland: Identifying student needs

With a different institutional setup, Finland's special teachers fulfil a role of early diagnosis and support, working closely with the class teachers to identify students in need of extra help and to work individually or in small groups with struggling students to provide the extra help and support they need to keep up with their classmates. It is not left solely to the discretion of the regular class teacher to identify a problem and alert the special teacher; every comprehensive school has a "pupils' multi-professional care group" that meets at least twice a month for two hours and which consists of the principal, the special education teacher, the school nurse, the school psychologist, a social worker, and the teachers whose students are being discussed. The parents of any child being discussed are contacted prior to the meeting and are sometimes asked to be present.

Source: OECD (2011), "Finland: Slow and Steady Reform for Consistently High Results", in *Lessons from PISA for the United States*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264096660-6-en.

Figure 3.2 Associations between teachers' teaching strategies and student mathematics performance by school socio-economic composition



Countries are ranked in ascending order of the standardised regression coefficient associated with the teaching strategy of interest, estimated on the data of students enrolled in the most socio-economically advantaged half of schools.

Note: The bars represent the regression coefficients associated with the school index of a given teaching strategy. The darker bars indicate regression coefficients that are significant at the 5% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Teachers' teaching strategies and student attitudes towards learning

Analyses

Previous research has shown that teaching practices not only have implications for the development of a student's cognitive skills, but also for their confidence, attitudes and interest in their learning (Algan et al., 2011). Thus, there is also interest in analysing the relationship between teachers' teaching strategies and students' attitudes towards mathematics and school in general. On the basis of preliminary analyses, two out of the numerous attitudinal variables derived from the PISA 2012 Student Questionnaire[3] were selected: student mathematics interest and student confidence about mathematics – labelled "mathematics anxiety" in PISA (see Boxes 3.4 and 3.5 for a more detailed description of these attitudinal indices).

Box 3.4 Items for measuring student mathematics interest

Four items measuring mathematics interest (INTMAT) are used in the Main Survey of PISA 2012 (ST29Q01, ST29Q03, ST29Q04 and ST29Q06). The wording of the question stem is "Thinking about your views on mathematics: to what extent do you agree with the following statements?" and the question items are the following:

- I enjoy reading about mathematics.
- I look forward to my mathematics lessons.
- I do mathematics because I enjoy it.
- I am interested in things I learn in mathematics.

The response categories are "Strongly agree", "Agree", "Disagree" and "Strongly disagree". A higher index value corresponds to a higher level of interest. More details can be found in the *PISA 2012 Technical Report* (OECD, 2014a: 321).

Source: OECD (2014a), "PISA 2012 Technical Report", OECD, Paris, www.oecd.org/pisa/pisaproducts/PISA-2012-technical-report-final.pdf.

3. For a detailed description of the complex scale indices, see OECD, 2014a, chapter 16.

Box 3.5 Items for measuring student confidence about mathematics

Five items measuring confidence about mathematics (ANXMAT, also labelled "mathematics anxiety" in PISA) are used in the Main Survey of PISA 2012 (ST42Q01, ST42Q03, ST42Q05, ST42Q08 and ST42Q10). The wording of the question stem is "Thinking about studying mathematics: to what extent do you agree with the following statements?" and the question items are the following:

- I often worry that it will be difficult for me in mathematics classes.
- I get very tense when I have to do mathematics homework.
- I get very nervous doing mathematics problems.
- I feel helpless when doing a mathematics problem.
- I worry that I will get poor <grades> in mathematics.

The response categories range from "Strongly agree", to "Strongly disagree". A higher index value corresponds to a higher level of confidence towards mathematics (reciprocally to a lower level of mathematics anxiety). More details can be found in the *PISA 2012 Technical Report* (OECD, 2014a, p.323).

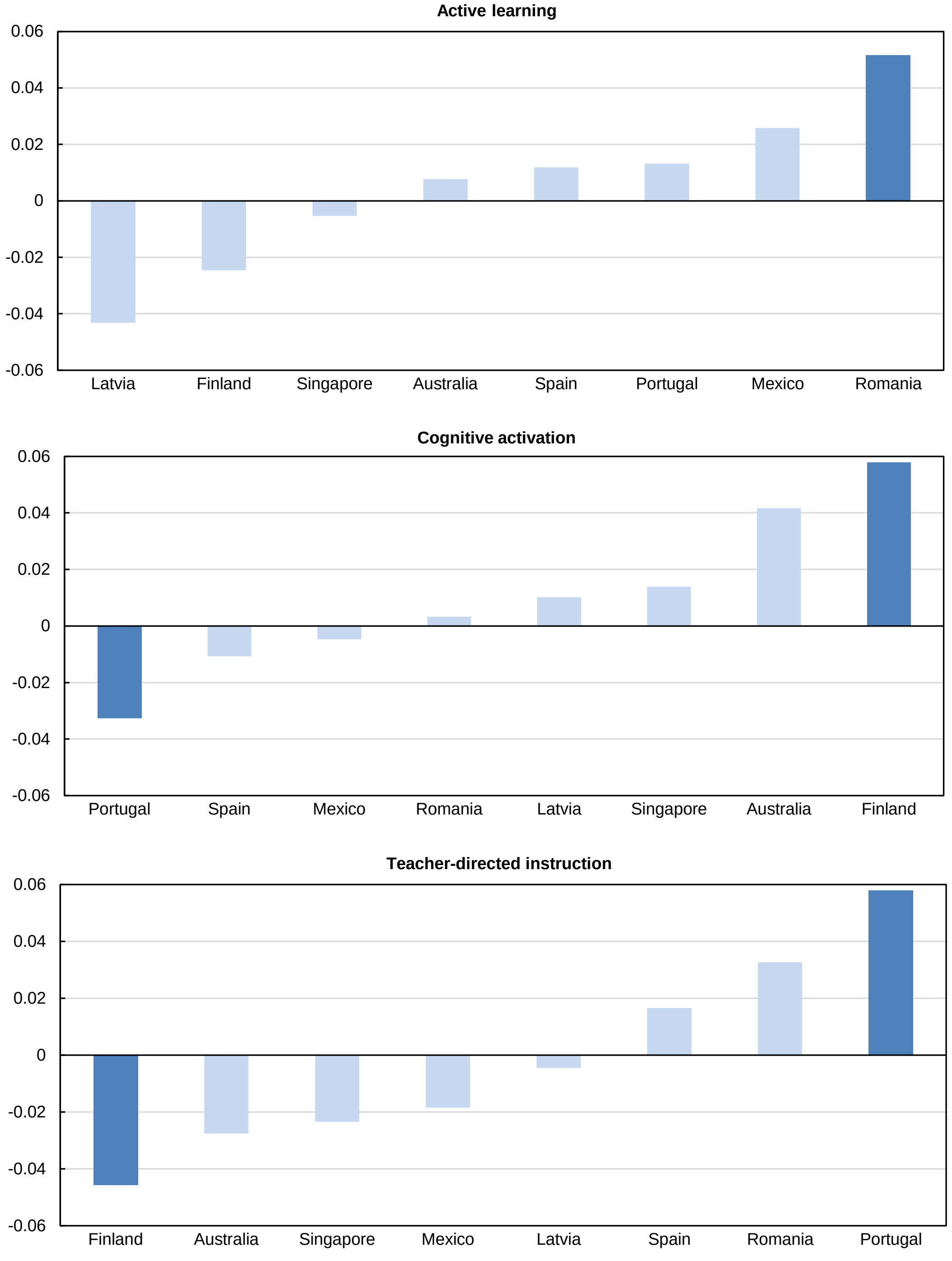
Source: OECD (2014a), "PISA 2012 Technical Report", OECD,Paris, www.oecd.org/pisa/pisaproducts/PISA-2012-technical-report-final.pdf.

Each of these variables was regressed using the same multilevel model. The same explanatory variables are included in the regression, with the addition of student performance in mathematics. For these statistical analyses, the number of student cases available drops by a third: because of the questionnaire rotation design, questions on attitudes towards mathematics and learning are only filled out by two-thirds of the responding students. This reduction in the number of observations can be detrimental to the significance of the estimations.

Results

As can be seen in Figure 3.3, teachers' use of a teaching strategy is, in general, not significantly associated with student level of interest in mathematics, except for a few countries – namely Finland, Portugal and Romania. A more frequent use of active learning strategies is found to be significantly related to a higher level of interest in mathematics in Romania. The cognitive activation and teacher-directed instruction strategies seem to have opposite effects in Finland and in Portugal: the use of cognitive activation is positively related to student mathematics interest in Finland and rather negatively in Portugal, while the use of teacher-directed instruction is positively associated with student interest in Portugal and negatively in Finland.

Figure 3.3 Associations between teachers' teaching strategies and student mathematics interest



Countries are ranked in ascending order of the standardised regression coefficient associated with the teaching strategy of interest.

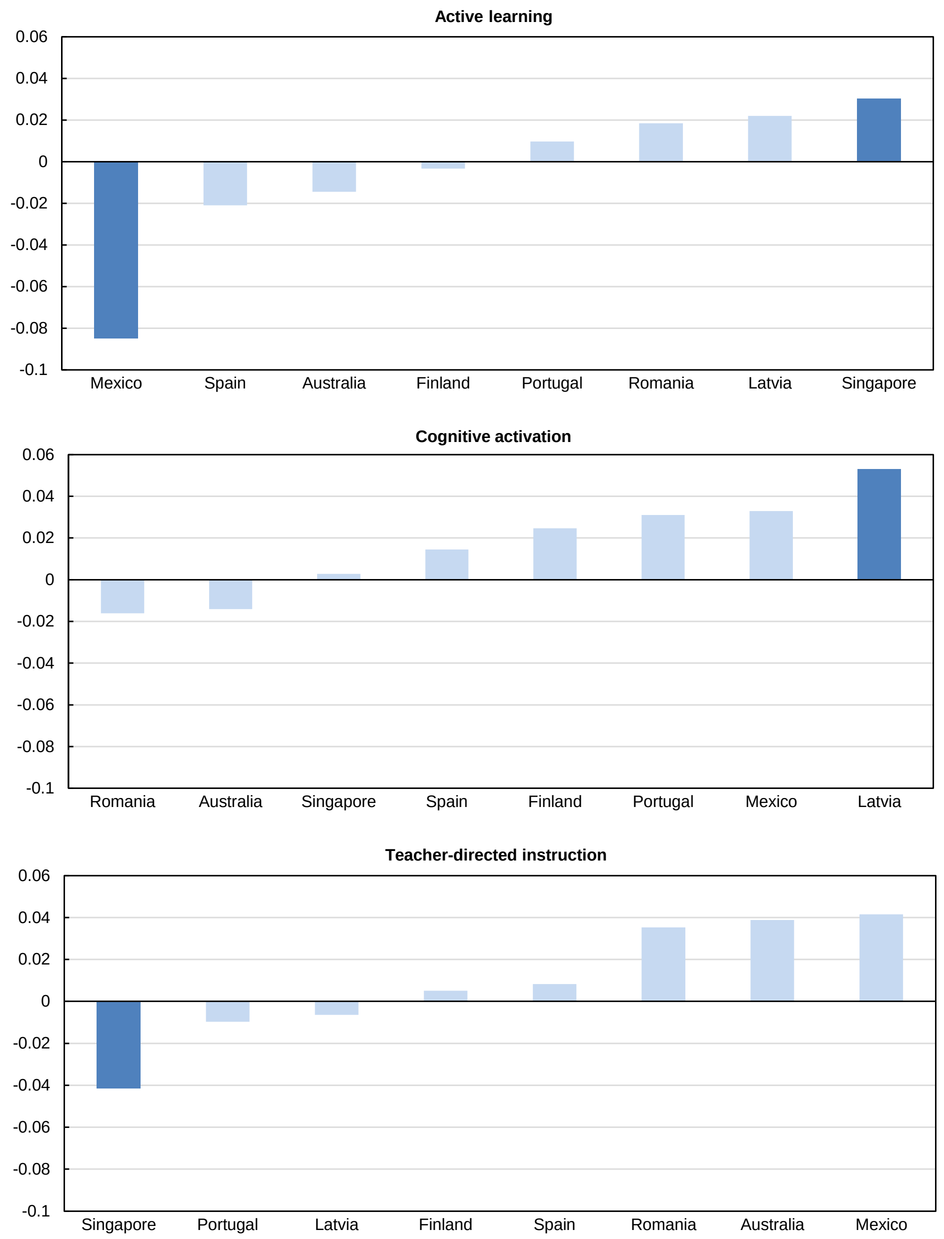
Note: The bars represent the regression coefficients associated with the school index of a given teaching strategy. The darker bars indicate regression coefficients that are significant at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Figure 3.4 (below) shows the estimated associations between teachers' teaching practices and students' confidence towards mathematics by country: most of them are not significant, except for a few countries for particular strategies. Singapore is the only country where several teaching strategies are found to contribute to student confidence towards mathematics: in Singapore, a more frequent use of active learning practices is associated with a higher level of student mathematics confidence, while teacher-directed instruction is related to a higher level of mathematics anxiety.

Overall, only a few results of the analyses carried out by country and by student attitudinal outcome prove to be significant. This is partly due to the fact that the sample size is smaller for the analyses on student attitudes than it was for those on student performances. But it is also worth acknowledging again that the school-level measures of teachers' teaching strategies used in this report cannot be strongly associated with student attitudes, as a very small share of the differences in student attitudes lies between schools.

Figure 3.4 Associations between teachers' teaching strategies and student confidence about mathematics



Countries are ranked in ascending order of the standardised regression coefficient associated with the teaching strategy of interest.

Note: The bars represent the regression coefficients associated with the school index of a given teaching strategy. The darker bars indicate regression coefficients that are significant at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

4. SCHOOL, CLASSROOM AND TEACHER ENABLING FACTORS

Research and policy objectives

In Section 3, cognitive activation and, to a lesser extent, active learning, have been identified as the teaching strategies positively associated with student learning outcomes. This section now seeks to analyse which factors can enable the adoption by mathematics teachers of these seemingly efficient teaching strategies. This is a crucial policy endeavour, since it can help guide the investment into those areas that are more likely to affect teaching practices.

Previous research has found that teacher classroom practices can be affected by a series of school factors (OECD, 2009; Richardson, 1996; Richardson et al., 1991; Shapiro and Kilbey, 1990). This section will examine how multiple school, classroom, teacher and student factors are associated with specific teaching strategies. The following factors are examined: school attributes, policies and practices; teacher's relationships with students and co-operation with other teachers; teachers' perceptions of their work and work environment; teacher background characteristics; classroom characteristics; school general composition and mathematics performance and students' overall attitudes within the school.

This section will address the following research and policy questions: To what extent can teachers' teaching strategies be explained? Which factors are the most important in explaining differences in teachers' teaching strategies? To what extent do they matter? How are they associated with the use of teaching strategies? Do the identified contributions and relationships vary across countries?

Conceptual and methodological approach

To address these questions, the analytical approach is structured into three steps, going from the most general level of analysis to the most detailed one. The first to be assessed is how much of the variance of teachers' teaching strategies can be explained by all the factors taken simultaneously. Second, going into a more detailed level of analysis, the relationships between teachers' teaching strategies and different sets of factors are studied. Thus, the contribution of each set of factors to the use of particular teaching strategies can be appraised. Finally, the understanding of how each discriminant factor is related to teachers' teaching is fine-tuned. The same analytical process and a cross-country comparative perspective will be adopted for both the cognitive activation and active learning strategies.

Shaping four sets of explanatory factors

Teachers' teaching strategies can be influenced by factors that pertain to the school and the classroom settings, as well as the teacher background, status and professional practices. Following an exploratory approach, a large set of factors derived from TALIS and PISA extant variables are included in the analysis. These variables are grouped into four overarching blocks pertaining to different institutional levels and characterising different education stakeholders. Box 4.1 presents the four overarching blocks and their main components. Forming coherent blocks of factors will help examine, in greater detail, their contribution to teachers' use of teaching strategies.

The first overarching block corresponds to *School attributes, policies and practices*. It comprises variables derived from the PISA School and TALIS Principal Questionnaires describing a school's general policies and practices, which systematically affect every teacher in the school. By introducing this block into the analyses, the interest is in checking whether such school-level factors can influence the shaping of teachers' teaching strategies.[4]

School composition denotes the second overarching block of factors. Although this block also contains school factors, it differs from the previous one by the stakeholders it depicts – students. The factors included in this block results from some aggregation of students' characteristics at the school level. The purpose of this second block is to examine the relationships between-school composition factors and teachers' use of cognitive activation and active learning.

The third block is made of *Classroom composition and climate*, such as classroom composition and disciplinary climate. They are based on teachers' self-reports regarding a class to which they teach mathematics (this class is identified and referred to as the "target class" in the TALIS Teacher Questionnaire; this is also the class for which teachers report the classroom practices they implement). While examining this block, the interest is in checking whether teachers adapt their teaching to their classroom.

Finally, the fourth block contains *Teacher characteristics, beliefs and professional practices*, including teacher background, teacher perceptions of work and relations with other school's stakeholders. As for the previous block, this block also pertains to the teacher level, but this one represents a teacher's individual features and beliefs rather than teacher classroom characteristics.

Box 4.1 Four overarching blocks of factors

The following four overarching blocks of factors are analysed in this section:

1. school attributes, policies and practices
2. school composition
   - school socio-demographic and academic composition
   - student attitudes.
3. classroom composition and climate
4. teacher characteristics, beliefs and professional practices
   - teacher background characteristics
   - teacher relations with the school's stakeholders
   - teacher perceptions of their work and work environment.

Statistical method

The frequency with which a teacher uses a teaching strategy is regressed on a set of explanatory variables introduced above, by using a multilevel model (teacher and school levels). Several models are

4. For more information about these factors, see Section 1.

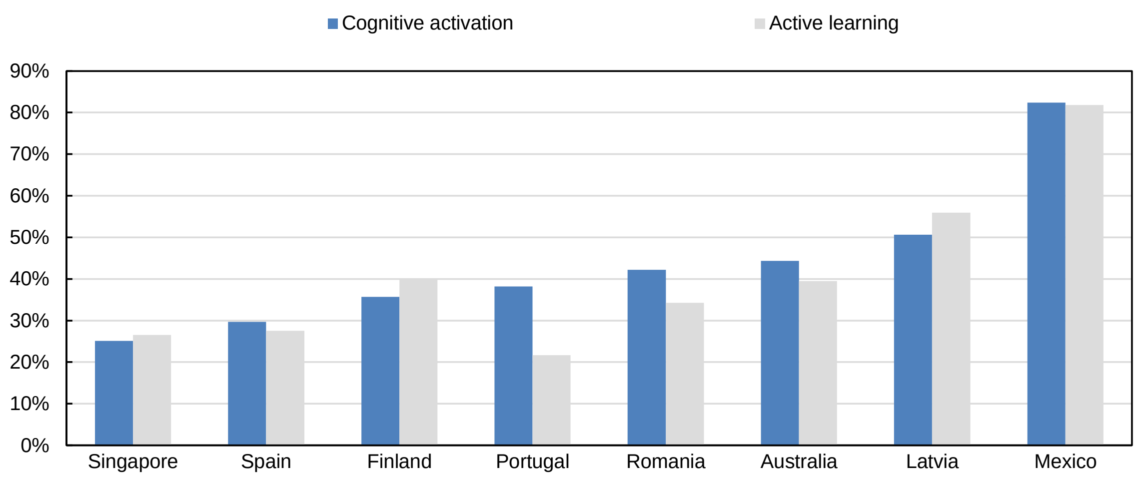
estimated (see Annex A for technical details). The first one – the *null model* – is a model where no explanatory variable is introduced. The results of the regression for this model will not be detailed here. The null model is estimated in order to have a reference that can be used to compare the other models. *The full model* is the model in which all explanatory variables are included. A *block model* refers to a model in which a coherent block of variables is included. The full model will be used to appraise the overall contribution of all the factors, taken simultaneously, to the use of a specific teaching strategy by teachers. Then the block models will allow for going into more detailed analysis, by looking at the specific contribution of each of the four overarching blocks described earlier.

This section will only highlight the main findings of the analyses. The detailed results can be found in Tables B.9, B.10 and B.11.

Can teachers' use of teaching strategies be explained?

Overall, how much can be explained of teachers' teaching strategies when taking into account the many school, classroom and teacher characteristics that are available? To answer this question, the share of the total variance in teacher use of a teaching strategy captured by all the explanatory variables included in the full model is estimated. This estimation is carried out for the two teaching strategies of interest: cognitive activation and active learning.

Figure 4.1 Total variance in teacher teaching strategies explained by the whole set of factors



Countries are ranked in ascending order of the percentage of the total variance in the frequency with which teachers use cognitive activation, "explained" by the whole set of explanatory variables (full model).

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013b), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

When all factors are taken into account, they explain a substantial proportion of the differences between teachers in the frequency with which they use cognitive or active learning (Figure 4.1). In every country, at least 20% of the total variance in each strategy can be explained. Yet, this proportion largely varies across countries. It ranges from 25% in Singapore to 82% in Mexico for the use of cognitive activation. In the case of active learning, the spread goes from 22% in Portugal to 82% in Mexico. This means that teachers' teaching strategies are probably more sensitive to the school and classroom environments, or to teachers' other characteristics and practices in countries such as Australia, Finland, Latvia, Mexico, or Romania than in Portugal, Singapore and Spain.

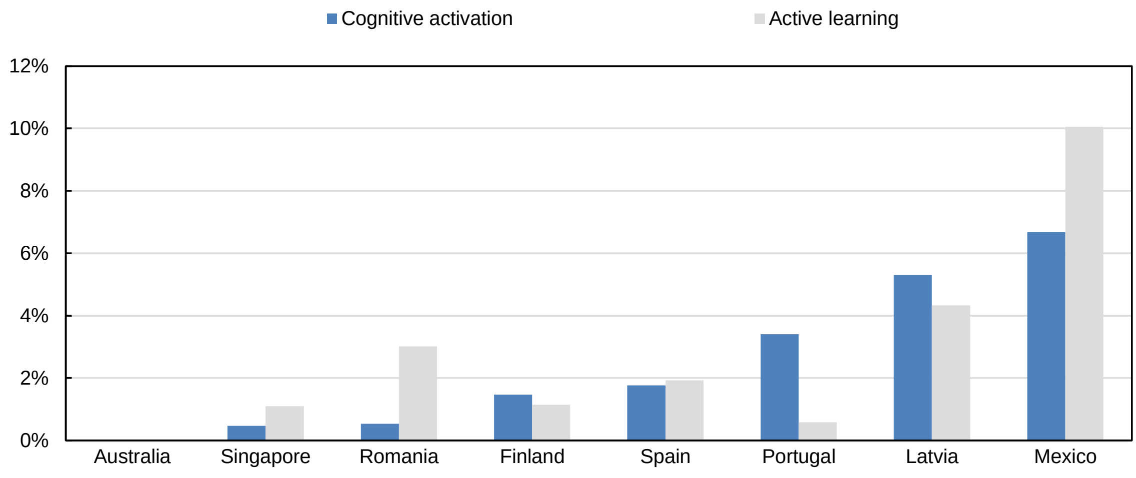
The specific contributions of the school context, the classroom environment and the teacher's own characteristics to teachers' teaching

To identify how the school context, the classroom environment and the teacher's own characteristics are related to the implementation of the cognitive activation and active learning strategies, first, the contributions of several subsets of factors (or blocks) to the adoption of each teaching strategy are estimated.

School attributes, policies and practices

The first block referred to as *School attributes, policies and practices* includes four factors. Two of them stem from the PISA 2012 dataset: the school sector (public/private) and the school's practice with respect to student ability grouping for mathematics classes (no ability grouping for any classes, some form of ability grouping between some classes; some form of ability grouping between all classes). The other two come from the TALIS 2013 dataset and describe teachers' involvement in the choice of course content including curricula and learning materials. Figure 4.2 shows the share of total variance in teachers' strategies captured by all these factors combined.

Figure 4.2 Total variance explained by school attributes, policies and practices only



Countries are ranked in ascending order of the percentage of the total variance in the frequency with which teachers use cognitive activation, "explained" by the relevant block of explanatory variables (block model).

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Overall, school attributes, policies and practices seem to have little relation to teachers' use of one or the other strategy. Their contribution to the total variation in teachers' use of any strategy does not exceed 5%, except for Latvia – in the case of cognitive activation – and for Mexico – for both teaching strategies – but to the limit equal to 10%.

This analysis brings interesting results: teachers from different school sectors do not differ substantially in their teaching practices; student ability grouping (or not) does not have much of an influence on teachers' teaching approaches; and having the choice of teaching material or determining course content does not have much influence either on the teachers regarding their use of the cognitive activation and the active learning strategies (for detailed information see Table A4.2).

School composition

The second overarching block is *School composition*. It is composed of two sub-blocks: the school socio-demographic composition and mathematics achievement; and the school climate and student attitudes towards learning and mathematics. The factors included in these two sub-blocks are derived from the PISA 2012 dataset and are detailed in Box 4.2.

Box 4.2 List of factors included in the block *School composition*

The sub-block *School socio-demographic composition and mathematics achievement* contains the following variables:

- the index of Economic, Social and Cultural Status (ESCS): school's mean value and standard deviation
- student mathematics performance: school's mean value and standard deviation
- the proportion of girls in the school
- the proportion of immigrant students in the school.

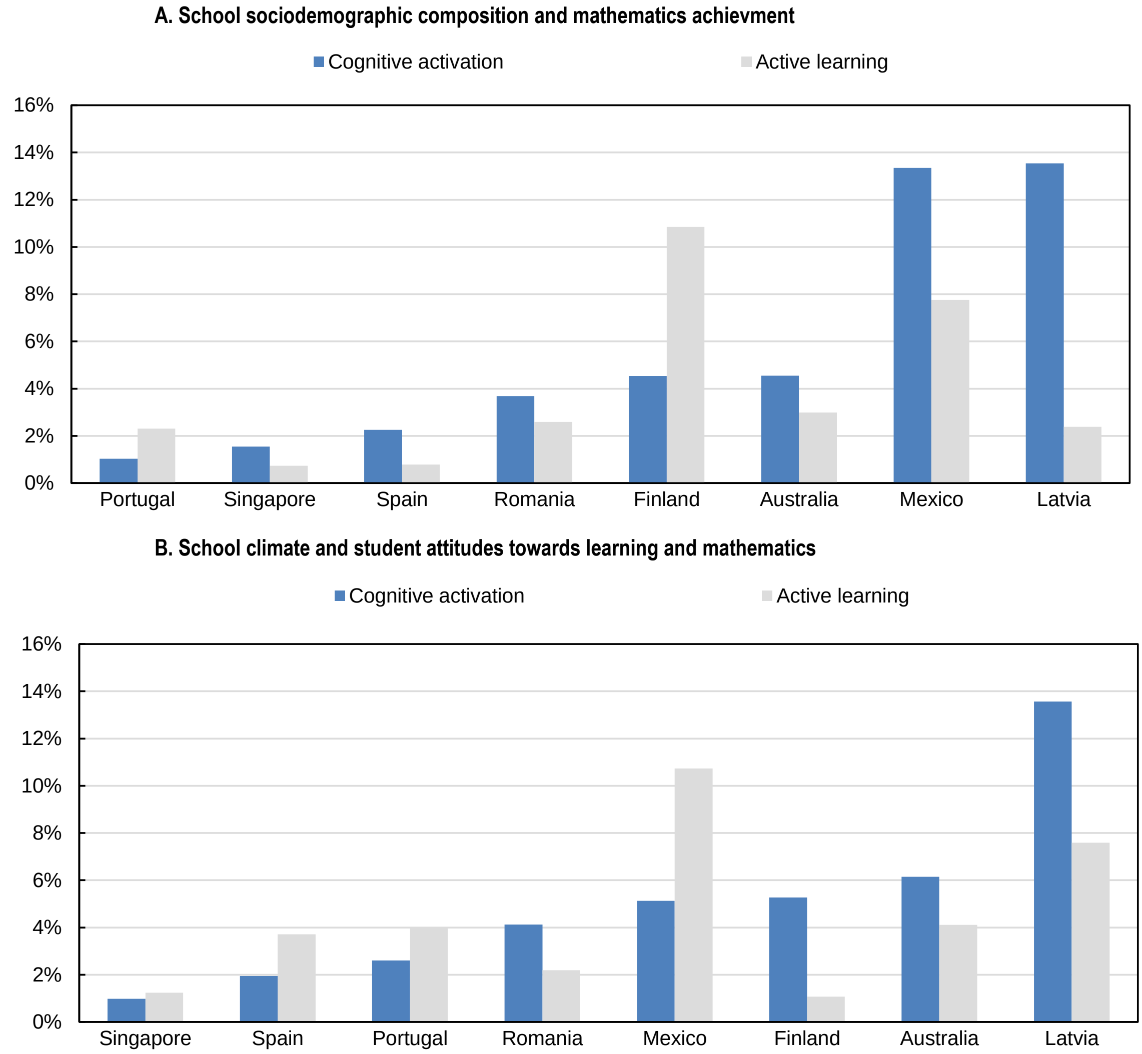
The sub-block *School climate and student attitudes toward learning and mathematics* contains the following variables:

- the index of interest in mathematics: school's mean value and standard deviation
- the index of confidence about mathematics: school's mean value and standard deviation
- the index of attitude towards learning outcomes: school's mean value and standard deviation
- the index of attitude towards learning activities: school's mean value and standard deviation.

Details about the scaling of the listed indices can be found in the *PISA 2012 Technical Report* (OECD, 2014a, Chapter 16).

Source: OECD (2014a), *PISA 2012 Technical Report*, OECD, Paris, www.oecd.org/pisa/pisaproducts/PISA-2012-technical-report-final.pdf.

Figure 4.3 Total variance, explained by school composition only



Countries are ranked in ascending order of the percentage of the total variance in the frequency with which teachers use cognitive activation, captured by the relevant block of explanatory variables (block model).

Source*:* OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

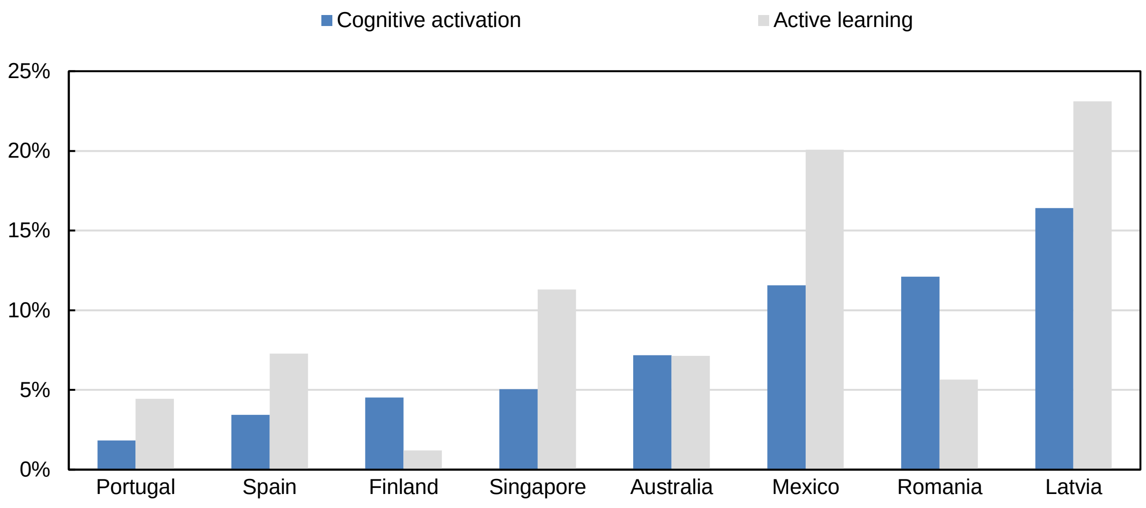
Figure 4.3 shows that, overall, school composition contributes more to explaining each of both teaching strategies than the previous block: school attributes, policies and practices. However, the contribution of the school's student characteristics to explain differences in teaching approaches between teachers is pretty low. For the use of cognitive activation, this contribution of the school socio-demographic and academic composition ranges from 1% for Portugal to 13% for Latvia and Mexico. For the use of active learning, it is comparable or even slightly smaller: it goes from less than 1% (Singapore and Spain) to 11% (Finland). Mexico is the only country for which the school socio-demographic and academic composition explains more than 5% of the total variance in teachers' use of each of both strategies. The results are pretty similar with respect to the role of school climate characteristics – they explain between 1% and 13% of the differences in strategies between teachers. Only Latvia shows a contribution of more than 5% for both strategies.

The results concerning school composition suggest that teachers tend to adapt their teaching to the overall characteristics of the school's student body, but to a limited extent only. The first two blocks, meaning the general school context and student body's composition, are not strongly associated with the use of the teaching strategies.

Classroom composition and climate

With the third main block, the *Classroom composition and climate* is used to get a closer look at contextual factors influencing more directly the teachers. This block is composed of a list of factors built on TALIS teachers' self-reports on their mathematics target class. It includes an index of classroom disciplinary climate and the broad percentages of students with the following characteristics: students whose first language is different from language of instruction; low academic achievers; students with special needs; students with behavioural problems; students from socio-economically disadvantaged homes; and academically gifted students.

Figure 4.4 Total variance explained by classroom composition and climate



Countries are ranked in ascending order of the percentage of the total variance in the frequency with which teachers use cognitive activation, captured by the relevant block of explanatory variables (block model).

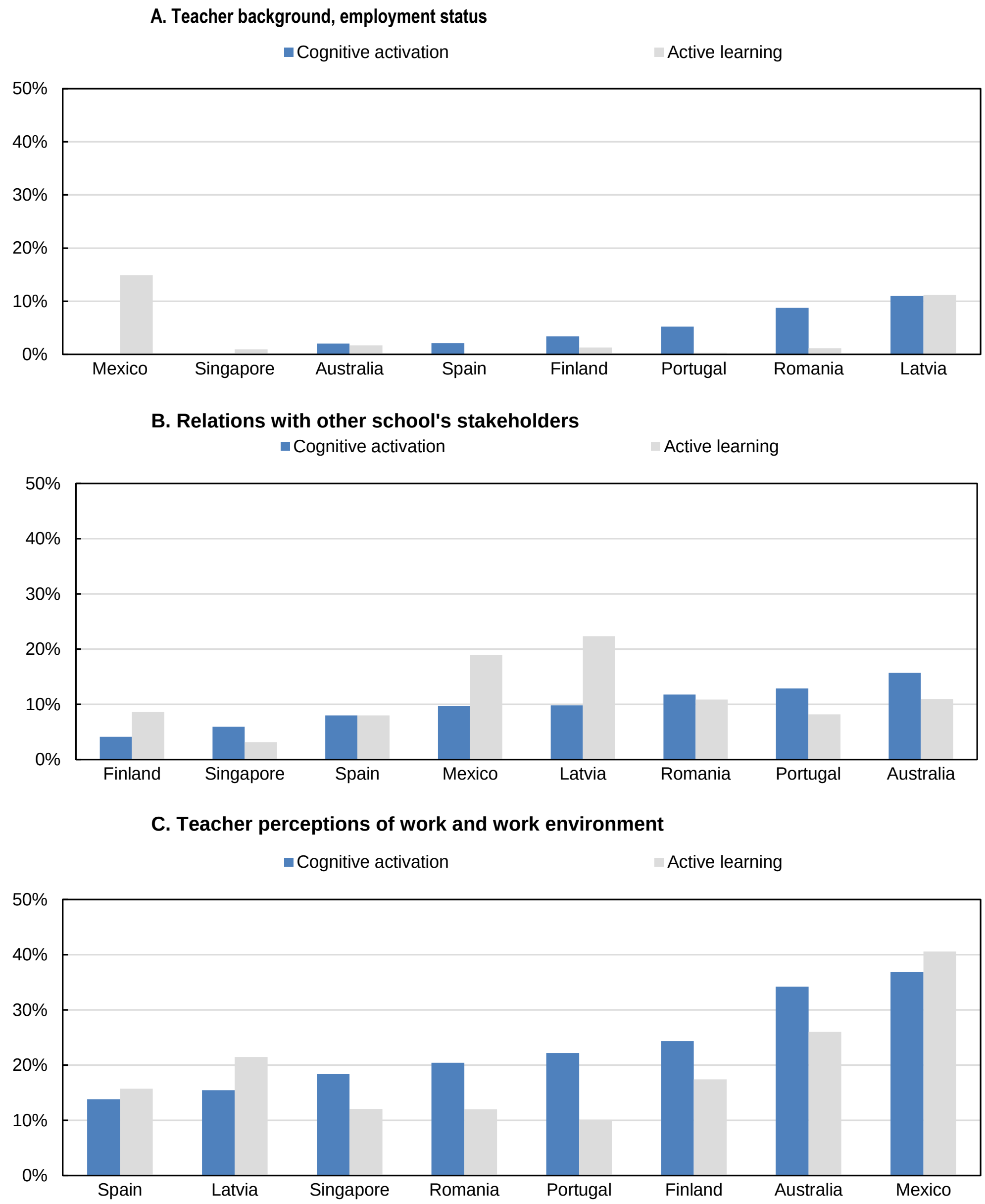
Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

To what extent do the composition and climate of their mathematics classroom explain differences in teaching strategies between teachers? Compared to the school factors examined so far, the classroom composition and climate tend to show a higher contribution to the total variance in the use of at least one and, for some countries, both of the teaching strategies (see Figure 4.4). It explains between 1% and 23% of the total variance in any teaching strategy across all countries. The contribution of the classroom-level factors varies substantially across countries: it amounts to more than 10% of the total variance in both strategies in Mexico and to more than 15% in Latvia, while it is very limited in Finland and Portugal (below 5%) for both teaching strategies.

Interestingly, classroom composition and climate tend to explain more of the differences between teachers in their tendency to adopt active learning practices over cognitive activation ones. Only two countries, Finland and Romania, present the opposite result. This suggests that teachers tend to adapt the frequency with which they employ a given teaching strategy to their classroom characteristics, and even more so when they use the active learning strategy. The strong focus on support that active learning strategies have on student learning might explain why this type of strategy is linked more strongly with classroom composition than cognitive activation practices.

Teacher characteristics, beliefs and professional practices

Figure 4.5 Total variance explained by teacher characteristics, beliefs and practices only



Countries are ranked in ascending order of the percentage of the total variance in the frequency with which teachers use cognitive activation, captured by the relevant block of explanatory variables (block model).

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

The last main block focuses on the *teacher characteristics, beliefs and professional practices* that represent teacher's personal attributes. This block is split into three sub-blocks: teacher background and employment status, teacher perceptions of their work and work environment and teacher relations with other school stakeholders. All the factors included in these sub-blocks are derived from teachers' self-reports collected as part of the TALIS 2013 dataset (see Box 4.3 for more details). Figure 4.5 shows the percentages of total variance in teachers' teaching strategies captured by each of these sub-blocks and per country.

Box 4.3 List of factors included in the block Teacher characteristics, beliefs and professional practices

The sub-block *Teacher background and employment status* contains the following variables:

- total number of years of experience as a teacher
- teacher sex (female/male)
- teacher employment status (permanent or fixed-term)
- teacher initial training (yes/no).

The sub-block *Teacher relations with other school stakeholders* contains the following indices:

- teacher relationships with students
- teacher co-operation with other teachers.

The sub-block *Teacher perceptions of work and environment* contains the following indices:

- constructivist beliefs
- effective professional development
- teacher job satisfaction
- need for professional development in subject matter and pedagogy
- self-efficacy.

Details about the scaling of the listed indices can be found in the *TALIS 2013 Technical Report* (OECD, 2014b, chapter 10).

Source: OECD (2014b), "PISA 2012 Technical Report", OECD, Paris, www.oecd.org/pisa/pisaproducts/PISA-2012-technical-report-final.pdf.

For most of the countries, *teacher's background and employment status* do not explain much of the differences between teachers in their use of both teaching strategies. Their total contribution goes over 5% of the total variance in only three countries: Latvia (for both teaching strategies), Romania (only for cognitive activation) and Mexico (only for active learning).

For every country, *teacher's relations with other school's stakeholders* contribute to at least 5% of the total variance in at least one of the two teaching strategies. Teacher's relations with students and co-operation with other teachers play a limited role in Finland, Singapore and Spain, where their contribution to any teaching strategy does not exceed 10%, and a more substantial one in the other five countries, where they explain more than 10% of the variance in the use of at least one of the strategies. Remarkably, teacher relations with other school stakeholders contribute to a great extent to teachers' use of active learning in Latvia (22%) and in Mexico (17%).

The most important teacher-level factors in the analysis of teachers' teaching strategies are *teachers' perceptions of their work and work environment*. These factors relate to aspects of teachers' work that go beyond the simple fact of teaching students. They are linked to teachers' career and skills development, as well as teachers' job satisfaction. For each country, teacher personal characteristics contribute to at least 10% of the variance in teacher use of any teaching strategy. There are, however, substantial cross-country differences in the size of their contribution to the use of active learning, in particular, as it ranges from 10% for Portugal to 40% for Mexico.

Finally, overall teacher perceptions of work and work environment seem to play a more important role with respect to the use of cognitive activation than active learning. This is the case in five countries: Australia, Finland Portugal, Romania and Singapore – Panel C of Figure 4.5 shows that the blue bar is higher than the grey bar. It will be interesting to see exactly which teacher characteristics are particularly related to teachers' tendency to use cognitive activation practices. This is one of the purposes of the analyses reported in the following sections.

Which factors are associated with teacher teaching strategies?

By examining the estimated coefficients of the regression, the association of each factor with the frequency with which teachers employ each strategy can be considered in greater detail. Thus, the two following sections present all the associations between a factor and a teaching strategy that are significant for at least four countries (the results of all the regressions can be found in Tables A4.2 and A4.3).

As mentioned previously, due to the limited sample of countries, it is not possible to infer a worldwide general trend from the associations presented in this section. Thus, results should be interpreted carefully. Results are presented by each country instead of relying on international averages.

Cognitive activation

Seven factors for which the association with the cognitive activation strategy is significant in at least four of the eight countries of this study can be isolated (see Table 4.1). These seven factors belong to five of the seven sub-blocks examined in the previous sections. None of the variables pertaining to *School policies and practices* and *Teacher background and employment status* appears in the list, confirming the weak contribution they have to the total variance (see Figures 4.2 and 4.5).

Table 4.1 Factors most significantly related to a teacher's use of cognitive activation

Block	Factor	Australia	Finland	Latvia	Mexico	Portugal	Romania	Singapore	Spain
Teacher perceptions of work and work environment	Constructivist beliefs	++				++	++	++	++
	Teacher self-efficacy	++	++	++	++	++	++	++	++
Teacher relations with other school stakeholders	Co-operation with other teachers	++		++		++		++	++
Classroom composition and climate	Classroom disciplinary climate			++			++	++	++
School socio-demographic composition and mathematic achievement	Heterogeneity of students with respect to their mathematics performances		++	-			--		++
	Proportion of immigrant students in the school			++			--	++	++
School climate and student attitudes towards mathematics	Heterogeneity of students with respect to their attitudes towards learning activities		--	--		++	--		++

Note: "++" and "--" indicate a significant association at the 5% threshold; "+" and "-" indicate a significant association at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

According to the results, across all countries, the teachers who use the cognitive activation strategy more often also tend to feel more efficient in their teaching. They also tend to conceive their teacher's role more often under a constructivist approach, in particular in Australia, Portugal, Romania, Spain and Singapore. All the positive relationships found and indicated in Table 4.1 are significant at the 5% threshold, confirming the strong contribution of these two aspects of teachers' work perceptions. Almost none of the other factors included in the block *Teacher perception of work and work environment* is significantly associated with teacher's use of cognitive activation (only teacher participation in effective professional development is positively related to the use of cognitive activation in Romania, see Table A4.2). This means that teachers' teaching depends less on a teachers' job satisfaction, participation or need for professional development than on teachers' conceptions of their role. Nevertheless, results from TALIS 2013 have shown that job satisfaction and professional development is strongly associated with teachers' self-efficacy.

The previous section found that teachers' relations with other school's stakeholders contribute greatly to teachers' use of one or the other teaching strategy. Yet, in the analysis, teachers' relations include two types of relations: teacher-student relations, for which only Portugal and Romania present a significant association with the use of cognitive activation (see Table A4.2); and co-operation with other teachers, for which Australia, Latvia, Portugal, Singapore and Spain show a positive and significant relationship. The key role played by teachers' relations (Figure 4.5) mostly comes from the latter factor: the more a teacher co-operates with other teachers in the school, the more he or she tends to frequently use the cognitive activation strategy.

The *Classroom composition and climate* block includes indicators of class composition based on students' first language, low or high academic profile, special needs and behavioural problems. According to the regression estimations, the correlations between these composition factors and teachers' use of cognitive activation are not particularly strong, with only three significant associations for the share of students whose first language is different from the language of instruction (Australia, Latvia and Singapore), two for the proportion of students with special needs (Portugal and Romania) and one for the percentage of students with behavioural problems (Portugal). At the same time, the classroom disciplinary climate is positively and significantly associated with the use of cognitive activation in four countries Romania, Singapore, Spain (at the 5% threshold) and Latvia (at the 10% threshold). This means that, in half of the participating countries, the more conducive and disciplined a classroom's climate is, the more frequently a teacher tends to use the cognitive activation strategy. As previous studies have shown, having an organised classroom environment is a key component for the implementation of good teaching practices (Echazarra et al., 2016; Wolfolk, 2010).

Finally, some factors pertaining to *school composition* presents significant associations with teachers' use of cognitive activation. Table 4.1 indicates mixed results regarding the possible influence of students' academic heterogeneity within a school with respect to student performance and attitudes towards learning. In Finland and Spain, teachers who teach students with more heterogeneous academic levels tend to use active learning more often, while it is the contrary in Latvia and Mexico, where more heterogeneity in student achievement within the school leads to a weaker implementation of cognitive activation by teachers. A similar mixed pattern is found for the within-school variation in students' attitudes towards learning activities: teachers teaching students with different degrees of engagement in learning activities tend to employ the cognitive activation strategy more often in Portugal and Spain but less often in Finland, Latvia and Romania. The results also show that teachers tend to implement cognitive activation practices more often when there are more immigrant students in the school in Latvia, Singapore and Spain and less in Romania.

Active learning

In relation to the use of active learning, six factors are found to present significant associations with the use of this strategy for at least four countries (see Table 4.2). They are part of four out of the seven sub-blocks previously examined. As could be expected, none of the variables pertaining to teacher background and employment status, school attributes, policies, practices and socio-demographic composition present consistent associations with teachers' use of active learning practices across countries. A closer look at the complete set of results (see Table A4.3) shows that, inside these blocks, for some countries, only a few factors are found to be significantly related to the use of active learning: teaching in a private school (Australia, Latvia and Spain); teaching in a school with no ability grouping for any mathematics classes (Portugal, Spain and Singapore); and teaching in a socio-economically heterogeneous school (Latvia, Romania and Spain).

As for the use of cognitive activation, in every participating country, teachers who feel more efficient about their teaching tend to use active learning more often. A positive relationship is, again, also found between a constructivist approach to teaching and the implementation of active learning, but only in three countries (Australia, Finland and Mexico) and this is why this is not reported in Table 4.2.

In all countries except Finland, the more teachers co-operate with other teachers, the more often they tend to use the active learning strategy. This again confirms that co-operation between teachers is a key factor for teachers' teaching.

Earlier in the report, classroom-level factors were found to matter more for teachers' implementation of active learning than cognitive activation (Figure 4.4). Table 4.2 shows that three classroom features tend to be associated with a more frequent use of active learning practices: a low share of low academic achievers combined with a high share of academically gifted students, as well as a positive disciplinary climate. These findings suggest that teachers tend to employ classroom practices requiring a strong engagement in learning activities from students only when the conditions conducive to it are met.

Table 4.2 Factors most significantly related to a teacher's use of active learning

Block	Factor	Australia	Finland	Latvia	Mexico	Portugal	Romania	Singapore	Spain
Teacher perception of work and work environment	Teacher self-efficacy	++	++	++	++	++	++	++	++
Teacher relations with other school stakeholders	Co-operation with other teachers	++		++	++	++	++	+	++
Classroom composition and climate	Proportion of low academic achievers	++	-	-			--	--	
	Proportion of academically gifted students	++					++	++	+
	Classroom disciplinary climate	+	++	+					++
School climate and student attitudes toward mathematics	Heterogeneity of students with respect to their confidence towards mathematics	-	+		--	-			

Note: "++" and "--" indicate a significant association at the 5% threshold; "+" and "-" indicate a significant association at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

From the list of variables pertaining to school composition, there is one factor that particularly matters for the adoption of the active learning strategy: the degree of heterogeneity among students with regard to their confidence about mathematics. In Australia, Mexico and Romania, teachers who teach to students with a similar degree of anxiety towards mathematics tend to use active learning more often than teachers teaching to students with different levels of confidence. In Finland, it is the other way round: teachers teaching students with diverse degrees of mathematics anxiety are more likely to employ active learning practices.

The analyses reported previously have highlighted the respective contributions of school setting, student body, classroom composition and climate, as well as teachers' personal characteristics and practices, to teachers' inclinations for one of two teaching strategies – cognitive activation and active learning – both found to be positively correlated with student achievement in several countries of the study. The results show that classroom- and teacher-level factors, such as the composition of the classroom, teacher co-operation with other teachers, as well as teachers' beliefs about their role and efficiency, matter more than the school sector, policies, practices and the composition of the school. Secondly, the results show that there are substantial differences between countries: for example, teachers' teaching strategies seem to be more sensitive to the classroom environment and to teachers' relations at school in Latvia and Romania than in the other countries. Thirdly, while most factors contribute in a similar way to the adoption of either strategy, some differences arise in some cases. For instance, it seems that classroom-level factors matter more for the use of active learning practices, while teacher-level factors tend to be more associated with the use of cognitive activation.

The results can provide important insights for the elaboration of policy. In particular, the consolidation of professional learning communities can help to promote several of the factors identified in this section. Previous TALIS studies have shown that professional learning communities can be effective arenas for teacher collaboration and the sharing of good teaching practices (Vieluf et al., 2012). Additionally, professional networks have been shown to be strongly associated with a teacher's self-efficacy (OECD, 2016c). Finally, as mentioned in Section 2, a support structure provided by the school leader is crucial to incentivising and consolidating this professional learning community (OECD, 2016b). Box 4.4 shows an interesting example from New South Wales where professional development is used to promote professional learning communities.

Box 4.4 Australia: New South Wales - *Great Teaching, Inspired Learning*

The *Great Teaching, Inspired Learning* education reforms underway in New South Wales (NSW), Australia, span the whole career cycle of a teacher from initial teacher education and induction for all beginning teachers, through to recognising and valuing experienced teachers and supporting aspiring school leaders. This series of initiatives aims to set a new direction for improving teacher quality and student learning outcomes in NSW schools.

A new model of support for beginning teachers is also being implemented, including strengthening the support for permanent, temporary and casual beginning teachers through improved induction models, online professional learning resources and streamlined probation and accreditation processes. There is also increased support for beginning teachers in their first two years of teaching by resourcing schools to increase release time for them to participate in a range of development activities, such as formal mentoring from an experienced teaching colleague.

Another element of the reforms aims to support teachers to build their professional capabilities through building communities of practice. The NSW Department of Education has partnered with the University of Newcastle to conduct research on the impact of teacher professional learning on teacher quality and student outcomes, using a Quality Teaching Rounds model. This model is based on objective observations of school and classroom practice by a Professional Learning Community, comprised of four or more teaching staff, to facilitate a common understanding and language of productive teaching and learning practices across school contexts.

Source: NSW Government (2016), Great Teaching Inspired Learning, www.dec.nsw.gov.au/our-services/schools/great-teaching-inspired-learning.

5. CONCLUSION AND POLICY RECOMMENDATIONS

Educational policy makers have acknowledged the relevance of investing in teachers and teaching. However, since the investment in the teacher workforce usually constitutes the largest share of the education budget, it is important to identify what classroom practices are the most cost-efficient and which policies can best support them. This report aims to tackle the following policy issues: how can policies better support instructional practices associated with improved outcomes and how can these policies be tailored to better meet the needs of different schools or student groups? It does so by addressing the following research questions: which teaching strategies are associated with better outcomes – that is to say, improved student performance and greater student engagement – and which school, student and teacher characteristics are associated with regular use of the teaching strategies that have the strongest association with student outcomes?

The TALIS-PISA link data presented itself as the ideal vehicle to answer these questions. It is a unique dataset that allows linking the rich data surrounding teachers' practices collected by TALIS, with students' performance and socio-demographic information collected by PISA. In addition, it allows for exploring the associations between teaching practices, school and classroom contexts, as well as student cognitive and non-cognitive outcomes in different national contexts. Eight countries decided to participate in the TALIS-PISA link option of the TALIS 2013 study: Australia, Finland, Latvia, Mexico, Portugal, Romania, Singapore and Spain. In order to best examine the factors associated with the use of specific teaching strategies, the report focused on one school subject, mathematics, which is the main subject of the PISA 2012 assessment and the TALIS-PISA link option.

An important limitation of the study is that the link between the TALIS and the PISA surveys operates at the school level and not at the classroom level. This means that no direct relation can be drawn between a teacher and his/her students. What is measured by the aggregation of teacher or student individual data at the school level relates to a school's overall context and needs to be interpreted accordingly. Therefore, the reported analyses may be fairly conservative, to the extent that an association between teachers' practice aggregated at the school level and individual student outcomes might not be significant, while a teacher's practice might truly contribute to individual student outcomes.

Finally, it is important to take into account that this study was based on the findings of only eight countries and, thus, inferences regarding frequencies and associations to other national contexts should be made carefully. These findings should be considered as tentative correlations that should be explored further in larger scale studies.

What are the most common teaching strategies?

The analysis of mathematics teachers' classroom practices has highlighted the existence of three underlying teaching strategies, referred to as active learning, cognitive activation and teacher-directed instruction (see Section 2). The active learning strategy consists of promoting the engagement of students in their own learning. It typically includes practices such as group work, use of information and communication technology, or student self-assessment. Cognitive activation consists of practices capable of challenging students in order to motivate them and stimulate higher-order skills, such as critical thinking, problem solving and decision making. Teacher-directed instruction encompasses practices based on lecturing, memorisation and repetition, where the main actor is the teacher who is responsible for transmitting knowledge to receptive students. Overall, these strategies are not mutually exclusive and teachers tend to engage in one or another type of strategy with different degrees of frequency.

Results showed that teacher-directed instruction is the most frequently used strategy. This means that practices such as presenting a summary of the lesson content, stating the learning goals of the instruction or asking short, fact-based questions are some of the most common teaching practices across participating countries. On the other hand, the active learning strategy is the least frequently used strategy.

A possible explanation for teacher-directed instruction being so common across participating countries is that this type of strategy is less time-consuming than active learning and cognitive activation and requires less commitment from disengaged students. Both active learning and cognitive activation require more planning and more student dedication than teacher-directed instruction. At the same time, active learning and cognitive activation feed from more sophisticated practices than teacher-directed instruction. Echazarra et al. (2016) argues that, overall, student-oriented practices produce a certain level of classroom disruptiveness, the management of which necessitates the use of time-consuming strategies. Teachers that need to cover lengthy curriculum or focus on preparing for standardised tests may not have sufficient time to prepare for these lessons. As results from PISA have shown, only 23% of students from OECD countries have reported that their teachers used incurred in student-oriented practices (Boardman and Woodruff, 2004). It is, thus, likely that not many teachers have been adequately trained to manage and implement the practices related to both of these strategies.

Therefore, augmenting the number of planning hours for teachers can provide them with more time to develop complex teaching strategies. Providing support and advice in dealing with disruptive classrooms would allow for fewer interruptions, better time management and the potential to innovate in the lesson. Likewise, supplying teachers with professional development activities focusing on the implementation of active learning or cognitive activation can be helpful to introduce these strategies to teachers.

An interesting finding is that high achieving educational systems, such as Finland and Singapore, engage in these types of strategies much less often than teachers from other countries participating in the study. The same result is observed by looking most of the practices under each teaching strategy (Annex D). Although much more study is needed to explain this situation, there is a potential hypothesis. Due to the self-reporting nature of the TALIS survey, teachers may tend to over- or understate their engagement in particular teaching practices based on a notion of social-desirability. In other words, teachers may tend to answer following cultural patterns of what is desirable or expected of them. Nevertheless, a deeper exploration of this issue is needed to understand this scenario.

Teaching strategies: Schools make a difference

Overall, teachers who work in the same schools tend to adopt more similar teaching approaches than teachers from different schools and this “school effect” is observed for each teaching strategy (see Section 2). However there are important cross-country differences regarding the size and significance of this school effect. Among the eight participating countries, Latvia and Mexico show the strongest degree of similarity on teaching strategies between teachers in the same schools, while Singapore, on the contrary, is the only country where no school effect has been identified for any strategy. Singapore’s results would seem to indicate that the school does not exert a great influence on teaching strategies. In that case, teacher’s individual attributes, such as certification or years of experience could explain the differences in teaching strategies.

Teachers collaborate on and discuss their teaching practices, so it is not uncommon to observe that teachers from the same school “share” their practices. This “school effect” is observed for each teaching strategy. This has important implications for the design of induction and professional development programmes: these training initiatives need to take into consideration the contexts in which teachers work.

Since strategies seem to be more similar among teachers within the same school than with teachers from different schools, a school-embedded approach to professional development, i.e. participating in professional networks, undertaking collaborative research, peer observation etc., is recommended. Trying to instil good teaching strategies in an isolated teacher may be unsuccessful if his or her colleagues at the school do not also engage or participate in these strategies. Teachers who have participated in the training of good classroom practices could work as mentors to other teachers and share their experience, since the results in this paper have shown there is a strong tendency to share practices within schools.

Thus, school leaders should seek to foster the collaboration of their staff in order to encourage and promote good teaching strategies.

Which teaching strategies are associated with better achievement?

Which teaching strategies are associated with improved mathematics performances? The findings show that, overall, a frequent use of the cognitive activation strategy, which stimulates student critical thinking, problem-solving and decision making, is associated with higher mathematics performances (see Section 3). This association is particularly strong in Australia, Latvia, Portugal, and Romania. These types of practices encourage students to solve problems in more than one way, explain their thinking on complex problems and be innovative in their work.

On the other hand, in most countries in this study, no positive association was found between teacher-directed instruction and student achievement in mathematics. A possible explanation for this lack of association is that teacher-directed strategies are more often used with low-performing students (Echazarra et al., 2016). However, it is important to note that the implementation of teacher-directed strategies should not necessarily be interpreted as something negative. Presenting clear instructions, or providing a summary of previous lessons, are an important component of a successful learning climate. Indeed, a previous study conducted by the OECD has shown that teacher-directed practices are positively associated with the likelihood of answering easy items on the PISA 2012 mathematics test (Echazarra et al., 2016). Since this study shows that, when teacher-directed instruction becomes the most frequently used type of instruction it may have unfavourable consequences on student learning, the issue may be for the teacher to find the right balance: when, in what way and with whom is it appropriate to use this type of practice?

Finally, the association between the implementation of active learning practices and student mathematics achievement does not show a clear pattern across countries. In Australia and Portugal there is a strong negative association between active learning and student achievement, while Mexico, Romania and Spain show a clear positive association. The reason for these differences might be that, even if teachers report implementing an active learning strategy, the way they implement it may vary considerably across countries. More research is need at the classroom level to observe and explore the difference in the implementation of teaching strategies that a self-reporting survey such as TALIS is not able to provide.

Finland and Singapore did not show a significant association between any teaching strategy and student mathematics outcomes. At the same time, Romania and Mexico are the countries that more frequently engage in these teaching strategies and exhibit a positive association with student outcomes when applying active learning strategies (both Mexico and Romania) and cognitive activation strategies (Romania only).

This poses the question: why are Mexico and Romania not among of the top performing systems? One possibility is that, although teaching strategies are a crucial element for improving student outcomes, they are not the only variable that matters in this association. Student outcomes are a complex product of student, teacher and school factors. This analysis has isolated a single variable – teaching strategies – but there may be other factors not taken into account by the model use here that may overshadow the overall contribution of teaching strategies in the aforementioned countries.

Does the link between teaching strategies and students' achievement vary according to the background of the students?

Overall, the contributions of the three teaching strategies to student mathematics performance seem more pronounced in socio-economically advantaged schools than in disadvantaged ones (see Section 3). This suggests that students enrolled in schools with a more advantaged background are more sensitive to teachers' teaching strategies than those of students in disadvantaged schools, regardless of whether these strategies tend to be associated with lower or higher performances. For example, teacher-directed instruction is found to be significantly associated with lower mathematics performances in socio-economically advantaged schools, while this association is not significant for students enrolled in disadvantaged schools. In other words, in socio-economically disadvantaged schools, the implementation of teacher-directed instruction does not have a negative contribution to student achievement, while it has one in socio-economically advantaged schools. This result is coherent with previous research showing that students in socio-economically deprived schools benefit somewhat from teacher-directed practices (Echazarra et al., 2016).

The positive association found between the cognitive activation strategy and student mathematics achievement is also stronger in socio-economically advantaged schools than in disadvantaged ones. A possible explanation for this is that schools with a higher proportion of disadvantaged students usually have fewer resources and fewer qualified teachers than schools with students coming from more advantaged socio-economic backgrounds. Indeed, TALIS results have shown that support for teachers to improve their practice is less present in socio-economically disadvantaged schools (OECD, 2014; OECD, 2016). Furthermore, socio-economically disadvantaged students are more likely to be exposed to teacher-directed practices than cognitive activation practices (Echazarra et. al, 2006). In addition, schools with a low socio-economic status tend to experience more disruptive classroom environments, which may make the implementation of demanding teaching strategies, such as cognitive activation, more difficult.

Thus, teacher training programmes seeking to improve teaching practices must take into account the social context in which the teacher performs and provide support in managing challenging classroom environments.

Which teaching strategies are associated with greater student engagement?

This report has analysed how teaching strategies implemented by the mathematics teachers of a school relate to students' interest and confidence in mathematics (see Section 3). The report only found significant associations in a few participating countries. For example, in Finland, a more frequent use of cognitive activation practices is strongly associated with greater student interest in mathematics. In Romania, the more often teachers use the active learning strategy, the more interested the students are in mathematics. Greater student confidence in mathematics is associated with a more frequent use of the active learning strategy in Singapore and of the cognitive activation strategy in Latvia. While a few relationships are significant in a few countries, no consistent pattern could be identified across all participating countries. The lack of significant results might be due to the fact that students' attitudes towards mathematics and learning do not rely as much on teaching practices as they do on other educational factors, such as the classroom and school climate.

What policies can better support teacher instruction strategies found to be associated with improved student outcomes?

Overall, two teaching strategies – cognitive activation and active learning – are found to be associated with better student achievement in mathematics (at least for several of the countries). What school and classroom factors can enable the implementation of these promising practices? Are certain teacher characteristics associated with a greater use of these strategies? These are important questions, since policy makers need to know in which areas to invest in order to improve teaching and, ultimately, learning.

Section 4 has examined how a wide range of factors relate to the use of each of both strategies. The results show that teacher- and classroom-level factors, such as teachers' beliefs about their role and efficiency, teacher co-operation with other teachers, as well as the classroom's climate and composition, matter more than school-level factors such as the school sector, policies, practices and the composition of the school. This suggests that policies should target factors that are as close as possible to teachers' working environments.

Teacher self-efficacy is the only studied factor that is associated with a more frequent use of both strategies in *all* participating countries. Teacher self-efficacy refers to the confidence that teachers have in teaching and managing their classroom. Teachers must, indeed, feel confident in their capabilities in order to implement relevant teaching strategies.

Which education policies can best support teacher self-efficacy? Results from TALIS 2013 have shown that the level of self-efficacy among teachers in a country is highly correlated with teachers' participation rates in professional development (OECD, 2014). In other words, the more teachers participate in training activities, the more confident they should feel about their ability to teach, and the more they should use cognitive activation and active learning strategies. In almost all participating counties, results show that the more a teacher co-operates with other teachers in the school, the more frequently he or she uses cognitive activation and active learning strategies. This suggests that exchanging ideas and experience about teaching with other teachers, observing each other's classrooms or providing mutual support increases the likelihood of implementing relevant teaching strategies. Thus school policies should encourage teachers not to work as isolated agents, but rather to engage in professional networks and in collaboration with colleagues.

Teachers holding constructivist beliefs about their teacher's role are also more likely to implement both teaching strategies. This is result is not entirely unexpected, as a constructivist approach towards teaching puts the student at the centre of their learning and both cognitive activation and active learning strategies can be categorised under this approach. Yet, this stresses the importance of designing training activities with a strong conceptual or theoretical component drawn from a constructivist approach towards learning.

A disciplinary classroom climate is also positively associated with a more regular use of these strategies in most countries. This is consistent with one of the previous remarks regarding the potential detrimental effect that disruptive classrooms can have on the implementation of more demanding teaching practices.

Some dimensions of the classroom's composition also matter for the use of one or the other teaching strategy, such as the share of high achievers, or students coming from an immigrant background, or the heterogeneity of student performance within a classroom. Nevertheless, the directions of these associations (e.g. positive or negative) vary considerably across the participating countries. This might result from the country or school regulations surrounding student diversity policies.

Finally, while most of the examined factors contribute in a similar way to the adoption of either strategy, some differences arise in some cases. For instance, it seems that classroom-level factors matter more for the use of active learning practices, while teacher-level factors tend to be more associated with the use of cognitive activation. This probably comes from the fact that the active learning strategy involves more group work and is thus more dependent on the classroom's climate and attributes than other teaching strategies.

Final policy recommendations

Cognitive activation and, to a lesser extent, active learning strategies, are associated with better student achievement and, in some countries, with greater student engagement. Thus, teacher training programmes, from pre-service teacher training to induction programmes and professional development activities should emphasise the importance of these strategies. Among other attributes, it is important that these training programmes build upon a school-embedded and context-sensitive approach, since the positive associations of these strategies with student outcomes varies depending on the school's and classroom's settings.

The findings of this report highlight a further key ingredient of policies that aim at increasing students' learning through improved teaching quality: the development and support of teacher co-operation. Thus, the promotion of professional learning communities that encourage teachers to work and teach jointly, exchange teaching materials with colleagues, engage in discussions about the learning development of their students, observe other teachers' classes and provide feedback are likely to foster the adoption of good and well-suited teaching strategies. Teachers who have participated in the training of good classroom practices could work as mentors to other teachers and share their experience, since the results in this report have shown there is a strong tendency to share practices within schools.

These initiatives cannot be carried out if the teachers do not have a support structure orienting their objectives and goals. Thus, principals and school leaders have a crucial role in developing and consolidating professional learning communities that foster teachers' co-operation, professional development and improving student learning.

ANNEX A: TECHNICAL NOTES ON THE ANALYSES IN THIS REPORT

Software

Statistical analyses were performed using SAS® software.

Exploratory factor analysis

In Section 2, an exploratory factor analysis (EFA) was performed on 3 390 teacher observations in order to investigate the possible underlying structure of a set of 24 classroom practices. In the analyses, teacher observations were weighted such that each of the eight participating country contributes equally to the international sample. The maximum likelihood estimation method was used to run the analyses.

A first EFA was performed in order to identify the number of underlying factors to extract. Several criteria were considered for extracting factors. Kaiser's criterion, which considers factors with an eigenvalue greater than 1, called for the extraction of three factors. The proportion criterion which keeps a factor if it accounts for more than a predetermined amount of the variance (in this case, 10%) also called for extracting three factors. So did the interpretability criterion. Therefore three factors were retained and extracted from the second EFA performed on the data. The second EFA was then run rotating the factor pattern so to allow the items to more distinctly group into factors.

Two criteria were considered for retaining practice items to define the extracted factors: (i) practice items with a factor loading of 0.30 or higher were retained; and (ii) a practice item was not allowed to define more than one factor. Box 2.2 in Section 2 lists the items retained to define each of the three factors (called teaching strategies) – active learning, cognitive activation and teacher-directed instruction.

The reliability of each extracted factor was assessed country by country, by looking at the internal consistency of the retained items, measured with Cronbach's coefficient alpha. Cronbach's coefficient alpha is on a scale from zero to one with a value closer to one being more reliable measurement and showing higher internal consistency. Table A1.1 below shows Cronbach's coefficient alphas as well as numbers of teacher cases by factor and country.

Table A.1 Reliability of each extracted factor, by country

	Number of observations	Factor 1: active learning	Factor 2: cognitive activation	Factor 3: teacher-directed instruction
Australia	411	0.63	0.75	0.6
Finland	319	0.64	0.56	0.57
Latvia	173	0.65	0.56	0.65
Mexico	155	0.62	0.71	0.58
Portugal	526	0.65	0.69	0.6
Romania	383	0.58	0.72	0.71
Singapore	706	0.75	0.66	0.65
Spain	717	0.65	0.59	0.65

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Factors scores (referred to as indices of teaching practices in Section 2) were calculated by averaging responses to the items retained to define the factor. The common practice of using the simple mean of the item responses rather than weighing them by the item factor loading was followed.

Statistics based on multilevel models

Statistics based on multilevel models include variance components (between- and within-school variance), the intra-class correlation coefficients derived from these components, and regression coefficients where this has been indicated. Multilevel models are generally specified as two-level regression models (with teacher and school levels in Sections 2 and 4, student and school levels in Section 3), with normally distributed residuals, and estimated with maximum likelihood estimation. In Section 3 where the dependent variable is mathematics performance, the estimation uses five plausible values for each student's performance on the mathematics scale.

In multilevel models, weights are used at the lower level (teacher or student). The purpose of these weights is to account for differences in the probabilities of teachers (respectively students) being selected in the sample. Since TALIS (respectively PISA) applies a two-stage sampling procedure, these differences are due to factors at both the school and the teacher (respectively student) levels.

In multilevel models, all supposedly continuous variables were standardised. The purpose of this standardisation is to allow comparing the size of the estimated regression coefficients in a regression.

The intra-class correlation coefficient is defined and estimated as: $\frac{\sigma_B^2}{\sigma_B^2+\sigma_w^2}$ where σ_W^2 and σ_B^2, respectively represent the within- and between-school variance estimates.

Because of the manner in which teachers (respectively students) were sampled, the within-school variation includes variation between classes as well as between teachers (respectively students).

Standard errors and significance tests

The statistics in this report represent estimates of national parameters based on samples of teachers and students, rather than values that could be calculated if every teacher and every student in every country had answered every question. Consequently, it is important to measure the degree of uncertainty of the estimates. Each estimate has an associated degree of uncertainty, which is expressed through a standard error.

Throughout the report, significance tests were undertaken to assess the statistical significance of the results. In the tables and charts used in this report, an estimate (for example a correlation coefficient, a regression coefficient, a variance component, etc.) is labelled as statistically significant when the risk of reporting an estimate as significant, if it is not, is contained at 5%, unless otherwise stated. When a 10% rather than a 5% threshold is used to test significance, it is states in the report.

Interpreting the results of the multilevel models in Section 3

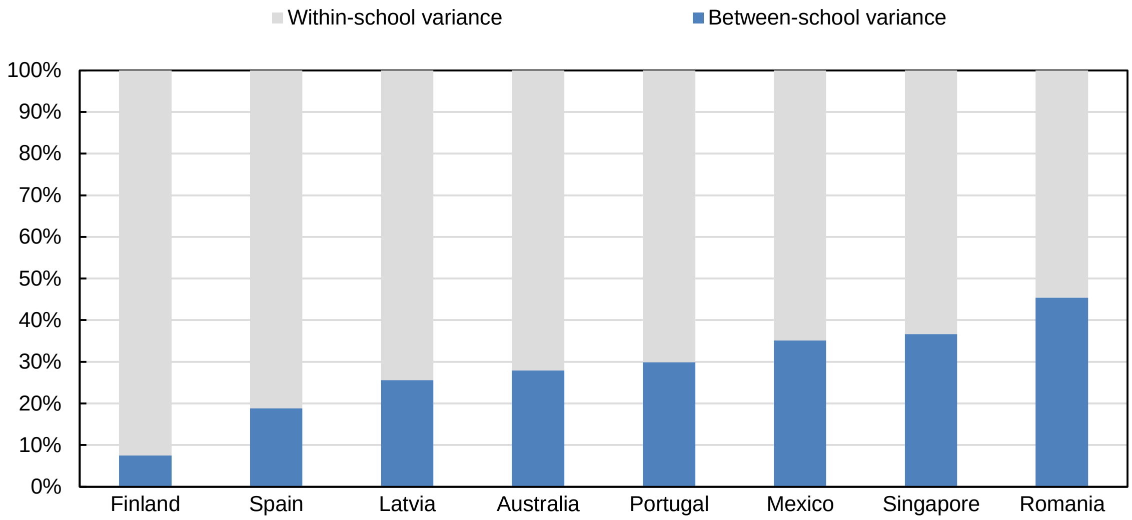
Using school- rather than teacher-level measures of teachers' teaching strategies (see previous section) has several implications for the interpretation of the analyses. First, the results will be even more reliable if the mathematics teachers from the same schools use teaching strategies with a more similar frequency. The more teachers of the same schools teach alike, the more school indices of teachers' teaching strategies represent good proxies of the teaching strategies used by the mathematics teacher of the assessed students.

Fortunately, teachers of the same schools do tend to teach more alike than teachers from different schools (see Figure 2.1 of Section 2). But the degree of similarity in teaching strategies among teachers of the same schools is not very high and it varies according to the teaching strategy and the country (see Section 2). The results of Section 3 must thus be interpreted in light of the findings reported in Section 2.

Second, the share of student differences in any outcome of interest that can be explained based on teachers' teaching strategies is limited: it cannot exceed the amount of variance in student outcomes that lies between schools. Yet, the share of variance in any student learning outcome which lies between schools (also referred to as the 'between-school variance') usually accounts for less than half of the total variation in student outcomes. Let's take the example of student mathematics performances. Figure A1.1 shows a breakdown of the total variation in student performances at the PISA 2012 mathematics test for each participating country. The total height of a bar indicates the total variance in student mathematics performance. Each bar comprises two areas: the grey one represents the share of variance that accounts for student differences in mathematics performance within schools; the blue one represents differences in average performances between schools.

For all countries, most of the variance in student performance lies between students within schools (the grey area of the chart). In other words, the between-school variance (the blue area of the chart) accounts for a somewhat limited share of the total variance. Depending on the country, it represents between 8% (Finland) and 45% (Romania) of the total variation in student performance. This implies that the measures of teachers' teaching strategies introduced in the analyses can only explain up to 8% of student differences in mathematics performances in Finland, respectively 45% in Romania. This is obviously a limit to the exploratory power of the measures used. As they are taken at the school level, the indices of teaching strategies can only explain differences between schools' average performances, which represent less than half of the total differences between students' mathematics performances.

Figure A.1 Breaking down the total variance in student mathematics performances between and within schools



Countries are ranked in ascending order of the between-school variance in student mathematics performance.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Replicating the same variance decomposition for student attitudinal variables, the share of variance that lies between schools was found not to exceed 10% of the total variance in the concerned student outcome, which is much less than for student performance. This means that the explanatory power of the measures of teaching strategies used is even more limited in the analyses of students' attitudes than in those of students' mathematics performances.

To conclude, the results of Section 3 are probably being quite conservative. It is indeed likely that, in using school-level measures of teachers' teaching strategies as a proxy for teacher-level measures of a teacher's teaching strategies, the true relationship between a teacher's teaching approaches and a student's given outcome will be underestimated. The measures used in the analyses only provide information about the general pattern of teaching strategies used by the group of mathematics teachers in the school.

ANNEX B: TALIS-PISA LINK DATA

Table B.1 Correlation between the frequencies with which teachers use teaching strategies

	Active learning and cognitive activation		**Active learning and teacher-directed instruction**		**Cognitive activation and teacher-directed instruction**	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Australia	0.48	0.04	0.30	0.06	0.48	0.05
Finland	0.35	0.06	0.35	0.07	0.56	0.05
Latvia	0.42	0.08	0.32	0.10	0.44	0.06
Mexico	0.51	0.11	0.55	0.09	0.56	0.08
Portugal	0.38	0.05	0.37	0.06	0.53	0.04
Romania	0.50	0.07	0.36	0.06	0.38	0.06
Singapore	0.43	0.03	0.41	0.04	0.47	0.03
Spain	0.34	0.05	0.35	0.05	0.51	0.05

Note: Linear correlation coefficients.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Table B.2 Between-school variance in teachers' use of teaching strategies

	Active learning		**Cognitive activation**		**Teacher-directed instruction**	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Australia	0.19	0.06	0.26	0.08	0.09	0.06
Finland	0.26	0.13	0.18	0.15	0.20	0.11
Latvia	0.40	0.13	0.48	0.08	0.35	0.10
Mexico	0.36	0.15	0.50	0.15	0.24	0.17
Portugal	0.17	0.05	0.19	0.05	0.15	0.05
Romania	0.12	0.10	0.16	0.07	0.33	0.08
Singapore	0.15	0.12	0.04	0.14	0.09	0.12
Spain	0.34	0.08	0.17	0.07	0.23	0.05

Note: Intra-class correlation coefficients.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Table B.3 Breaking down the total variance in student mathematics performances between and within schools

	Total variance	**Between-school variance**	**Within-school variance**
Finland	7063	530	6533
Latvia	6599	1691	4908
Mexico	5517	1940	3578
Australia	9322	2602	6720
Portugal	8865	2653	6212
Romania	6577	2986	3591
Singapore	11103	4070	7033
Spain	7717	1454	6263

Countries are ranked in ascending order of the between-school variance.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Table B.4 Relationship between teachers' teaching strategies and student mathematics performances

Block	Variables	Australia		Finland		Latvia		Mexico		Portugal		Romania		Singapore		Spain	
		Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Teaching strategies	Active learning	-0.08*	0.019	-0.022	0.018	-0.055+	0.03	0.052*	0.025	-0.055*	0.013	0.043*	0.008	0.011	0.012	0.018*	0.008
	Cognitive activation	0.111*	0.031	0.021	0.018	0.123*	0.022	-0.011	0.025	0.070*	0.015	0.119*	0.011	0.011	0.013	-0.003	0.01
	Teacher-directed	-0.042*	0.018	-0.016	0.016	-0.026+	0.014	-0.025	0.027	-0.070*	0.013	-0.052*	0.010	0.000	0.013	-0.03*	0.009
Control variables	Female	-0.025*	0.012	0.005	0.014	-0.048+	0.029	-0.052*	0.009	-0.037*	0.006	-0.031*	0.007	0.004	0.009	-0.039*	0.006
	Immigrant background	0.036*	0.013	-0.219*	0.030	-0.063	0.053	-0.125*	0.032	-0.050*	0.022	-0.007	0.056	0.024*	0.010	0.063*	0.01
	PISA Index of Economic, Social and Cultural Status (ESCS)	0.167*	0.028	0.25*	0.021	0.261*	0.027	0.035	0.042	0.299*	0.020	0.175*	0.019	0.178*	0.014	0.295*	0.019
	Teacher co-operation	-0.031*	0.013	0.002	0.015	-0.016	0.019	-0.080*	0.023	0.005	0.016	-0.036	0.009	-0.006	0.012	0.005	0.011
	School Index of Socio-economic, Cultural and Social status (ESCS)	0.589*	0.049	0.157*	0.045	0.457*	0.052	0.563*	0.055	0.413*	0.029	0.696*	0.022	0.864*	0.027	0.259*	0.025
	School average of constructivist beliefs	0.008	0.012	-0.006	0.017	-0.062*	0.019	-0.014	0.019	-0.041*	0.013	0.033*	0.009	0.002	0.012	0.026*	0.007
	School with no ability grouping for any classes	0.036+	0.019	0.035*	0.014	-0.004	0.029	0.016*	0.005	0.022*	0.006	0.020*	0.004	-0.018	0.021	0.005	0.006
	School with one form of ability grouping between some classes	-0.021*	0.005	0.019	0.013	0.017	0.026	-0.018*	0.007	-0.036*	0.006	0.003	0.003	0.007	0.009	0.000	0.004
	Private school	-0.034*	0.011	0.016	0.031	-0.023	0.056	-0.046*	0.012	0.020*	0.007	0.000	0.000	0.05+	0.026	0.13*	0.004

Note: Multilevel regression model (teacher and school levels): students' mathematics achievement regressed on all the variables presented in this table. * indicates values that are statistically significant at the 5% threshold. + indicates values that are statistically significant at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Table B.5 Relationship between teachers' teaching strategies and student mathematics performances in socio-economically disadvantaged schools

Block	Variable	Australia		Finland		Latvia		Mexico		Portugal		Romania		Singapore		Spain	
		Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Teaching strategies	Active learning	-0.069+	0.040	-0.012	0.021	0.053	0.058	-0.009	0.044	-0.116*	0.015	0.076*	0.009	0.008	0.017	0.023+	0.013
	Cognitive activation	0.026	0.051	-0.008	0.016	0.114*	0.044	0.048	0.041	0.046*	0.022	0.013	0.015	0.021	0.019	0.031+	0.016
	Teacher-directed	0.012	0.026	0.000	0.021	-0.057+	0.030	0.038	0.035	-0.077*	0.019	-0.021	0.015	-0.014	0.022	-0.036*	0.012
Control variables	Female	-0.007	0.014	0.012	0.021	-0.012	0.039	-0.046*	0.012	-0.040*	0.008	-0.021*	0.009	0.007	0.011	-0.038*	0.009
	Immigrant background	0.002	0.021	-0.236*	0.047	0.012	0.079	-0.115*	0.038	0.012	0.032	0.065	0.083	0.045*	0.018	-0.065*	0.011
	PISA Index of Economic, Social and Cultural Status (ESCS)	0.185*	0.038	0.219*	0.030	0.300*	0.036	0.056	0.054	0.331*	0.032	0.188*	0.030	0.179*	0.017	0.301*	0.028
	Teacher co-operation	0.033	0.029	0.015	0.020	-0.061*	0.025	-0.179*	0.036	0.032	0.021	-0.014	0.012	0.048*	0.016	-0.043*	0.014
	School average of constructivist beliefs	0.014	0.025	-0.018	0.020	-0.113*	0.029	0.009	0.029	-0.057*	0.019	0.050*	0.014	-0.016	0.016	0.015	0.012
	School with no ability grouping for any classes	0.143*	0.049	0.044*	0.020	0.047	0.051	0.058*	0.010	0.055*	0.009	0.013+	0.007	0.007	0.039	-0.019+	0.010
	School with one form of ability grouping between some classes	-0.016	0.011	0.022	0.020	0.005	0.037	0.016	0.015	-0.065*	0.008	-0.004	0.004	0.025+	0.014	-0.009	0.006
	Private school	0.047+	0.026	0.000	0.000	0.086+	0.052	0.019	0.018	0.030*	0.012	0.000	0.000	0.088**	0.028	0.038*	0.006

Note: Multilevel regression model (teacher and school levels): students' mathematics achievement regressed on all the variables presented in this table. * indicates values that are statistically significant at the 5% threshold. $^{+}$ indicates values that are statistically significant at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Table B.6 Relationship between teachers' teaching strategies and student mathematics performances in socio-economically advantaged schools

Block	Variable	Australia		Finland		Latvia		Mexico		Portugal		Romania		Singapore		Spain	
		Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Teaching strategies	Active learning	-0.056*	0.020	-0.039	0.032	-0.136*	0.028	0.252*	0.042	-0.002	0.019	-0.022*	0.010	0.149*	0.017	0.004	0.011
	Cognitive activation	0.226*	0.029	0.055+	0.031	0.092*	0.024	-0.299*	0.040	0.149*	0.025	0.224*	0.017	0.093*	0.015	0.006	0.013
	Teacher-directed	-0.203*	0.029	-0.027	0.027	-0.042+	0.024	-0.102*	0.051	-0.087	0.018	-0.102*	0.011	-0.074*	0.019	-0.042*	0.017
Control variables	Female	-0.042*	0.016	-0.193*	0.036	-0.085*	0.040	-0.057*	0.017	-0.034*	0.010	-0.042*	0.009	0.002	0.013	-0.041*	0.009
	Immigrant background	0.060*	0.016	-0.236*	0.047	-0.131+	0.073	-0.151*	0.054	-0.081*	0.025	-0.054	0.062	0.006	0.014	-0.060*	0.014
	PISA Index of Economic, Social and Cultural Status (ESCS)	0.174*	0.042	0.295*	0.028	0.243*	0.036	0.033	0.066	0.290*	0.022	0.177*	0.027	0.193*	0.021	0.304*	0.021
	Teacher co-operation	-0.066*	0.018	-0.003	0.022	0.093*	0.036	0.003	0.036	-0.093*	0.018	-0.110*	0.012	-0.112*	0.017	0.067*	0.015
	School average of constructivist beliefs	-0.081*	0.014	0.008	0.024	-0.032	0.033	-0.117*	0.045	-0.016	0.018	-0.013	0.010	0.063*	0.019	0.026*	0.012
	School with no ability grouping for any classes	-0.055*	0.016	0.030	0.020	-0.011	0.043	-0.014	0.013	0.033*	0.008	0.027*	0.004	-0.012	0.025	0.024*	0.009
	School with one form of ability grouping between some classes	-0.004	0.011	0.013	0.019	0.009	0.035	-0.088*	0.016	-0.017	0.010	0.004	0.006	-0.079*	0.013	0.010*	0.004
	Private school	-0.071*	0.015	0.015	0.032	-0.025	0.076	-0.034	0.024	-0.004	0.010	0.000	0.000	0.000	0.000	0.028*	0.005

Note: Multilevel regression model (teacher and school levels): students' mathematics achievement regressed on all the variables presented in this table. * indicates values that are statistically significant at the 5% threshold. + indicates values that are statistically significant at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Table B.7 Relationship between teachers' teaching strategies and student mathematics interest

Block	Variable	Australia		Finland		Latvia		Mexico		Portugal		Romania		Singapore		Spain	
		Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Teaching strategies	Active learning	0.008	0.029	-0.025	0.017	-0.043	0.030	0.026	0.044	0.013	0.017	0.052*	0.021	-0.005	0.019	0.012	0.011
	Cognitive activation	0.042	0.043	0.058*	0.019	0.010	0.024	-0.005	0.032	-0.033+	0.019	0.003	0.020	0.014	0.022	-0.011	0.013
	Teacher-directed	-0.028	0.024	-0.046*	0.020	-0.004	0.030	-0.019	0.031	0.058*	0.021	0.033	0.021	-0.023	0.021	0.017	0.012
Control variables	Female	-0.054*	0.013	-0.077*	0.016	-0.082*	0.033	-0.013	0.013	-0.006	0.011	-0.005	0.007	-0.033*	0.011	-0.025*	0.007
	Immigrant background	0.056*	0.015	0.287*	0.039	0.174*	0.072	0.072*	0.035	0.026	0.021	-0.072	0.085	0.041*	0.014	0.076*	0.011
	Student achievement in mathematics	0.358*	0.038	0.373*	0.023	0.181*	0.030	0.200*	0.049	0.258*	0.027	-0.144*	0.025	0.141*	0.020	0.272*	0.024
	PISA Index of Economic, Social and Cultural Status (ESCS)	0.032	0.035	0.059*	0.022	0.019	0.033	-0.114*	0.056	0.012	0.024	0.028	0.024	-0.027	0.017	0.027	0.023
	Teacher co-operation	-0.030	0.024	0.003	0.022	0.017	0.031	0.017	0.033	0.051*	0.019	-0.013	0.022	-0.017	0.020	0.001	0.013
	School Index of Socio-economic, Cultural and Social status (ESCS)	-0.298*	0.067	0.061	0.054	-0.046	0.057	-0.239*	0.079	-0.134*	0.044	0.116*	0.040	-0.258*	0.044	-0.151*	0.034
	School average of constructivist beliefs	-0.013	0.020	0.015	0.021	0.019	0.030	-0.027	0.029	0.022	0.014	-0.039*	0.017	-0.030+	0.018	0.008	0.011
	School with no ability grouping for any classes	0.007	0.020	0.003	0.015	-0.066*	0.032	-0.017	0.011	-0.002	0.013	-0.009	0.010	0.013	0.030	-0.019+	0.010
	School with one form of ability grouping between some classes	0.016+	0.009	-0.021	0.017	0.027	0.031	-0.003	0.009	0.006	0.012	-0.024*	0.007	-0.014	0.012	-0.001	0.004
	Private school	0.011	0.014	-0.044	0.029	-0.013	0.076	-0.018+	0.011	-0.017	0.014	0.000	0.000	0.011	0.044	0.000	0.005

Note: Multilevel regression model (teacher and school levels): students' mathematics achievement regressed on all the variables presented in this table. * indicates values that are statistically significant at the 5% threshold. + indicates values that are statistically significant at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Table B.8 Relationship between teachers' teaching strategies and student confidence about mathematics

Block	Variable	Australia		Finland		Latvia		Mexico		Portugal		Romania		Singapore		Spain	
		Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Teaching strategies	Active learning	-0.015	0.035	-0.003	0.016	0.022	0.022	-0.085*	0.041	0.010	0.025	0.018	0.022	0.030+	0.016	-0.021	0.014
	Cognitive activation	-0.014	0.043	0.025	0.019	0.053+	0.030	0.033	0.038	0.031	0.027	-0.016	0.024	0.003	0.019	0.014	0.014
	Teacher-directed	0.039	0.029	0.005	0.017	-0.006	0.024	0.041	0.036	-0.010	0.020	0.035+	0.020	-0.042*	0.015	0.008	0.014
Control variables	Female	0.054*	0.012	0.143*	0.012	0.025	0.026	0.015	0.010	0.018+	0.010	-0.007	0.008	0.056*	0.010	0.049*	0.008
	Immigrant background	-0.017	0.018	-0.068*	0.022	0.016	0.064	-0.049	0.031	0.001	0.018	-0.099	0.083	-0.068*	0.014	-0.003	0.010
	Student achievement in mathematics	-0.457*	0.036	-0.529*	0.023	-0.528*	0.035	-0.404*	0.053	-0.377*	0.028	-0.332	0.027	-0.432*	0.019	-0.306*	0.023
	PISA Index of Economic, Social and Cultural Status (ESCS)	0.000	0.033	0.055*	0.019	0.019	0.033	-0.060	0.042	-0.073*	0.026	-0.039	0.024	-0.060*	0.016	-0.021	0.020
	Teacher co-operation	-0.028	0.022	-0.016	0.020	-0.010	0.025	0.014	0.029	-0.002	0.020	-0.034	0.017	0.007	0.015	0.012	0.013
	School Index of Socio-economic, Cultural and Social status (ESCS)	0.129+	0.077	0.167*	0.040	0.279*	0.073	0.117+	0.062	0.106*	0.037	-0.013	0.045	0.080*	0.040	0.120*	0.035
	School average of constructivist beliefs	0.021	0.018	0.020	0.022	-0.034	0.027	-0.020	0.027	-0.033+	0.017	0.009	0.019	0.002	0.012	-0.017	0.011
	School with no ability grouping for any classes	0.010	0.016	0.039*	0.015	-0.027	0.031	0.021*	0.009	0.017	0.013	0.005	0.011	-0.020	0.036	0.017+	0.009
	School with one form of ability grouping between some classes	-0.013	0.012	0.027+	0.015	-0.002	0.031	0.021*	0.009	0.015	0.012	-0.001	0.007	0.011	0.013	0.000	0.005
	Private school	0.030+	0.017	0.012	0.021	0.084+	0.045	-0.034*	0.010	0.016	0.015	0.000	0.000	0.026	0.037	0.007	0.005

Note: Multilevel regression model (teacher and school levels): students mathematics achievement regressed on all the variables presented in this table. * indicates values that are statistically significant at the 5% threshold. + indicates values that are statistically significant at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Table B.9 Detailed content of the four overarching blocks

Block	Sub-block	Factor
School attributes, practices and policies		School with no ability grouping for any classes
		School with one form of ability grouping between some classes
		Private school
		Teacher determines course content, including curricula
		Teacher chooses learning materials
School composition	**School socio-demographic composition and mathematic achievement**	School ESCS: mean
		School ESCS: standard deviation
		School mathematics performance: mean
		School mathematics performance: standard deviation
		Proportion of girls in the school
		Proportion of immigrant students in the school
	School climate and student attitudes toward mathematics	School index of confidence towards mathematics: mean
		School index of confidence towards mathematics: standard deviation
		School index of attitudes towards learning outcomes: mean
		School index of attitudes towards learning outcomes: standard deviation
		School index of attitudes towards learning activities: mean
		School index of attitudes towards learning activities: standard deviation
		School index of interest towards mathematics: mean
		School index of interest towards mathematics: standard deviation
Classroom composition and climate		Disciplinary climate
		Composition of the target classroom - proportion of …
		- students whose first language is different from language of instruction
		- low academic achievers
		- students with special needs
		- students with behavioural problems
		- students from socio-economically disadvantaged homes
		- academically gifted students
Teacher characteristics, beliefs and professional practices	**Teacher background and employment status**	Total number of years of experience as a teacher
		Female teacher
		Teacher has a fixed-term contract
		Teacher has completed initial training
	Teacher relations with other school stakeholders	Teacher co-operation
		Teacher-student relations
	Teacher perception of their work and work environment	Constructivist beliefs
		Effective professional development
		Teacher job satisfaction
		Need for professional development in subject matter and pedagogy
		Teacher self-efficacy

Note: Multilevel regression model (teacher and school levels): students' mathematics achievement regressed on all the variables presented in this table. * indicates values that are statistically significant at the 5% threshold. + indicates values that are statistically significant at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Table B.10 Relationship between the use of cognitive activation and school and teacher characteristics

Block	Factor	Australia		Finland		Latvia		Mexico		Portugal		Romania		Singapore		Spain	
		Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Teacher perception of their work and work environment	Constructivist beliefs	0.361*	0.123	-0.002	0.042	0.045	0.058	0.549	0.409	0.123*	0.060	0.231*	0.093	0.081*	0.025	0.221*	0.097
	Effective professional development	0.127	0.116	-0.009	0.057	0.077	0.059	-0.562	0.712	0.072	0.069	0.179*	0.069	-0.012	0.023	0.083	0.072
	Teacher job satisfaction	-0.074	0.122	0.081	0.058	-0.019	0.057	-0.002	0.558	-0.057	0.054	-0.065	0.110	-0.052*	0.026	0.119	0.131
	Need for professional development in subject matter and pedagogy	-0.039	0.121	0.014	0.062	0.033	0.053	-0.581	0.563	-0.032	0.056	0.081	0.089	0.004	0.023	-0.262*	0.091
	Teacher self-efficacy	0.908*	0.134	0.368*	0.063	0.152*	0.054	1.055*	0.316	0.323*	0.073	0.309*	0.085	0.228*	0.025	0.347*	0.107
Teacher relations with other school stakeholders	Teacher co-operation	0.394*	0.142	0.032	0.074	0.139*	0.055	0.668	0.608	0.250*	0.063	0.114	0.097	0.057*	0.024	0.368*	0.103
	Teacher-student relations	0.134	0.120	-0.020	0.070	-0.052	0.082	-0.103	0.610	0.229*	0.073	0.326*	0.086	0.026	0.024	0.017	0.109
Classroom composition and climate	Disciplinary climate	-0.035	0.169	0.028	0.058	0.098+	0.058	-0.360	0.544	-0.025	0.082	0.252*	0.074	0.059*	0.026	0.329*	0.095
	Composition of the Target Classroom - Proportion of …																
	- Students whose first language is different from language of instruction	0.281*	0.139	0.003	0.050	0.168*	0.063	0.558	0.784	0.008	0.087	0.084	0.089	-0.050+	0.029	-0.082	0.073
	- Low academic achievers	-0.059	0.115	0.032	0.059	0.010	0.063	-0.009	0.685	0.060	0.082	-0.143	0.109	0.011	0.029	-0.170	0.129
	- Students with special needs	-0.162	0.126	-0.052	0.079	0.061	0.048	0.519	0.752	-0.106+	0.061	-0.173+	0.089	-0.012	0.026	0.041	0.100
	- Students with behavioural problems	-0.055	0.236	-0.037	0.070	-0.036	0.088	1.178	0.793	-0.152+	0.088	0.087	0.073	0.044	0.028	0.064	0.103
	- Students from socio-economically disadvantaged homes	0.206	0.177	0.038	0.058	-0.047	0.065	0.482	0.585	0.064	0.087	0.194	0.119	-0.025	0.027	0.039	0.069
	- Academically gifted students	0.208+	0.112	-0.010	0.076	0.017	0.054	0.121	0.517	0.036	0.038	-0.049	0.094	0.029	0.019	-0.030	0.076
School socio-demographic composition and mathematic achievement	School ESCS: mean	0.162	0.194	-0.010	0.057	-0.082	0.099	0.706	1.086	0.129	0.083	-0.299*	0.134	-0.024	0.039	0.014	0.071
	School ESCS: standard deviation	-0.159	0.111	-0.065	0.055	0.052	0.057	-1.979	1.442	0.023	0.070	-0.154*	0.072	-0.017	0.025	0.005	0.049
	School mathematics performance: mean	0.061	0.183	-0.003	0.067	0.171*	0.063	-1.102	0.726	0.107	0.091	0.258*	0.129	0.019	0.051	0.044	0.085
	School mathematics performance: standard deviation	0.127	0.094	0.128*	0.045	-0.095+	0.054	-0.103	1.427	-0.083	0.053	-0.168*	0.081	-0.015	0.032	0.225*	0.057
	Proportion of girls in the school	-0.119	0.080	-0.018	0.052	-0.134*	0.040	0.483	0.544	-0.161*	0.074	0.062	0.080	0.067*	0.025	-0.012	0.059
	Proportion of immigrant students in the school	-0.088	0.157	0.076	0.048	0.085*	0.040	-0.125	0.668	0.019	0.080	-0.091*	0.040	0.058*	0.023	0.170*	0.064

Note: Multilevel regression model (teacher and school levels): students' mathematics achievement regressed on all the variables presented in this table. * indicates values that are statistically significant at the 5% threshold. + indicates values that are statistically significant at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Table B.10 Relationship between the use of cognitive activation and school and teacher characteristics *(continued)*

Block	Factor	Australia		Finland		Latvia		Mexico		Portugal		Romania		Singapore		Spain	
		Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Teacher background and employment status	Total number of years of experience as a teacher	0.045	0.106	-0.081+	0.048	-0.053	0.053	0.423	0.461	-0.084	0.072	-0.026	0.087	-0.060*	0.024	-0.056	0.093
	Female teacher	0.028	0.066	0.017	0.052	-0.029	0.143	0.077	0.155	0.133*	0.053	0.084+	0.044	-0.010	0.032	0.059	0.041
	Teacher has a fixed-term contract	0.052	0.074	-0.163	0.112	-0.256*	0.096	0.103	0.253	-0.006	0.073	-0.111	0.093	0.252*	0.095	-0.064	0.108
	Teacher has completed initial training	-0.289*	0.123	0.056	0.118	0.122+	0.072	0.194	0.141	0.021	0.049	0.063	0.141	-0.087	0.119	0.017	0.146
School climate and student attitudes toward mathematics	School index of confidence towards mathematics: mean	-0.022	0.098	0.054	0.054	0.086*	0.041	-1.223*	0.568	0.036	0.051	-0.139	0.115	0.017	0.036	0.116*	0.055
	School index of confidence towards mathematics: standard deviation	-0.183+	0.100	0.002	0.051	-0.003	0.076	0.558	0.488	0.019	0.036	-0.124	0.088	0.030	0.023	0.209*	0.063
	School index of attitudes towards learning outcomes: mean	0.242	0.150	0.032	0.087	0.032	0.079	0.283	0.555	-0.038	0.069	-0.117	0.105	-0.061*	0.029	0.051	0.071
	School index of attitudes towards learning outcomes: standard deviation	-0.183	0.159	0.099+	0.053	0.106	0.066	-0.667	0.678	0.050	0.064	-0.054	0.101	0.062*	0.029	0.042	0.062
	School index of attitudes towards learning activities: mean	-0.087	0.133	0.009	0.069	0.061	0.078	1.671*	0.644	-0.022	0.062	-0.150	0.100	0.013	0.026	0.066	0.080
	School index of attitudes towards learning activities: standard deviation	-0.027	0.101	-0.133*	0.051	-0.187*	0.086	-0.074	0.547	0.084+	0.050	-0.206*	0.079	-0.008	0.025	0.193*	0.087
	School index of interest towards mathematics: mean	-0.072	0.107	0.013	0.043	-0.035	0.049	1.578*	0.498	0.025	0.044	0.139	0.094	0.029	0.027	0.111+	0.057
	School index of interest towards mathematics: standard deviation	0.194*	0.095	-0.039	0.052	0.036	0.091	0.135	0.676	-0.037	0.050	0.477*	0.113	0.015	0.027	-0.123*	0.060
School attributes, practices and policies	School with no ability grouping for any classes	-0.193*	0.086	-0.048	0.091	0.158*	0.059	0.073	0.116	0.018	0.037	0.091	0.053	0.066	0.125	0.127*	0.038
	School with one form of ability grouping between some classes	-0.050	0.038	-0.022	0.085	0.090	0.057	-0.200	0.183	-0.050	0.039	-0.032	0.035	0.031	0.037	0.013	0.023
	Private school	0.077	0.050	-0.233*	0.110	0.140	0.219	0.118	0.315	-0.152*	0.065	0.000	0.000	0.000	0.000	-0.038	0.034
	Teacher determines course content, including curricula	0.015	0.062	0.018	0.056	-0.061	0.054	0.037	0.117	-0.080	0.065	-0.070	0.046	-0.071	0.045	0.000	0.029
	Teacher chooses learning materials	-0.101	0.063	0.119	0.080	0.023	0.087	0.097	0.146	0.041	0.038	0.078+	0.047	0.065	0.049	-0.090*	0.035

Note: Multilevel regression model (teacher and school levels): students' mathematics achievement regressed on all the variables presented in this table. * indicates values that are statistically significant at the 5% threshold. + indicates values that are statistically significant at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Table B.11 Relationship between the use of active learning and school and teacher characteristics

Block	Factor	Australia		Finland		Latvia		Mexico		Portugal		Romania		Singapore		Spain	
		Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Teacher perception of their work and work environment	Constructivist beliefs	0.561*	0.127	0.173*	0.048	0.049	0.067	1.809*	0.662	0.023	0.085	0.021	0.070	0.016	0.024	0.158+	0.085
	Effective professional development	0.186	0.122	-0.007	0.037	0.045	0.057	0.744	0.571	0.090	0.064	0.196*	0.087	0.056*	0.027	0.008	0.077
	Teacher job satisfaction	-0.098	0.103	0.065	0.051	0.055	0.055	1.081*	0.480	-0.030	0.072	-0.003	0.098	-0.020	0.027	0.068	0.141
	Need for professional development in subject matter and pedagogy	0.263*	0.077	0.057	0.043	0.056	0.061	-0.440	0.507	0.066	0.092	0.192*	0.086	-0.014	0.027	0.159	0.108
	Teacher self-efficacy	0.587*	0.112	0.138*	0.063	0.154*	0.061	1.734*	0.395	0.232*	0.101	0.201*	0.067	0.180*	0.025	0.425*	0.097
Teacher relations with other school stakeholders	Teacher co-operation	0.394	0.128	0.093	0.059	0.182*	0.055	1.148*	0.436	0.265*	0.079	0.228*	0.096	0.051+	0.029	0.416*	0.122
	Teacher-student relations	-0.065	0.130	-0.094*	0.041	0.084	0.058	-2.230*	0.890	0.051	0.078	0.199*	0.077	0.014	0.025	-0.093	0.109
Classroom composition and climate	Disciplinary climate	0.299**	0.164	0.163*	0.055	0.086+	0.051	0.089	0.481	0.132	0.085	0.116	0.077	-0.008	0.031	0.285*	0.116
	Composition of the target classroom - proportion of …																
	- Students whose first language is different from language of instruction	0.061	0.155	-0.067+	0.035	0.179*	0.041	-1.114	0.827	0.085	0.092	0.339+	0.206	0.009	0.025	-0.023	0.087
	- Low academic achievers	0.278*	0.135	-0.085+	0.051	-0.132+	0.072	0.427	0.775	-0.006	0.095	-0.312*	0.093	-0.094*	0.033	0.031	0.143
	- Students with special needs	-0.018	0.120	0.029	0.070	0.151*	0.054	-0.493	0.529	-0.075	0.066	0.039	0.066	0.180*	0.034	0.027	0.098
	- Students with behavioural problems	-0.108	0.139	0.059	0.056	-0.075	0.059	-0.016	0.800	-0.094	0.094	0.008	0.071	0.014	0.035	-0.009	0.152
	- Students from socio-economically disadvantaged homes	0.151	0.128	-0.015	0.054	-0.007	0.041	0.650	0.694	0.144+	0.083	-0.058	0.087	0.015	0.028	0.312*	0.111
	- Academically gifted students	0.303*	0.103	0.007	0.043	0.011	0.046	0.477	0.517	0.087	0.066	0.120*	0.059	0.052*	0.025	0.120+	0.065
School socio-demographic composition and mathematic achievement	School ESCS: mean	-0.083	0.205	0.032	0.060	-0.018	0.087	-1.093	0.876	0.141	0.097	-0.426+	0.097	-0.047	0.044	-0.084	0.066
	School ESCS: standard deviation	-0.058	0.142	0.016	0.054	0.104+	0.056	-1.068	0.975	-0.083	0.064	-0.165+	0.080	0.000	0.029	0.157*	0.058
	School mathematics performance: mean	-0.356*	0.096	-0.075	0.051	-0.076	0.053	-0.405	0.430	-0.044	0.070	-0.037	0.098	0.037	0.023	-0.032	0.062
	School mathematics performance: standard deviation	-0.311+	0.182	0.203*	0.040	0.023	0.051	1.143	0.768	-0.012	0.080	-0.016	0.051	0.012	0.027	-0.003	0.060
	Proportion of girls in the school	0.092	0.176	-0.149*	0.067	0.077	0.084	0.807	0.642	-0.023	0.110	0.022	0.126	0.072	0.058	-0.169*	0.078
	Proportion of immigrant students in the school	-0.002	0.120	0.010	0.045	-0.048	0.062	0.065	1.345	0.070	0.075	-0.042	0.073	-0.022	0.029	0.196*	0.059

Note: Multilevel regression model (teacher and school levels): students' mathematics achievement regressed on all the variables presented in this table. * indicates values that are statistically significant at the 5% threshold. + indicates values that are statistically significant at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Table B.11 Relationship between the use of active learning and school and teacher characteristics *(continued)*

Block	Factor	Australia		Finland		Latvia		Mexico		Portugal		Romania		Singapore		Spain	
		Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Teacher background and employment status	Total number of years of experience as a teacher	0.041	0.089	0.034	0.050	-0.031	0.054	-0.018	0.450	0.017	0.060	0.109	0.072	-0.050*	0.024	0.054	0.118
	Female teacher	-0.035	0.053	-0.086*	0.043	-0.033	0.122	-0.126	0.142	-0.080	0.050	0.016	0.039	-0.052	0.033	0.013	0.055
	Teacher has a fixed-term contract	0.096	0.073	0.021	0.084	-0.188	0.127	0.319*	0.134	-0.008	0.088	-0.056	0.062	-0.051	0.066	0.148+	0.087
	Teacher has completed initial training	-0.278+	0.145	-0.097	0.088	-0.014	0.105	0.055	0.120	-0.067	0.070	-0.068	0.101	-0.493+	0.270	0.136	0.109
School climate and student attitudes toward mathematics	School index of confidence towards mathematics: mean	0.030	0.088	-0.046	0.046	0.017	0.056	-1.283	0.897	0.195*	0.064	-0.054	0.103	0.027	0.036	-0.021	0.066
	School index of confidence towards mathematics: standard deviation	-0.218+	0.114	0.068+	0.041	-0.044	0.055	-1.271*	0.477	-0.108+	0.060	0.096	0.085	-0.006	0.022	0.070	0.076
	School index of attitudes towards learning outcomes: mean	0.123	0.119	0.129*	0.064	-0.142*	0.069	-0.390	0.475	-0.049	0.091	0.116	0.123	-0.008	0.026	0.230*	0.081
	School index of attitudes towards learning outcomes: standard deviation	-0.243*	0.108	-0.052	0.060	0.086	0.073	1.578+	0.837	-0.001	0.052	-0.105	0.084	0.047+	0.025	-0.142*	0.067
	School index of attitudes towards learning activities: mean	0.155	0.153	-0.060	0.053	0.145*	0.065	0.314	0.921	-0.089	0.090	-0.074	0.110	-0.035	0.033	-0.275+	0.093
	School index of attitudes towards learning activities: standard deviation	0.147	0.113	0.023	0.054	-0.041	0.079	-0.800	0.697	-0.010	0.072	-0.046	0.071	0.000	0.025	-0.262+	0.100
	School index of interest towards mathematics: mean	0.083	0.101	-0.069	0.045	-0.098*	0.049	-0.963	0.683	0.020	0.059	0.298*	0.076	-0.008	0.028	0.206+	0.072
	School index of interest towards mathematics: standard deviation	-0.036	0.118	-0.059	0.037	-0.002	0.095	-1.587*	0.483	0.065	0.063	0.156+	0.093	0.020	0.027	0.003	0.054
School attributes, practices and policies	School with no ability grouping for any classes	0.080	0.092	0.059	0.059	-0.058	0.081	0.072	0.101	-0.095+	0.055	-0.070	0.065	-0.240*	0.100	0.136*	0.061
	School with one form of ability grouping between some classes	-0.068	0.047	0.012	0.063	-0.051	0.054	-0.321*	0.100	'-0.141*	0.058	-0.041	0.038	0.000	0.031	0.022	0.028
	Private school	0.097*	0.046	-0.119	0.088	0.553*	0.271	-0.238	0.213	-0.051	0.082	0.000	0.000	0.000	0.000	0.207*	0.049
	Teacher determines course content, including curricula	0.023	0.058	0.010	0.067	-0.012	0.047	-0.033	0.124	0.021	0.052	0.078*	0.039	-0.048	0.043	-0.073*	0.033
	Teacher chooses learning materials	-0.135+	0.070	0.075	0.081	-0.014	0.095	-0.020	0.168	-0.116*	0.041	0.019	0.046	0.049	0.045	0.028	0.034

Note: Multilevel regression model (teacher and school levels): students' mathematics achievement regressed on all the variables presented in this table. * indicates values that are statistically significant at the 5% threshold. + indicates values that are statistically significant at the 10% threshold.

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

ANNEX C: POLICY EXAMPLES FROM TALIS-PISA LINK COUNTRIES

This section of the annexes shows a group of selected policies from each of the countries participating in the TALIS-PISA link. Although these reforms may be different in nature, they share the goal of directly or indirectly modifying and improving teaching practices. The policies presented here are by no means an exhaustive representation of the efforts currently being made in these systems to improve instructional quality.

Box C.1 Implementation of the Teacher Education Ministerial Advisory Group report

The Teacher Education Ministerial Advisory Group (TEMAG) was established on 19 February 2014 to provide advice on how teacher education courses could be improved to better prepare new teachers with the right mix of academic and practical skills needed for the classroom. The Australian Government response to the TEMAG report *Action Now: Classroom Ready Teachers* addresses five themes:

- stronger quality assurance of teacher education courses
- rigorous selection for entry to teacher education courses
- improved and structured practical experience for teacher education students
- robust assessment of graduates to ensure classroom readiness
- national research and workforce planning capabilities.

Implementation of the recommendations from the report is being led by the Australian Institute for Teaching and School Leadership (AITSL) in collaboration with stakeholders.

Source: Australian Government, Department of Education and Training (2016), Teacher Education Ministerial Advisory Group, www.studentsfirst.gov.au/teacher-education-ministerial-advisory-group.

Box C.2 Finland – OSAAVA Programme

The Osaava Programme (2010-16), a national fixed-term programme for continuing professional development (CPD), aims to ensure systematic CPD of staff in schools. The programme supports education providers to systematically and continually develop the skills and knowledge of their staff according to locally identified needs. Participants in Osaava and other government-funded CPD increased from 30 000 in 2009 to almost 70 000 in 2013.

Source: OECD (2015), Education Policy Outlook Reforms Finder, www.oecd.org/edu/reformsfinder.htm.

Box C.3 Latvia – Curriculum reform

As the curriculum was nearing its 10th anniversary it was felt it needed updating. The reform currently underway will replace the largely knowledge-based curriculum with a competency-based one. The new curriculum is expected to be gradually piloted from the academic year 2015/16 onwards and introduced in 2018/19, starting in Grades 1-6. It is to include a focus on student-centred teaching, foreign language acquisition from Grade 1 onwards, and competences such as entrepreneurial spirit, a healthy lifestyle, financial literacy and civic education.

Source: OECD (2016), *Education in Latvia*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264250628-en, p 126.

Box C.4 Mexico – Reforma Educativa 2012-2013

Improve teacher quality by creating a professional teaching service (and eventually, a service for directors and supervisors), with national competitions for teaching posts and rules for granting tenure, and ensuring that salary increases correspond to the teachers' appraisal and performance. Also, the government will aim at strengthening initial teacher training by supporting *Normales* (Initial teacher training institutions) and mobilising the knowledge and human capital available in the country.

Source: OECD (2013), *Improving Education in Mexico: A State-level Perspective from Puebla*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264200197-en, p. 56.

Box C.5 Portugal – Model of the national system of teachers' and school leaders' performance appraisal

A new model of the national system of performance appraisal for teachers and school leaders (2012/13) relies on external and internal appraisal and targets three dimensions: scientific and pedagogic; participation in school life and relationship with community; and continuing training and professional development.

Source: OECD (2015), Education Policy Outlook Reforms Finder, www.oecd.org/edu/reformsfinder.htm.

Box C.6 Romania – A national curriculum reform

A national curriculum reform in pre-university education was recently launched, following the New National Education Law (No. 1/2011). Currently, the new curricula for primary education are already implemented (for grades I-IV). The new curricula for grades V-X are planned to be set to public debate early next year, to be shortly followed by the curricula for upper secondary education (high school, grades XI-XII/XII,I respectively). New textbooks for primary education have been approved, the innovation consisting of a digital version along with the "traditional", printed version of each textbook. Various teacher training courses are initiated at local and regional levels in order to prepare the teachers for understanding and developing the new elements of the curriculum reform. Currently, the OECD, with the support of UNICEF, is conducting "The Review on Evaluation and Assessment in Romania", which will analyse Romania's policies and practices for evaluation and assessment for pre-university education (primary, lower and upper secondary levels of education) in order to assess the strengths and challenges, and compare with international practices. The written report, providing policy and implementation advice for improvement will be available in early 2017.

Source: Ministry of Education Romania.

Box C.7 Singapore – Induction and mentoring programme in Singapore

At the national level, teachers attend a three-day induction programme, called the Beginning Teachers' Orientation Programme, conducted by the Singapore Ministry of Education. This programme emphasises the importance of the role of teachers in nurturing the whole child and enables beginning teachers to consolidate their learning at the teacher institute. By communicating the roles and expectations of teachers, this programme also inducts new teachers into Singapore's teaching fraternity in the areas of professional beliefs, values and behaviours.

During the first two years of teaching, mentoring is situated as part of the induction process in schools. Instructional mentors, who are experienced teachers in schools, are equipped with mentoring knowledge and skills through the Instructional Mentoring Programme. This programme enables instructional mentors to tailor the necessary support to accelerate beginning teachers' professional growth. Besides practical skills, instructional mentors also help to deepen beginning teachers' understanding of the values and ethos of the teaching profession

Source: Schleicher, A. (2016), *Teaching Excellence through Professional Learning and Policy Reform: Lessons from Around the World*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264252059-en, p. 50.

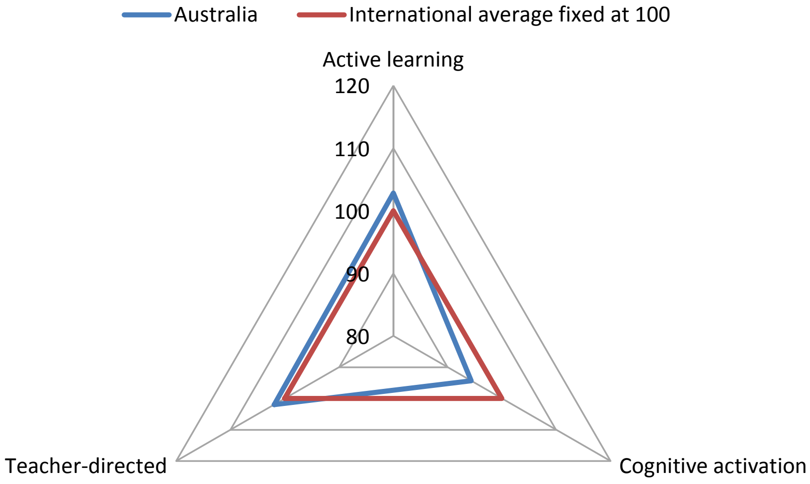
Box C.8 Spain – Organic Law for the Improvement of Educational Quality

A new reform in the process of implementation is the Organic Law for the Improvement of Educational Quality (*Ley Orgánica para la Mejora de la Calidad Educativa,* LOMCE). To enhance the quality of schools, LOMCE establishes greater autonomy for schools regarding scheduling, content and pedagogical approach and will allow further autonomy in co-operation with regional administrations. It also modifies the selection process for school leaders, requiring candidates to have taken a specialised training course, to value previous experience and to consider candidates from any school (in the past, priority was given to internal school candidates. The reform will be fully implemented by 2017.

Source: OECD (2015), Education Policy Outlook Reforms Finder, www.oecd.org/edu/reformsfinder.htm.

ANNEX D: TEACHING STRATEGIES COUNTRY PROFILES

Figure D.1 Teaching strategies profile of Australia



Note: The international average for teaching strategies was fixed at 100. All values above 100 are above the international average and all values below 100 are below the international average. Every 10 units represent a standard deviation away from the average.

How to interpret the graph: Australian teachers report engaging less often (around half a standard deviation less) in cognitive strategies than the average international teacher.

Active learning	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
Students work on projects that require at least one week to complete	16.18	9.66
Students use ICT (information and communication technology) for projects or class work	45.87	24.38
I require students to work on mathematics projects that take more than a single class period to complete	24.83	16.83
I let students evaluate their own progress	27.51	31.80
Students work in small groups to come up with a joint solution to a problem or task	26.15	34.90

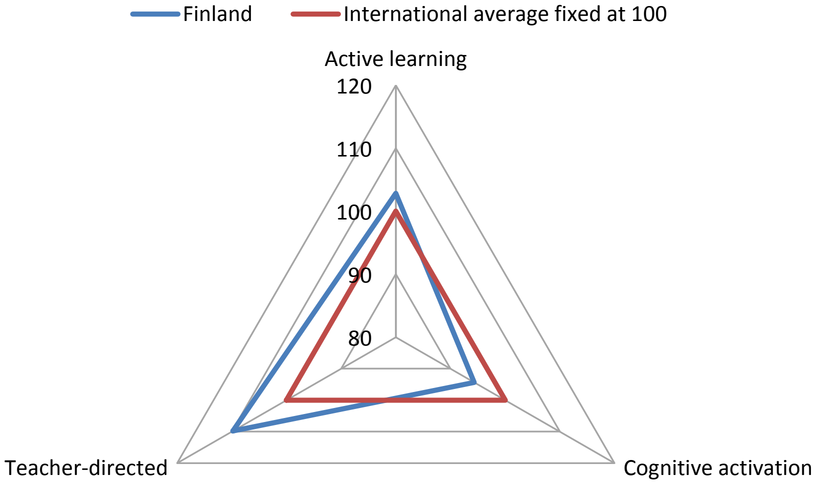
Cognitive activation	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I expect students to explain their thinking on complex problems	75.43	75.72
I encourage students to solve problems in more than one way	72.05	78.79
I require students to provide written explanations of how they solve problems	59.12	66.38
I encourage students to work together to solve problems	74.01	72.52
I connect mathematics concepts I teach to uses of those concepts outside of school	73.47	70.91
I go over homework problems that students were not able to solve	71.30	89.04

Teacher-directed	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I explicitly state learning goals	85.52	90.06
I let students practice similar tasks until I know that every student has understood the subject matter	78.31	78.08
I observe students when working on particular tasks and provide immediate feedback	84.55	80.82
I ask short, fact-based questions	90.44	89.17
I present a summary of recently learned content	78.86	78.1
I give different work to the students who have difficulties learning and/or to those who can advance faster	44.19	40.92
I refer to a problem from everyday life or work to demonstrate why new knowledge is useful	72.93	67.93

Note: *Significant differences from the international average are in dark grey (5% threshold).

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Figure D.2 Teaching strategies profile of Finland



Note: The international average for teaching strategies was fixed at 100. All values above 100 are above the international average and all values below 100 are below the international average. Every 10 units represent a standard deviation away from the average.

How to interpret the graph: Finnish teachers report engaging less often (almost two standard deviations less) in active learning strategies than the average international teacher.

Active learning	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
Students work on projects that require at least one week to complete	1.27	9.66
Students use ICT (information and communication technology) for projects or class work	4.9	24.38
I require students to work on mathematics projects that take more than a single class period to complete	1.57	16.83
I let students evaluate their own progress	13.92	31.80
Students work in small groups to come up with a joint solution to a problem or task	21.58	34.90

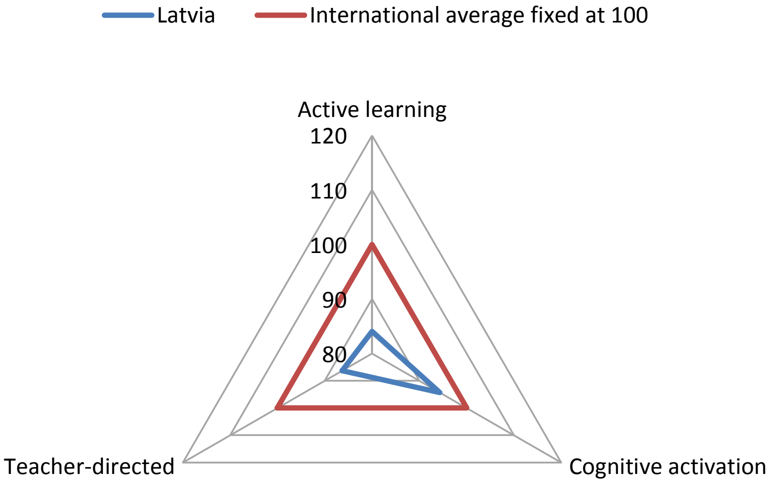
Cognitive activation	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I expect students to explain their thinking on complex problems	74.02	75.72
I encourage students to solve problems in more than one way	48.3	78.79
I require students to provide written explanations of how they solve problems	78.9	66.38
I encourage students to work together to solve problems	69.28	72.52
I connect mathematics concepts I teach to uses of those concepts outside of school	51.89	70.91
I go over homework problems that students were not able to solve	91.68	89.04

Teacher-directed	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I explicitly state learning goals	76.7	90.06
I let students practice similar tasks until I know that every student has understood the subject matter	65.87	78.08
I observe students when working on particular tasks and provide immediate feedback	65.98	80.82
I ask short, fact-based questions	85.88	89.17
I present a summary of recently learned content	72.06	78.1
I give different work to the students who have difficulties learning and/or to those who can advance faster	55.39	40.92
I refer to a problem from everyday life or work to demonstrate why new knowledge is useful	60.70	67.93

Note: *Significant differences from the international average are in dark grey (5% threshold).

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Figure D.3 Teaching strategies profile of Latvia



Note: The international average for teaching strategies was fixed at 100. All values above 100 are above the international average and all values below 100 are below the international average. Every 10 units represent a standard deviation away from the average.

How to interpret the graph: Latvian teachers report engaging more often (almost one standard deviation more) in teacher-directed strategies than the average international teacher.

Active learning	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
Students work on projects that require at least one week to complete	4.68	9.66
Students use ICT (information and communication technology) for projects or class work	34.5	24.38
I require students to work on mathematics projects that take more than a single class period to complete	7.31	16.83
I let students evaluate their own progress	34.69	31.80
Students work in small groups to come up with a joint solution to a problem or task	25	34.90

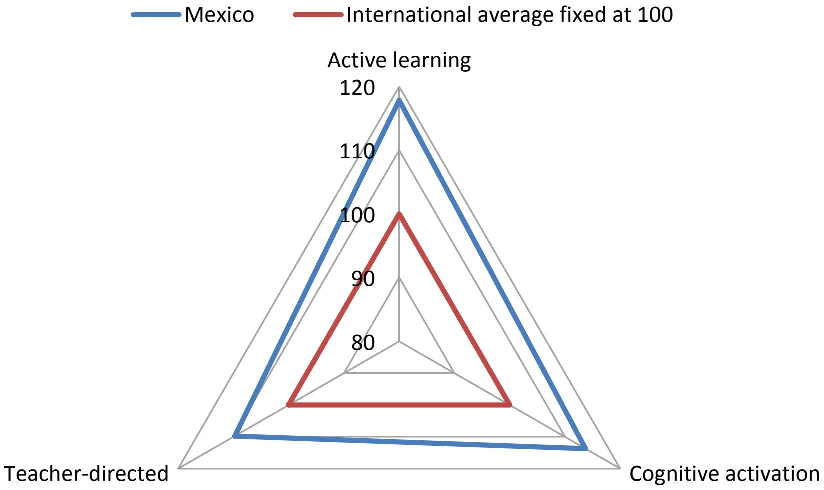
Cognitive activation	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I expect students to explain their thinking on complex problems	79.54	75.72%
I encourage students to solve problems in more than one way	77.08	78.79
I require students to provide written explanations of how they solve problems	71.64	66.38
I encourage students to work together to solve problems	70.04	72.52
I connect mathematics concepts I teach to uses of those concepts outside of school	74.6	70.91
I go over homework problems that students were not able to solve	86.84	89.04

Teacher-directed	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I explicitly state learning goals	98.83	90.06
I let students practice similar tasks until I know that every student has understood the subject matter	90.94	78.08
I observe students when working on particular tasks and provide immediate feedback	80.27	80.82
I ask short, fact-based questions	95.91	89.17
I present a summary of recently learned content	87.43	78.1
I give different work to the students who have difficulties learning and/or to those who can advance faster	47.7	40.92
I refer to a problem from everyday life or work to demonstrate why new knowledge is useful	84.67	67.93

Note: *Significant differences from the international average are in dark grey (5% threshold).

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Figure D.4 Teaching strategies profile of Mexico



Note: The international average for teaching strategies was fixed at 100. All values above 100 are above the international average and all values below 100 are below the international average. Every 10 units represent a standard deviation away from the average.

How to interpret the graph: Mexican teachers report engaging more often (almost two standard deviations more) in active learning strategies than the average international teacher.

Active learning	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
Students work on projects that require at least one week to complete	27.71	9.66
Students use ICT (information and communication technology) for projects or class work	42.35	24.38
I require students to work on mathematics projects that take more than a single class period to complete	32.64	16.83
I let students evaluate their own progress	53.68	31.80
Students work in small groups to come up with a joint solution to a problem or task	80.6	34.90

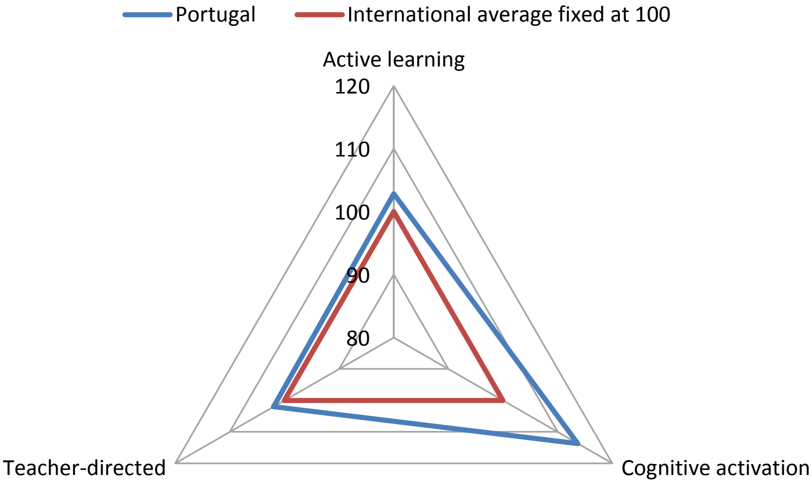
Cognitive activation	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I expect students to explain their thinking on complex problems	84.72	75.72
I encourage students to solve problems in more than one way	95.92	78.79
I require students to provide written explanations of how they solve problems	63	66.38
I encourage students to work together to solve problems	92.4	72.52
I connect mathematics concepts I teach to uses of those concepts outside of school	85.21	70.91
I go over homework problems that students were not able to solve	84.84	89.04

Teacher-directed	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I explicitly state learning goals	88.45	90.06
I let students practice similar tasks until I know that every student has understood the subject matter	82.32	78.08
I observe students when working on particular tasks and provide immediate feedback	91.95	80.82
I ask short, fact-based questions	94.46	89.17
I present a summary of recently learned content	71.26	78.1
I give different work to the students who have difficulties learning and/or to those who can advance faster	27.67	40.92
I refer to a problem from everyday life or work to demonstrate why new knowledge is useful	87.83	67.93

Note: *Significant differences from the international average are in dark grey (5% threshold).

Source*:* OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Figure D.5 Teaching strategies profile of Portugal



Note: The international average for teaching strategies was fixed at 100. All values above 100 are above the international average and all values below 100 are below the international average. Every 10 units represent a standard deviation away from the average.

How to interpret the graph: Portuguese teachers report engaging more often (above one standard deviation more) in cognitive activation strategies than the average international teacher.

Active learning	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
Students work on projects that require at least one week to complete	3.18	9.66
Students use ICT (information and communication technology) for projects or class work	21.63	24.38
I require students to work on mathematics projects that take more than a single class period to complete	17.79	16.83
I let students evaluate their own progress	47.26	31.80
Students work in small groups to come up with a joint solution to a problem or task	46.21	34.90

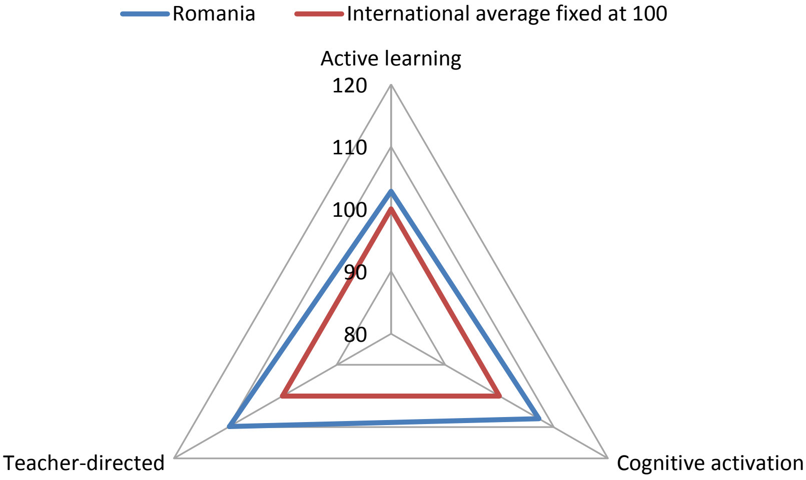
Cognitive activation	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I expect students to explain their thinking on complex problems	95.15	75.72
I encourage students to solve problems in more than one way	87.9	78.79
I require students to provide written explanations of how they solve problems	86.26	66.38
I encourage students to work together to solve problems	66.4	72.52
I connect mathematics concepts I teach to uses of those concepts outside of school	87.91	70.91
I go over homework problems that students were not able to solve	93.58	89.04

Teacher-directed	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I explicitly state learning goals	92.45	90.06
I let students practice similar tasks until I know that every student has understood the subject matter	64.04	78.08
I observe students when working on particular tasks and provide immediate feedback	82.31	80.82
I ask short, fact-based questions	85.35	89.17
I present a summary of recently learned content	84.5	78.1
I give different work to the students who have difficulties learning and/or to those who can advance faster	44.65	40.92
I refer to a problem from everyday life or work to demonstrate why new knowledge is useful	77.97	67.93

Note: *Significant differences from the international average are in dark grey (5% threshold).

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Figure D.6 Teaching strategies profile of Romania



Note: The international average for teaching strategies was fixed at 100. All values above 100 are above the international average and all values below 100 are below the international average. Every 10 units represent a standard deviation away from the average.

How to interpret the graph: Romanian teachers report engaging more often (almost one standard deviation more) in teacher-directed strategies than the average international teacher.

Active learning	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
Students work on projects that require at least one week to complete	10.19	9.66
Students use ICT (information and communication technology) for projects or class work	15.13	24.38
I require students to work on mathematics projects that take more than a single class period to complete	28.96	16.83
I let students evaluate their own progress	34.09	31.80
Students work in small groups to come up with a joint solution to a problem or task	38.03	34.90

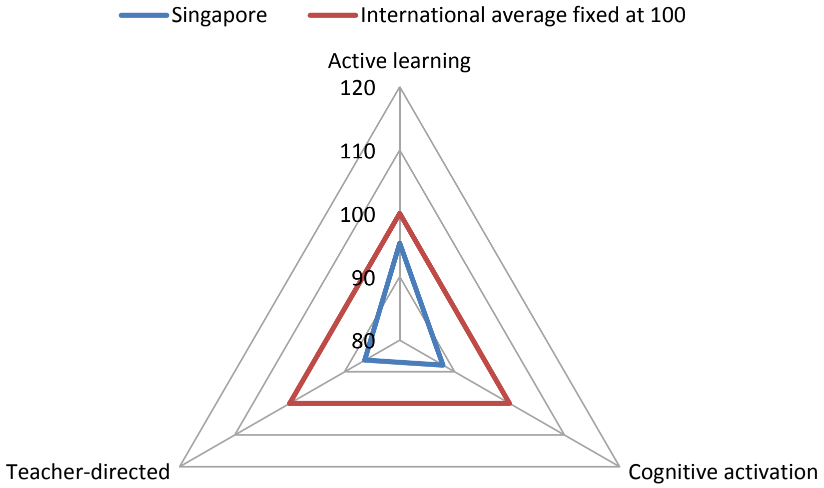
Cognitive activation	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I expect students to explain their thinking on complex problems	74.31	75.72
I encourage students to solve problems in more than one way	87.91	78.79
I require students to provide written explanations of how they solve problems	63.84	66.38
I encourage students to work together to solve problems	75.33	72.52
I connect mathematics concepts I teach to uses of those concepts outside of school	69.07	70.91
I go over homework problems that students were not able to solve	94.99	89.04

Teacher-directed	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I explicitly state learning goals	96.9	90.06
I let students practice similar tasks until I know that every student has understood the subject matter	85.02	78.08
I observe students when working on particular tasks and provide immediate feedback	78.69	80.82
I ask short, fact-based questions	93.75	89.17
I present a summary of recently learned content	84.05	78.1
I give different work to the students who have difficulties learning and/or to those who can advance faster	55.02	40.92
I refer to a problem from everyday life or work to demonstrate why new knowledge is useful	41.85	67.93

Note: *Significant differences from the international average are in dark grey (5% threshold).

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Figure D.7 Teaching strategies profile of Singapore



Note: The international average for teaching strategies was fixed at 100. All values above 100 are above the international average and all values below 100 are below the international average. Every 10 units represent a standard deviation away from the average.

How to interpret the graph: Singaporean teachers report engaging less often (above one standard deviation less) in teacher-directed strategies than the average international teacher.

Active learning	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
Students work on projects that require at least one week to complete	7.47	9.66
Students use ICT (information and communication technology) for projects or class work	13.78	24.38
I require students to work on mathematics projects that take more than a single class period to complete	10.67	16.83
I let students evaluate their own progress	30.28	31.80
Students work in small groups to come up with a joint solution to a problem or task	17.32	34.90

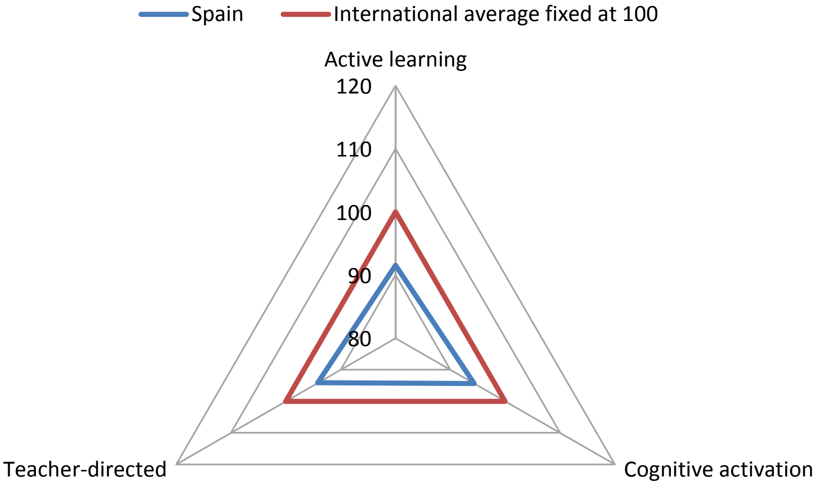
Cognitive activation	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I expect students to explain their thinking on complex problems	62.25	75.72
I encourage students to solve problems in more than one way	78.97	78.79
I require students to provide written explanations of how they solve problems	48.54	66.38
I encourage students to work together to solve problems	77.65	72.52
I connect mathematics concepts I teach to uses of those concepts outside of school	52.76	70.91
I go over homework problems that students were not able to solve	91.39	89.04

Teacher-directed	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I explicitly state learning goals	87.93	90.06
I let students practice similar tasks until I know that every student has understood the subject matter	77.64	78.08
I observe students when working on particular tasks and provide immediate feedback	80.08	80.82
I ask short, fact-based questions	86.34	89.17
I present a summary of recently learned content	73.96	78.1
I give different work to the students who have difficulties learning and/or to those who can advance faster	22.36	40.92
I refer to a problem from everyday life or work to demonstrate why new knowledge is useful	38.75	67.93

Note: *Significant differences from the international average are in dark grey (5% threshold)

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

Figure D.8 Teaching strategies profile of Spain



Note: The international average for teaching strategies was fixed at 100. All values above 100 are above the international average and all values below 100 are below the international average. Every 10 units represent a standard deviation away from the average.

How to interpret the graph: Spanish teachers report engaging less often (almost one standard deviation less) in active learning strategies than the average international teacher.

Active learning	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
Students work on projects that require at least one week to complete	6.57	9.66
Students use ICT (information and communication technology) for projects or class work	16.91	24.38
I require students to work on mathematics projects that take more than a single class period to complete	10.88	16.83
I let students evaluate their own progress	12.71	31.80
Students work in small groups to come up with a joint solution to a problem or task	24.28	34.90

Cognitive activation	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I expect students to explain their thinking on complex problems	60.3	75.72
I encourage students to solve problems in more than one way	82.11	78.79
I require students to provide written explanations of how they solve problems	60.33	66.38
I encourage students to work together to solve problems	55.04	72.52
I connect mathematics concepts I teach to uses of those concepts outside of school	72.35	70.91
I go over homework problems that students were not able to solve	97.73	89.04

Teacher-directed	% of maths teachers who engage in this practice frequently/in all or nearly all lessons	International average
I explicitly state learning goals	93.6	90.06
I let students practice similar tasks until I know that every student has understood the subject matter	80.49	78.08
I observe students when working on particular tasks and provide immediate feedback	82.70	80.82
I ask short, fact-based questions	81.34	89.17
I present a summary of recently learned content	72.68	78.1
I give different work to the students who have difficulties learning and/or to those who can advance faster	30.4	40.92
I refer to a problem from everyday life or work to demonstrate why new knowledge is useful	79.83	67.93

Note: *Significant differences from the international average are in dark grey (5% threshold).

Source: OECD (2012), *Programme for International Survey Assessment (PISA): 2012 complete database*, www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm; OECD (2013), *Teaching and Learning International Survey (TALIS): 2013 complete database*, http://stats.oecd.org/index.aspx?datasetcode=talis_2013%20.

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