2 What do teachers and schools do that matters most for student achievement?

We know that teachers and schools matter. However, there is less certainty about the specific characteristics and actions of teachers and school leaders that matter for student achievement. This chapter explores teacher and school factors that are significantly related to student achievement in the three subject domains covered by PISA: reading, mathematics and science. In order to best harness the richness of the TALIS-PISA link data, the analysis is centred around a machine learning technique. While the chapter focuses mainly on the characteristics and practices of teachers and schools that matter for student performance in all three subjects, it also attempts to identify cross-country patterns, differential teacher and school effects and the mediating effects of classmates' characteristics.

Highlights

- TALIS-PISA link[1] data are more likely to provide insights for the Czech Republic and Turkey, where differences in school average performances represent about half of the total variance in student achievements, as opposed to countries, including Australia, Denmark and Malta, where 25% or less of the total variation in student outcomes lie between schools.
- A machine learning technique applied to TALIS-PISA link data retains six potential key predictors of student achievement in reading, mathematics and science: teachers' classroom practices, teachers' well-being and job satisfaction, teachers' use of working time, classmates' characteristics, school culture and school leadership. Variance decomposition analysis suggests that each of these factors explain at least 20% of the variation in student performances between schools.
- On average across the countries and economies participating in the TALIS-PISA link, students tend to perform better in all three subjects covered by PISA (i.e. reading, mathematics and science) the more class time the average school teacher spends on actual teaching and learning. Moreover, results suggest that the use of class time is more closely linked to student performance in mathematics than in reading and science.
- As teachers are more satisfied with their work environment, students tend to perform better in school on average across TALIS-PISA link countries and economies. Moreover, results suggest that teachers' satisfaction with their work environment is more closely related to student performance in science than in reading and mathematics. Students who attend schools where teachers report workload as an important source of stress tend to perform better in school on average across the countries and economies participating in the TALIS-PISA link. This may signal teachers' commitment and dedication to their work as well as highly competitive school environments (attended by higher-performing students) that can lead to workload being an important source of stress for teachers.
- As the amount of working hours teachers spend on marking and correcting increases on average within the school students tend to perform better academically on average across the countries and economies participating in the TALIS-PISA link. This may point to the importance of assessment of student work in providing feedback to students about their learning progress. Yet, it may also signal highly competitive school environments (attended by higher-performing students) that can lead to more frequent feedback to students in the form of tests and exams.
- TALIS-PISA link data suggest the presence of peer effects. Indeed, as the average concentration of students from socio-economically disadvantaged homes in the classrooms increases, students tend to perform worse academically in several countries and economies participating in the TALIS-PISA link. This finding holds while accounting for students' own socio-economic background. In addition, in most countries and economies participating in the TALIS-PISA link, as the average concentration of academically gifted students in the classrooms increases, the better students tend to perform. This may not only signal the presence of peer effects, but also the presence of academic segregation.
- On average across TALIS-PISA link countries and economies, students who attend schools where stakeholders (i.e. parents and local community) are involved in school-related activities tend to perform better in school. However, this association does not remain significant for most participating countries and economies once classmates' characteristics are taken into account.
- The findings highlighted above cannot be interpreted as causal but only as correlational given that TALIS and PISA measure student, teacher, principal and school characteristics in many countries at a single point of time. For example, while students may perform better if a greater share of class time is spent on actual learning, the causality can also go the other way around. Indeed, more disruptive classrooms are more likely to have lower-achieving students, which, in turn, leads to more time spent on other tasks such as keeping order or administrative tasks.

Introduction

Identifying the factors that help younger generations to succeed later in life has long been a main interest for education policy. In fact, student achievement is driven by many factors that are beyond the reach of the school, including students' abilities and attitudes, family background and support as well as peer group effects (OECD, 2005[1]). Although teachers and school leaders also have an impact on student learning outcomes by shaping the quality of instruction (Barber and Mourshed, 2009[2]; Darling-Hammond, 2017[3]; OECD, 2018[4]), the evidence is less clear about the specific characteristics of teachers and school leaders that matter for student achievement. Therefore, investigating what teachers and schools do that matter for student performance can provide insights to raise the quality of education and ensure that every student succeeds in school and later in life.

Past educational research has shown that teacher quality is the most important school-related predictor of student achievement (Hattie, 2009[5]; Rice, 2003[6]; Seidel and Shavelson, 2007[7]; Wayne and Youngs, 2003[8]). It is well established that teacher effect (or teacher's value-added), which refers to the systematic variation in outcome across students assigned to the same teacher given the teacher's ability to increase students' initial knowledge and skills, accounts for significant variation in student achievement (Chetty, Friedman and Rockoff, 2014[9]; Chetty, Friedman and Rockoff, 2014[10]; Hanushek and Rivkin, 2010[11]; Jackson, Rockoff and Staiger, 2014[12]; Kane and Staiger, 2008[13]; Rivkin, Hanushek and Kain, 2005[14]; Rockoff, 2004[15]). The magnitude of teacher effect estimates is relatively large compared to the effects of other school factors (Jackson, Rockoff and Staiger, 2014[12]).[2]

There is evidence that teacher's value-added goes beyond test scores. For example, Chetty, Friedman and Rockoff (2014[10]) found that students exposed to high-quality teachers (i.e. those with high value-added based on their impacts on students' test scores) in primary school are more likely to attend college, earn higher salaries, live in neighbourhoods with a higher share of college graduates, and have higher savings rates. Girls who had good teachers in primary school are also less likely to have teenage pregnancies. Good teachers also have an impact on social-emotional competencies, such as students' beliefs in their mathematics skills, behaviour in class, perseverance, growth mindset, happiness and truancy (Blazar and Kraft, 2017[16]; Jackson, 2018[17]; Kraft, 2019[18]).

Thus, we do know that teachers matter. However, evidence is less conclusive about the specific characteristics and actions of teachers that matter for student achievement. Observable teacher characteristics, such as level of education and type of certification, tend to explain little of the variation in teacher effectiveness (Gordon, Kane and Staiger, 2008[19]; Hanushek and Rivkin, 2010[11]; Jackson, Rockoff and Staiger, 2014[12]; Kane, Rockoff and Staiger, 2008[20]; Rivkin, Hanushek and Kain, 2005[14]). Another body of research focusing on attributes of new teaching candidates show that no single teacher characteristic predicts student achievement (Dobbie, 2011[21]; Rockoff et al., 2011[22]). However, the combination of certain attributes – such as general intelligence, personality traits, beliefs regarding self-efficacy (Rockoff et al., 2011[22]); and academic achievement, leadership experience, perseverance, critical thinking, organisational ability, motivational ability and respect for others (Dobbie, 2011[21]) – explain a substantial part of the variance in teachers' value-added.

The complexity and context-based nature of a teacher's work provide some explanation for the fact that research still strives to pinpoint what makes an effective teacher. One strand in the literature on teacher effectiveness focuses on the relationship between teachers' actual classroom practices and student outcomes (Hattie, 2009[5]; Muijs et al., 2014[23]). One of the main findings from this strand of research is that teachers' classroom practices explain a large share of the variance in student outcomes (Muijs et al., 2014[23]). What happens in the classroom is important for student performance – the learning environment in the classroom, the quantity, pacing and quality of instruction, and interaction with students (Muijs et al., 2014[23]; Teddlie and Reynolds, 2000[24]). In addition, there is a distinct line of research that moves away from indirect measures of teaching, typically in the form of questionnaires, and focuses on direct measures like classroom observation through video. One such example is the TALIS Video Study, which is an

international large-scale, video-based study of teaching and learning featuring a longitudinal design. It shows that the quality of instructional practices applied in the classroom has the largest impact on student learning compared to classroom management and socio-emotional practices, before accounting for students' abilities and background (OECD, 2020[25]).

In turn, teachers' classroom practices are embedded in the context and functioning of the school. School-level factors that determine the context and functioning of the school have mainly indirect effects on student performance by developing and evaluating the school policy on teaching and the policy on creating a learning environment at the school (Creemers and Kyriakides, 2010[26]). School effectiveness research, which tries to establish the school-level determinants of students' learning outcomes, indicates relatively small effects from schools' resource-input and organisational measures (Scheerens, 2001[27]). However, schools' instructional conditions are found to have average to large effects on school effectiveness (Scheerens, 2001[27]). For instance, Dobbie and Fryer (2013[28]) finds that the school-level factors that matter for school effectiveness include frequent teacher feedback, data-driven instruction, high-dosage tutoring, increased instructional time and a relentless focus on academic achievement, as opposed to input measures such as class size, per-pupil expenditure and the fraction of teachers with an advanced degree.

The teacher and school factors that matter for student achievement also vary depending on the different student outcomes. Research findings on teacher effectiveness (Muijs et al., 2014[23]; Rice, 2003[6]; Seidel and Shavelson, 2007[7]; Wayne and Youngs, 2003[8]) and school effectiveness (Hattie, 2009[5]; Reynolds et al., 2014[29]) point to the notion of multidimensionality of teacher and school effectiveness. Indeed, there is empirical evidence for differential teacher and school effects across subjects (Muijs et al., 2014[23]; Reynolds et al., 2014[29]; Rockoff, 2004[15]; Seidel and Shavelson, 2007[7]). Thus, analysing the teacher- and school-level factors that matter for student achievement by subject domain may provide more nuanced insights that are specific to student outcomes in a given subject.

Chapter 2 of this report attempts to identify specific characteristics and practices of teachers and school leaders that matter the most for student achievement. It explores these in the three subject domains covered by PISA:[3] reading, mathematics and science. It draws on the rich TALIS-PISA 2018 link dataset of 15-year-old students and their teachers and schools, and presents results for eight countries and economies – Australia, Ciudad Autónoma de Buenos Aires (hereafter CABA [Argentina]), Colombia, the Czech Republic, Denmark, Georgia, Malta and Turkey.[4] The first section discusses how teacher and school dimensions can be mapped to student achievement and how they interact with each other. The chapter then presents the analytical approach taken to best harness the richness of the TALIS-PISA link data. The third section presents the teacher and school factors that matter for student achievement across the three subject domains covered by PISA, given the characteristics of the TALIS-PISA link data and in light of the modelling approach taken. This section not only explores the characteristics and practices of teachers and schools that are significantly related to student performance in all three subjects, but also attempts to identify cross-country patterns, differential teacher and school effects and the mediating effects of classmates' characteristics.

Conceptual mapping of teacher and school factors to student achievement

The theoretical framework of this chapter discusses the approach taken to conceptualise the relationship between teacher and school factors, and student cognitive outcomes. First, it presents a framework with two axes of effect and level, based on which the relationship between the dimensions of teacher and school characteristics and practices can be linked to student achievement. Second, it introduces the teacher and school dimensions that are included in the analysis by focusing on previous research findings about the potential effect of a given dimension on students' cognitive outcomes. Last, it provides a rationale for the subject domain focus of the analysis and for the inclusion of certain student characteristics as controls.

The conceptual mapping of Teaching and Learning International Survey (TALIS) dimensions to student achievement is framed along two axes: effect and level (Figure 2.1). The first axis (i.e. effect) is based on whether a dimension can have a direct effect on student achievement. For example, the student composition of the classroom, or certain elements of school culture, such as parental support and involvement, can have a direct effect on student outcomes irrespective of teachers' classroom practices. That said, most of the teacher and school factors collected by TALIS influence student achievement indirectly through their effect on the quality of instruction. The second axis (i.e. level) refers to whether the dimension mainly operates at the school[5] or teacher level. Dimensions that reveal more about the characteristics of a school and that are mostly influenced by school- or system-level policies are categorised as school-level dimensions. However, teachers' practices that are specific to certain teachers in a given school and are mainly at the discretion of individual teachers belong to the teacher level. Yet, it is important to note that the TALIS-PISA link data only allows for the link between teacher-level dimensions and student achievement at the school level. Hence, dimensions that reflect on the characteristics and practices of teachers measured at the school level are referred to as teacher dimensions (or factors).

This analysis focuses on the association between teacher and school characteristics and practices, and student outcomes. Nevertheless, it is important to note that relationships between teacher and school dimensions are often characterised by reciprocity and inter-connectedness. For example, professional development influences classroom practices, and in turn, those practices have an effect on the type of professional development provided to teachers (Ainley and Carstens, 2018[30]). Moreover, these feedback loops are present across different levels. For instance, not only do school culture and school leadership influence classroom practices but they themselves are shaped by the practices teachers use in the classroom. Indeed, the various levels and components of the educational system are inter-related and work in interaction (Reynolds et al., 2014[29]). Therefore, dynamic models of school effectiveness aim to capture these reciprocal associations between variables and their effect on student outcomes in an integrated and comprehensive fashion (Creemers and Kyriakides, 2015[31]; Creemers and Kyriakides, 2010[26]; Creemers and Kyriakides, 2007[32]; Kyriakides, Christoforou and Charalambous, 2013[33]).

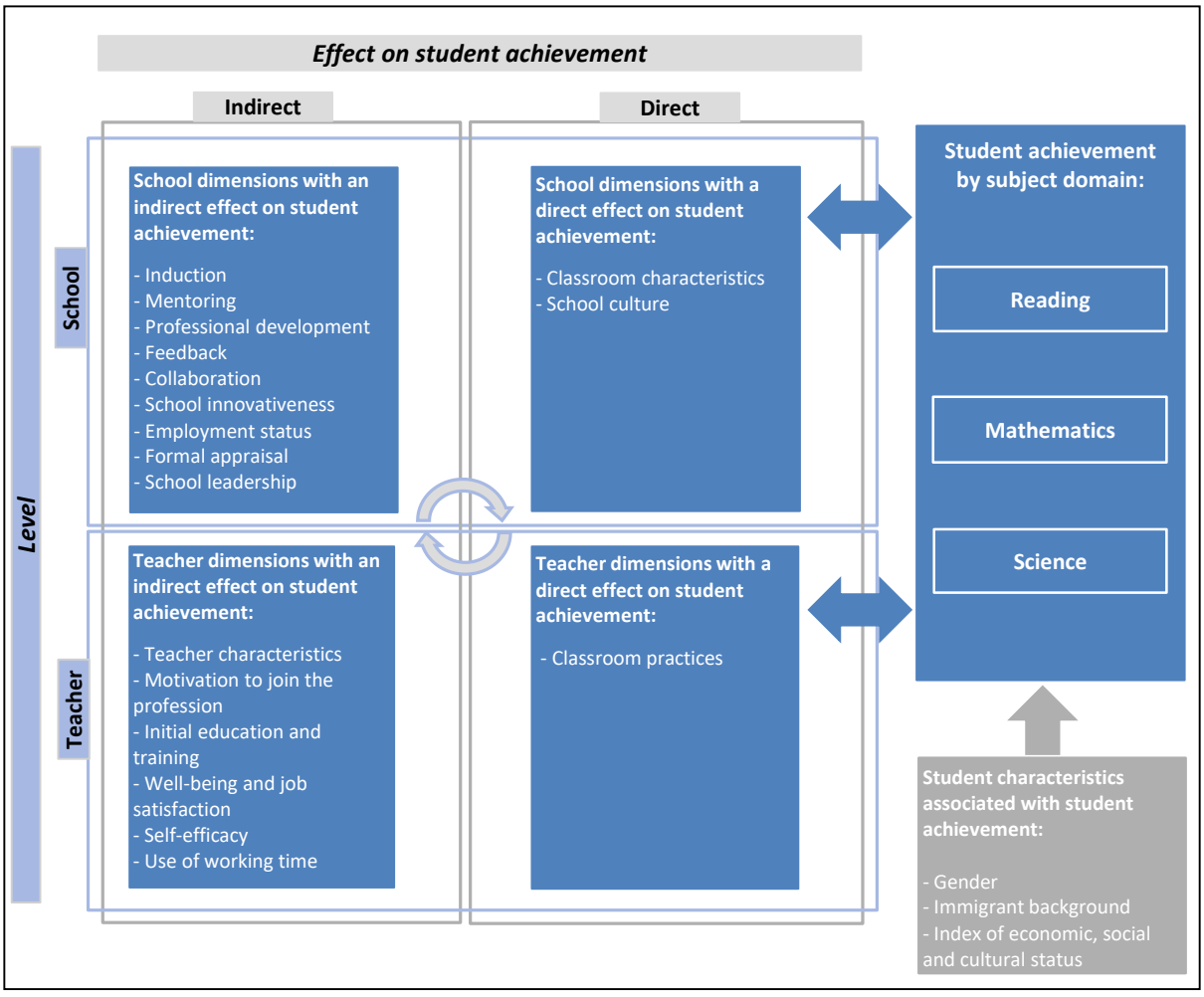
Given the often reciprocal nature of relationships, certain factors can be both an input and an output of schooling (Creemers and Kyriakides, 2015[31]). Indeed, the reciprocity also holds for the relationship between various teacher and school factors, and student achievement. For instance, student performance can have an impact on the choice of teaching strategies applied in the classroom, but it can also influence other factors such as school culture (e.g. teacher-student relations), the type of professional development provided to teachers or teacher well-being, job satisfaction and self-efficacy.

Teacher dimensions with a direct effect on student achievement

Classroom practices

The importance of teachers' classroom practices is key to any study of teaching and learning because what teachers do in the classroom is the strongest direct school-based influence on student learning outcomes (Hattie, 2009[5]). Most other school factors influence student learning mainly because they influence teachers' practices and, thereby, have a transmitted influence on student learning (OECD, 2019[34]). Teachers' classroom practices encompass various dimensions, including classroom management, teacher support, clarity of instruction, cognitive activation and feedback to students (Ainley and Carstens, 2018[30]). According to past research, the core factors that may be significantly related to student outcomes include, among others, the quantity and pacing of instruction (i.e. use of class time, classroom disciplinary climate, academic pressure) and the modalities of instruction and interaction (i.e. giving information, asking questions, providing feedback) (Muijs et al., 2014[23]). In this report, the dimension of teachers' classroom practices includes indicators on use of class time, autonomy over planning and teaching, teachers' perceived disciplinary climate,[6] use of practices related to clarity of instruction and cognitive activation as well as use of different types of assessment practices.[7]

Figure 2.1. The conceptual mapping of TALIS dimensions to student achievement



Research looking at the relationship between different teaching strategies and students' academic achievement demonstrate that certain strategies are more closely associated with student performance than others. A former OECD study exploring the relationship between student performance on the PISA mathematics test and exposure to specific teaching approaches found that higher-achieving students reported being more often exposed to cognitive-activation instruction[8] (Echazarra et al., 2016[35]). Teaching practices that focus on cognitive activation consist of exposing students to problems for which there is no immediately obvious solution or that can be solved in several different ways, or by using alternative routes and procedures to solve a problem. These instructional practices may also require students to apply what they have learned to new contexts (Echazarra et al., 2016[35]). Similarly, the previous 2013 TALIS-PISA link report (Le Donné, Fraser and Bousquet, 2016[36]), which focused on the relationship between mathematics teachers' teaching strategies and student learning outcomes in mathematics as well as students' attitudes toward learning, showed that, overall, a frequent use of the cognitive activation strategy and, to a lesser extent, the active learning strategies, were associated with higher mathematics performances. In contrast with cognitive activation, teacher-directed instruction consists of practices based on lecturing, memorisation and repetition, where the teacher is the main actor responsible for transmitting knowledge to receptive students (Le Donné, Fraser and Bousquet, 2016[36]).

Teacher dimensions with an indirect effect on student achievement

Teacher characteristics, motivation to join the profession and initial education and training

The evidence on the relationship between observable teacher characteristics, such as level of education, type of certification and experience, and student achievement is mixed. For example, Rivkin, Hanushek and Kain (2005[14]) found no evidence that a master's degree improves teacher effectiveness. Regarding teacher certification, recent OECD findings suggest that students in schools with a larger share of certified teachers perform better in reading, as measured by PISA (OECD, 2020[37]). However, other research findings show that the type of teaching certification has negligible impact on student test scores (Kane, Rockoff and Staiger, 2008[20]). The evidence on the relationship between experience and teacher effectiveness is also mixed. While there is research showing that the benefits of additional years of experience tend to fade away after the initial years in the profession (Rivkin, Hanushek and Kain, 2005[14]), there is also evidence that experience matters in teacher effectiveness later in the career (Papay and Kraft, 2015[38]).

Teachers' characteristics, background and initial education and training may have an effect on student outcomes due to their influence on the quality of teachers' instruction. For instance, it is plausible to assume that novice teachers build up their skills and become more effective in their teaching as they become more experienced, which eventually translates into better student outcomes. Moreover, the knowledge acquired during initial education and training has an effect on the teaching strategies adopted by teachers and the quality of their instruction (Blömeke, Gustafsson and Shavelson, 2015[39]), which are, in turn, significantly related to student achievement (Baumert et al., 2010[40]; Hill, Rowan and Ball, 2005[41]; Kersting et al., 2012[42]).

Teachers' motivation to join the profession can influence student achievement through indirect channels. The reasons motivating someone to join the teaching profession strongly correlate with the extent of job satisfaction (Ainley and Carstens, 2018[30]). Moreover, teachers' desire to make teaching their first choice as a profession also relates to job satisfaction and reported self-efficacy (OECD, 2019[34]). Teachers whose first career choice was teaching are more likely to be satisfied with their job in almost all countries and economies participating in TALIS, and they also tend to report higher self-efficacy in around two-thirds of countries and economies participating in TALIS (OECD, 2019[34]).

Job satisfaction, well-being and self-efficacy

Teachers' job satisfaction, well-being and beliefs are inter-related and have an indirect effect on student outcomes. Job satisfaction, which is the sense of fulfilment and gratification from working, has a positive impact on teachers, school culture and, ultimately, on students (Ainley and Carstens, 2018[30]). Based on TALIS results, teachers' job satisfaction (both with the current work environment and with the profession) is positively associated with teachers' self-efficacy (OECD, 2020[43]; OECD, 2014[44]). Moreover, job satisfaction also plays a key role in teachers' attitudes, efforts and confidence in their daily work with students (Caprara et al., 2003[45]; Klassen et al., 2013[46]; Tschannen-Moran and Hoy, 2001[47]). Thus, positive job satisfaction may also have an indirect effect on student achievement through enhanced commitment leading to better performance of teachers.

Well-being and stress, whether classroom- or workload-based, is integral to teachers' job satisfaction (Ainley and Carstens, 2018[30]). Stressful working environments and challenging working conditions can affect the practices of teachers and principals, their motivation for their work and even student achievement (Viac and Fraser, 2020[48]). Indeed, research has associated high levels of stress with lower self-efficacy for teaching, lower job satisfaction, and lower commitment (Collie, Shapka and Perry, 2012[49]). Conversely, teachers with high levels of well-being are likely to report higher levels of self-efficacy and job satisfaction as well as stronger motivation at work (Viac and Fraser, 2020[48]).

There is consensus among educational researchers, policy makers and practitioners that teacher self-efficacy is an essential teacher characteristic. It is strongly associated with teachers' pedagogical practices and the quality of teachers' instruction (Holzberger, Philipp and Kunter, 2013[50]), which are, in turn, associated with students' academic achievement. (Ainley and Carstens, 2018[30]). Moreover, teachers with high self-efficacy show higher job satisfaction and commitment, and are less likely to be affected by burnout (Avanzi et al., 2013[51]; Chesnut and Burley, 2015[52]; Klusmann et al., 2008[53]; Skaalvik and Skaalvik, 2010[54]).

Use of working time

The way teachers balance their time among competing tasks is important for the quality of the teaching and for student learning (OECD, 2019[34]). Apart from actual teaching, teachers also need to allocate their working time to other tasks, including, among others, lesson planning and preparation, marking and correcting student work, general administrative work, team work and dialogue with colleagues as well as communication and co-operation with parents. The way the different tasks of teachers are related to student learning varies. Allocating more time to administrative work allows less time for core activities such as lesson planning and preparation, which directly affect student learning in the classroom. The time teachers spend on preparing their lessons is highly beneficial to the quality of their instruction (Boeskens and Nusche, 2021[55]; Hargreaves, 1992[56]; Paniagua and Istance, 2018[57]).

Teachers' use of working time may not only influence student outcomes through their effect on the quality of teaching, but also through teachers' stress and well-being. Indeed, research shows that time pressures and workload are among the main factors affecting teachers' stress and well-being (Bakker et al., 2007[58]; Collie, Shapka and Perry, 2012[49]; Hakanen, Bakker and Schaufeli, 2006[59]; Klassen and Chiu, 2010[60]; Viac and Fraser, 2020[48]). Based on TALIS data, teachers' stress is just slightly related to teaching intensity (OECD, 2020[43]). However, the share of teachers reporting that they experience a great deal of stress in their work increases more sharply in planning, marking and, particularly, administrative tasks (OECD, 2020[43]).

School dimensions with a direct effect on student achievement

Classroom characteristics

The classroom's student composition in terms of cultural background, language spoken at home, socio-economic background, ability level and learning needs, can strongly influence student outcomes. Research on school-level peer effects show that the performances of both low- and high-achieving students are negatively affected by the presence of classmates with learning difficulties. Yet, high-performing students tend to be less affected than their low-achieving peers by the composition of their classes (Burke and Sass, 2013[61]; Lavy, Silva and Weinhardt, 2012[62]; Sacerdote, 2011[63]). There are various channels – both direct and indirect – through which peer effects can influence student outcomes. Students not only learn directly from their classmates with higher innate ability, but competition with high-achieving peers often makes students more motivated and work harder (Sacerdote, 2011[63]). Peer effects may also have a positive effect on future education expectations and career aspirations of students who lack sufficient knowledge and hold lower ambitions compared to their socio-economically more advantaged peers (OECD, 2019[64]). On the negative side, peer effects can influence student achievement indirectly through reduced teaching time due to disruptive behaviour or the detrimental effect of teaching practices being adapted to the needs of low performers (OECD, 2019[64]; Sacerdote, 2011[63]). The previous TALIS-PISA link report showed that the type of teaching strategies applied matters more for students' mathematics performance in socio-economically advantaged schools than in disadvantaged ones (Le Donné, Fraser and Bousquet, 2016[36]).

It sounds plausible that class size, another attribute of the classroom, has an inverse relationship with students' academic achievement since teachers can devote more time and attention to each student. Indeed, TALIS data show that smaller classes tend correlate with more actual teaching and learning time (OECD, 2019[34]). PISA 2018 results show that, on average, education systems with smaller language-of-instruction classes tend to feature higher PISA reading scores (OECD, 2020[37]). However, class size is not a predictor for other quality indicators of teaching processes captured by TALIS, such as the use of cognitive activation practices and teachers' reported self-efficacy in teaching (OECD, 2019[34]). Indeed, the empirical evidence on the effects of class size reduction on student achievement is somewhat mixed with certain research findings suggesting very little or no effect (Hanushek, 2006[65]; Hanushek, 2003[66]; Hanushek, 1999[67]; Hoxby, 2000[68]) while others find evidence of a positive impact (Angrist and Lavy, 1999[69]; Krueger, 2003[70]). Nevertheless, overall, the positive effects of smaller classes, especially at primary level, seem to be established by the literature (Bouguen, Grenet and Gurgand, 2017[71]). And research is also conclusive that, due to the high costs of such policy intervention, there can be a trade-off between reducing class size and improving teaching quality (Jepsen and Rivkin, 2009[72]; Rivkin, Hanushek and Kain, 2005[14]).

School culture

School culture is a multi-faceted concept that includes participation of staff, teachers and students in school decisions, collaborative school culture, student-teacher relations, academic pressure and involvement of parents and the community. This has both direct and indirect effects on students. The right school culture can enhance student learning directly and foster the conditions for effective teacher instruction (Ainley and Carstens, 2018[30]). For instance, parental support of student achievement, which is one of the factors captured by stakeholders' involvement, can have a direct effect on student outcomes irrespective of teachers' classroom practices. Indeed, past research findings show that a positive school culture has a powerful influence on many of the elements that affect both students and teachers. School culture relates not only to student learning and well-being (Battistich et al., 1997[73]; Bryk and Schneider, 2002[74]; Cohen et al., 2009[75]; Engel, Rutkowski and Rutkowski, 2009[76]; Hoy, Tarter and Hoy, 2006[77]; Martin et al., 2013[78]; Nilsen and Gustafsson, 2014[79]), but also to teacher effectiveness, confidence, and commitment to teaching (Hoy and Woolfolk, 1993[80]; Thapa et al., 2013[81]; Weiss, 1999[82]). Regarding the specific elements of school culture that may have a particularly close relationship with student achievement, Muijs et al. (2014[23]) highlight student-teacher relations and teacher expectations of students.

School dimensions with an indirect effect on student achievement

Teacher induction, mentoring, professional development and feedback

Support and early professional development is crucial for the development of novice teachers, who not only lack experience but often face more challenging working conditions than their more experienced peers (OECD, 2019[34]). Empirical evidence shows that support and assistance for beginning teachers in the form of induction and mentoring have a positive influence on outcomes such as commitment and retention of teachers, classroom teaching practices and student achievement (Ingersoll and Strong, 2011[83]). Induction and mentoring are also identified at the system level as being common to high-performing and equitable education systems (OECD, 2018[4]). Teacher induction can have an effect on student outcomes through teaching quality and job satisfaction. TALIS data show that teachers who took part in some kind of induction activity, formal or informal, also tend to report higher self-efficacy and job satisfaction on average across OECD countries and economies (OECD, 2019[34]). Rockoff (2008[84]) provides evidence of the beneficial effects of high-intensity mentoring on teaching quality and, ultimately, student achievement.

Supporting teachers to improve their skills is equally important at later stages of a teacher's career. Since teachers are assumed to be lifelong learners with different professional needs throughout their careers it is important that their instructional practices and ability to implement innovation in teaching and learning

are developed through continuous professional development (Ainley and Carstens, 2018[30]; OECD, 2019[34]). Indeed, effective continuous professional development programmes can improve teachers' skills (Borko, 2004[85]; Garet et al., 2016[86]) and classroom practices (Fischer et al., 2018[87]), thereby influencing student outcomes. For example, there is empirical evidence that a high-intensity and multifaceted in-service teacher training programme, which is designed to improve teaching skills (rather than provide course content) and includes counselling and feedback sessions for teachers, is associated with students' test score improvements (Angrist and Lavy, 2001[88]). Indeed, research concludes that professional development programmes are effective when they are intensive, sustained, collaborative and focused on teachers' practice (Opfer, 2016[89]). Moreover, as a recent OECD study shows, one of the common components of high-performing education systems is the opportunity for in-service teachers to participate in professional development workshops organised by the school (OECD, 2018[4]).

Feedback to teachers in the form of evaluation and appraisal can affect teaching quality. It is considered a key feature of effective professional development (Ingvarson, Meiers and Beavis, 2005[90]) and continuous learning (Jensen and Reichl, 2011[91]). By recognising teachers' strengths and addressing weaknesses in their pedagogical practices, feedback improves teachers' effectiveness (OECD, 2014[44]; OECD, 2013[92]), and has the largest impact on student performance of any school intervention (Hattie, 2009[5]). TALIS 2018 results show a significant positive association between teachers' job satisfaction and receiving impactful feedback (OECD, 2020[43]). Moreover, peer feedback from other teachers is a particularly important and unique form of collaboration between educators as it involves close contact and interaction between colleagues, driven by the purpose of learning from colleagues' expertise and suggestions (OECD, 2020[43]).

Collaboration

Research points to the value of two or more teachers interacting or working together to accomplish a specific goal. Teacher collaboration enables teacher learning, stemming from the exchange of ideas and interactions (Goddard, Goddard and Tschannen-Moran, 2007[93]). It helps teachers learn from each others' practices and experiences, which can help improve their own practices (Reeves, Pun and Chung, 2017[94]). Based on TALIS data, teachers who report deeper forms of collaboration (also referred to as professional collaboration) with their peers – such as team teaching, providing feedback based on classroom observations, engaging in joint activities across different classes and participating in collaborative professional learning – tend to report higher levels of job satisfaction, self-efficacy and the use of cognitive activation practices in the classroom (OECD, 2020[43]). Thus, teacher collaboration may have an indirect effect on student outcomes through its influence on teachers' instructional practices, job satisfaction and self-efficacy.

Except for a few countries and economies that participated in TALIS, most of the variation in teachers' responses regarding deeper forms of collaborative activities is spread across teachers (OECD, 2020[43]). This suggests that a teacher who collaborates within a school does not collaborate with all teachers of the school but only a few, while other colleagues from the same school do not collaborate at all (OECD, 2020[43]). Nevertheless, teacher collaboration is considered a school factor since school leadership has a major role in shaping the degree of collaboration as well as the culture of collaboration in the school. Indeed, research shows that leadership actions of school leaders are strong predictors of collaborative actions between teachers (Leithwood, Leonard and Sharratt, 1998[95]; Marks and Printy, 2003[96]; O'Donnell and White, 2005[97]). Moreover, analysis based on TALIS data suggests that teachers who report that their school provides staff with opportunities to participate in school decisions also tend to engage in deeper forms of collaborative activities more frequently (OECD, 2020[43]).

School innovativeness

Teachers' openness to change and their take-up of innovative teaching practices is important in supporting students' acquisition of cross-curricular skills. Today's generation of students needs broader and more complex skills – creativity, innovation, problem solving, critical thinking and digital literacy – to succeed in our complex and rapidly changing world (Ainley and Carstens, 2018[30]). But teachers must first embrace these skills in their teaching before they can develop them in their students (Ainley and Carstens, 2018[30]). Research evidence shows that teacher openness and extraversion – qualities that lend themselves to innovativeness – significantly influence teacher performance in the classroom (Ainley and Carstens, 2018[30]). TALIS aims to capture teachers' innovativeness through teachers' perceptions of their colleagues' openness towards innovation and how conducive the school context is toward innovation. In practice, innovativeness within TALIS refers to innovation at the school level,[9] and is therefore categorised as a school dimension.

Employment status and formal appraisal

Working conditions significantly affect the quality of the teacher's job and, subsequently, the teacher's motivation, engagement and well-being as well as the learning environment (Bascia and Rottmann, 2011[98]; Gomendio, 2017[99]; Viac and Fraser, 2020[48]). Job insecurity in the form of fixed-term employment, for example, can lead to insecurity and unpredictability, which may cause strain and prevent certain teachers from functioning optimally in their work environment (de Cuyper, de Witte and Van Emmerik, 2011[100]). Flexible time arrangements such as part-time work (both voluntary and involuntary), can help teachers achieve work-life balance and personal well-being. However, they can also have a negative impact on career progression and professional practices, including collaboration with other colleagues (Ainley and Carstens, 2018[30]; OECD, 2020[43]). Teachers' employment status can be categorised as a teacher dimension as different teachers in the same school may have different employment arrangements. Yet, for the theoretical framework of this chapter, employment status is defined as a school dimension since it also reflects on system-level characteristics of an education system.

Previous TALIS findings provide some insights into the different ways employment status influence student outcomes through its effect on teacher practices. Based on TALIS 2013 results, fixed-term employment is associated with participating less in formal induction programmes and professional development activities, and receiving less mentoring (OECD, 2014[44]). Similarly, results from TALIS 2018 show that part-time teachers are less likely to participate in professional development (OECD, 2019[34]) or professional collaboration (OECD, 2020[43]). And short-term work and part-time work tend to be negatively associated with teachers' self-efficacy (OECD, 2020[43]).

Teacher appraisal, which refers to the formal evaluation of teachers, is an important element of high-performing schools (Ainley and Carstens, 2018[30]; OECD, 2020[43]). In fact, a common characteristic of high-performing education systems is the presence of teacher-appraisal mechanisms, either legislated or deeply rooted in school practice, with a strong focus on teachers' continuous improvement (OECD, 2018[4]).Teacher appraisal can be a tool for ensuring that required standards are met or recommended practices followed. It also allows teachers to reflect on their teaching practice – their strengths and weaknesses – and identify areas for improvement (OECD, 2020[43]). Indeed, well-designed appraisal systems can support effective teaching practices (Ainley and Carstens, 2018[30]). They can also improve recognition of teachers' efforts and competencies, leading to more satisfied and motivated teachers (Isoré, 2009[101]; OECD, 2013[92]). Thus, teacher appraisal may have an indirect effect on student achievement through teachers' practices and beliefs.

School leadership

School leadership is one of the most important school factors influencing students' achievement (Chapman et al., 2015[102]; Hallinger, 2018[103]). The relationship between leadership and student outcomes is considered indirect as effective leadership practices aim to create supportive learning environments in which teachers are able to develop their practices and engage effectively with students' learning (Hallinger, 2011[104]; Muijs, 2011[105]; Reynolds and Muijs, 2016[106]). Instructional leadership is of particular interest in the context of the relationship between school leadership and student outcomes since it refers to principals' efforts to improve teachers' instructional quality (Ainley and Carstens, 2018[30]; OECD, 2020[43]). Instructional leadership refers to principals' actions to manage curriculum, attend to teachers' professional development needs and create a culture of collaboration (Hallinger, 2015[107]; Hallinger, 2011[104]; Hallinger and Heck, 2010[108]), and there is empirical evidence of its effect on student learning outcomes (Goddard et al., 2015[109]; Hallinger, 2015[107]).

Differential effects on student achievement by subject domain

Former research found differences in the size and nature of teacher and school effects across subjects. While teaching experience has been found to be more beneficial for test scores in reading than in mathematics (Rockoff, 2004[15]), teacher and school effects in mathematics and science tend to be larger than in reading (Seidel and Shavelson, 2007[7]; Reynolds et al., 2014[29]). One explanation for these findings is that, unlike reading, mathematics and science are mainly learned at school while their exposure in the family is more limited (Reynolds et al., 2014[29]). Although effective schools in one subject area tend to be more effective in other areas, there is also evidence for the contrary showing that certain schools can be effective in one subject domain but ineffective in another (Reynolds et al., 2014[29]). Therefore, the research literature warrants that the identification of the teacher and school factors that matter for student achievement be conducted by subject domain. In particular, as TALIS collects information on the subjects taught by teachers, it is possible to analyse student performances in a given subject by looking specifically at what the corresponding subject teachers do.[10]

Student characteristics associated with student achievement

Besides the teacher and school factors that are the main point of interest in this chapter, it is also important to take into account that there are student-level characteristics influencing student achievement. Ignoring them may lead to wrong conclusions about the relationship between teacher and school characteristics and practices, and student outcomes if there are student-level factors that are significantly related to student achievement but which are omitted from the analysis. Indeed, based on evidence from PISA, there are certain student characteristics, including student's socio-economic background, gender and immigrant background, which are reliable predictors of student outcomes. There is firm research evidence showing that the most stable predictor of a student's future success at school is his or her family background (OECD, 2019[64]). In addition, PISA results suggest that students' gender can also predict academic performance. Girls tend to outperform boys in reading and, to a lesser extent, boys outperform girls in mathematics on average across all participating countries and economies (OECD, 2019[64]).[11] The general pattern of the relationship between students' immigrant status and their achievement on the PISA test show that non-immigrant students outperform their first and second-generation immigrant peers in most countries (OECD, 2019[64]). However, this association is closely related to the socio-economic background of immigrant students, and thus may not hold for countries that apply selective immigration policies favouring highly skilled immigrants.

How to make the most of TALIS-PISA link data in exploring the factors that matter for student achievement?

Linking TALIS data, which provides information regarding the background, beliefs and practices of teachers and principals, and PISA data, which delivers insights into the background characteristics and cognitive and non-cognitive skills of 15-year-old students, offers an internationally comparable dataset combining information on key stakeholders. The breadth and depth of the TALIS-PISA link data provides an opportunity to identify teacher and school factors that have a significant association with student achievement.

Yet, the TALIS-PISA link data also present important limitations. The link between teachers and students is established at the school and not at the classroom level. In other words, the data do not allow matching a teacher with her or his students; rather, the data only allow matching a sample of teachers teaching 15-year-old students in a school with a sample of 15-year-old students of that same school. Information on teachers is therefore averaged at the school level and then analysed together with students' outcomes. Given that teachers of the same school differ significantly in terms of their characteristics and practices, linking data by averaging teachers' variables at the school level triggers a considerable loss of information.[12] Moreover, the cross-sectional design of the survey prevents measurement of any causal effects of teachers. Neither can short-term effects of teachers and schools on students' outcomes be distinguished from long-term ones.

As the focus of this chapter is to examine the teacher and school factors that matter for student achievement, TALIS and PISA data are linked by merging individual student data collected by PISA with TALIS principal data and TALIS teacher data averaged at the school level. Due to the survey design of the TALIS-PISA link data discussed above, teacher dimensions measure the average teacher's characteristics and practices at the school. Nevertheless, analysing the relationship between teacher and school factors, and student performance at the student level allows student characteristics at the level of students to be accounted for.

In order to make the most of the TALIS-PISA link data, this chapter takes a mixed data- and theory-driven approach. It is data-driven insofar as the identification of the teacher and school characteristics and practices that matter for student outcomes is centred around a supervised statistical learning method. And it is theory-driven because theory and previous research findings further inform the selection of variables used for the statistical method as well as interpret and validate the findings.

The main statistical technique used to investigate the relationship between teacher and school factors, and student achievement is the least absolute shrinkage and selection operator (also known as lasso). It is a machine learning technique within the family of supervised statistical learning methods (Box 2.1). Lasso is an attractive tool in analysing the relationship between the many variables collected through the TALIS questionnaires and the student outcomes measured by the PISA test. It selects the variables that are highly correlated with the outcome variable even when the number of potential variables is high relative to the number of observations (Box 2.1).

Box 2.1. The least absolute shrinkage and selection operator (lasso)

The least absolute shrinkage and selection operator (also known as lasso) is a machine learning technique within the family of supervised statistical learning methods. It has several attributes that enable it to identify the teacher and school factors that matter for student outcomes out of the many potential variables collected through the TALIS questionnaires. These are:

- Lasso is designed to select variables that are important and should be included in the model.
- The outcome variable guides the model selection process (i.e. supervised statistical learning method).
- Lasso can handle high-dimensional models where the number of variables is high relative to the number of observations.

Lasso estimates coefficients in a model. It selects variables that correlate well with the outcome in one dataset (training sample) and then tests whether the selected variables predict the outcome well in another dataset (validation sample). In the TALIS-PISA link data analysis, the training and validation samples are sub-samples of the TALIS-PISA link sample. Lasso proceeds with model selection by estimating model coefficients in such a way that some of the coefficient estimates are exactly zero, and hence, excluded from the model, while others are not (Hastie, Tibshirani and Friedman, 2017[110]; Hastie, Tibshirani and Wainwright, 2015[111]; Tibshirani, 1996[112]).

While lasso has several attributes that makes it an attractive tool for model selection, there are certain assumptions and limitations that need to be taken into account when applying this statistical technique:

- Lasso is most useful when only a few out of many potential variables affect the outcome (Hastie, Tibshirani and Friedman, 2017[110]; Hastie, Tibshirani and Wainwright, 2015[111]; Tibshirani, 1996[112]). The assumption that the number of coefficients that are non-zero (i.e. correlated with the outcome variable) in the true model is small relative to the sample size is known as a sparsity assumption. The approximate sparsity assumption requires that the number of non-zero coefficients in the model that best approximates the true model be small relative to the sample size.
- In the context of model selection, lasso may not always be able to distinguish an irrelevant predictor that is highly correlated with the predictors in the true model from the true predictors.
- Applying lasso for model selection means finding a model that fits the data, not finding a model that allows for interpreting estimated coefficients as effects. Thus, when used for model selection, lasso selects variables and estimates coefficients but it does not provide the standard errors required for performing statistical inference.

Note: For additional information on lasso, see Annex B.
Sources: Hastie, T., R. Tibshirani and J. Friedman (2017[110]), "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", in *Springer Series in Statistics*, https://web.stanford.edu/~hastie/ElemStatLearn//printings/ESLII_print12.pdf; Hastie, T., R. Tibshirani and M. Wainwright (2015[111]), "Statistical learning with sparsity: The lasso and generalizations", *Monographs on Statistics and Applied Probability*, https://web.stanford.edu/~hastie/StatLearnSparsity_files/SLS.pdf; Tibshirani, R. (1996), "Regression shrinkage and selection via the lasso", *Journal of the Royal Statistical Society: Series B (Methodological)*, http://dx.doi.org/10.1111/j.2517-6161.1996.tb02080.x.

Nevertheless, lasso also has certain limitations (Box 2.1) that warrant a balanced approach to identifying the teacher and school dimensions that might be key predictors of student achievement. Therefore, the results from lasso regressions are complemented with a theory-driven approach grounded in the relevant research literature and a variance decomposition analysis.

Identifying the dimensions that explain most of the differences in school average performances (and ultimately, variance in student achievement) may provide insights about specific teacher and school factors that may be significantly related to student performance. Yet, the variance decomposition analysis complements the findings from the lasso regressions as it can reveal the relative importance of each teacher and school dimension in explaining the average differences in student performances across schools. Moreover, unlike the results of lasso regressions (Box 2.1), the variance decomposition analysis is not influenced by the presence of highly correlated variables.

Once the teacher and school dimensions that might be key predictors of student achievement are identified based on lasso regression results, the variance decomposition analysis, as well as the relevant research literature, then the country-level regression analyses (featuring teacher and school dimensions separately) are applied. Thus, students' individual PISA scores are regressed on indicators of each teacher and school dimension (taken separately) that lasso regression results flag as important predictors. These dimensions explain a substantial part of between-school variance in student performance (i.e. 20% or above on average across subjects). In the context of this chapter, multiple linear regressions are estimated on one dimension at a time and provide insights into how the value of student performance in a given subject changes when any one of the independent variables within a dimension varies while all other independent variables included in the model are held constant. In comparison to lasso regressions, multiple linear regressions provide the confidence intervals of the coefficient estimates, which, in turn, allow for drawing inferences about the overall population. Moreover, they lead to more accurate coefficient estimates through the introduction of final and balanced repeated replicate weights and the use of plausible values of student performance. In contrast to lasso regressions, which are based on the overall population of 15-year-old students, teachers and principals surveyed within the TALIS-PISA link, multiple linear regressions are applied at the country level. This allows cross-country patterns to be established. Nested multiple linear regressions provide additional insights into the effects of potential confounding factors such as classmates' characteristics, and the relationship between teacher- or school-level factors and student achievement. Furthermore, the country-level multiple linear regressions do not focus solely on subject teachers but also looks at the relationships of interest by considering all teachers within the school. This provides the opportunity to identify differential teacher and school effects on student outcomes across subject domains.

What are the characteristics and practices of teachers and schools that matter for student achievement across subject domains?

Past research has shown that teacher and school factors do matter for student achievement. However, the evidence is mixed regarding the specific characteristics and practices of teachers and principals that are significantly related to students' cognitive outcomes across the three subject domains covered by PISA – reading, mathematics and science. The TALIS-PISA link data may provide further insights into this field of research given that it is an internationally comparable dataset combining information on students, teachers and principals.

This section aims to investigate the teacher and school factors that matter for student achievement across the three subject domains covered by PISA. First, it presents the dimensions that are selected by lasso regression analysis as being significantly related to student performance in all three subjects. Apart from presenting the teacher and school dimensions that are consistently highlighted by lasso, the first section also discusses the indicators selected for at least two out of the three subject domains within each highlighted dimension. Then, the section examines which dimensions explain a substantial share of the variance in student achievement at the school level. Lastly, it looks at the relationships between student achievement and the dimensions that are highlighted by the mixed data- and theory-driven approach more in detail, focusing on cross-country patterns, differential teacher and school effects in relation to the three subjects covered and the mediating effects of classmates' characteristics.

Teacher and school factors selected by lasso, a supervised statistical learning method

Following a data-driven approach, one can let lasso regressions select which of the almost 150 potential predictors of the 18 teacher and school dimensions actually matter for student performance in reading, mathematics and science. Figure 2.2 provides an overview of the teacher and school factors that are significantly related to student performance by focusing on the average subject domain teacher within schools.[13] Lasso regression results suggest that, considering the overall population of 15-year-old students, subject domain teachers and principals surveyed within the TALIS-PISA link, a third of the teacher and school dimensions under consideration matter for student performance consistently in all three subject domains covered by PISA.

The six dimensions highlighted consistently by lasso regression analysis as having a significant association with student achievement in all three subjects include both teacher and school dimensions as well as factors with direct and indirect effects on student achievement (Figure 2.2). These dimensions are teachers' classroom practices, teachers' well-being and job satisfaction, teachers' use of working time, classmates' characteristics, school culture and school leadership.

Teachers' classroom practices

The relationship between classroom practices and student achievement is well established in past research (Hattie, 2009[5]; Le Donné, Fraser and Bousquet, 2016[36]; Muijs et al., 2014[23]). Among the various aspects of teachers' classroom practices, such as teachers' autonomy over planning and teaching, teaching strategies, classroom management and assessment practices, lasso regression results highlight the use of class time and classroom disciplinary climate[14] as factors that are significantly related to student performance in at least two out of the three subject domains (Figure 2.2). Indeed, the link between the quantity and pacing of instruction, and student achievement is consistently confirmed by past research (Muijs et al., 2014[23]). Research has shown that students' opportunity to learn has significant effects on student achievement (Schmidt, Zoido and Cogan, 2014[113]). Clearly, students' opportunities to learn is closely linked to the amount of time allocated to academic instruction (Muijs et al., 2014[23]). However, the amount of time students are actively engaged in learning during a lesson is, in turn, highly related to the classroom's disciplinary environment and the teacher's classroom management practices and skills (Muijs et al., 2014[23]). As previous TALIS findings show, experienced teachers spend more time on actual teaching and learning partly because they teach less challenging classrooms (OECD, 2019[34]). Hence, the positive association highlighted by lasso between the share of class time spent on actual teaching and learning – as opposed to administrative and classroom management tasks – and student achievement may also point to a reverse causal relationship. Indeed, more disruptive classrooms are more likely to have lower achieving students, which, in turn, leads to more time spent on other tasks such as keeping order or administrative tasks.

Teachers' well-being and job satisfaction

Lasso regression results are in line with previous research findings, which indicate that teachers' satisfaction with their job can have an indirect positive effect on student achievement through teachers' beliefs, attitudes and practices as well as school culture (Ainley and Carstens, 2018[30]). In particular, teachers' job satisfaction with work environment is found to have a significant positive relationship with student performance (Figure 2.2). Yet, this finding may also point to reverse causality. It can be assumed that teachers may be particularly satisfied with their school assignment when they work in schools attended by high-achieving students. These teachers might be particularly committed to helping their academically gifted students progress further, and, in turn, the students may respond positively to the teachers' increased motivation.

Figure 2.2. Teacher and school factors that matter for student achievement, based on lasso

Dimensions and variables selected by lasso regressions based on responses of the overall population of 15-year-old students, subject domain teachers and principals surveyed within the TALIS-PISA link, by subject

Dimensions	Variables selected	Reading	Maths	Science
		(sign of standardised coefficients: +/-)		
Teacher dimensions with a direct effect on student achievement				
Classroom practices	Use of class time (%): Keeping order in the classroom	-	-	
	Use of class time (%): Actual teaching and learning	+	+	+
	Teachers' perceived disciplinary climate *(higher values indicate higher need for classroom discipline)*		-	-
Teacher dimensions with an indirect effect on student achievement				
Teacher characteristics	Age		+	
Motivation to join the profession	*No variables selected*			
Initial education and training	Highest level of formal education completed: ISCED 8	+		+
	Content: Teaching in a mixed ability setting	-	-	
	Content: Monitoring students' development and learning	-	-	
	Sense of preparedness: Content of some or all subject(s) I teach		+	
	Sense of preparedness: Teaching in a mixed ability setting			-
Well-being and job satisfaction	Workload stress *(higher values indicate workload being considered a more important source of stress)*	+	+	
	Job satisfaction with work environment	+	+	+
	Job satisfaction with profession		-	-
	Teachers' views of the way different stakeholders value the profession	-	-	
Self-efficacy	*No variables selected*			
Use of working time	Working hours by tasks: Marking/correcting of student work	+	+	+
	Working hours by tasks: General administrative work			-
	Working hours by tasks: Professional development activities	-		
School dimensions with a direct effect on student achievement				
Classroom characteristics (*classmates' characteristics and class size*)	Classroom composition (%): Low academic achievers	-	-	-
	Classroom composition (%): Students with special needs	-	-	
	Classroom composition (%): Students with behavioural problems		-	
	Classroom composition (%): Students from socio-economically disadvantaged homes	-	-	-
	Classroom composition (%): Academically gifted students		+	+
	Class size (no. of students)	+		+
School culture	Teachers' actions towards achieving academic excellence		+	
	Stakeholder (i.e., parents and local community) involvement in school-related activities	+	+	+
	Teacher-student relations	+	+	
School dimensions with an indirect effect on student achievement				
Induction	Took part in formal induction activities during first employment			+
Mentoring	*No variables selected*			
Professional development	Type: Online courses/seminars	+		
	Type: Observation visits to other schools	-		-
	Type: Participation in a network of teachers formed specifically for the professional development of teachers			-
	Type: Reading professional literature		+	
	Content: Knowledge and understanding of my subject field(s)	+		
	Content: School management and administration			-
	Content: Approaches to individualised learning	-		-
	Content: Teaching students with special needs	-	-	
	Content: Teacher-parent/guardian co-operation			-
Feedback	Feedback received by source: External individuals or bodies	+	-	
	Feedback received by method: School-based and classroom-based results (e.g. performance results, project results, test scores)	+		
Collaboration	*No variables selected*			
School innovativeness	*No variables selected*			
Employment status	Permanent employment		+	
	Part-time (50-70% of full time hours)		-	
	Part-time (less than 50% of full time hours)	-		
Formal appraisal	*No variables selected*			
School leadership	Principals' leadership activities: Collaborated with teachers to solve classroom discipline problems	-		-
	Principals' leadership activities: Took actions to support co-operation among teachers to develop new teaching practices	-	-	-
	Principals' leadership activities: Collaborated with principals from other schools on challenging work tasks		-	

Notes: Country fixed effects and student characteristics, such as gender, immigrant background and index of economic, social and cultural status are always included among the variables selected by lasso.
Teacher variables are averaged at the school level for subject domain teachers. Thus, the analyses by subject are based on samples restricted to schools with at least one subject domain teacher.
Dimensions and variables selected consistently across subject domains are highlighted in blue. Dimensions that are not selected based on any of the subject domains are highlighted in light grey. Since lasso is applied as a model selection technique, it does not provide the standard errors required for performing statistical inference. The interpretation of the estimated standardised coefficients is conditional on the selected model and cannot be interpreted as causal. Moreover, in the presence of correlated explanatory variables, the signs of the coefficient estimates can swing based on which other independent variables are in the model.
For additional information on the full list of potential variables included in the lasso regressions, as well as more information on lasso in general, see Annex B.
Sources: OECD, TALIS 2018 Database; OECD, PISA 2018 Database, Table 2.1.

Lasso regression results also highlight teachers' workload-induced stress[15] as an important factor in student performance (Figure 2.2). Interestingly, the relationship between workload being an important source of stress and student achievement is positive. Workload-induced stress may signal teachers' commitment and dedication to their work. While teachers' passion and dedication to their work can be a source of satisfaction, it can also lead to burnout by engaging with the work with too much intensity (Carbonneau et al., 2008[114]). But, this finding may also point to a reverse causal relationship as highly competitive school environments (attended by higher-performing students) can lead to workload being an important source of stress for teachers.

Based on lasso regression analysis, there is a significant negative relationship between average teachers' satisfaction with the profession and student achievement (Figure 2.2). TALIS asks teachers how they generally feel about their profession – whether the advantages of being a teacher outweigh the disadvantages; if they would still choose to work as a teacher if they could decide again; if they regret that they decided to become teachers; and if they wonder whether it would have been better to choose another profession. The negative relationship with student achievement is observed specifically in the case of student performance in mathematics and science. This could be explained by the possibility that mathematics and science teachers who teach in schools where student achievement is high may be more apt to consider alternative opportunities on the labour market that have better career opportunities and remuneration packages. Research evidence shows that science teachers are more likely to leave the teaching profession than their peers (Allen and Sims, 2017[115]), and that increasing science teachers' salaries can have a positive effect on retention (Clotfelter et al., 2008[116]; Feng and Sass, 2018[117]). Hence, the negative association highlighted by lasso regression results likely reveals how mathematics and science teachers regard their profession in light of other potential career opportunities. Nevertheless, this finding may also result from the limitations of the lasso regressions. Indeed, an irrelevant predictor may just as well be flagged by lasso as an important one missed (Box 2.1).

Past research found evidence for the positive relationship between teachers' social status and student achievement (Dolton et al., 2018[118]). Nevertheless, lasso regression results point towards a significant negative association between average teachers' views of the way different stakeholders value the profession[16] and student achievement (Figure 2.2). A possible explanation for this finding is that teachers in low-performing schools are actually higher up in the social ladder than most of the local adult population surrounding these schools. Higher local social status likely goes hand in hand with teachers' greater influence on local issues in comparison to other workers. This could trigger a better perception of the influence of teachers as a whole. However, similar to the lasso results related to teachers' satisfaction with the profession, this finding may also result from the limitations of the lasso regressions.

Teachers' use of working time

As part of teachers' use of working time, time spent on marking and correcting student work is selected by lasso regressions as an important predictor of student achievement (Figure 2.2). Assessment of student work, which tends to be one of the most time-consuming activities in teachers' work after teaching and lesson preparation (OECD, 2019[34]), is an essential part of a teacher's job to nurture student academic growth. Research shows that effective teaching includes formative assessment in the form of constructive and immediate feedback and that this type of feedback has positive implications for teaching and learning (Muijs and Reynolds, 2001[119]). Nevertheless, summative assessment of students' work, in the form of tests and exams, also provides feedback to students about their learning progress (Ainley and Carstens, 2018[30]). In addition, teachers' time spent on summative assessment can be indicative of their engagement in formative assessment. Thus, teachers' working hours spent on marking and correcting student work can be linked to student performance through teachers' feedback on students' learning progress. Nevertheless, it can be assumed that the relationship between hours spent marking and correcting, and student performance is non-linear. Providing feedback to students in the form of tests and exams only benefits learning outcomes if it does not lead to students' exhaustion and burnout. In addition, this finding may also

point to a reverse causal relationship as highly competitive school environments (attended by higher- performing students) can provide more frequent feedback to students in the form of tests and exams.

Classmates' characteristics and class size

As one would expect, lasso regression analysis points to a significant relationship between the context in which teaching and learning takes place in schools, and student outcomes (Figure 2.2). The relationship between student achievement and the average concentration of low academic achievers, students with special needs and students from socio-economically disadvantaged backgrounds within classrooms is negative, while the association between student performance and the concentration of academically gifted students in classes is positive.[17] Indeed, the existence of peer effects in relation to student outcomes is well established in the research literature (Ammermueller and Pischke, 2009[120]; Avvisati et al., 2014[121]; Burke and Sass, 2013[61]; Chetty, Hendren and Katz, 2016[122]; Duflo, Dupas and Kremer, 2011[123]; Lavy, Silva and Weinhardt, 2012[62]; Sacerdote, 2011[63]). Past analyses of PISA data also show that students, regardless of their own socio-economic background, tend to be advantaged scholastically if they attend a school whose students are from more advantaged socio-economic backgrounds (OECD, 2013[124]; OECD, 2019[64]). Students can potentially influence the motivations, the behaviour and ultimately the academic performance of their peers directly through interaction (Avvisati et al., 2014[121]; Sacerdote, 2011[63]). Moreover, students can also have an indirect effect on their classmates through the overall level of teacher effort and teachers' choice of the level at which to target instruction (Duflo, Dupas and Kremer, 2011[123]; Sacerdote, 2011[63]).

Based on lasso regression results, there is a significant positive relationship between the average class size at a school and student achievement (Figure 2.2). However, the relationship between class size and student achievement is hard to disentangle. Research shows that smaller classes tend to have a positive effect on student achievement (Bouguen, Grenet and Gurgand, 2017[71]). However, academically gifted students tend to attend larger classes. Typically, schools sort the least able students into smaller classes, which results in well-performing students attending larger classes (Bouguen, Grenet and Gurgand, 2017[71]). As a result, the true effect of class size on pupil performance cannot be determined without accounting for selection bias due to the way students are usually sorted into different classes.

School culture

Besides classroom characteristics, lasso regression analysis also highlights the importance of school culture in relation to student achievement (Figure 2.2). Past research findings show that school culture can have both direct and indirect influences on students and teachers, and as a result it is closely related to student achievement (Ainley and Carstens, 2018[30]). In particular, findings from lasso regressions point to the involvement of parents and the community[18] as a specific factor in a positive relationship with student performance. Indeed, research evidence is conclusive on the positive association between parental and community involvement, and student achievement (Wang and Degol, 2016[125]; Wilder, 2014[126]). Former research provides some insights regarding the channels through which parental involvement may be linked to student performance. The relationship tends to be the strongest if parental involvement refers to higher expectations for academic achievement, as opposed to involvement being defined as homework assistance (Wilder, 2014[126]). In addition, it can be also assumed that the positive association between stakeholder involvement in school-related activities and student achievement partly captures the overall positive influence of parental involvement in an adolescent's life, including psychological and emotional support that are not necessarily observed by school leaders. Moreover, there is evidence for spillover effects in parents' involvement in education as the impact of more involved parents on their children is amplified at the class level by peer group interaction (Avvisati et al., 2014[121]). Nevertheless, similar to most of the relationships presented above, this finding may also signal reverse causality. As students

perform better academically, parents may see more worth in supporting students' achievement and being more involved in school-related activities.

In addition to stakeholder involvement, lasso regression results indicate that teacher-student relations[19] are another important element of school culture with respect to student performance (Figure 2.2). This finding is in line with previous research that identified teacher-student interaction as an important component in creating an effective learning environment (Muijs et al., 2014[23]). Together with the finding that shows the importance of the share of class time spent on actual teaching and learning, the potential link between student-teacher relations and student achievement highlights the importance of the classroom-level context when it comes to student performance.

School leadership

Past research findings identify school leadership as one of the most important school factors influencing students' achievement (Chapman et al., 2015[102]; Hallinger, 2018[103]). Lasso regression analysis highlights, in particular, principals' actions to support co-operation among teachers in developing new teaching practices as an important predictor of student performance, but the association is negative (Figure 2.2). Similarly, according to lasso regression analysis, there is a negative relationship between student performance and the frequency with which principals collaborate with teachers to solve classroom disciplinary problems, and with principals from other schools to solve challenging work tasks. These findings may signal a reverse causal relationship. It can be assumed that in school environments characterised by co-operation among teachers as well as a lack of disciplinary issues and challenging work tasks, which also happen to be attended by higher-performing students, school leaders do not feel the need to engage in such activities on a regular basis.

Teacher and school dimensions not selected by lasso

More than half of the teacher and school dimensions introduced in the regressions are not consistently selected across subjects as important predictors by lasso. These dimensions are assumed to have indirect links with student achievement (Figure 2.1). Teachers' initial education and training, and teachers' participation in professional development are flagged by lasso as important predictors of student performance in each subject (Figure 2.2). However, there is no common variable within these two dimensions of teacher training deemed relevant for all of reading, mathematics and science. Moreover, most of the variables selected by lasso regressions within these two dimensions reveal a negative relationship with student achievement. For instance, lasso regression results show a negative association between the share of teachers within schools for whom teaching in a mixed ability setting was included in their formal education or who felt prepared for this type of teaching, and student achievement (Figure 2.2). What this result potentially reveals is that teachers who had formal pre-service training in teaching in challenging classrooms end up teaching such classes later on in their career. In turn, these classes tend to be characterised by lower student performance on average. Similarly, most of the associations between teachers' participation in professional development and student performance that are highlighted by lasso regression results show an inverse relationship. These negative associations potentially identify areas in which teachers are facing challenges that eventually create the link between participating in certain professional development activities and teaching low-achieving students.

Nevertheless, there are some elements within initial education and training and professional development that are selected by the lasso regressions for a specific subject, including teachers' sense of preparedness for the content of the subject taught, participation in professional development in the form of online courses or seminars and in the form of reading professional literature, and participation in professional development focusing on knowledge and understanding of subject field (Figure 2.2). It could be assumed that these factors are more closely related to student performance in a given subject as compared to other subjects. Yet, the country-level regression results by each dimension taken separately do not confirm the differential

effect of teachers' pre- and in-service training across subject domains, since the relationships between the above-mentioned elements within initial education and training and student performance, as well as professional development and student performance, are not significant at the country level. (Tables 2.21, 2.22, 2.23, 2.24, 2.71, 2.72, 2.73, 2.74, 2.75, 2.76, 2.77, 2.78, 2.79, 2.80, 2.81 and 2.82). Given the limitations of the lasso regressions and/or the TALIS-PISA link data, an important factor may be missed for a given subject. In the case of specific teacher and school factors that are not consistently selected across subject domains it is not possible to draw a conclusion with respect to their relationship with student performance.

Teacher characteristics, induction, feedback and employment status are only selected for one or two subjects of the three, which are reading, mathematics and science (Figure 2.2). Since all these dimensions are assumed to have an indirect effect on student achievement (Figure 2.1), lasso regression results may simply point towards this indirect link with student outcomes. Indeed, teacher characteristics, induction, feedback and employment status may influence student performance through their effects on classroom practices and school culture, which have been incorporated in the lasso model. It could be also assumed that some of these teacher and school factors may be more closely linked to a specific subject. Yet, looking at each dimension taken separately at the country-level (Tables 2.17, 2.18, 2.19, 2.20, 2.67, 2.68, 2.69, 2.70, 2.83, 2.84, 2.85, 2.86, 2.87, 2.88, 2.89 and 2.90), as well as the average between-school differences in student performances explained by these dimensions (Figure 2.4), there is little evidence for the presence of differential teacher effects.

There are teacher and school dimensions that are not selected by lasso regressions for any of the subjects included in the analysis. These dimensions include motivation to join the profession, self-efficacy, mentoring, collaboration, school innovativeness and formal appraisal (Figure 2.2). Nevertheless, these teacher and school factors may still matter for student achievement. First, these dimensions may have an indirect effect on student achievement (Figure 2.1). For instance, teachers who report higher self-efficacy tend to be more satisfied with their job and more committed to it (Avanzi et al., 2013[51]; Chesnut and Burley, 2015[52]; Mostafa and Pál, 2018[127]; OECD, 2019[34]), while students taught by teachers who are more satisfied with their jobs and are more committed also tend to perform better in school (Ainley and Carstens, 2018[30]; Carbonneau et al., 2008[114]). As another example, engaging in professional collaboration more often may influence student achievement through the beneficial effects of the exchange of ideas on teachers' instructional practices as well as on the risk of teacher attrition (OECD, 2020[43]). Second, the lack of significant relationship may be an artefact resulting from the characteristics and limitations of the TALIS-PISA link data and/or the modelling approach taken. The aggregation of teacher data at the school level means that all the relationships analysed within this chapter relate to a school's overall context and needs to be interpreted accordingly. Therefore, it is plausible to assume that the analyses within this chapter may miss some factors that do contribute to student achievement but are not captured because no direct link can be drawn between an average teacher in a school and a sample of students.

Differences in student achievement explained by teacher and school factors

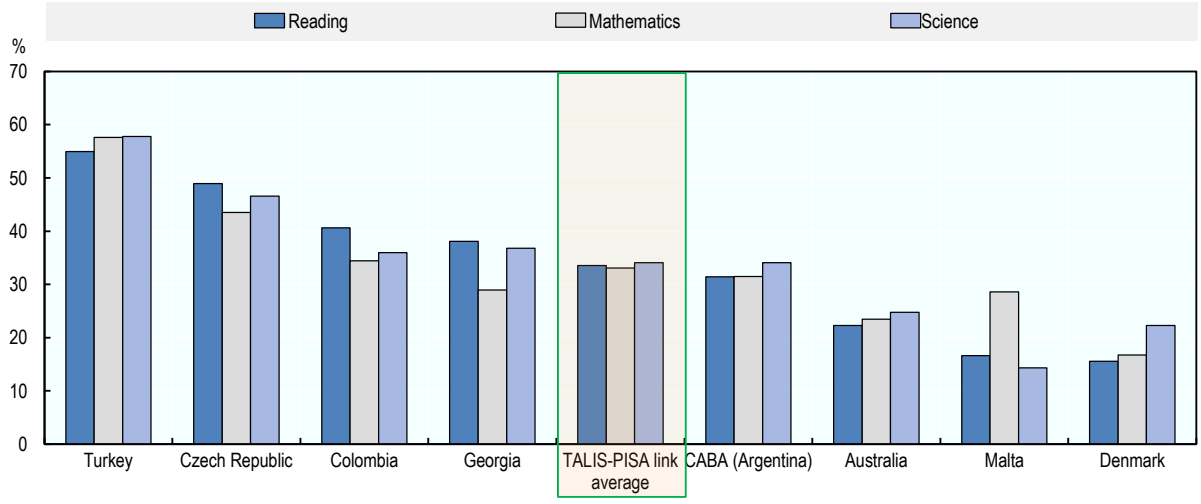
This chapter aims at identifying the teacher and school dimensions that matter the most for student performance. Analysing results from lasso regressions is one way to do this (see previous section). Another complementary approach consists of retaining those dimensions that explain the highest shares of variance in student performance by relying on a variance decomposition analysis. Although this approach cannot highlight the specific factors within a dimension that may matter the most for student achievement, it complements the findings of the lasso regressions by revealing the relative importance of each teacher and school dimension in explaining the average differences in student performance across schools. Another advantage of the variance decomposition analysis is that, unlike the results of lasso regressions (Box 2.1), the presence of highly correlated variables does not affect the results.

However, the variance decomposition analysis is not without limitations either. Most importantly, the shares of between-school variance explained by each dimension may be artificially driven by the number of variables included in a given dimension. Indeed, the dimensions that have the lowest explanatory power, such as collaboration, school innovativeness, mentoring, motivation to join the profession, employment status, self-efficacy, induction and teacher characteristics, include four or fewer variables, while the dimensions that explain larger shares of the differences in school average performance include between seven and 14 variables. Thus, caution is warranted when interpreting these results.

Yet, with the aforementioned advantages and limitations in mind, one can examine the share of variation in student achievement that is possible to explain with the help of TALIS-PISA link data as well as the explanatory power of each teacher and school dimension. TALIS-PISA link data suggest that differences in school average performance across the eight TALIS-PISA link countries and economies with available data represent about one-third of the total variance in student performance, irrespective of the subject domain (Figure 2.3). This means that on average across TALIS-PISA link countries and economies around a third of the total variation in student performance can actually be captured by the analyses included in this chapter. Obviously, as the factors of interest included in the analyses are introduced at the school level, one can only explain the share of variance in students' performance at the school level. For the same reason, as the link between teachers and students is established at the school and not at the classroom level, the within-school variance in student performance explained by each teacher dimension cannot be examined based on the TALIS-PISA link data.

Figure 2.3. Schools differ in student achievement

Percentage of total variance in PISA scores explained at the school level, by subject



Notes: The analyses are based on samples restricted to schools with at least one subject domain teacher. The TALIS-PISA link average corresponds to the arithmetic mean of the estimates of participating countries and economies, excluding Viet Nam.
Countries and economies are ranked in descending order of the percentage of total variance in PISA reading score, explained at the school level.
Sources: OECD, TALIS 2018 Database; OECD, PISA 2018 Database, Tables 2.2, 2.3 and 2.4.

StatLink https://doi.org/10.1787/888934223707

Nevertheless, the variation in the share of total variance in student performance that can be explained at the school level varies across countries and economies. While in the Czech Republic and Turkey differences in school average performance represent about half of the total variance in student

achievements, at the other end of the spectrum, the same shares are below 25% in most subjects in Australia, Denmark and Malta (Figure 2.3). This means that the TALIS-PISA link data is more likely to provide insights for countries such as the Czech Republic and Turkey, where the school-level variations in student performance are considerably higher as opposed to countries, including Australia, Denmark and Malta, where TALIS-PISA link data can only capture 25% or less of the total variation in student outcomes.

The share of between-school variance explained by each dimension included in the analyses is fairly similar across reading, mathematics and science. In line with research findings that highlight the importance of the classroom level in relation to teaching and learning (Hattie, 2009[5]; Muijs et al., 2014[23]), classroom characteristics explain the largest share of variance in student performance that exists between schools (44-45%) (Figure 2.4). At the other end of the spectrum, school innovativeness and teacher collaboration have the lowest explanatory power. Depending on the subject, these dimensions account for 5% or less of the variation in student achievement that exists between schools (Figure 2.4).

Except for a few exceptions, the dimensions that explain the largest shares of between-school variance turn out to be the ones that are also identified by the lasso regression analysis. These nine dimensions, which represent both teacher and school dimensions as well as factors with direct and indirect effects on student achievement include: classroom characteristics (44-45%), use of working time (26-31%), school leadership (23-25%), classroom practices (23-28%), well-being and job satisfaction (17-27%) and school culture (20-22%). The dimensions that are not consistently highlighted by the lasso regressions but do explain a substantial share of between-school variance in student achievement (i.e. 20% or above on average across subjects) include professional development – both in terms of type and content (19-34%) – initial education and training – both in terms of content and teachers' sense of preparedness for a given element of pre-service training (20-27%) – and formal appraisal (19-24%) (Figure 2.4). On average across countries and economies participating in the TALIS-PISA link, these dimensions explain between 17-45% of the differences in school average performances across subjects (Figure 2.4).

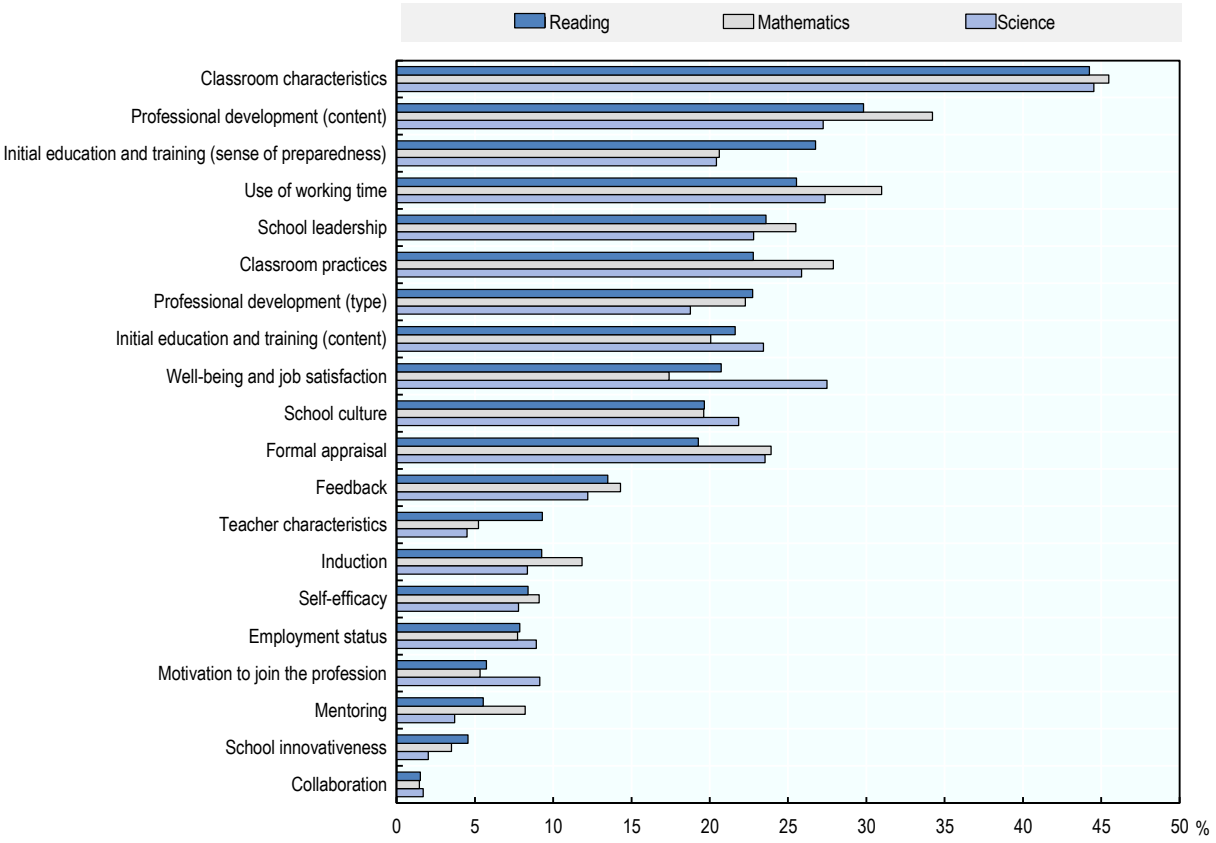
Do teacher and school factors matter equally across countries and subject domains?

The findings presented in the previous sections mainly focused on the teacher and school dimensions that matter for student performance for the overall population surveyed within the TALIS-PISA link in the case of the lasso regression analysis, and on average across countries in the case of the variance decomposition analysis. However, these results may mask important differences across the TALIS-PISA link countries and economies. Therefore, this section examines cross-country patterns. Student performance is regressed on each teacher and school dimension (taken separately) that is flagged by the lasso estimation results as an important predictor and explains a substantial part of between-school variance in student performance (i.e. 20% or above on average across subjects).

Besides revealing how the teacher and school factors that matter vary across countries and economies, the nested multiple linear regressions provide insights regarding the potential role of classmates' characteristics as confounding factors in the association between a teacher or school factor and student achievement. While controls for student characteristics such as gender, immigrant background and the index of economic, social and cultural status are always included in these regression models, the controls for the average classroom composition[20] within the school (also referred to as classmates' characteristics) are introduced in the augmented version of the models. Since these controls for classmates' characteristics are introduced in the nested multiple linear regression models while students' own characteristics are also included, they account for the mediating role of the academic abilities, behaviour problems and socio-economic and linguistic background of classmates.

Figure 2.4. School average differences in student achievement explained by teacher and school factors

Percentage of between-school variance in PISA scores, by dimension and by subject (TALIS-PISA link average)



Notes: Teacher variables are averaged for subject domain teachers. Thus, the analyses are based on samples restricted to schools with at least one subject domain teacher. The sum of between-school variances in student performance explained across all dimensions exceeds 100%, since such a sum does not take into account that the different dimensions are correlated with each other. The TALIS-PISA link average corresponds to the arithmetic mean of the estimates of participating countries and economies, excluding Viet Nam.
Values are ranked in descending order of the percentage of variance in PISA reading score explained at the school level.
Sources: OECD, TALIS 2018 Database; OECD, PISA 2018 Database, Tables 2.2, 2.3 and 2.4.

StatLink https://doi.org/10.1787/888934223726

Moreover, the country-level analysis does not focus solely on subject teachers, but it also looks at the relationships of interest by considering all teachers within the school. This complementary approach serves two goals: 1) it allows for revealing significant relationships that might be undetected due to low sample sizes given that the analyses are conducted at the country level; 2) it provides an opportunity to identify differential teacher and school effects on student outcomes (Box 2.2).

Based on lasso regression results presented above, six dimensions, including teachers' classroom practices, classroom characteristics, teachers' well-being and job satisfaction, teachers' use of working time, school culture and school leadership, have a significant association with student achievement in reading, mathematics and science. These dimensions also explain a significant part of the average school-level differences in student performances. Hence, this section examines how the relationships between the six teacher and school dimensions and student achievement in reading, mathematics and science vary across countries and subject domains. Moreover, this section also looks at the role of

classmates' characteristics as a mediating factor in the relationship between specific teacher and school dimensions and student performance. It is also important to stress that, similarly to the lasso regression results, causal interpretation of the country-level regressions is not possible. All the results presented here are correlational and should be interpreted accordingly.

Box 2.2. How does the inclusion of non-subject teachers benefit the interpretation of the country-level findings?

Cross-country patterns in the relationships between teacher and school factors, and student performances are explored by considering all teachers within the school. As compared to analysing the overall population surveyed within the TALIS-PISA link, moving to country-level analysis leads to smaller sample sizes, which reduces the probability of identifying significant relationships. Therefore, to raise statistical power, the country-level analysis does not focus solely on subject teachers but also looks at relationships of interest by considering all teachers within the school.

If a teacher or a school factor matters for student achievement in a given subject by considering all teachers in the school, then it can be assumed that this factor also matters when focusing on teachers of that given subject. Subsequently, if a significant association is only established when all teachers are taken into account but not when the focus is on subject teachers, then it can be assumed that the lack of statistical power is at play.

On the other hand, a relationship may only be significant when focusing on subject teachers, but not when all teachers' practices or characteristics are taken into account. This suggests that the given factor matters specifically for subject teachers. Indeed, it can be assumed that certain teacher characteristics and practices are subject-specific and they can cancel each other out if averaged across teachers teaching different subjects. Past research shows that differential teacher and school effects on student outcomes may exist (Reynolds et al., 2014[29]; Rockoff, 2004[15]; Seidel and Shavelson, 2007[7]).

Thus, considering all teachers for the country-level analyses not only allows for revealing significant relationships that might be undetected due to low sample size, but it also provides an opportunity to identify differential teacher and school effects on student outcomes.

Sources: Reynolds, D. et al. (2014[29]), "Educational effectiveness research (EER): A state-of-the-art review", *School Effectiveness and School Improvement*, http://dx.doi.org/10.1080/09243453.2014.885450; Rockoff J. (2004[15]), "The impact of individual teachers on student achievement: Evidence from panel data", *American Economic Review*, http://dx.doi.org/10.1257/0002828041302244; Seidel, T. and R. Shavelson (2007[7]), "Teaching effectiveness research in the past decade: The role of theory and research design in disentangling meta-analysis results", *Review of Educational Research*, http://dx.doi.org/10.3102/0034654307310317.

Teachers' classroom practices

The teacher dimension of classroom practices is consistently highlighted by the lasso regressions and the variance decomposition analysis as well as by education research as an important predictor of student performance. According to country-level regression results, as the average school teacher spends more class time on actual teaching and learning, students tend to perform better in all three subjects covered by PISA (i.e. reading, mathematics and science), in the Czech Republic, Turkey and on average across the countries and economies participating in the TALIS-PISA link (Figure 2.5). In Denmark, there is a positive relationship for mathematics and science, but for reading the association is not statistically significant.

When focusing on subject teachers, the relationship between student achievement and class time spent on actual teaching and learning by the school's average teacher becomes non-significant for reading and science in most countries (Figure 2.5). This may be an artefact of smaller sample sizes as the analyses are restricted to those schools that have at least one subject domain teacher. Yet, in Georgia, the

relationship between student performance in science and the average class time spent on actual teaching and learning within the school becomes significant only when the focus is on science teachers. This suggests that, in the case of Georgia, the class time spent on actual teaching and learning by the school's average teacher may matter specifically for student performance in science.

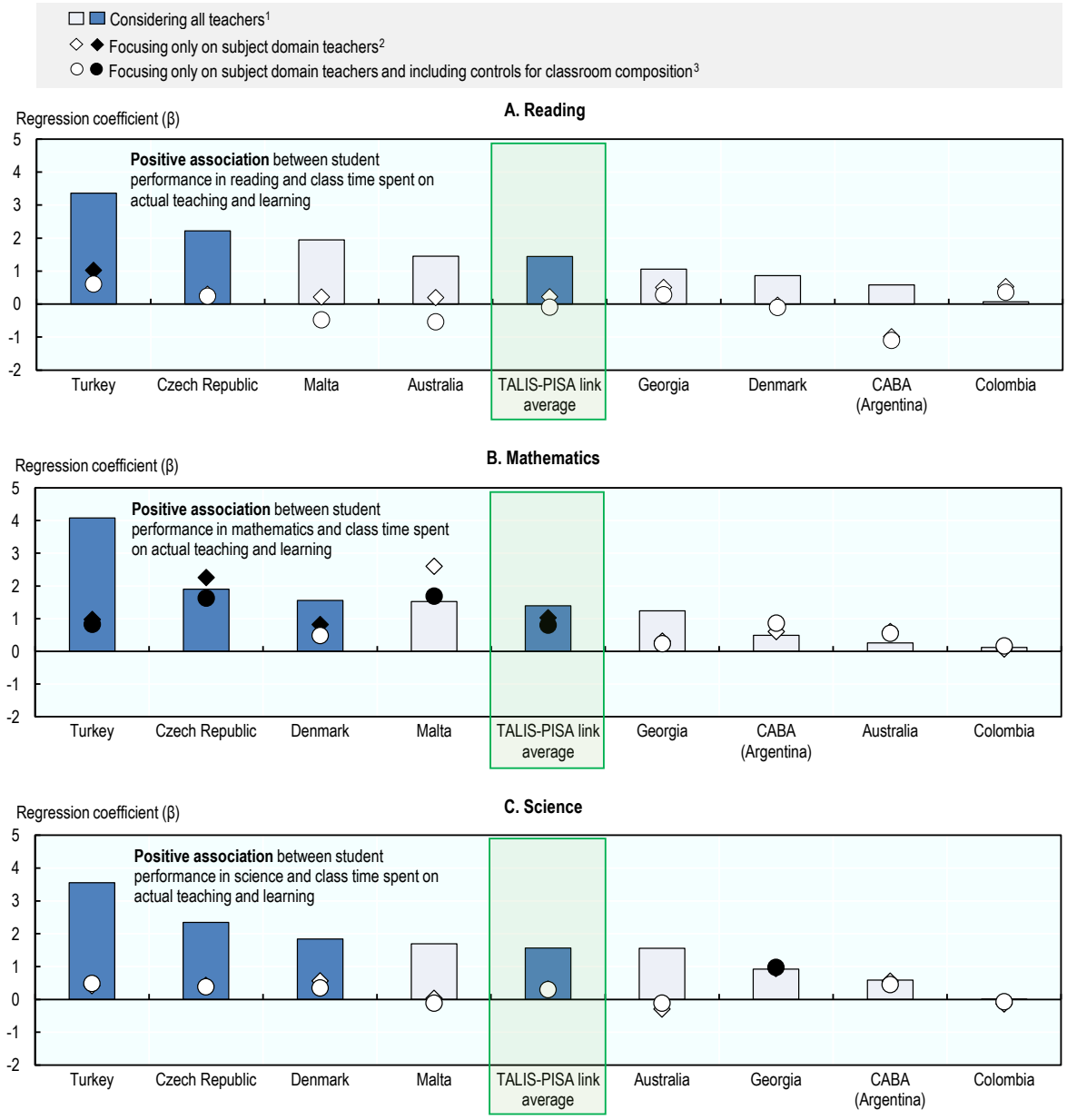
After accounting for classmates' characteristics, the association between student achievement and class time spent on actual teaching and learning by the school's average teacher remains significant only in the case of mathematics performance (Figure 2.5). This holds true in the Czech Republic, Turkey and on average across participating countries and economies. These results suggest that, especially in the case of reading and science classes, those with high academic achievers and students from privileged backgrounds likely have more exposure to actual teaching and learning than classes with a higher number of students who are struggling and come from socio-economically disadvantaged homes. These findings also indicate that, in general, the use of class time may be more closely linked to student performance in mathematics than in reading and science. This is also confirmed by the fact that classroom practices explain a larger share of the between-school variation in student performances in mathematics (28%) as compared to reading (23%), especially, and science (26%), to a lesser extent (Figure 2.4). Indeed, unlike reading, to which students are more exposed in all their academic activities as well as everyday life, mathematics and science are mainly learned at school (Reynolds et al., 2014[29]). In addition, there is research evidence for teacher and school effects being larger in mathematics and science than in reading (Reynolds et al., 2014[29]; Seidel and Shavelson, 2007[7]).

Classroom disciplinary climate, which can also be regarded as a partial measure for teachers' classroom management skills, is another element within classroom practices that turns out to be closely linked to student achievement. Indeed, based on country-level regression analysis, students who attend schools where there are classroom disciplinary issues tend to perform worse in all subjects in CABA (Argentina), the Czech Republic, Turkey and on average across participating countries and economies (Tables 2.5, 2.9 and 2.13).

The association between student achievement and school-level classroom disciplinary climate becomes non-significant in most countries and economies after controlling for classmates' characteristics (Tables 2.6, 2.8, 2.10, 2.12, 2.14 and 2.16). This suggests that students whose classmates are from privileged backgrounds might not only benefit from more class time spent on actual teaching and learning than their peers from socio-economically disadvantaged homes, but they also tend to attend schools where disciplinary problems are less of an issue.

Figure 2.5. Relationship between class time spent on teaching and student achievement

Change in PISA score associated with the average class time spent on actual teaching and learning at the school, by subject



1. Teacher variables are averaged for all teachers within the school.
2. Since teacher variables are averaged only for subject domain teachers, the analysis is based on a sample restricted to schools with at least one subject domain teacher.
3. Since teacher variables are averaged only for subject domain teachers, the analysis is based on a sample restricted to schools with at least one subject domain teacher. Besides controlling for student characteristics, the following controls are also included in order to account for the average classroom composition within the school: share of students whose first language is different from the language(s) of instruction, low academic achievers, students with special needs, students with behavioural problems, students from socio-economically disadvantaged homes, academically gifted students, students who are immigrants or with a migrant background and students who are refugees.

Notes: Results of linear regressions are based on responses of 15-year-old students and teachers. Controlling for the following classroom practices of teachers: teachers' autonomy over planning and teaching, perceived disciplinary climate, use of practices related to clarity of instruction, use of practices related to cognitive activation, use of assessment practices such as administering own assessment, providing written feedback on student work in addition to marking, letting students evaluate their own progress and observing students when working on particular tasks and providing immediate feedback; and for the following student characteristics: gender, immigrant background and index of economic, social and cultural status. The TALIS-PISA link average corresponds to the arithmetic mean of the estimates of participating countries and economies, excluding Viet Nam.

Statistically significant coefficients are marked in a darker tone (see Annex B).

Countries and economies are ranked in descending order of the change in PISA score associated with the average class time spent on actual teaching and learning, considering all teachers at the school.

Sources: OECD, TALIS 2018 Database; OECD, PISA 2018 Database, Tables 2.5, 2.6, 2.8, 2.9, 2.10, 2.12, 2.13, 2.14 and 2.16.

StatLink https://doi.org/10.1787/888934223745

Teachers' well-being and job satisfaction

Teachers' well-being and job satisfaction is a dimension that is found to matter for student performance by the lasso regression and the variance decomposition analyses presented above. According to country-level regression results, the more teachers are satisfied with the work environment on average at the school the better students tend to perform in all three subjects covered by PISA. This relationship holds in Australia, the Czech Republic, Georgia, Turkey and on average across participating countries and economies (Figure 2.6).

However, after controlling for classmates' characteristics, the relationship is no longer significant for student performance in reading and mathematics across most countries and economies (Figure 2.6). This indicates that, in the case of reading and mathematics, the association between student performance and teachers' satisfaction with the work environment may largely be driven by classmates' characteristics.

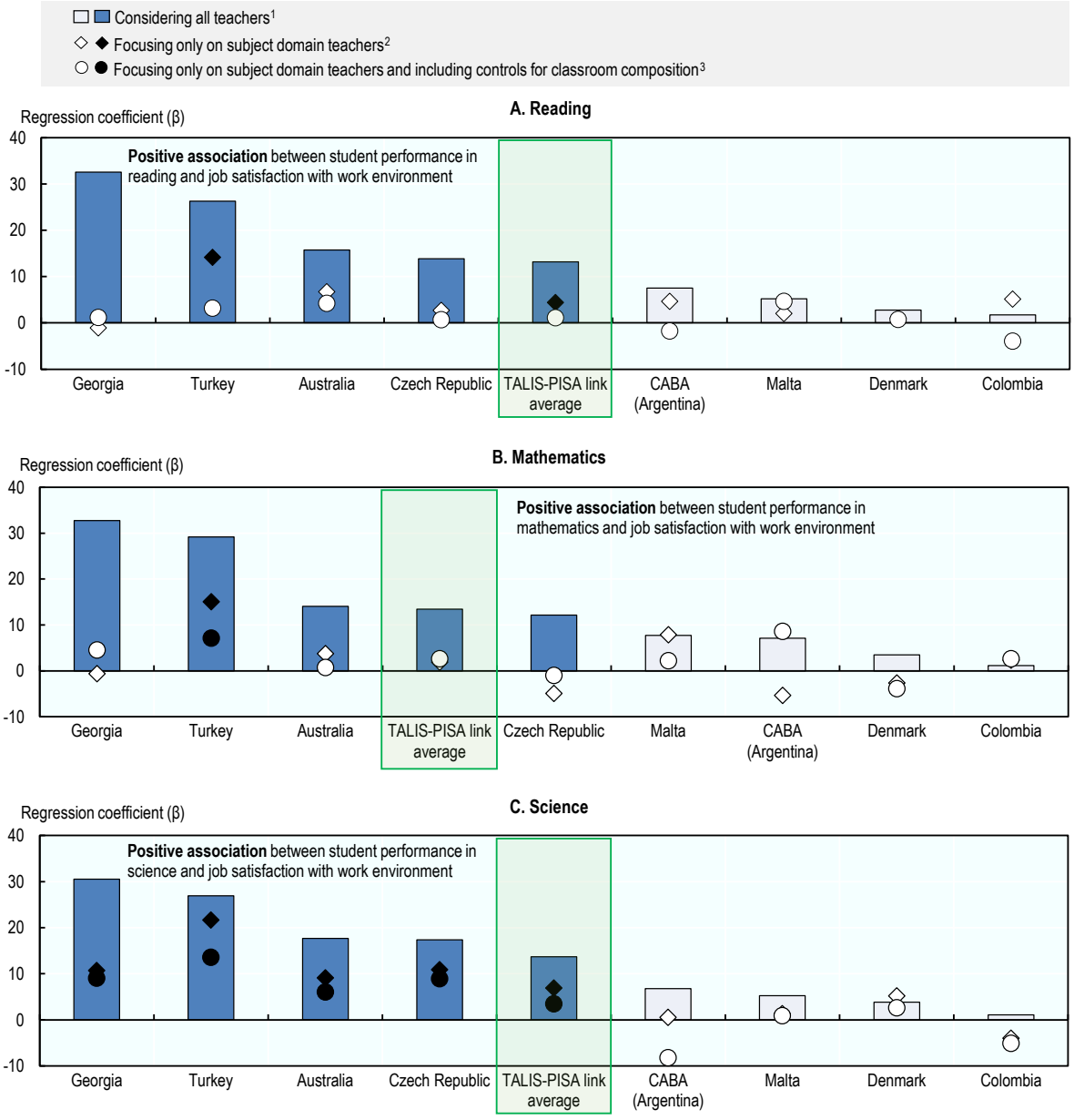
Teachers' satisfaction with the work environment seems to matter almost exclusively for student achievement in science once the average classroom composition within the school is accounted for and the focus shifts to subject teachers. This is the case in Australia, the Czech Republic, Georgia, Turkey and on average across participating countries and economies (Figure 2.6). Thus, country-level analysis suggests that teachers' satisfaction with the work environment may be more closely related to student performance in science than in reading and mathematics. This finding is in line with the results of the variance decomposition analysis presented in the previous section, which shows that the teacher well-being and job satisfaction dimension can explain a considerably larger share of the average school-level differences in performance in science (27%) than in reading (21%) and mathematics (17%) (Figure 2.4).

Similarly to why the use of class time may be most pertinent to mathematics, the close relationship between teachers' satisfaction with the work environment and student achievement in science can be also explained by the fact that, unlike reading, students mainly acquire their knowledge in science and mathematics at school (Reynolds et al., 2014[29]). Thus, science teachers' satisfaction with the work environment may indeed be more closely related with student achievement since students are most likely to learn about science in school. This can also explain why research points towards larger teacher and school effects in mathematics and science than in reading (Reynolds et al., 2014[29]; Seidel and Shavelson, 2007[7]). Moreover, work environment may matter specifically for science since teaching this subject has certain requirements regarding the work environment, such as a well-equipped school lab, that are critical for teachers to do their work properly.

Lasso regression results suggest that, besides teachers' satisfaction with the work environment, the extent to which workload is an important source of stress is also an important predictor of student achievement. In Colombia, the Czech Republic, Denmark and on average across participating countries and economies, students who attend schools where teachers, on average, report workload, including lesson preparation, number of lessons to teach, marking, administrative work and extra duties due to absent teachers, as an important source of stress, tend to perform better in all three subjects covered by PISA (Tables 2.25, 2.29 and 2.33). The relationship also becomes significant in CABA (Argentina) in the case of reading performance, when only reading teachers are included in the analysis (Table 2.26). This indicates that in CABA (Argentina) workload-induced stress may matter specifically for student achievement in reading. Overall, these findings may signal teachers' commitment and dedication to their work as well as point to a reverse causal relationship as highly competitive school environments (attended by higher-performing students) can lead to workload being an important source of stress for teachers.

Figure 2.6. Relationship between teachers' satisfaction with work environment and student achievement

Change in PISA score associated with the average job satisfaction with work environment at the school, by subject



1. Teacher variables averaged for all teachers within the school.
2. Since teacher variables are averaged only for subject domain teachers, the analysis is based on a sample restricted to schools with at least one subject domain teacher.
3. Since teacher variables are averaged only for subject domain teachers, the analysis is based on a sample restricted to schools with at least one subject domain teacher. Besides controlling for student characteristics, the following controls are also included in order to account for the average classroom composition within the school: share of students whose first language is different from the language(s) of instruction, low academic achievers, students with special needs, students with behavioural problems, students from socio-economically disadvantaged homes, academically gifted students, students who are immigrants or with a migrant background and students who are refugees.

Notes: Results of linear regression based on responses of 15-year-old students and teachers. Controlling for the following aspects of well-being and job satisfaction: workplace well-being and stress, workload stress, job satisfaction with profession, teachers' satisfaction with the salary, teachers' satisfaction with the terms of the teaching contract apart from salary (e.g. benefits, work schedule), teachers' views of the way different stakeholders value the profession; and for the following student characteristics: gender, immigrant background and index of economic, social and cultural status. The TALIS-PISA link average corresponds to the arithmetic mean of the estimates of participating countries and economies, excluding Viet Nam. Statistically significant coefficients are marked in a darker tone (see Annex B).

Countries and economies are ranked in descending order of the change in PISA score associated with the average job satisfaction with work environment, considering all teachers at the school.

Sources: OECD, TALIS 2018 Database; OECD, PISA 2018 Database, Tables 2.25, 2.26, 2.28, 2.29, 2.30, 2.32, 2.33, 2.34 and 2.36.

StatLink https://doi.org/10.1787/888934223764

The association between student performance in science and the extent to which science teachers report workload as an important source of stress on average within the school seems to be mainly driven by classmates' characteristics. The relationship in the case of science performance is no longer significant in any of the participating countries and economies once classmates' characteristics are taken into account (Table 2.36). Nevertheless, while focusing on subject teachers, the association remains significant in CABA (Argentina), the Czech Republic, Denmark and on average across participating countries and economies in the case of reading performance, and in Colombia, the Czech Republic and on average across participating countries and economies in the case of mathematics performance, even after accounting for classmates' characteristics (Tables 2.28 and 2.32).

Teachers' use of working time

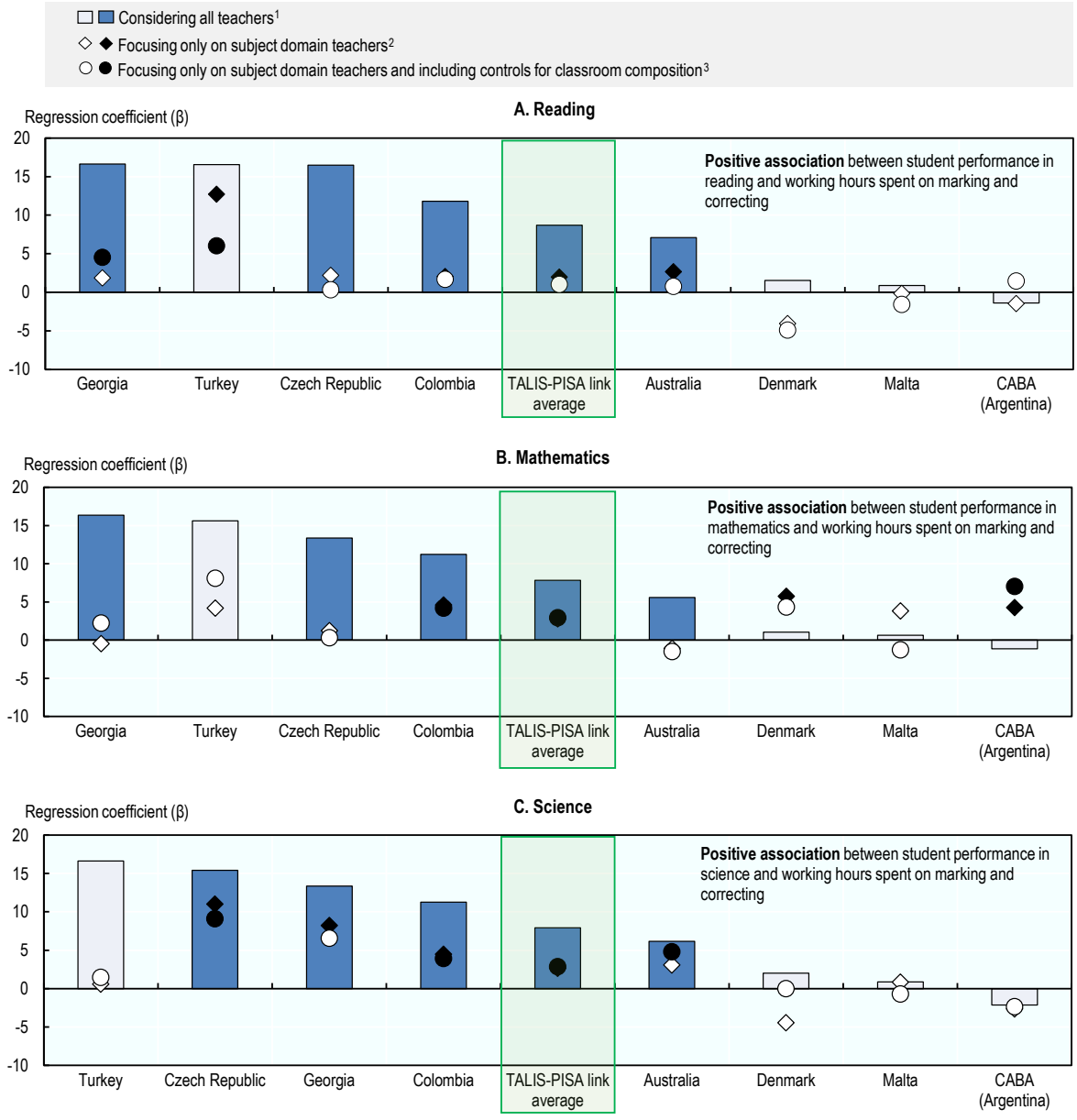
Teachers' use of working time is another teacher dimension with a potential indirect effect on student achievement that is flagged by the lasso regression and the variance decomposition analyses presented in previous sections. According to country-level regressions, as the amount of working hours teachers spend on marking and correcting increases on average at the school, the better students tend to perform in all three subjects covered by PISA in Australia, Colombia, the Czech Republic, Georgia and on average across participating countries and economies (Figure 2.7). This finding may point to a reverse causal relationship as highly competitive school environments (attended by higher-performing students) are characterised by more frequent feedback to students in the form of tests and exams.

As the focus shifts to the average working hours of subject teachers, the relationship also becomes significant for Turkey in the case of reading performance, and for CABA (Argentina) and Denmark in the case of mathematics performance (Figure 2.7). These results suggest that in Turkey the amount of working hours the school's average teacher spends on marking and correcting may matter specifically for student performance in reading, while in CABA (Argentina) and Denmark, marking and correcting may matter more for reading and mathematics compared to student performance in science.

Overall, the relationship between student achievement and teachers' average working hours spent on marking and correcting seems to be partly driven by the average classroom composition within the school. After controlling for classmates' characteristics, the association remains significant for student achievement in reading in the case of Georgia and Turkey, for performance in mathematics in the case of CABA (Argentina), Colombia and the TALIS-PISA link average, and for performance in science in the case of Australia, Colombia, the Czech Republic and the TALIS-PISA link average (Figure 2.7).

Figure 2.7. Relationship between time spent by teachers on marking and correcting student work and student achievement

Change in PISA score associated with the average working hours spent on marking and correcting at the school, by subject



1. Teacher variables are averaged for all teachers within the school.
2. Since teacher variables are averaged only for subject domain teachers, the analysis is based on a sample restricted to schools with at least one subject domain teacher.
3. Since teacher variables are averaged only for subject domain teachers, the analysis is based on a sample restricted to schools with at least one subject domain teacher. Besides controlling for student characteristics, the following controls are also included in order to account for the average classroom composition within the school: share of students whose first language is different from the language(s) of instruction, low academic achievers, students with special needs, students with behavioural problems, students from socio-economically disadvantaged homes, academically gifted students, students who are immigrants or with a migrant background and students who are refugees.

Notes: Results of linear regression based on responses of 15-year-old students and teachers. Controlling for the following elements of teachers' use of working time: total working hours, total teaching hours and teachers' use of working time on tasks other than marking and correcting (such as individual planning or preparation of lessons either at school or out of school, general administrative work, etc.); and for the following student characteristics: gender, immigrant background and index of economic, social and cultural status. The TALIS-PISA link average corresponds to the arithmetic mean of the estimates of participating countries and economies, excluding Viet Nam.

Statistically significant coefficients are marked in a darker tone (see Annex B).

Countries and economies are ranked in descending order of the change in PISA score associated with the average working hours spent on marking and correcting, considering all teachers at the school.

Sources: OECD, TALIS 2018 Database; OECD, PISA 2018 Database, Tables 2.37, 2.38, 2.40, 2.41, 2.42, 2.44, 2.45, 2.46 and 2.48.

StatLink https://doi.org/10.1787/888934223783

Classmates' characteristics

Regarding the characteristics of the classroom, one of the factors that shows the most consistent country-level pattern in student achievement across all three subjects is the concentration of students from socio-economically disadvantaged homes. In Australia, Colombia and Georgia, as the average concentration of students from socio-economically disadvantaged homes in the classrooms increases, the worse students tend to perform in all subjects covered by PISA (Figure 2.8). Since these findings hold while accounting for student's own socio-economic background, they point to the potential presence of peer effects. Indeed, a student's performance can be negatively affected by classmates with limited social, economic and cultural resources because this reflects the concentration of important disadvantages in the student's local community. Such concentration of disadvantages may also affect the student's cognitive and socio-emotional development due to fewer available material learning resources at the school and altered teaching strategies (in addition, see findings in Chapter 3).

As the focus shifts exclusively to subject teachers, the relationships become significant for Denmark in reading, for Malta in reading and mathematics, and for the TALIS-PISA link average for all three subjects (Figure 2.8). These findings indicate that peer effects may matter specifically in reading classes in Denmark and Malta, and in mathematics classes in Malta.

It is interesting to note that, based on TALIS-PISA link data, there are no indications for the presence of peer effects induced by the concentration of socio-economic disadvantage in CABA (Argentina), the Czech Republic and Turkey (Figure 2.8). In the case of CABA (Argentina) and the Czech Republic, this finding may be explained by the fact that disadvantaged students are often concentrated in schools with a small proportion of high achievers. Indeed, based on the PISA 2018 results, the probability that a typical disadvantaged student was enrolled in the same school as high achievers was less than one in eight in Argentina[21] and the Czech Republic (OECD, 2019[64]). Thus, detecting peer effects triggered by the concentration of disadvantage may be more challenging in these two education systems given that students with different ability levels and socio-economic status are less likely to attend the same school.

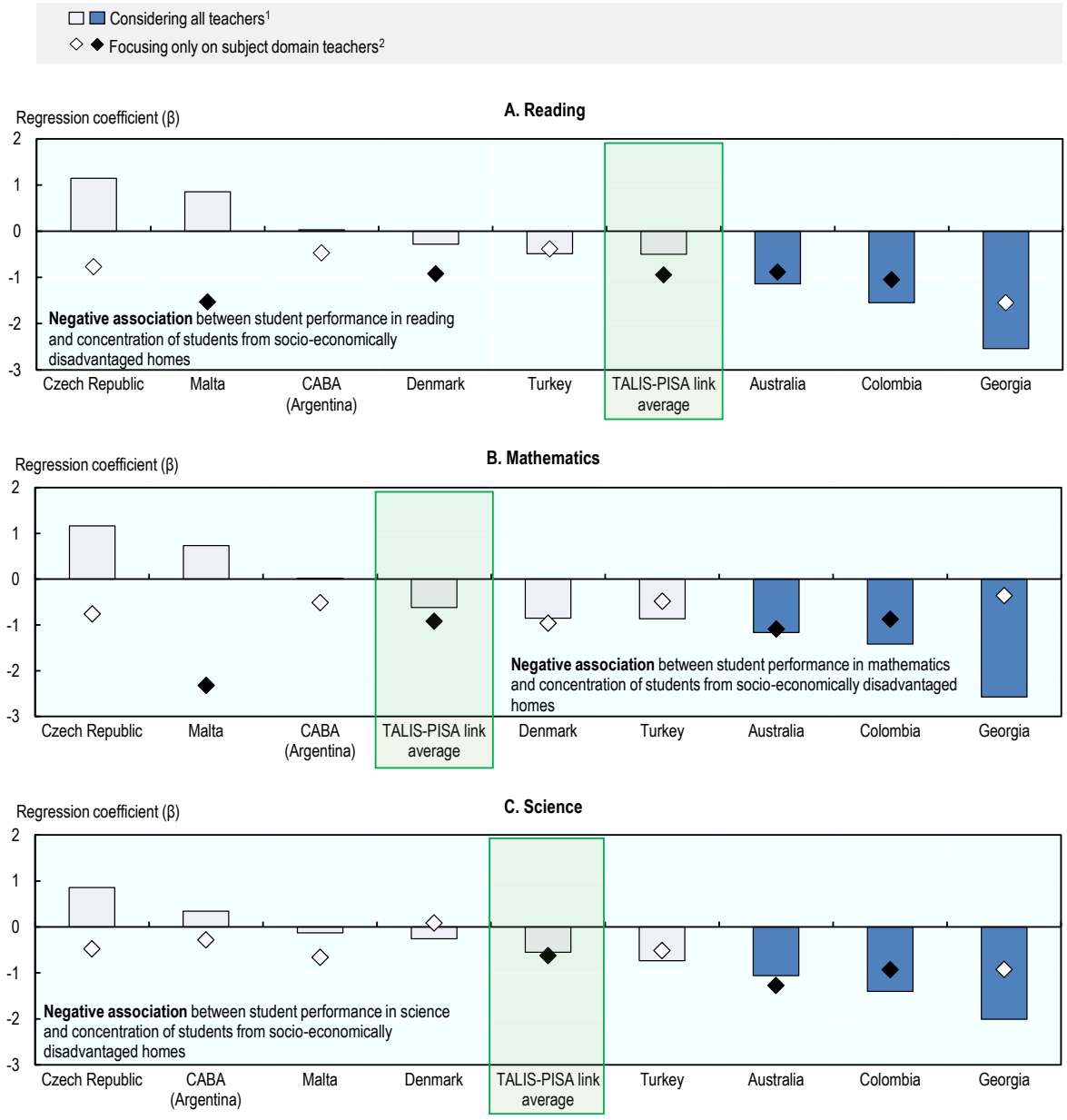
Another element within classmates' characteristics that shows a clear pattern across countries and economies is the share of academically gifted students. As the average concentration of academically gifted students in the classrooms increases, the better students tend to perform in all subjects covered by PISA, in Australia, CABA (Argentina), the Czech Republic, Turkey and on average across participating countries and economies (Figure 2.9). The only country where the association between the average concentration of academically gifted students in the classrooms and student achievement is not significant for any of the subject domains is Colombia.

These results can signal the presence of academic segregation. This means that academically gifted students, who fulfil their potential and become high achievers, are likely to attend schools where other students also tend to be high achievers. Indeed, based on the PISA 2018 results, there are education systems where low- and high-achieving students tend to be clustered in distinct schools (OECD, 2019[64]). For example, in the Czech Republic and Turkey, high achievers in reading are especially likely to be concentrated in certain schools.[22] By contrast, the degree of academic segregation, based on PISA reading scores, is low in Australia and Denmark. In these countries, students with different ability are likely to attend the same school.

As the relationship between the average concentration of academically gifted students in the classrooms and student achievement holds in all participating countries and economies, except for Colombia, irrespective of the degree of academic segregation, these results can also point to the potential presence of peer effects. Indeed, a student's performance can be positively affected by classmates with higher innate ability through an increase in motivation, competition and career aspirations (OECD, 2020[43]; Sacerdote, 2011[63]).

Figure 2.8. Relationship between concentration of students from socio-economically disadvantaged homes and student achievement

Change in PISA score associated with the average concentration of students from socio-economically disadvantaged homes at the school, by subject

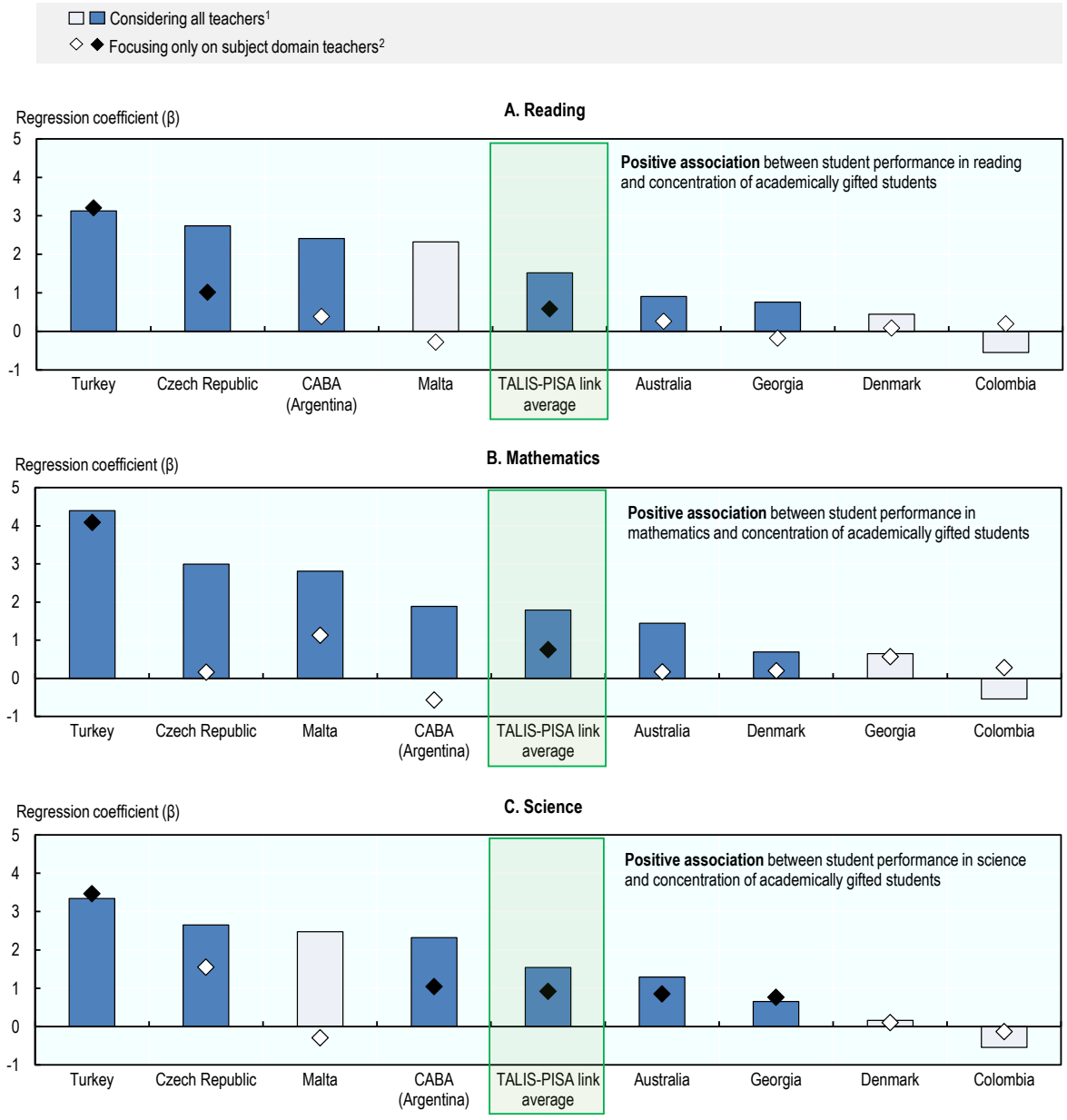


1. Teacher variables are averaged for all teachers within the school.
2. Since teacher variables are averaged only for subject domain teachers, the analysis is based on a sample restricted to schools with at least one subject domain teacher.
Notes: Results of linear regression based on responses of 15-year-old students and teachers. Controlling for the following classroom characteristics: class size, share of students whose first language is different from the language(s) of instruction, low academic achievers, students with special needs, students with behavioural problems, academically gifted students, students who are immigrants or with migrant background and students who are refugees; and for the following student characteristics: gender, immigrant background and index of economic, social and cultural status. The TALIS-PISA link average corresponds to the arithmetic mean of the estimates of participating countries and economies, excluding Viet Nam.
Statistically significant coefficients are marked in a darker tone (see Annex B).
Countries and economies are ranked in descending order of the change in PISA score associated with the average concentration of students from socio-economically disadvantaged homes, considering all teachers at the school.
Sources: OECD, TALIS 2018 Database; OECD, PISA 2018 Database, Tables 2.49, 2.50, 2.51, 2.52, 2.53 and 2.54.

StatLink https://doi.org/10.1787/888934223802

Figure 2.9. Relationship between concentration of academically gifted students and student achievement

Change in PISA score associated with the average concentration of academically gifted students at the school, by subject



1. Teacher variables are averaged for all teachers within the school.
2. Since teacher variables are averaged only for subject domain teachers, the analysis is based on a sample restricted to schools with at least one subject domain teacher.
Notes: Results of linear regression based on responses of 15-year-old students and teachers. Controlling for the following classroom characteristics: class size, share of students whose first language is different from the language(s) of instruction, low academic achievers, students with special needs, students with behavioural problems, students from socio-economically disadvantaged homes, students who are immigrants or with a migrant background and students who are refugees; and for the following student characteristics: gender, immigrant background and index of economic, social and cultural status. The TALIS-PISA link average corresponds to the arithmetic mean of the estimates of participating countries and economies, excluding Viet Nam.
Statistically significant coefficients are marked in a darker tone (see Annex B).
Countries and economies are ranked in descending order of the change in PISA score associated with the average concentration of academically gifted students, considering all teachers at the school.
Sources: OECD, TALIS 2018 Database; OECD, PISA 2018 Database, Tables 2.49, 2.50, 2.51, 2.52, 2.53 and 2.54.

StatLink https://doi.org/10.1787/888934223821

School culture

Findings of lasso regression analysis presented above showed the importance of the involvement of parents and community in school-related activities for students' academic achievement. Similar results are found at the country level. In Australia, Colombia, Denmark and on average across participating countries and economies, students who attend schools where stakeholders (i.e. parents and community) are involved in school-related activities tend to perform better in the PISA test in all subjects (Figure 2.10).

However, after controlling for classmates' characteristics, the association between students' academic achievement and the involvement of parents and the community in school-related activities is no longer significant for most countries and economies participating in the TALIS-PISA link (Figure 2.10). The academic abilities, behaviour problems, and socio-economic and linguistic background of classmates seem to play an important mediating role in the association between student performance and stakeholder involvement in school-related activities. Yet, there are exceptions. In Denmark, the relationship still holds for all subjects even if the average classroom composition at the school is taken into account. The same holds for students' science performance in Colombia, where stakeholder involvement seems to matter for student achievement irrespective of classmates' characteristics.

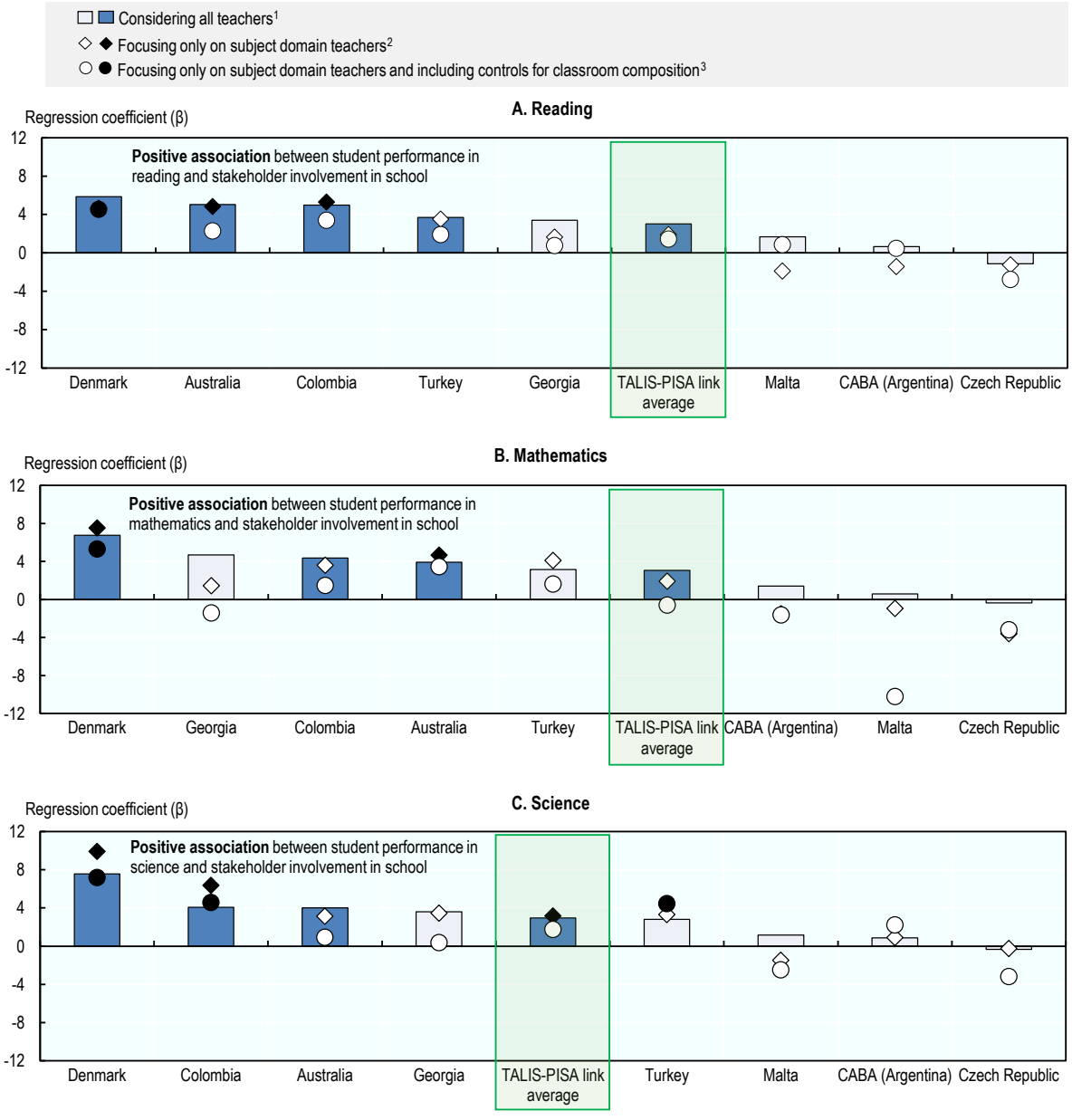
Teacher-student relations is another element of school culture highlighted by lasso regression analysis as being an important predictor of student achievement. In Australia, Turkey and on average across participating countries and economies, students who attend schools where teachers and students get along well also tend to perform well in all subjects covered by PISA (Tables 2.55, 2.59 and 2.63). The same relationship becomes significant in CABA (Argentina) when the focus is exclusively on mathematics teachers (Table 2.60). This suggests that, in the case of CABA (Argentina), teacher-student relations may matter specifically for student performance in mathematics. However, the relationship only remains significant in CABA (Argentina) in mathematics performance when classmates' characteristics are accounted for (Table 2.62). Hence, similarly to stakeholder involvement in school-related activities, classmates' characteristics have an important mediating effect in the relationship between teacher-student relations and student achievement.

School leadership

Based on the analyses presented in the previous sections, school leadership seems to matter for student performance. However, the country-level regression results indicate that the relationship of principals' leadership activities with student achievement mostly captures classmates' characteristics and classroom disciplinary issues. The only leadership activity for which there is a significant relationship in relation to student achievement for at least two participating countries and economies are principals' actions to solve disciplinary issues. Indeed, in CABA (Argentina), the Czech Republic and on average across participating countries and economies, students whose school leaders report having collaborated with teachers to solve classroom disciplinary problems in the 12 months prior to the survey tend to perform worse in all three subjects covered by PISA (Tables 2.91, 2.95 and 2.99). However, once classmates' characteristics are taken into account and the focus shifts to subject teachers, the relationship only remains significant in CABA (Argentina) in student performance in reading and mathematics, and in the Czech Republic in science performance (Tables 2.94, 2.98 and 2.102). This suggests that school leaders' collaboration with teachers to solve classroom disciplinary problems is in most cases closely related to the average classroom composition within the school.

Figure 2.10. Relationship between stakeholder involvement in school and student achievement

Change in PISA score associated with stakeholder (i.e. parents and local community) involvement in school, by subject



1. Teacher variables are averaged for all teachers within the school.
2. Since teacher variables are averaged only for subject domain teachers, the analysis is based on a sample restricted to schools with at least one subject domain teacher.
3. Since teacher variables are averaged only for subject domain teachers, the analysis is based on a sample restricted to schools with at least one subject domain teacher. Besides controlling for student characteristics, the following controls are also included in order to account for the average classroom composition within the school: share of students whose first language is different from the language(s) of instruction, low academic achievers, students with special needs, students with behavioural problems, students from socio-economically disadvantaged homes, academically gifted students, students who are immigrants or with a migrant background and students who are refugees.

Notes: Results of linear regressions based on responses of 15-year-old students and teachers. Controlling for the following aspects of school culture: collaborative school culture, teacher-student relations and teachers' actions towards achieving academic excellence; and for the following student characteristics: gender, immigrant background and index of economic, social and cultural status. The TALIS-PISA link average corresponds to the arithmetic mean of the estimates of participating countries and economies, excluding Viet Nam. Statistically significant coefficients are marked in a darker tone (see Annex B).

Countries and economies are ranked in descending order of the change in PISA score associated with stakeholder involvement in school, considering all teachers.

Sources: OECD, TALIS 2018 Database; OECD, PISA 2018 Database, Tables 2.55, 2.56, 2.58, 2.59, 2.60, 2.62, 2.63, 2.64 and 2.66.

StatLink https://doi.org/10.1787/888934223840

Summary

Drawing on the TALIS-PISA link data, this chapter identifies three main teacher and school factors that are not only found to matter for student achievement but are also within the reach of policy levers. These factors are: teachers' classroom practices (in particular the share of class time spent on actual teaching and learning), teachers' well-being and job satisfaction (in particular teachers' satisfaction with the work environment) and classroom characteristics (in particular the concentration of socio-economically disadvantaged students and the share of academically gifted students in the average classroom).

First, teachers' classroom practices seem to matter for student achievement. Average students tend to perform better the more class time school teachers spend on actual teaching and learning. This finding suggests that students' opportunity to learn, which is closely linked to the amount of time allocated to actual learning, is important for student achievement. When teachers do not actually teach and students do not learn in the class, it is usually either due to disciplinary issues or administrative tasks. More disruptive classrooms are more likely to have lower-achieving students, which, in turn, leads to more time spent on other activities such as keeping order or taking care of administrative tasks. Moreover, results suggest that the opportunities to learn are more closely linked to student performance in mathematics than in reading and science. This signals that the share of class time spent on actual teaching and learning matters specifically for those subjects that are mainly learnt at school, such as mathematics.

Second, teachers' job satisfaction seems to matter for student performance. The more satisfied teachers are with their work environment the better students tend to perform in school. This finding suggests that teachers' satisfaction with their work environment can play a role in teachers' attitudes, efforts and commitment, which, in turn, can lead to better performance. It can also signal the presence of self-enforcing dynamics. Teachers may be particularly satisfied with their school assignment when they work in schools attended by high-achieving students. In turn, these teachers might be particularly engaged in making their academically gifted students progress further. In addition, results signal the presence of differential effects across subjects as teachers' satisfaction with their work environment seems to be more closely related to student performance in science than in reading and mathematics. While this may be explained by the fact that, unlike reading, students mainly acquire their knowledge in science at school, it can also point to the fact that certain requirements regarding the work environment, such as a well-equipped school lab, are critical for science teachers to do their work properly.

Third, classroom characteristics, in particular, the concentration of socio-economic disadvantage and the concentration of academically gifted students, seem to matter for student achievement. The greater the average concentration of students from socio-economically disadvantaged homes in the classroom, the worse students tend to perform academically. Since this finding holds while accounting for students' own socio-economic background, it suggests the presence of peer effects. This finding suggests that a student's performance can be negatively affected if the student is surrounded by classmates with limited social, economic and cultural resources as this may reflect the concentration of significant disadvantages in the student's local community. Such concentration of disadvantages may also affect the student's cognitive development due to fewer available material learning resources at the school and altered teaching strategies. In fact, students, regardless of their own socio-economic background, tend to be advantaged scholastically if they attend a school whose students are from more advantaged socio-economic backgrounds. In addition, as the average concentration of academically gifted students in the classroom increases, students tend to perform better. This may signal the presence of academic segregation, as well as the presence of peer effects. Indeed, a student's performance can be also positively affected by classmates with higher innate ability through an increase in motivation, competition and career aspirations. Yet, high-performing students still tend to be less affected than their low-achieving peers by the composition of their classes. This indicates that addressing socio-economic and academic segregation of schools may be beneficial for both increasing student performance at the country level as well as improving equity.

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Notes

[1] TALIS-PISA link: Teaching and Learning International Survey (TALIS) and Programme for International Student Assessment (PISA) link covers schools that participated in both TALIS and PISA.

[2] Based on the research literature, estimates of teacher effects (i.e. the difference between an average teacher and one at the 84th percentile), typically range from 0.1 to 0.2 standard deviations of student achievement (Jackson, Rockoff and Staiger, 2014[12]).

[3] PISA is a triennial survey of 15-year-old students that assesses the extent to which they have acquired key competencies essential for full participation in social and economic life (OECD, 2019[128]). PISA assessments do not just ascertain whether students can reproduce what they have learned, but they also examine how well students can extrapolate from what they have learned and apply their knowledge. Hence, while PISA focusses on students' competencies and on how well these competences are applied in different contexts, it may not reflect the curriculum for 15-year-old students. In each round of PISA, one subject, among reading, mathematics and science, is tested in detail. The main subject in 2018 was reading.

[4] Since Viet Nam does not have data on PISA test scores, it is not included in the analyses presented in Chapter 2.

[5] It has to be noted that the school level could also refer to system level depending on the school governance arrangements that are in place.

[6] Teachers' perceived disciplinary climate is included within the dimension of classroom practices, since it can be regarded as a partial measure for teachers' classroom management skills.

[7] TALIS covers the following types of assessment practices: administering own assessment, providing written feedback on student work in addition to marking, letting students evaluate their own progress and observing students when working on particular tasks and providing immediate feedback.

[8] Instruction characterised by cognitive-activation include asking students to solve problems that require them to think for an extended time, for which there is no immediately obvious solution or that can be solved in several different ways, or by using alternative routes and procedures. These instructional practices may also include having students reflect on and share with their peers the process through which they solved specific problems covered in class or assigned as homework as well as require students to apply what they have learned to new contexts (Echazarra et al., 2016[35]).

[9] TALIS asks teachers about their views ("strongly disagree"; "disagree"; "agree"; or "strongly agree") on innovation with four statements: "most teachers in this school strive to develop new ideas for teaching and learning"; "most teachers in this school are open to change"; "most teachers in this school search for new ways to solve problems"; "most teachers in this school provide practical support to each other for the application of new ideas".

[10] Based on the TALIS 2018 teacher questionnaire, reading teachers are defined as those who teach reading, writing and literature in the mother tongue, in the language of instruction, or in the tongue of the country (region) as a second language (for non-natives); language studies, public speaking. Science teachers are those who teach science, physics, physical science, chemistry, biology, human biology, environmental science, agriculture/horticulture/forestry.

[11] Based on PISA results, girls slightly outperformed boys in science, by only two score points, on average across OECD countries (OECD, 2019[64]).

[12] For instance, analysis based on TALIS data show that in the case of teachers' satisfaction with the profession only a small percentage (i.e. 4%) of the total variance comes from differences between schools (OECD, 2020[43]).

[13] Since the focus is on the average subject domain teacher within schools, teacher variables averaged only for subject domain teachers and the analyses by subject are based on samples restricted to schools with at least one subject domain teacher.

[14] In TALIS, the index of classroom disciplinary climate measures the extent to which teachers perceive disciplinary issues in the class. Higher values of the index of classroom disciplinary climate indicate a higher need in classroom discipline.

[15] In TALIS, the index of workload stress measures the extent to which workload, including lesson preparation, lessons to teach, marking, administrative work and extra duties due to absent teachers, is considered a source of stress. Higher values of the index of workload stress correspond to workload being considered a more important source of stress.

[16] In TALIS, the index of stakeholders' view of the value of the teaching profession measures the extent to which teachers feel that their views are valued by policy makers and the media in the country/region and that they can influence educational policy in the country/region.

[17] In TALIS, indicators related to classroom composition, including the average concentration of low academic achievers and of students from socio-economically disadvantaged backgrounds, are based on teachers' responses. For the analyses included in this report, these indicators on classroom composition are measured as the central values of percentage ranges: 0%, 5%, 20%, 45% or 80%.

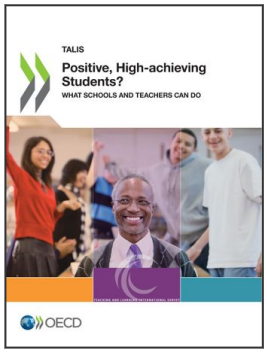
[18] In TALIS, the index of stakeholder involvement measures principals' account on the extent to which the following statements apply to the school: parents/guardians support student achievement; parents/guardians are involved in school activities; and the school co-operates with the local community.

[19] In TALIS, the index of teacher-student relations measures how strongly teachers agree or disagree with the following statements about what happens in the school: teachers and students usually get on well with each other; most teachers believe that the students' well-being is important; most teachers are interested in what students have to say; and if a student needs extra assistance, the school provides it.

[20] The controls for the average classroom composition within the school (also referred to as classmates' characteristics) include the share of students whose first language is different from the language(s) of instruction, low academic achievers, students with special needs, students with behavioural problems, students from socio-economically disadvantaged homes, academically gifted students, students who are immigrants or with migrant background and students who are refugees.

[21] The results of Argentina can be considered as a proxy for Ciudad Autónoma de Buenos Aires.

[22] Based on PISA 2018 results, for the Czech Republic and Turkey, the isolation index of high-achieving students in reading is between 0.35 and 0.4. This means that, in these countries, a student who scores in the top quarter of the distribution of PISA performance within a country has a more than one-in-two chance of attending the same school than students who are also high achievers, while this likelihood would have been only one in four if students had been uniformly distributed across schools (OECD, 2020[43]).



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