FOSTERING INCLUSIVE EDUCATION BY ENHANCING COLLABORATIVE SKILLS

Gabriel Bădescu

ABSTRACT

Collaboration problem solving (CPS) skills deserve to be considered as one of the key educational outcomes. As a result, any definition of inclusive education has to recognize the importance of CPS among students with and without disabilities, with diverse socio-economic and cultural background.

This paper is based on a systematic review of the literature on the relationship between CPS and attributes such as wealth, ethnicity, immigration, minority language, and special needs, as well as on analyses of data from the Programme for International Student Assessment (PISA).

This study presents evidence showing that generalized trust, openness and agreeableness have positive effects on CPS. It also shows that migrant students, as well as students speaking a minority language, received similar CPS scores with the rest of the students in the vast majority of societies, whereas students with low economic status tend to be associated with low values of CPS scores in all countries. At the same time, the non-cognitive component of CPS has fewer negative determinants among the variables that measure minority status than the cognitive component. In addition, schools that cultivate good relationships with parents and between parents and students tend to be a resource for collaboration skills of the students. Finally, developing collaborative skills in school seems to be an effective way for making a positive learning environment.

Given the limited evidence and divergent patterns between countries regarding these links, a better mapping of teaching interventions that encourage pro social attitudes and norms among vulnerable students, and a move towards employing research designs with greater leverage for drawing causal inference, are necessary.

INTRODUCTION

Cooperation and collaboration are prerequisites of economic performance (Banderia et al. 2005) and of the functioning of democratic institutions (Putnam 2000). The benefits of pro social behaviours have been documented in various social contexts, including communities, firms, volunteer associations, political organizations and schools (Coleman, 1990; Sampson and Groves, 1989; Allen & Catts 2014). John Dewey stressed the importance of learning prosocial behavior and he identified schools as the ideal setting for students to learn to cooperate and collaborate (Dewey 1916). As a result, any definition of inclusive education that does not recognize the importance of collaborative skills and relationships among students with and without disabilities, with diverse socio-economic and cultural background, is incomplete (UNESCO 2016).

The terms cooperation and collaboration are often used interchangeably to describe effective team work, but not always. According to Hathorn and Ingram (2002), cooperation is possible when individuals in a group divide the work so that each member solves a portion of the problem. In contrast, collaboration is the interdependence of the group members as they share ideas and reach a conclusion.

My concern in this paper is with how inequalities in socioeconomic, ethnic minority, immigrant, and special needs status, as well as exposure to diversity influence collaboration as an educational outcome. The broader environment within which schools operate poses significant challenges to the attaining goals of collaborative aptitude. Globally, a trend toward greater income inequality (Piketty 2015), as well as growing cultural diversity as a result of international migration (United Nations 2019) have been identified, although we see variance across cases, time, and measurement instruments. Among the more provocative implications of this pattern is its contribution to the rise of illiberal politics (Bourguignon 2015). The links between increasing disparities of wealth and cultural diversity on the one hand, and the quality of democratic governance on the other come through a shift in citizen values and norms. For example, increases in income gaps accompany a decline in generalized trust among citizens who feel the system is rigged against them (Uslaner 2012). At the same time, generalized trust has been shown to be a strong determinant of cooperation (Sonderskov 2011; Petersen 2009). As a result, increase of inequality tend to erode pro-social behavior. Moreover, populist politics work against cooperative behavior, inherent in the functioning of democracy, in favour of pitting groups against each other. Radical right political parties cultivate an agenda of exclusion (Mudde 2013).

Most commonly, the literature concerned with the effects of membership to vulnerable groups has been applied to the traditional academic outcomes of reading, mathematics, and science. This paper expands this to include collaborative problem solving (CPS) skills, which have been argued to consist of both cognitive and non-cognitive skills.

The main aim of this study is to evaluate the relationships between minority status and diversity on the one hand, and attainment of collaboration skills on the other, among students. It has four specific objectives:

(O1) To conduct a systematic review of the literature on the relationship between collaborative skills and attributes such as wealth, ethnicity, immigration, minority language, and special needs;

(O2) To assess some of the main approaches to operationalize and measure Collaborative Problem Solving (CPS) skills and to recommend future directions of development.

(O3) To analyse the links between collaborative skills and other academic outcomes, as well as interactions between these links and various measures of inequality, including ones that are based on data of the Programme for International Student Assessment (PISA);
(O4) To identify policies and practices that could improve collaborative skills and alleviate the negative effects of social exclusion.

By extending the range of indicators that capture education attainment and achievement, and by identifying inclusive education policies and practices to ensure the achievement of SDG 4, this paper aims to contribute to the 2020 Global Education Monitoring Report.

LITERATURE REVIEW ON THE DETERMINANTS OF COLLABORATIVE SKILLS AND THE MEDIATING ROLE OF EDUCATION

Skills, norms and contexts that facilitate collaboration

Skills are capacities to function, giving agency to people to shape their lives and to create social well-being. Greater levels of skill can foster social inclusion and promote economic and social mobility. Norms refer to the fact that the individual attaches an internal valuation—positive or negative—to taking particular types of action. Since norms are learned, they vary substantially across individuals, and within individuals across the different types of situations they face, and across time within any particular situation (Ostrom 2009).
What are the skills and norms that matter for collaboration, and how are their relationships influenced by the patterns of interactions between individuals in space and time?

Cognitive skills, achievement and literacy

Measures of cognition have been developed over more than one century. Psychologists distinguish between fluid intelligence, defined as capacity to solve problems in novel situations, and crystallised intelligence, commonly understood as capacity to use acquired knowledge. Achievement tests are designed to capture crystallised intelligence whereas IQ tests are designed to capture fluid intelligence.
The most influential international large-scale assessment, the Programme for International Student Assessment (PISA), evaluates student performance in maths, science, and reading across countries, and was labelled as literacy tests (OECD, 2014). However, since the original PISA measures similar skills with those measured by achievement tests, literacy and achievement in this case are synonymous. Moreover, applying a factor analysis to PISA mathematical achievement tasks, Kobarg and Dalehefte (2012) found a stronger intelligence factor (mean loading $\lambda = .42$) than a mathematical literacy/achievement factor (mean loading $\lambda = .31$). Also, correlations of society ability means within student assessment studies are r=.60–.98, whereas student assessment means with intelligence tests are r=.85–.86 (Rindermann 2007 p.680). Results of factor analyses indicate a strong g-factor of differences between societies, explaining 94–95% of the variance. These high correlations between achievement and intelligence measures are likely the results of the similarities of the cognitive demands for tasks from different tests, and the common developmental factors at the individual and national levels including known environmental and genetic influences (Rindermann 2007, Rindermann and Baumeister 2014).

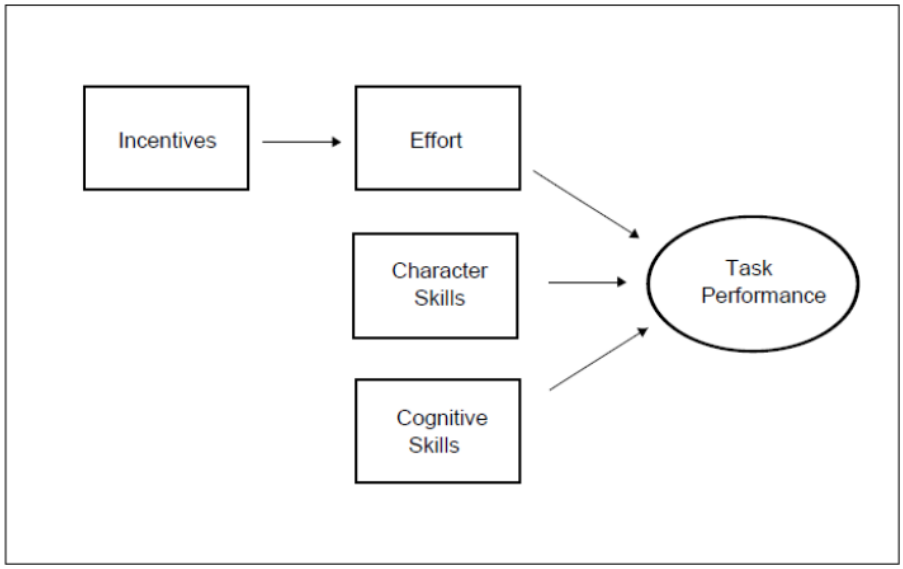
The importance of non-cognitive skills

In all longitudinal studies cognitive test scores predicted only a small fraction of the variance in later-life success. At the same time, there is a long list of non-cognitive skills that were found to be relevant in the labour market and in society at large. Non-cognitive skills describe the personal attributes not measured by IQ tests or achievement tests. They are known in the literature as soft skills, personality traits, non-cognitive abilities, character skills, and socioemotional skills, and include attributes such as perseverance, conscientiousness, self-control, trust, attentiveness, self-esteem and self-efficacy, resilience to adversity, openness to experience, empathy, humility, tolerance of diverse opinions and the ability to engage productively in society. At the same time, psychologists use several taxonomies of non-cognitive skills, including the Big Five, which stands for: Openness to Experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. There are several other taxonomies, including the Big Three, the MPQ, and the Big Nine, which are conceptually and empirically related to the Big Five.

Until recently non-cognitive skills have largely been ignored in evaluations of schools and interventions. A report by a group of economists that reviews the recent literature on measuring and fostering non-cognitive skills found that for many outcomes, the predictive power of non-cognitive skills and attributes exceed that of cognitive skills (Kautz & al 2014). Additionally, the Big Five personality traits and general cognitive ability have been found to be interrelated (Escorial & al. 2019). Of the Big Five, Conscientiousness – the tendency to be organised, responsible, and hardworking—is the most widely predictive across a variety of outcomes. (See Almlund et al., 2011; Heckman and Kautz, 2012). Conscientiousness predicts years of schooling with the same strength as measures of intelligence (Almlund et al., 2011), is associated with job performance and wages, being about half as predictive as IQ (Nyhus and Pons, 2005). Damian et al. (2015) investigated the interactions between personality traits, intelligence and family background, in predicting educational attainment, annual income, and occupational prestige eleven years later. By using data from Project Talent, a national longitudinal study that started in 1960 on a 5% representative sample of U.S. high school students in grades 9 through 12, they found that personality traits and intelligence in adolescence, in addition to parental SES, matter in predicting status attainment in adulthood. They also brought evidence for the resource substitution hypothesis, where conscientiousness was stronger predictors of attainments at lower levels of parental SES.

Moreover, Almlund et al. (2011) and Heckman and Kautz (2012) developed a model in which any task performance is the result of cognitive skills, non-cognitive skills (“character skills”) and effort, where effort is influenced by incentives (Figure 1).

Figure 1. Determinants of task performance



Source: Kautz & al (2014), p. 16

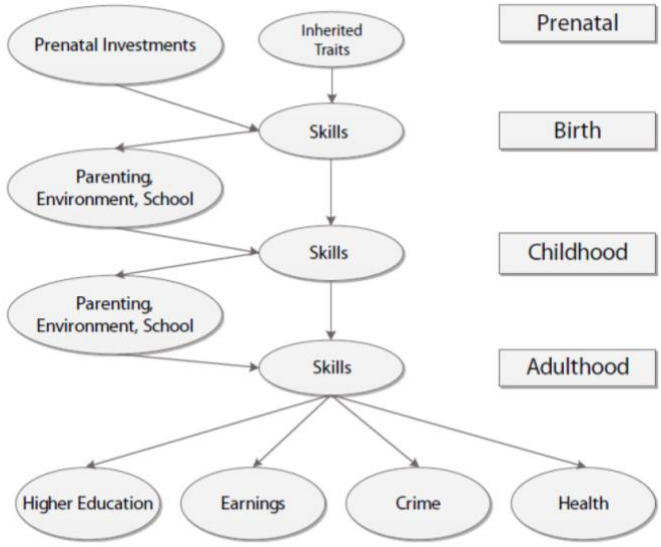
One important implication of this model is that measures of cognitive skills, achievement (and literacy) incorporate non-cognitive skills and vary with incentives. For instance, several studies show that incentives, like money or candy, can increase IQ scores, particularly among low-IQ individuals (See Almlund et al. 2011). The responsiveness to incentives in turn depends on a child's levels of conscientiousness (See Heckman and Kautz, 2012; Roberts et al., 2007). Also, other personality traits correlate with cognitive skill measures. For instance, a recent study that measured PISA reading performance and the Big Five personality traits on a sample of 748 students from Germany found positive correlations between reading results and openness (r = 0.15**), and between reading and agreeableness (r = 0.08*) (Stadler & al 2019). In addition, self-regulation has emerged as an important factor in mediating and moderating associations between child poverty and psychopathology. Self-regulation can be broadly defined as the ability to adaptively modulate one's own cognitions, emotions, and actions for the purposes of goal-directed behavior [18,19]. Underscoring the importance of self-regulation, a growing body of research has found that greater levels of this ability in early or middle childhood are related to more positive mental health across the lifespan.

Stability of non-cognitive skills

A large body of evidence reviewed in Almlund et al. (2011) shows that people tend to act in a predictable way with a high level of reliability of average behavior across situations, a fact that indicate stability of the measured non-cognitive skills. In addition, many of the non-cognitive skills are about 30%–60% heritable (Bouchard and Loehlin 2001). However, skill development is a dynamic process, and both cognitive and non-cognitive skills can be shaped. Investment theories, such as PPIK (intelligence-as process, personality, interests, and knowledge), show the interdependent development between cognitive and non-cognitive abilities during childhood and adolescence, which ultimately creates patterns of skills and interests (Ackerman 2013). As a result, the levels of cognitive and noncognitive skills at any age depend in part on levels of those skills at younger ages which depend on earlier investments (Figures 2). The early years are important in shaping all skills and in laying the foundations for successful investment in the later years. During the early years, both cognitive and non-cognitive skills are highly malleable. During the adolescent years, non-cognitive skills are more

malleable than cognitive skills (Walsh 2005). The differential plasticity of different skills by age has important implications for the design of effective policies.

Figure 2. Framework for understanding skill development



Source: Kautz & al (2014), p. 32

The effects of education on non-cognitive skills. Empirical evidence on the efficiency of interventions and policy implications

Kautz et al. (2014) reviewed the available evaluations of interventions and found that the evidence base is larger on the long-term effectiveness of programmes that start in early childhood and elementary school compared to their adolescent counter-parts. They also found that only interventions that start before kindergarten begins have been shown to have long-term effects on IQ. If cognitive measures were the only measure of success, most intervention programmes would seem futile. Yet, using a broad set of outcomes that include non-cognitive skills presents a more optimistic point of view. Moreover, the available evidence suggests that adolescent remediation is possible for children who grow up in disadvantaged environments in their early years, and that the most promising adolescent interventions are those that offer mentoring, guidance and information. Additionally, a recent study by Negru-Subtirica et al. (2019) found positive reciprocal relationships between academic achievement and non-cognitive skills. Based on a three-wave longitudinal study on 1151 adolescents, the research shows that at the group level, higher academic achievement (measured by GPA scores) fostered students' extraversion, agreeableness, and openness, while openness reinforced high levels of GPA. At the individual level, GPA was a protective factor against negative affect, as it drove longitudinal decreases in neuroticism.

Cooperation and collaborative problem-solving skills

Cooperation is when people act prosocially in situations in which there is not only a personal disincentive to be group-regarding but also an incentive to take advantage of the helpful actions of others. Studying actions for the good of the group, a behavior that happens far more frequently than rational models predict, is one of the central topics of social sciences (Ostrom

2009, 18). The empirical literature looks at both the individual and situational influences on cooperative social dilemma choice, occurring in a wide range of contexts, including the evolution of institutions to facilitate long distance trading patterns (Greif, Milgrom, and Weingast 1994); the problems of gaining international cooperation (Snidal 1985; Keohane and Ostrom 1995); studies of protest, civil war, and revolution (Lichbach 1995; McGinnis 2007); the provision of national defence (Wallner 2002); international assistance (Gibson et al. 2005); and voting (de Matos and Barros 2004).

A rich array of formal models and computer models of evolutionary processes have generated a list of structural variables that are postulated to affect the likelihood of cooperative behavior (Lichbach 1996, Agrawal 2002). Ostrom (2009) has listed eight key structural variables, divided on two categories: those that do not essentially depend on a situation being repeated, and those that depend. The first category includes:

(1) The number of participants involved. The impact of group size has been subject to considerable theoretical debate. Mancur Olson (1965) argued that as the size of a group increased, the probability of a group achieving a public good decreased and the extent of non-optimality increased.

(2) Whether benefits are subtractive or fully shared. Goods that are subtractable in nature are defined as common-pool resources (CPRs) (Ostrom, Walker, and Gardner 1992). In a CPR environment, an increase in the number of participants, holding other variables constant, is negatively related to achieving social benefits.

(3) The heterogeneity of participants. The literature contains many arguments that point to heterogeneity as a serious deterrent to cooperation (Hardin 1982; Jones 2004).

(4) Face-to-face communication. Kerr and Kaufman-Gilliland (1994) conclude that communication in general helps a group gain a sense of “solidarity” and that face-to-face communication enhances the likelihood that individuals will keep their promises to cooperate. When they are in a repeated situation, they use the opportunity for communication to discuss deviations from promises made in a highly critical and moralistic tone (Ostrom, Gardner, and Walker 1994).

(5) The shape of the production function. The theoretical predictions depend on the particular shape of the production function, on whether all participants are symmetric or have different levels of assets, on the sequence in which individuals contribute, and on the information generated by each action (Marwell and Oliver 1996).

Situations where repetition of the situation makes possible the impact of additional structural variables:

(6) Information about past actions. Various ways of monitoring the actions of participants increase or decrease the availability and accuracy of the information that individuals have concerning the particular actions of known individuals in the past (Janssen 2004).

(7) How individuals are linked. Sociologists and social psychologists have posited that individuals who are linked in networks of closed reciprocity are more likely to contribute to each other's welfare than individuals whose resource contribution goes to a generalized pool from which all individuals obtain benefits (Granovetter 1973; Cook and Hardin 2001).

(8) Whether individuals can enter or exit voluntarily. Hauk and Nagel (2001) have argued that when individuals have a choice as to whether to play social dilemma games with others, and they can identify the individuals with whom they have played, they

will choose partners so as to increase the frequency with which cooperative outcomes are achieved.

Heuristics and norms

Most real-life situations do not generate information about all potential actions that one could take, all outcomes that could be obtained, and all strategies that others could take. As a result, in most everyday situations, individuals tend to use heuristics that they have learned over time regarding responses that tend to give them good outcomes in particular kinds of situations (Gigerenzer and Selten 2001). In addition to learning instrumental heuristics, individuals also learn norms (Ostrom 2009). Many theorists posit that one can explain cooperative behavior better if one assumes that individuals enter situations with an initial probability of using reciprocity based on a calculated strategy that reciprocity leads to higher outcomes or based on a norm that this is how one should behave (Panchanathan and Boyd 2004). The most famous strategy—tit-for-tat—has been the subject of considerable study from an evolutionary perspective. Axelrod (1984) has shown that when individuals are grouped so that they are more likely to interact with one another than with the general population, and when the expected number of interactions is sufficiently large, reciprocating strategies such as tit-for-tat can successfully invade populations composed of individuals following an all-defect strategy. Thus, the implication is that at the core of a successful or unsuccessful collective action are the links between the trust that one participant has in the others involved in a collective action situation, the investment others make in trustworthy reputations, and the probability of all participants using reciprocity norms (Ostrom 2009).

Generalized trust and education

Generalized trust, defined as trust in people you do not know, has been linked with important benefits at both the individual and societal level, including better health, higher levels of civic and political participation and economic growth (Knack and Keefer 1997; Putnam 1993; Uslaner and Brown 2005; Bjørnskov 2012). Generalized trust has these positive effects because it reduces transaction costs and enhances cooperation (Hardin 1999). Because of this particular propensity, it has been labelled as the "resource that oils the wheels of the market economy and democratic politics" (Stolle 2003, p. 19). Generalized trust tends to be associated with a stronger sense of self-efficacy, and with pro-social values and norms, including reciprocity, tolerance, and civic morality (Bjørnskov 2007; Letki 2006).

Overall, there seems to have been a significant decline of generalized trust in countries across the world, with the exception of Eastern Europe (Putnam 2000, Wilson 2018, Letki 2018). This is repeatedly shown by relying on the standard trust item used in the General Social Survey (GSS), World Values Survey (WVS) and the American National Election Study. Therefore, it is important to identify what are the main factors that shape trust and to device policies that address this decline.

At the same time, it is well known that attitudes and behavior tend to be weakly correlated (Eagly and Chaiken 1993), and the behavioural measures of trust and the standard attitudinal measures of trust are no exception (Wilson 2018). In a metastudy of trust games conducted across the globe, Johnson and Mislin (2011) found substantial reservoirs of trust in places where attitudinal measures found almost nothing. Therefore, more research is needed to evaluate what are the trends of generalized trust and what are the causal mechanisms explaining what trust means for behavior.

What drives generalized trust? Traditionally, standard theories in psychology have treated trust as a personality trait, largely immutable over the life span. Cultural accounts in sociology have regarded trust as a stable adult orientation acquired during the early childhood through early socialisation processes. Finally, rational choice theories suggest that trust reflects strategic judgements about trustworthy people driven by evidence and logical reasoning.

However, a series of recent studies found that generalized trust is still dynamic among mid to late adolescents. Flanagan and Stout show that trust is strongly related to respondents' sense of solidarity in school and opportunities to engage in free discussions (2010). Abdelzadeh and Lundberg (2017), who reported on a Swedish longitudinal study, also found generalized trust to be relatively volatile in early to mid-adolescence and to become more stable in early adulthood. Most recently, Janmaat evaluated how experiences in late adolescence and early adulthood shape generalized trust among young people in England (2019). His research is based on the longest longitudinal study on trust available, on the Citizenship Education Longitudinal Survey (CELS) data, which started from a cohort of youngsters who were aged 11 and 12 (in 2002–2003), then were surveyed every two years until 2011, with a last wave collected in 2014 when respondents were 23 years old. Janmaat found that between ages 16 and 23 disparities in trust appear to widen across groups defined by highest level of education, degree of civic participation. All these findings support the social learning perspective and suggests that the precarious conditions that young adults experience dampen their trust in other people and lead to a widening of the trust gap between the disadvantaged and the privileged.

Education has been argued to be one of the strongest determinants of generalized trust. It tends to foster generalized trust by enhancing people's cognitive skills and by inculcating trust as a social norm. Better cognitive skills enable people to process more information and interpret the behaviours of others more accurately, making the actions of other people and the interactions with them more transparent and predicable (Knack and Keefer 1997; Knack and Zak 2002). The socialization function of education concerns teaching young people to have an open mind to other people, to believe in their trustworthiness and to treat them with respect (Bjørnskov 2007; Stubager 2008). In addition, education offers more social and economic resources, which makes trusting less risky (Delhey & Newton, 2003).

There is strong empirical evidence for the idea that school education enhances generalized trust. In a meta-analysis of 28 studies, Huang et al. (2009), for instance, found that one additional year of schooling increases generalized trust by 4.6% of a standard deviation. Comparing the effect sizes obtained from surveys conducted before the 1990s with those from surveys in a later period, they found a decline in the return to education on social participation but not on generalized trust. The size of the schooling effect varies with the levels of education. Effect sizes are significantly higher for people with a college degree or above. The analysis also found support in favour of a virtuous circle between trust and civic participation that is spurred by education (Huang et al. 2009: 462). Moreover, Campbell (2006) claims that the effect of education on generalized trust is cumulative: the more you are surrounded by well-educated people, the more trusting you become irrespective of your own education level.

Whereas quantity of formal education is a strong determinant of generalized trust in most societies, much less is known about what types of school contexts matter for shaping trust. One notable exception is the research on the effects of diversity. For instance, a recent article by Dinesen, Schaeffer and Sønderskov (2020), which reviews the existing literature on relationship between ethnic diversity and social trust through a narrative review and a meta-analysis of 87 studies, finds a statistically significant negative relationship between ethnic

diversity and social trust across all studies. Yet, in the school setting, the results are scattered, although mostly negative relationships are reported, varying between countries, types of trust and specific sub-groups (Janmaat 2015). For instance, Dinesen (2011) addressed the question of the impact of ethnic diversity in school on the trust of schoolchildren on a unique survey of children with immigrant and native Danish backgrounds, respectively, in the last three grades of primary school in Denmark. He found that the primary school setting, ethnic diversity does not affect generalized trust and even has a positive impact on out-group trust of native Danish pupils (i.e., their trust in immigrants). Sum and Badescu (2015) assessed the effects of ethnic diversity in Romanian high schools, based on three years panel data, and found that generalized trust tends to decline in classes with high proportions of ethnic minorities.
Even fewer studies evaluate the extent to which exposure to socioeconomic diversity in school influences generalized trust among students. By using national survey data of Romanian eighth grade and high school students, Badescu and Sum (2018) evaluated the impact of socioeconomic diversity within the classroom, controlling for the social status of the students as well as socioeconomic inequality within the community where the school is located. Their analysis shows that youth exposed to greater levels of socioeconomic diversity have significantly lower levels of trust.

Collaborative problem-solving instruments

Collaborative problem solving (CPS) refers to the coordinated attempt between two or more people to share their skills and knowledge for the purpose of constructing and maintaining a unified solution to a problem (Roschelle & Teasley, 1995; OECD, 2017a). Researchers often emphasize individuals' cognitive abilities and social skills required for effective collaboration with the recognition that these skills are only fully expressed in the context of individuals' interactions with each other (Griffin et al., 2012; OECD, 2017a). The overall results indicate that it is important to cultivate students' CPS skills, but there are serious challenges in effectively teaching these skills (Fiore et al., 2017). One issue is that there is no consensus on a CPS model to operationalize this construct and to measure it effectively (Andrews-Todd & Forsyth, 2018). Throughout the CPS literature, there have been a large variety of proposed instruments, including those developed by Roschelle and Teasley (1995), Nelson (1999), PISA (OECD, 2017a), ATC21S (Griffin et al., 2012), Andrews-Todd & Forsyth (2018) and Cukurova, Luckin, Millan, & Mavrikis (2018). In a recent review of the CPS operationalisations, Oliveri and colleagues (2017) reported that research studies use various instruments, including surveys, tests, observations, and think-aloud protocols, and that the quality of the CPS assessments vary widely. More and more, researchers are calling for guiding principles for CPS assessment, since the absence of a consensus systematic framework for operationalizing the construct and providing guidance for its assessment, makes difficult to teach, evaluate, and support CPS effectively (Andrews Todd & Forsyth, 2018; Bause, Brich, Wesselein, & Hesse, 2018).

DESCRIPTION OF METHODOLOGY AND DATA

Given the availability of comparative data on collaborative skills for a large number of countries, this paper relies on data from the Programme for International Student Assessment (PISA). PISA is the largest international education study in the world, applied every three years, to 15-year old students in the form of a two-hour standardized test. I will use all iterations of

PISA data, with a focus on those collected in 2015, which include results from the new assessment of student collaborative problem solving (OECD 2017b, 24-25).
In addition, I use other data sets, including data from the World Inequality Database on Education (WIDE), from the Varieties of Democracy Project (V-Dem), and from the World Values Surveys (WVS).
I use measures of collaboration using results from the collaborative problem-solving competency measured by PISA 2015. PISA defines this as the capacity of an individual to effectively engage in a process whereby two or more agents attempt to solve a problem by sharing the understanding and effort required to come to a solution and pooling their knowledge, skills, and efforts to reach that solution (OECDb 2017, 26). Collaboration was assessed through students' responses in their interactions with computer-based agents (OECD 2017b, 32).
According to the latest PISA report (OECD, 2017a), CPS consists of three competencies that overlap with four problem solving processes, resulting in 12 levels of CPS skills (Graesser et al., 2018; Webb & Gibson, 2015). The CPS construct includes the following competencies: (1) Establishing and maintaining a shared understanding among team members, which requires establishing common ground, achieved via a free exchange of knowledge and perspectives, (2) Taking appropriate action to solve problems via explaining and justifying possible solution plans, negotiating with others, and monitoring solution execution, (3) Establishing and maintaining group organization, which relies on each team member fully understanding and fulfilling his or her roles/responsibilities in the team and providing timely feedback on progress. Additionally, the CPS construct includes problem solving competencies including: (1) Exploring and understanding, (2) Representing and formulating, (3) Planning and executing, (4) Monitoring and reflecting.
Taken together, these form a matrix of CPS competencies (Table 1). Across the CPS units, items were developed to fit all cells in that matrix.

Table 1. The matrix of CPS competencies in PISA 2015.

	(1) Establishing and maintaining shared understanding	**(2) Taking appropriate action to solve the problem**	**(3) Establishing and maintaining team organisation**
(A) Exploring and understanding	**A1)** Discovering perspectives and abilities of team members	**(A2)** Discovering the type of collaborative interaction to solve the problem, along with goals	**(A3)** Understanding roles to solve the problem
(B) Representing and formulating	**(B1)** Building a shared representation and negotiating the meaning of the problem (common ground)	**(B2)** Identifying and describing tasks to be completed	**(B3)** Describing roles and team organisation (communication protocol/rules of engagement)
(C) Planning and executing	**(C1)** Communicating with team members about the actions to be/being performed	**(C2)** Enacting plans	**(C3)** Following rules of engagement (e.g. prompting other team members to perform their tasks)
(D) Monitoring and reflecting	**(D1)** Monitoring and repairing the shared understanding	**(D2)** Monitoring results of actions and evaluating success in solving the problem	**(D3)** Monitoring, providing feedback and adapting the team organisation and roles

Source: PISA 2015 released field trial cognitive items. OECD Programme for International Student Assessment 2015 (p. 49).

The process through which a student is assessed is as follows:

> "In the PISA assessment, one agent is the student whose performance is being evaluated; all other agents are computerized simulations. This allows the assessment

> to control the behaviour of the other agents in order to isolate the collaborative problem-solving ability of the student being evaluated. Had the student been in a group with other students, his or her performance would have depended on the ability of the other students and the pre-existing relationships between them. All questions in the assessment were either multiple choice or involved moving icons into the appropriate slot; there were no free-response questions. Since it was an interactive assessment, students were required to respond to each question before moving onto the next and could not skip or omit questions. Collaboration was assessed through students' responses in their interactions with computer-based agents" (OECD 2017b, 32).

The PISA design is highly complex and one of the consequences is that the recommended method to analyse competencies is by using multiple plausible values (see for ex. Davier, Gonzales and Mislevy 2009). One of the benefits of this method is that although only few students, less than 10% of all, responded to all three domains, they have individual scores imputed for each domain. However, the validity of some of the assumptions on which PVs are built have been contested. Svend Kreiner and Karl Bang Christensen studied invariance across subscales on PISA 2006 and found evidence of misfit of the PISA scaling model and evidence of differential item functioning (2014). In addition, it seems that the imputation inflates the correlations between the measures of subjects and, as a result, makes harder to identify determinants of their difference.

Because of these concerns, I will explore the possibility of using alternative measures, which assess only the students who answered the collaborative problem-solving module.

My measures of inequality are also derived from the PISA data set. In addition to competency data, students are asked to complete a survey that includes their demographic information, including wealth of their family. I take the standard deviation of the mean for each school to measure the school inequality, which refers to SES differences to which students are directly exposed at school. I also estimate inequality across schools, which is the standard deviation of the school means for each country. The resulting measure is national in scope but refers to an indirect exposure to inequality. Inequality across schools refers only to the population of families with 15-year old students, and thus deviates from alternative national measures, such as the Gini coefficient.

In addition, the analyses merge PISA data with country level data that assess level of political equality, generalized trust, and communist legacy.

To estimate political equality, which refers to the extent to which members of a polity possess equal political power, the analyses use a set of measures developed by the Varieties of Democracy Project (www.v-dem.net). V-DEM measures evaluate the extent that groups possess power to: (a) actively participate in politics (by voting, etc. et al.), (b) are involved in civil society organizations, (c) secure representation in government, (d) are able to set the political agenda, (e) influence political decisions, and (f) influence the implementation of those decisions. For generalized trust, the analyses use the World Values Surveys (www.worldvaluessurvey.org) which ask citizens worldwide if they think that "most people can be trusted or if you can't be too careful these days".

RESULTS OF ANALYSIS ON THE LINKS BETWEEN COLLABORATIVE SKILLS, OTHER ACADEMIC OUTCOMES AND VARIOUS MEASURES OF INEQUALITY

The correlations between scores in collaborative problem solving, science, reading and mathematics, as measured by the standard measures in PISA 2015, have values that exceed 0.7 at the individual level (Table 2).

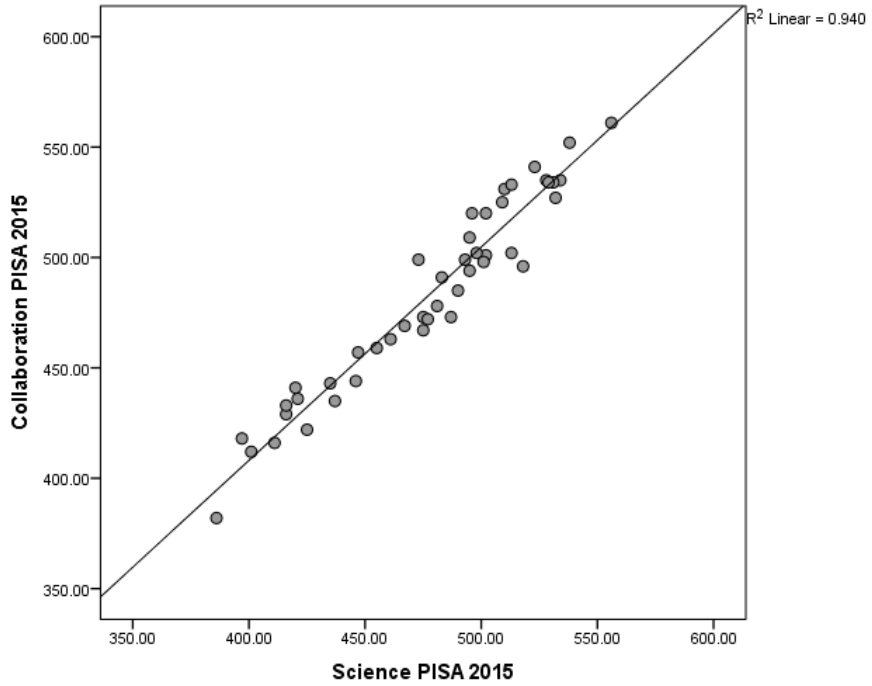
Table 2. Correlations among performance in collaborative problem solving and in core PISA subjects, as measured by the standard measures

Correlations between			
Mathematics	Reading	Science	… and
0.70	0.74	0.77	Collaborative problem solving
	0.80	0.88	Mathematics
		0.87	Reading

Source: OECD, PISA 2015 Database, Table V.3.4.

At the society level correlations between CPS mean scores and the other academic outcomes are even stronger. Figure 3 illustrates the very strong link between measures of collaboration skills and science.

Figure 3. Link between country level mean scores in collaboration skills and science.



Source: own calculations, based on PISA 2015 data

Thus, one may wonder to what extent the collaborative problem-solving assessment measures collaboration skills as opposed to general cognitive skills. However, the correlations between scores that are based on aggregation of answers without the use of imputation for missing are lower, suggesting that collaborative problem-solving outcomes, while still closely related to outcomes in science, reading and mathematics, are less strongly related to these core subject outcomes than these core subject outcomes are related to each other (Table 3).

Table 3. Individual level correlations among performance in collaborative problem solving and in core PISA subjects, as measured by the new measures

Correlations between Mathematics	Reading	Science	… and
0.52	0.58	0.65	Collaborative problem solving
	0.57	0.73	Mathematics
		0.70	Reading

Source: own calculations, based on PISA 2015 data

A country by country analysis finds that the mean of the correlations between CPS scores and the core subject scores is 0.72. At the same time, the correlations between measures without imputation of the performance in collaborative problem solving and outcomes in science, reading and mathematics range between 0.29 in Tunisia, 0.34 in Hong Kong and 0.34 in Mexico, and 0.35 in Costa Rica at the lower extreme, and 0.68 in Israel and in the United States, and 0.66 in Thailand at the higher one. In conclusion, collaborative problem-solving outcomes include a significant part of specificity when compared to the core subjects, therefore it makes sense to identify what are its main determinants.

Determinants of CPS PISA 2015 at society level

Previous analyses found that socio-economic status, as measured in PISA by the PISA index of economic, social and cultural status (ESCS), relates positively to performance in all domains assessed in PISA, including performance in problem solving. At the same time, the relationship between socio-economic status and performance is weaker in collaborative problem solving than in the three other domains. Still, even in collaborative problem solving, about 15% of the variation in performance can be explained by differences in socio-economic status (OECD 2017b).

On average across OECD countries that participated in the collaborative problem-solving assessment, a one-point increase in students' socio-economic status is associated with a 13-point improvement in collaborative problem-solving performance, compared to between 17 and 19 points in the three core PISA subjects. A one-point increase in schools' socio-economic profile is associated with a 59-point improvement in collaborative problem-solving performance compared to between 66 and 73 points in the three core PISA subjects (OECD 2017b).

Also, previous research found that, on average across OECD countries, there is no significant difference in collaborative problem-solving performance between advantaged and disadvantaged students – defined as those students who are in the top and bottom quarter of socio-economic status (ESCS) within a country – once performance in science, reading and mathematics has been accounted for. At the same time, PISA data show a gap in collaborative problem-solving performance between immigrant and non-immigrant students even after accounting for gender and socioeconomic status. After accounting for these two factors, immigrant students still score 26 points below non-immigrant students, on average across OECD countries. However, on average across OECD countries, there is no significant difference between immigrant and non-immigrant students after accounting for performance in the three core PISA subjects (OECD 2017b).

The importance of mezzo and society level context

Since a student's performance in collaborative problem solving is not only related to his or her own attributes, but is also linked to the types of interactions with other students, it is possible that students who are exposed to a variety of backgrounds unlike their own might develop a greater range of interpersonal skills. Such diversity in backgrounds might include socio-economic, immigrant, and special needs diversity.

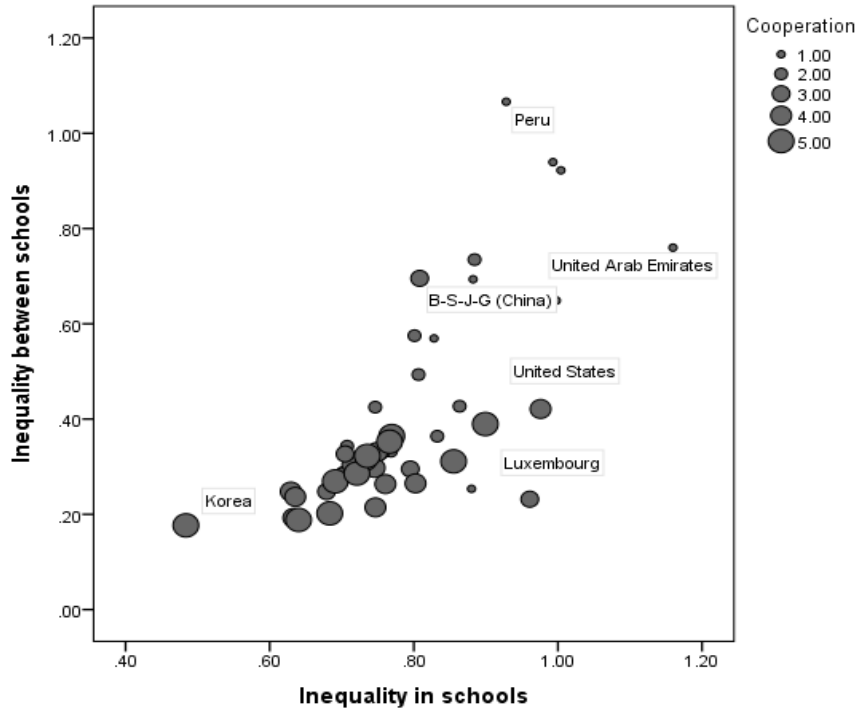
Previous research found that, on average across OECD countries, there is no difference in the performance of non-immigrant students between those in schools with large numbers of immigrant students and those in schools with low numbers of immigrant students. However, this difference becomes significant after accounting for performance in science, reading and mathematics: non-immigrant students in a more diverse environment score higher than their non-immigrant peers with similar performance in science, reading and mathematics but in a less diverse environment (OECD 2017b).

Similar results are seen when diversity is measured as the school-level variation in socio-economic status, or the proportion of advantaged or disadvantaged students, or students with special needs in individual schools. There appears to be no significant relationship between diversity and the uniquely collaborative aspects of the collaborative problem-solving assessment, after the relationship between diversity and socio-economic profile has been accounted for (OECD 2017b).

However, a recent paper that I co-authored with Paul Sum brings support to the assertion that socio-economic inequality has a corrosive effect on students' ability to learn collaborative problem-solving skills, when assessed by the non-standard measure, even after accounting for gender and socioeconomic status, as well as for performance in science, reading and mathematics. We also show that it is important how inequality is conceived and measured. Whereas most of its commonly used measures describe aspects of the entire society, we found that inequality inside certain groups matter, and can have strong effects on people's views and behaviors. Thus, one of the two types of inequalities that we investigate refers to the school context where the respondents learn, whereas the other describe differences among schools in terms of the mean wealth of parents.

Figure 4 represents the relationship between in-school inequality and across school inequality with relation to the relative achievement (in quintiles) on the PISA cooperation competency. The two types of inequality tend to correlate closely within a country, and collaborative problem-solving tends to be stronger in countries where greater equality prevails (Sum and Bădescu 2018).

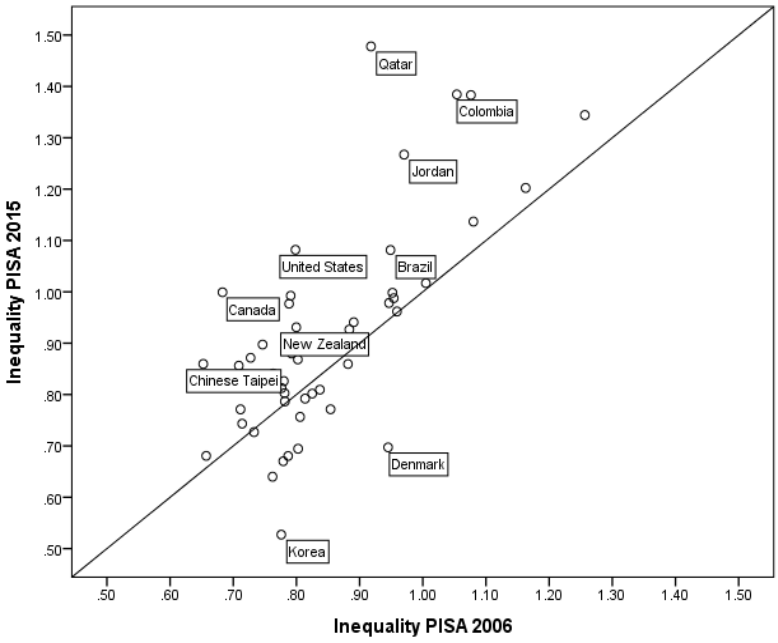
Figure 4. Two forms of inequality and cooperation competency among countries. PISA 2015



Source: Sum and Bădescu 2018

The stronger of the two effects is at the school level, suggesting that when inequality is experienced on a more intimate, its corrosive impact is greater. This finding further implies that societies could look stable from the point of view of Gini or similar measures, and, at the same time, could have a rapid growth of sub-national types of inequalities. The PISA instrument suggests that this is could be the case for many of the countries involved in the project since inequality among 15 years old increased in 75 percent of these countries since 2006 (Figure 3).

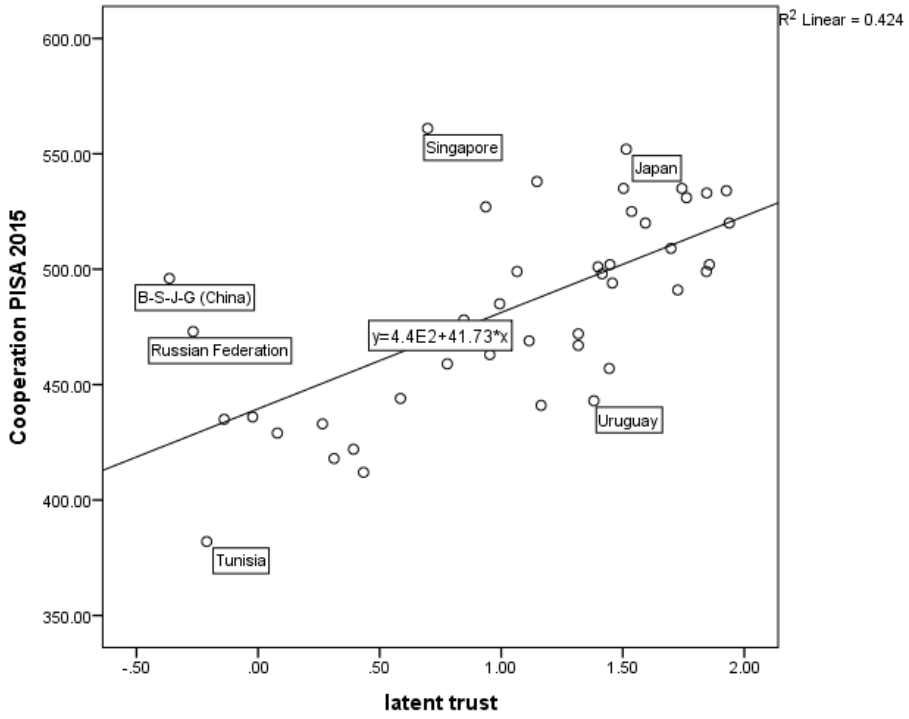
Figure 5. Inequality among 15 years old in PISA 2006 and PISA 2015 among countries.



Source: Sum and Bădescu 2018

Analyses at the country level show that the mean scores of collaboration competency among countries in PISA 2015 are strongly correlated with mean levels of generalized trust, as measured by the World Value Surveys (r = 0.66**) (Figure 6). Since generalized trust has been shown to be both a resource and an effect of collaboration, this finding provides additional support for the validity of the CPS instrument in PISA 2015.

Figure 6. Generalized trust (WVS) and cooperation competency among countries (PISA 2015).



When considered together simultaneously, the main determinants of the specific component of collaboration in PISA 2015 on society level data are performance in science (as measured in PISA), generalized trust and inequality between schools. All of them have positive effects, which is expected in the case of Science and Generalized trust, but unexpected for inequality. It is possible that societies that have high level of inequality between schools tend also to be more developed, beyond what is captured by the measure included in the analysis (log of GDP/cap. The level of wealth has an effect on collaboration that is entirely mediated by the scores in science (Table 4).

Table 4. Determinants of collaborative problem solving in a structural equations model on society level PISA 2015 data.

			Standardized Estimate	P
Collaboration	<---	Science	0.906	0.000
Collaboration	<---	Inequality 2	0.117	0.014
Collaboration	<---	Generalized trust	0.159	0.000
Collaboration	<---	GDP/cap (log)	0.056	0.030
Science	<---	Inequality 2	-0.354	0.000
Science	<---	Generalized trust	0.116	0.116

Science	<---	GDP/cap (log)	0.368	0.000

Effects of the disadvantaged status on the CPS scores

PISA 2015 data include information about several types of attributes that tend to confer a disadvantaged status to the students: migration background of the students (born in other country than that of testing vs. the same country), migration background of the parents (at least one of the parents was born in other country than that of testing vs. the same country), and speaking a minority language at home. Additionally, data include an index of economic, social and cultural status (ESCS). Table 5 represents the unstandardized effects of each of these four attributes on individual CPS scores in country by country regression models.

Table 5. Unstandardized effects of migration background of the students, migration background of the parents, speaking a minority language at home and ESCS on individual CPS scores in country by country regression models in PISA 2015.

	Migration of student		Migration of parents		Minority language		ESCS	
Country Identifier	b	p	b	p	b	p	b	p
Australia	79.15	.227	-8.67	.790	-32.93	.525	56.11	.010
Austria	36.98	.163	15.80	.511	-73.31	.007	35.69	.068
Belgium	-2.93	.838	-1.52	.884	-21.18	.075	62.11	.000
Brazil			-50.87	.036	4.90	.872	41.97	.000
Bulgaria	55.73	.159	40.14	.262	-31.11	.135	58.94	.000
Canada	-13.65	.430	9.35	.468	-8.66	.529	40.05	.000
Chile	-83.29	.158	-26.96	.432	33.96	.457	31.15	.000
Chinese Taipei	-27.03	.663	25.20	.068	-48.43	.444	53.56	.000
Colombia	-19.14	.702	15.57	.538			41.66	.000
Costa Rica	10.18	.778	9.96	.575	-37.83	.600	43.78	.000
Croatia	-44.53	.156	5.90	.615	9.19	.783	70.11	.000
Czech Republic	-48.86	.309	-21.61	.525	107.21	.005	98.06	.000
Estonia	-133.33	.113	-64.12	.000	10.84	.663	39.84	.009
Finland	-47.34	.089	-17.09	.369	-39.70	.074	30.52	.020
Greece	-21.31	.620	-15.57	.467	-48.74	.177	28.33	.078
Hong Kong	9.44	.468	18.92	.281	-123.17	.000	19.98	.066
Hungary			-91.77	.042			119.83	.000
Iceland	-4.77	.909	-37.21	.220	-32.56	.502	-8.53	.651
Israel	-20.27	.338	30.04	.014	5.03	.765	52.21	.000
Italy	-28.59	.307	-26.52	.266	-10.50	.480	49.50	.002
Japan	-112.52	.134	16.81	.698			56.55	.000
Korea			37.53	.243			40.36	.002
Lithuania	223.61	.017	13.82	.633	-79.79	.052	16.84	.570
Luxembourg	-12.67	.309	16.98	.383	-28.03	.209	26.17	.001
Macao	-0.70	.959	8.51	.590	-69.25	.000	32.54	.002
Mexico	-2.97	.928	4.32	.912	-28.80	.289	34.73	.000
Montenegro	-14.70	.496	1.93	.846	-64.62	.003	50.07	.000
Netherlands	-13.79	.851	11.50	.755	-112.30	.031	-12.51	.634
New Zealand	-27.37	.376	10.37	.648	15.92	.558	36.61	.091
Peru	56.82	.353			-59.95	.092	26.88	.017
Portugal	-27.30	.336	6.90	.750	7.15	.854	34.66	.000

Russian Federation	-20.56	.477	1.67	.912	20.27	.468	22.77	.076
Singapore	-47.51	.057	22.16	.161	-15.43	.408	65.00	.000
Slovak Republic	73.68	.285	49.00	.221	-60.33	.054	89.77	.000
Spain	-49.53	.072	34.53	.134	-13.40	.345	22.88	.001
Sweden	5.78	.882	-4.43	.880	-33.45	.308	26.66	.220
Thailand			21.20	.407	34.33	.410	50.56	.000
United Arab Emirates	21.29	.013	38.23	.000	-1.29	.868	46.63	.000
Tunisia	-16.71	.671	-14.84	.707	-13.09	.616	17.09	.004
Turkey			-20.84	.741	-14.65	.389	49.43	.000
United Kingdom	99.69	.132	112.31	.055	-94.83	.232	36.47	.351
United States	-0.88	.970	-2.98	.895	28.17	.235	33.69	.005
Uruguay	163.24	.053	1.16	.974	24.79	.589	49.26	.000
B-S-J-G (China)			-83.33	.126	-17.54	.747	49.19	.000

The analyses show that the students who were born in a different country than the one of testing received similar CPS scores with the rest of the students in each society, except for Lithuania and UAE (in Uruguay p=0.053), where the differences are positive and statistically significant. Having parents who were born abroad has a negative statistically significant effect in Brazil, Estonia and Hungary, and a positive and statistically significant effect in UAE. Also, speaking a minority language has a negative statistically significant effect in Belgium, Hong Kong, Iceland, Macao, Montenegro and Sweden. Finally, low ESCS values tend to be associated with low values of CPS scores in all countries, except for Austria, Greece, Hong Kong, Iceland, Lithuania, Netherlands, Russia, Sweden and the UK.

The effects of the same four attributes on the individual CPS scores, controlling for Science scores in PISA 2015, were assessed in country by country regression models. Table 6 represents the unstandardized effects of each of each of them.

Table 6. Unstandardized effects of migration background of the students, migration background of the parents, speaking a minority language at home and ESCS on individual CPS scores in country by country regression models, controlling for Science scores in PISA 2015.

	Migration of student		Migration of parents		Minority language		ESCS	
Country	b	p	b	p	b	p	b	p
Australia	-36.37	.283	-5.11	.750	32.52	.219	2.22	.846
Austria	3.05	.863	23.02	.149	-39.87	.027	-19.06	.164
Belgium	4.97	.609	-6.69	.343	-2.02	.802	4.93	.368
Brazil			0.28	.987	28.65	.186	13.64	.000
Bulgaria	36.68	.077	2.60	.890	2.04	.852	-7.51	.223
Canada	-6.16	.580	6.18	.456	1.62	.855	4.73	.456
Chile	10.51	.744	3.80	.839	30.86	.214	-4.77	.098
Chinese Taipei	24.71	.497	-4.05	.620	-1.80	.961	4.54	.378
Colombia	23.68	.395	30.41	.031			7.74	.003
Costa Rica	-1.47	.947	19.89	.068	32.80	.458	6.62	.241
Croatia	-24.47	.216	5.26	.476	10.25	.626	12.22	.137
Czech Republic	-9.28	.766	6.71	.762	64.74	.010	10.37	.426
Estonia	2.28	.961	-16.96	.057	12.46	.366	2.93	.733
Finland	-22.94	.195	2.87	.812	-22.53	.110	-8.96	.294
Greece	1.17	.968	-8.93	.541	0.39	.988	-0.84	.941

Hong Kong	7.93	.350	-8.07	.485	-27.88	.122	-4.53	.529
Hungary			-69.99	.027			30.29	.086
Iceland	-37.69	.145	-11.73	.527	48.57	.112	-14.26	.216
Israel	-14.00	.333	9.47	.258	-1.32	.909	7.69	.222
Italy	7.57	.606	10.61	.399	-11.60	.135	0.30	.972
Japan	-41.77	.380	-10.94	.690			-21.89	.026
Korea			30.21	.175			-11.21	.254
Lithuania	89.50	.174	9.03	.646	-53.48	.058	-13.38	.519
Luxembourg	-8.70	.257	27.60	.022	-7.96	.563	-5.02	.311
Macao	-6.87	.337	0.54	.948	-19.46	.022	9.76	.079
Mexico	-29.65	.134	56.33	.017	-9.82	.545	9.98	.006
Montenegro	-16.11	.267	-4.54	.497	1.03	.945	19.70	.001
Netherlands	44.26	.482	9.92	.743	-50.11	.267	-9.13	.672
New Zealand	16.70	.445	2.47	.874	-3.53	.851	-11.76	.456
Peru	32.08	.437			-53.89	.026	-2.25	.784
Portugal	8.81	.595	-20.32	.110	39.10	.085	-0.92	.858
Russian Federation	-9.17	.637	8.89	.383	12.08	.520	4.67	.591
Singapore	5.50	.700	3.55	.691	-8.91	.396	3.56	.652
Slovak Republic	44.02	.381	15.57	.595	-39.42	.085	18.79	.173
Spain	2.27	.896	19.00	.187	1.84	.836	-2.17	.643
Sweden	-9.87	.657	-22.96	.176	29.84	.129	-0.57	.964
Thailand			18.06	.182	-14.70	.506	10.69	.001
United Arab Emirates	7.00	.185	1.23	.815	-8.15	.091	9.54	.008
Tunisia	-2.11	.946	-16.96	.590	2.32	.912	5.26	.280
Turkey			0.94	.982	-4.97	.659	5.47	.351
United Kingdom	30.27	.472	105.81	.005	-122.67	.018	-9.25	.714
United States	3.46	.762	-1.56	.888	8.85	.444	0.53	.930
Uruguay	46.76	.376	5.73	.796	-15.36	.592	6.14	.335
B-S-J-G (China)			-21.79	.511	16.96	.609	1.53	.672

The overall results show that the specific part of collaboration has fewer negative determinants among the four variables that measure minority status than the CPS measure without control for Science. Thus, students who were born in a different country obtained similar CPS scores with the rest of the students in each society, when controlling for Science. Having parents who were born abroad has a negative statistically significant effect in Hungary, and a positive and statistically significant effect in Colombia, Luxembourg, Mexico and the UK, whereas speaking a minority language has a negative statistically significant effect in Austria, Lithuania, Macao, and the UK. Low ESCS values tend to be associated with low values of CPS scores only in Brazil, Colombia, Mexico, Montenegro, Thailand, and UAE, and with high values in Japan. Even when statistically significant ($p<0.05$), the effects are much weaker than in the absence of control for Science.

Effects of parents on CPS

PISA 2015 included information on parents' views on schools and education of their children. The module was applied in 11 societies that collected CPS data: Belgium, Chile, Croatia, Hong Kong, Italy, Korea, Luxembourg, Macao, Mexico, Portugal and Spain[1].

[1] UK has only 95 completed questionnaires and was not included in the analyses.

The results show that the schools where parents feel welcomed tend to have higher CPS scores, controlling for minority status, ESCS and gender, in Chile, Croatia, Hong Kong, Luxembourg, and Mexico. When the effects of Science scores are controlled for, none of the effects of views on school are statistically significant. Additionally, parents who report that know by name many friends tend to have children with high CPS scores in Belgium, Luxembourg and Portugal. The positive effects of schools that have many such parents on CPS scores are found in Belgium, Chile, Croatia, Hong Kong, Italy, Korea, Luxembourg, Macao. However, the effects are not statistically significant in any of the 11 societies.

Effects of diversity in school on the CPS scores

PISA 2015 include two categories of data about diversity: (A) measures that result from the school questionnaires, where the respondents were the school principals, and (B) aggregate measures of the individual responses of the students. The first category has the following three variables: (1) estimated percentage of the students in school whose primary language is different than the one of the testing, (2) estimated percentage of the students in school with special needs, and (3) estimated percentage of the students in school from socioeconomic disadvantaged homes. The second category has the following four variables: (1) diversity of ESCS, measured as relative standard deviation of ESCS in school, (2) diversity of students with migration background, measured as their proportion in school, (3) diversity of students having at least one parent with migration background, measured as their proportion in school, and (4) diversity of students whose primary language is not the one of the testing, measured as their proportion in school.

The effects of these seven school level measures of diversity on the individual CPS scores, were assessed in country by country regression models (Table 7).

Table 7. Unstandardized effects of school level measures of diversity—relative standard deviation of ESCS, % of students with migration background, % of students with migrant parents, % of students with minority language, % of students with minority language assessed by school principals, % of students with special needs, % of students with low SES--, on individual CPS scores in country by country regression models in PISA 2015.

	Diversity of ESCS		% of students with migration background		% of students with migrant parents		% of students with minority language		% of students with minority language (2)		% of students with special needs		% of students with low SES	
Country	B	p	B	p	B	p	B	p	B	p	B	p	B	p
Australia	-0.01	.898	-150.26	.389	163.68	.057	-160.70	.030	0.33	.566	0.50	.568	-0.78	.003
Austria	1.64	.022	65.85	.660	106.75	.080	-151.33	.069	-0.31	.531	-2.15	.007	-0.61	.351
Belgium	0.00	.903	-75.70	.022	40.53	.028	-71.20	.001	0.21	.077	-0.47	.002	-0.86	.000
Brazil	-0.19	.705	349.24	.226	-116.51	.308	-158.63	.315	-0.06	.555	0.36	.559	-0.43	.000
Bulgaria	0.51	.027	233.79	.345	-275.44	.027	-147.06	.007	-0.20	.484	-10.36	.002	0.22	.380
Canada	0.17	.339	75.33	.023	17.42	.287	-103.61	.000	0.24	.064	-0.49	.167	-0.45	.044
Chile	0.00	.982	-230.68	.204	35.82	.730	-322.23	.189	-0.56	.034	-0.53	.166	-0.87	.000
Chinese Taipei	-0.35	.214	288.72	.035	-192.94	.000	-21.42	.910	0.03	.769	0.17	.504	-0.84	.000
Colombia	0.88	.350	148.24	.375	-96.80	.492	-72.84	.602	-0.20	.086	0.14	.772	-0.42	.000
Costa Rica	1.88	.042	-353.58	.003	108.64	.091	168.86	.403	-0.27	.059	0.03	.915	-0.04	.793
Croatia	-0.27	.248	-4.64	.961	-50.45	.062	-98.63	.285	0.03	.889	-2.67	.001	-0.89	.000
Czech Republic	0.11	.785	-254.31	.256	214.16	.016	-279.23	.027	9.06	.000	-1.10	.091	-1.46	.002
Estonia	0.00	.974	113.98	.502	-116.08	.000	-32.03	.376	0.22	.269	-0.40	.254	-0.05	.887
Finland	-0.04	.050	-100.03	.379	31.27	.569	-38.62	.372	-0.26	.187	-0.96	.081	0.13	.662
Greece	0.62	.058	48.10	.723	-4.31	.936	-118.06	.183	0.52	.040	-0.01	.995	-0.68	.005

Hong Kong	-0.55	.051	-65.52	.046	34.45	.234	-112.63	.000	-0.13	.250	-2.92	.000	-0.52	.002
Hungary	2.76	.057	1008.34	.011	199.25	.154	-1185.09	.000	-5.07	.026	-2.21	.003	-2.59	.000
Iceland	4.37	.643	111.53	.361	-45.38	.609	-71.64	.662	-0.52	.073	-0.86	.095	1.10	.044
Israel	0.00	.414	-91.55	.042	132.19	.000	-154.79	.000	-0.54	.000	0.70	.000	-1.15	.000
Italy	0.23	.210	-363.06	.039	86.51	.555	21.19	.344	-1.14	.201	0.36	.586	-1.05	.000
Korea	0.62	.324	-387.15	.310	218.58	.153	-879.63	.047	-5.63	.196	2.05	.449	-0.75	.001
Lithuania	3.27	.100	488.64	.207	67.81	.175	-10.71	.903	1.10	.294	-3.36	.203	1.14	.242
Luxembourg	1.03	.002	-103.33	.000	-83.69	.006	-150.59	.000	0.09	.658	0.12	.545	-0.54	.000
Macao	0.54	.000	-109.69	.001	220.21	.000	-94.55	.000	0.66	.000	-0.09	.728	-1.01	.000
Mexico	0.14	.142	-76.43	.219	-208.77	.000	-49.89	.616	-0.45	.292	-0.89	.129	-0.25	.000
Montenegro	1.15	.008	-134.43	.332	55.74	.041	-403.75	.001	0.20	.403	-1.28	.076	-0.45	.013
Netherlands	-20.62	.000	-1806.32	.011	-294.91	.159	758.50	.164	-0.06	.971	-4.77	.187	-24.18	.000
New Zealand	-0.14	.780	140.08	.085	-71.81	.194	72.57	.294	-0.13	.792	-0.68	.682	-0.37	.284
Peru	-0.61	.469	936.55	.058	529.23	.229	-76.24	.027	-0.67	.185	-0.38	.935	-0.12	.505
Portugal	0.08	.145	119.49	.129	90.81	.014	-370.64	.009	-0.27	.812	-0.63	.377	-0.80	.000
Russian Fed.	-0.31	.274	105.64	.166	-2.04	.959	-54.37	.152	-0.16	.432	-0.38	.510	0.03	.931
Singapore	0.12	.781	-121.36	.003	102.15	.004	-109.00	.000	0.13	.181	-1.54	.023	-1.00	.018
Slovak Republic	-0.39	.397	290.58	.193	121.48	.218	-421.86	.000	1.60	.002	-1.88	.037	-1.73	.001
Spain	-0.47	.118	-48.22	.462	57.72	.291	-10.67	.531	0.28	.118	1.01	.040	-0.51	.019
Thailand	-0.58	.259	-131.50	.512	-16.92	.711	98.51	.027	-0.22	.058	0.18	.388	-0.71	.000
UAE	0.18	.000	48.21	.014	64.15	.000	-10.57	.277	0.27	.000	0.19	.331	-0.53	.000
Tunisia	2.11	.243	68.45	.419	-177.01	.023	-85.85	.284	-2.41	.150	-1.13	.229	-0.45	.000
Turkey	-4.06	.041	-35.87	.786	72.69	.367	-73.80	.000	-0.07	.559	-0.73	.197	-0.52	.000
United Kingdom	4.86	.356	485.23	.190	-86.75	.443	-328.37	.439	-1.53	.460	0.71	.660	-1.00	.187
United States	0.00	.973	-98.70	.055	86.24	.021	12.84	.816	-0.46	.085	-0.36	.358	-0.99	.000
Uruguay	-1.10	.429	-101.34	.619	156.62	.076	-274.61	.000	2.14	.030	-0.39	.133	-0.32	.023
B-S-J-G (China)	-0.21	.040	146.58	.600	-1228.65	.000	-475.67	.001	-0.19	.630	1.09	.014	-0.55	.006

The analyses show that the effects of the variables that assess diversity at the school level are statistically significant in less than half of the cases (38%). The effect of the proportion of students with low SES is statistically significant in 76% of the countries, but in less than half for each of the other six variables. Lithuania, New Zeeland, Russian Federation and the UK are the only countries having no significant effects of any of the seven diversity measures.

In addition, the effects are more often negative than positive (62% vs. 38%): all negative but five for the proportion of low SES, and all negative but six for the proportion of students who report that speak a minority language. The numbers of positive and negative effects are closer to even for the other measures. In the cases of the diversity of ESCS and of proportion of students having parents with migrant background, positive effects are slightly more numerous than negative ones (60% of the countries for each variable).

The analyses show also that there are different configurations of statistically significant effects across countries: 27 countries have more statistically significant effects that are negative than positive, 13 are even and two have more positive than negative. At one extreme, Hong Kong has four negative and none positive; Belgium, Hungary, Luxembourg, Singapore and China have each four negative and one positive. At the other extreme, UAE has four positive effects and one negative, and Iceland has one effect that is positive and none that are negative.

Table 8. Unstandardized effects of school level measures of diversity—relative standard deviation of ESCS, % of students with migration background, % of students with migrant parents, % of students with minority language, % of students with minority language assessed by school principals, % of students with special needs, % of students with low SES--, on individual CPS scores in country by country regression models, controlling for Science scores in PISA 2015.

	Diversity of ESCS		% of students with migration background		% of students with migrant parents		% of students with minority language		% of students with minority language (2)		% of students with special needs		% of students with low SES	
Country	B	p	B	p	B	p	B	p	B	p	B	p	B	p
Australia	0.05	.394	18.72	.845	16.59	.726	-1.29	.975	-0.23	.471	1.38	.004	-0.39	.008
Austria	0.83	.046	-131.19	.133	55.80	.114	34.14	.483	0.14	.616	0.55	.248	-0.79	.037
Belgium	0.01	.312	20.12	.323	-9.27	.415	-7.10	.592	-0.01	.936	0.14	.126	-0.07	.382
Brazil	0.03	.920	-146.42	.411	1.15	.987	145.08	.137	0.04	.525	-1.22	.002	-0.03	.671
Bulgaria	-0.11	.383	175.70	.182	-27.43	.679	8.31	.776	-0.16	.281	-2.98	.098	0.17	.207
Canada	0.12	.242	15.96	.392	0.11	.991	-24.36	.004	0.06	.393	-0.38	.058	0.23	.074
Chile	0.05	.301	135.95	.185	-66.52	.254	214.15	.123	-0.02	.884	-0.15	.480	-0.10	.230
Chinese Taipei	0.04	.785	32.50	.680	32.43	.219	34.74	.750	0.01	.848	-0.35	.021	0.06	.429
Colombia	-0.63	.245	85.34	.369	37.77	.638	87.59	.271	0.14	.036	-0.45	.099	-0.09	.064
Costa Rica	0.27	.667	-156.75	.055	120.58	.005	168.57	.214	-0.05	.591	-0.02	.930	-0.10	.383
Croatia	0.05	.711	-55.72	.326	18.79	.244	28.55	.602	0.06	.621	-1.01	.030	0.15	.238
Czech Republic	-0.10	.695	287.93	.047	-13.02	.821	61.53	.451	0.47	.760	0.77	.067	-0.33	.269
Estonia	0.08	.253	83.19	.375	-39.19	.001	14.39	.472	0.05	.667	0.08	.663	0.05	.783
Finland	-0.01	.347	-48.52	.447	3.50	.909	-18.29	.451	-0.07	.555	-0.33	.291	0.03	.842
Greece	0.32	.094	-45.43	.567	-4.40	.889	38.73	.457	0.28	.060	0.33	.578	0.11	.462
Hong Kong	-0.03	.875	9.52	.664	1.97	.918	7.80	.700	-0.09	.262	-0.76	.000	0.01	.933
Hungary	1.36	.130	576.16	.020	14.83	.865	-280.62	.186	-3.18	.024	-0.37	.430	-0.99	.025
Iceland	-0.93	.868	-27.79	.702	4.65	.930	-16.50	.865	-0.17	.318	0.10	.739	0.09	.783
Israel	0.00	.156	-33.82	.213	77.77	.000	-52.49	.014	-0.26	.000	0.36	.000	-0.22	.004
Italy	0.12	.229	86.28	.383	-87.15	.288	14.25	.254	0.37	.454	0.03	.926	0.06	.711
Korea	0.17	.665	-282.99	.228	198.68	.035	-330.53	.225	-0.12	.964	1.24	.455	-0.13	.360
Lithuania	-0.35	.782	264.86	.272	-4.40	.888	-96.05	.081	0.62	.343	0.10	.953	0.22	.718
Luxembourg	0.28	.171	-24.00	.103	9.90	.592	-2.04	.890	-0.03	.813	0.07	.581	-0.08	.325
Macao	0.14	.080	-52.58	.005	27.76	.371	-35.08	.000	0.13	.183	-0.21	.132	-0.15	.078
Mexico	-0.04	.519	8.24	.825	-25.17	.482	-10.19	.864	-0.08	.745	0.16	.647	0.01	.870
Montenegro	0.32	.250	149.87	.094	-5.74	.744	-104.87	.190	0.08	.585	-0.44	.339	-0.20	.079
Netherlands	3.31	.457	139.65	.809	37.03	.820	-195.86	.646	0.22	.858	4.15	.158	-0.35	.946
New Zealand	-0.17	.558	81.80	.090	-25.55	.436	-5.37	.896	-0.17	.570	0.65	.511	0.18	.374
Peru	0.18	.758	554.62	.098	406.44	.173	-33.24	.156	-0.23	.506	-1.83	.561	0.03	.813
Portugal	0.02	.610	6.50	.886	13.15	.536	10.71	.896	0.42	.512	0.06	.886	-0.19	.070
Russian Fed.	-0.08	.639	101.00	.038	21.14	.410	-27.63	.255	0.02	.889	0.37	.316	-0.25	.323
Singapore	0.12	.629	-23.69	.314	22.98	.265	-3.28	.828	-0.04	.505	-0.60	.123	-0.04	.879
Slovak Republic	-0.91	.003	18.00	.903	102.49	.116	-56.09	.474	-0.23	.503	-0.97	.103	-0.19	.579
Spain	0.10	.571	-29.05	.457	66.33	.042	-21.40	.035	0.16	.141	0.50	.087	-0.26	.044
Thailand	0.28	.309	-47.75	.662	-29.07	.242	-38.51	.114	0.05	.441	-0.09	.435	-0.02	.653
United Arab Emirates	0.01	.745	46.29	.000	-19.57	.041	1.94	.745	0.02	.651	-0.30	.014	0.15	.059
Tunisia	0.69	.625	-24.83	.710	130.64	.046	32.23	.612	-2.19	.096	-0.85	.249	-0.04	.647
Turkey	0.18	.882	101.76	.215	35.66	.475	-32.15	.004	0.07	.346	0.16	.641	-0.01	.830

United Kingdom	-2.61	.360	55.46	.781	-213.84	.001	80.88	.723	-0.40	.721	1.25	.153	-0.67	.099
United States	0.02	.439	3.75	.884	1.95	.917	26.86	.330	-0.18	.180	0.09	.632	-0.21	.024
Uruguay	-1.66	.053	-51.28	.684	-1.81	.974	-106.44	.024	0.83	.173	-0.04	.805	0.01	.906
B-S-J-G (China)	0.03	.588	131.25	.428	-44.38	.713	54.17	.524	-0.47	.044	0.03	.907	0.03	.771

Overall, the effects of the variables that assess diversity at the school level, when controlling for Science scores, are statistically significant in less than one quarter of the cases. At one extreme, the proportion of students with special needs has statistically significant effects in 17% of the countries, whereas at the other extreme, the effect of ESCS diversity has statistically significant effects in 5%. Also, 43% of all countries have no significant effects of any of the seven diversity measures.

In contrast with the analyses that do not include control for Science scores, the effects are more often positive than negative (56%). ESCS diversity, proportion of students with migration background and proportion of students having migrant parents have higher proportions of positive effects (69%, 62% and 62%, respectively). The other four variables have close to even proportions between positive and negative effects (between 50% and 52%).

In addition, the analyses show that there are different configurations of statistically significant effects across countries: 17 countries have more statistically significant effects that are negative than positive, 19 are even and six have more positive than negative. No country stands out as having a large number of positive or negative effects that are statistically significant.

Effects of collaborative school environment on school outcomes

Learning environment has been shown to play an important role in shaping school outcomes (for instance Debra and Fraser 2007). PISA 2015 data allow us to test the assertion that schools where collaborative skills are prevalent tend to have students with better education skills and with more positive feelings regarding their school. The following analyses evaluate what are the effects of a collaborative school environment on individual collaborative skills, science skills and attitudes toward school.

Effects of collaborative school environment on CPS individual scores

The collaborative school environment (School CPS) is measured as the mean of all CPS scores in a school, except for the CPS score of the respondent. Its effect on individual CPS scores are tested in three types of regression models for each society: (A) with gender and ESCS as control variables, (B) with Science, gender and ESCS as control variables, and (C) with Science, School Science (measured as the mean of all Science scores in a school, except for the Science score of the respondent), gender and ESCS as control variables (Model C). The results are represented in Table 9.

Table 9. Unstandardized effects of the collaborative school environment (School CPS) on individual CPS scores in three types of regression models for each society: (A) with gender and ESCS as control variables, (B) with Science, gender and ESCS as control variables, and (C) with Science, School Science, gender and ESCS as control variables (Model C), in PISA 2015.

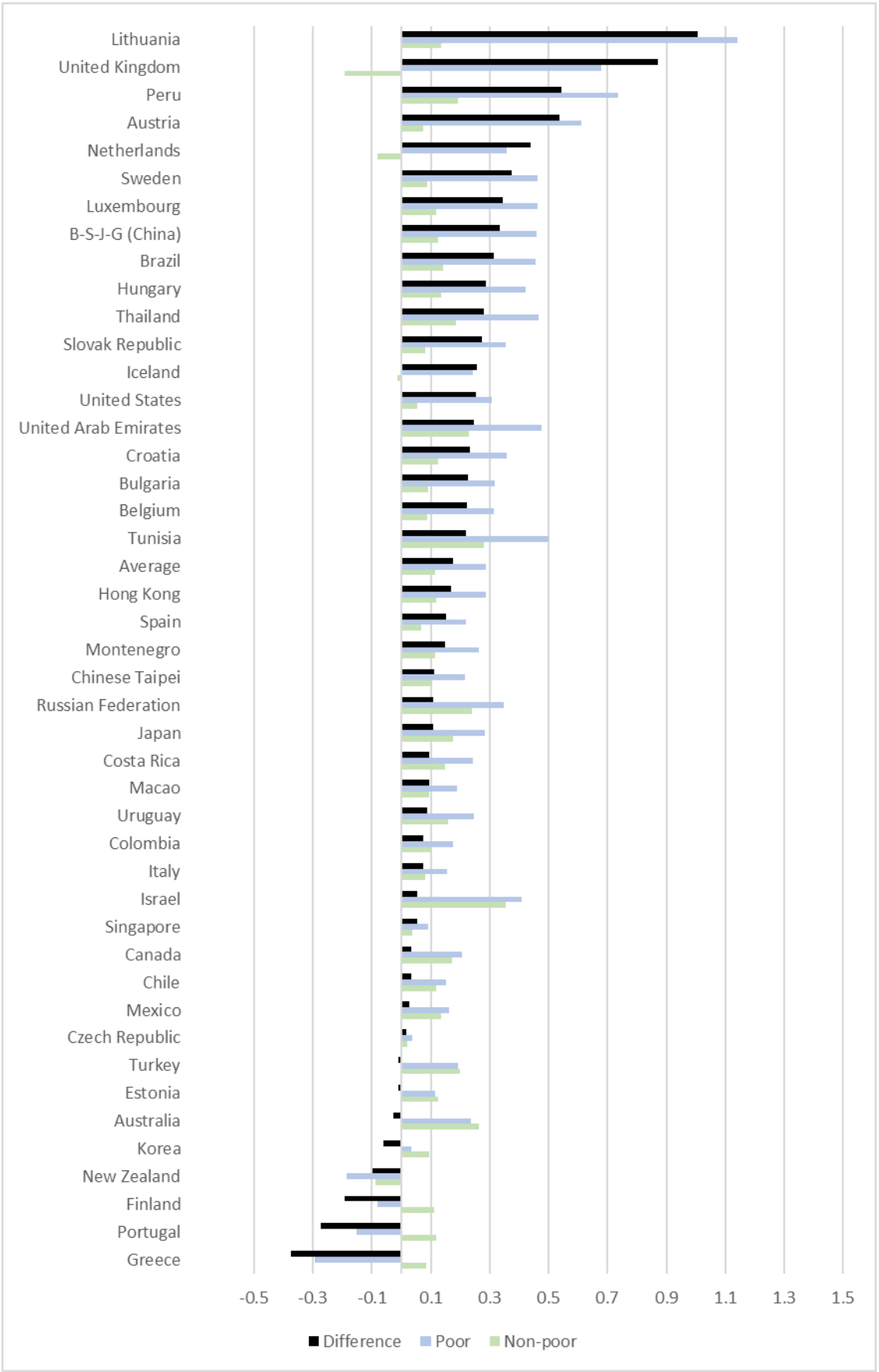
	Model A		Model B		Model C	
	School CPS		School CPS		School CPS	
Country	b	p	b	p	b	p
Australia	.568	.000	.268	.000	.413	.000

Austria	.721	.000	.103	.016	.348	.000
Belgium	.731	.000	.097	.000	.280	.000
Brazil	.735	.000	.156	.000	.404	.000
Bulgaria	.808	.000	.079	.005	.211	.000
Canada	.514	.000	.137	.000	.269	.000
Chile	.715	.000	.105	.000	.253	.000
Chinese Taipei	.685	.000	.096	.000	.312	.000
Colombia	.681	.000	.107	.000	.224	.000
Costa Rica	.586	.000	.151	.005	.299	.001
Croatia	.724	.000	.126	.000	.269	.000
Czech Republic	.749	.000	.031	.571	.172	.065
Estonia	.619	.000	.128	.000	.193	.001
Finland	.321	.000	.059	.153	.096	.091
Greece	.572	.000	.107	.083	.168	.103
Hong Kong	.731	.000	.148	.000	.270	.000
Hungary	.773	.000	.148	.008	.119	.271
Iceland	.289	.018	.044	.535	.024	.800
Israel	.847	.000	.344	.000	.457	.000
Italy	.734	.000	.078	.055	.145	.037
Japan	.741	.000	.131	.001	.444	.000
Korea	.565	.000	.083	.042	.136	.021
Lithuania	.691	.000	.216	.005	.410	.002
Luxembourg	.791	.000	.133	.000	.175	.059
Macao	.831	.000	.116	.001	.206	.025
Mexico	.708	.000	.136	.000	.213	.000
Montenegro	.826	.000	.120	.001	.410	.000
Netherlands	.754	.000	-.137	.221	-.344	.164
New Zealand	.236	.046	-.055	.422	-.112	.270
Peru	.646	.000	.222	.000	.378	.001
Portugal	.591	.000	.100	.006	.115	.124
Russian Federation	.638	.000	.234	.000	.343	.000
Singapore	.654	.000	.013	.717	.118	.077
Slovak Republic	.724	.000	.133	.002	.197	.022
Spain	.255	.000	.061	.168	.164	.003
Sweden	.545	.000	.090	.170	.110	.319
Thailand	.764	.000	.180	.000	.410	.000
United Arab Emirates	.840	.000	.226	.000	.487	.000
Tunisia	.778	.000	.287	.000	.523	.000
Turkey	.853	.000	.184	.000	.362	.000
United Kingdom	.337	.058	-.081	.430	.173	.201
United States	.573	.000	.059	.072	.303	.000
Uruguay	.537	.000	.136	.002	.300	.000
B-S-J-G (China)	.801	.000	.111	.000	.345	.000

The analyses show that a school that is collaborative tends to have a positive effect on CPS scores of students, even when controlling for the effect of Science score and Science scores of the school, with the exceptions of Netherlands and New Zeeland for Model A, Netherlands, New Zeeland and the UK for Model B, and Netherlands and New Zeeland for Model C.

When poorest students in each school, defined as students with ESCS scores lower than the mean (ESCS) at school level, minus one standard deviation, are compared to other students, the effects of the collaborative school environment on individual CPS scores tend to be stronger (Figure 7).

Figure 7. Unstandardized effects of the collaborative school environment (School CPS) on individual CPS scores, controlling for Science scores, gender and ESCS, across poorest students, other students, and difference between estimates, in PISA 2015.


Lithuania
United Kingdom
Peru
Austria
Netherlands
Sweden
Luxembourg
B-S-J-G (China)
Brazil
Hungary
Thailand
Slovak Republic
Iceland
United States
United Arab Emirates
Croatia
Bulgaria
Belgium
Tunisia
Average
Hong Kong
Spain
Montenegro
Chinese Taipei
Russian Federation
Japan
Costa Rica
Macao
Uruguay
Colombia
Italy
Israel
Singapore
Canada
Chile
Mexico
Czech Republic
Turkey
Estonia
Australia
Korea
New Zealand
Finland
Portugal
Greece
-0.5
-0.3
-0.1
0.1
0.3
0.5
0.7
0.9
1.1
1.3
1.5
Difference
Poor
Non-poor

In all countries but eight the effect of the collaborative school environment (School CPS) on individual CPS scores, controlling for Science scores, gender and ESCS, is greater among poor students than among others. One possible reason is that school is more relevant for poorer students since they tend to have less exposure to other contexts that promote collaboration. Also, it could be that disadvantaged students are more likely to value teamwork, perhaps because they value more the extra boost that teamwork can bring to their own performance. In the entire sample, students who are among the poorest in their schools and learn in schools that are among the most collaborative (more than one standard deviation above the society mean) have on the average more than 12 points at CPS than other students, with similar Science scores.

Effects of collaborative school environment on Science individual scores

The effects of collaborative school environment (School CPS) on individual Science scores are tested in two types of regression models for each society: (A) with gender and ESCS as control variables, (B) with CPS, gender and ESCS as control variables. The results are represented in Table 10.

Table 10. Unstandardized effects of the collaborative school environment (School CPS) on individual Science scores in two types of regression models for each society: (A) with gender and ESCS as control variables, (B) with CPS, gender and ESCS as control variables, in PISA 2015.

	Model A		Model B	
	School CPS		School CPS	
Country	b	p	b	p
Australia	0.32	.011	-0.12	.123
Austria	0.77	.000	0.25	.000
Belgium	0.83	.000	0.29	.000
Brazil	0.78	.000	0.21	.000
Bulgaria	0.93	.000	0.31	.000
Canada	0.41	.000	0.03	.207
Chile	0.75	.000	0.20	.000
Chinese Taipei	0.81	.000	0.22	.000
Colombia	0.68	.000	0.15	.000
Costa Rica	0.52	.000	0.17	.000
Croatia	0.80	.000	0.25	.000
Czech Republic	0.97	.000	0.45	.000
Estonia	0.59	.000	0.08	.022
Finland	0.31	.000	0.06	.163
Greece	0.59	.000	0.15	.012
Hong Kong	0.70	.000	0.19	.000
Hungary	0.72	.000	0.18	.000
Iceland	0.30	.013	0.07	.345
Israel	0.72	.000	0.01	.640
Italy	0.76	.000	0.19	.000
Japan	0.93	.000	0.34	.000
Korea	0.72	.000	0.20	.000
Lithuania	0.66	.000	0.06	.472
Luxembourg	0.83	.000	0.23	.000

Macao	0.82	.000	0.20	.000
Mexico	0.68	.000	0.17	.000
Montenegro	1.00	.000	0.33	.000
Netherlands	1.25	.000	0.75	.000
New Zealand	0.36	.003	0.17	.017
Peru	0.53	.000	0.08	.185
Portugal	0.62	.000	0.14	.000
Russian Federation	0.52	.000	0.07	.076
Singapore	0.81	.000	0.27	.000
Slovak Republic	0.83	.000	0.31	.000
Spain	0.25	.001	0.05	.301
Sweden	0.61	.000	0.15	.035
Thailand	0.74	.000	0.10	.000
United Arab Emirates	0.85	.000	0.13	.000
Tunisia	0.87	.000	0.32	.000
Turkey	0.97	.000	0.39	.000
United Kingdom	0.50	.005	0.23	.025
United States	0.54	.000	0.09	.002
Uruguay	0.47	.000	0.09	.021
B-S-J-G (China)	0.94	.000	0.34	.000

The analyses show that a school that is collaborative tends to have a positive and statistically significant effect on Science scores of students, even when controlling for the effect of CPS score, with the exceptions of Canada, Finland, Iceland, Israel, Lithuania, Peru, Russia and Spain (all positive but $p > 0.05$).

Effects of collaborative school environment on attitudes toward school

PISA 2015 data include a battery of six questions that assess how the students feel about school, assessing the level of agreement with each of the following statements: (1) “I feel like an outsider (or left out of things) at school”, (2) “I make friends easily at school”, (3) “I feel like I belong at school”, (4) “I feel awkward and out of place in my school”, (5) “Other students seem to like me”, and (6) “I feel lonely at school”. These six questions were aggregated by factor analysis in a unique individual score that measure feeling toward school. The effects of collaborative school environment (School CPS) on this score in regression models with gender and ESCS as control variables, are represented in the first two columns of Table 11. The last two columns describe the effects of the school level science scores on the measure of the feelings toward school in regression models with gender and ESCS as control variables.

Table 11. Unstandardized effects of the collaborative school environment (School CPS) on individual scores of the feelings toward school in regression models for each society, with gender and ESCS as control variables, and unstandardized effects the school level science scores (School Science) on individual scores of the feelings toward school in regression models for each society, with gender and ESCS as control variables, in PISA 2015.

	School CPS		School Science	
Country	b	p	b	p
Australia	0.0033	.035	0.0033	.044
Austria	0.0011	.200	0.0004	.587

Belgium	0.0009	.069	0.0010	.030
Brazil	0.0013	.007	0.0014	.002
Bulgaria	0.0016	.006	0.0012	.021
Canada	0.0000	.942	0.0014	.055
Chile	0.0022	.000	0.0024	.000
Chinese Taipei	0.0012	.021	0.0014	.002
Colombia	0.0017	.002	0.0019	.001
Costa Rica	0.0024	.029	0.0024	.049
Croatia	0.0008	.213	0.0010	.098
Czech Republic	0.0012	.256	0.0006	.429
Estonia	0.0018	.021	0.0029	.001
Finland	0.0010	.248	0.0011	.256
Greece	-0.0005	.709	-0.0007	.614
Hong Kong	-0.0009	.133	-0.0014	.042
Hungary	-0.0027	.017	-0.0021	.077
Iceland	-0.0014	.345	-0.0020	.350
Italy	0.0022	.074	0.0026	.029
Japan	0.0010	.145	0.0010	.068
Korea	-0.0001	.886	0.0017	.040
Lithuania	0.0030	.136	0.0027	.273
Luxembourg	0.0010	.501	0.0004	.741
Macao	-0.0001	.871	0.0002	.855
Mexico	0.0014	.048	0.0017	.035
Montenegro	-0.0010	.201	-0.0010	.126
Netherlands	0.0009	.624	0.0009	.540
New Zealand	0.0000	.997	-0.0011	.397
Peru	0.0018	.246	0.0031	.066
Portugal	-0.0002	.753	-0.0006	.438
Russian Federation	0.0002	.800	0.0005	.535
Singapore	0.0021	.026	0.0022	.008
Slovak Republic	0.0016	.047	0.0016	.023
Spain	0.0004	.689	-0.0012	.328
Sweden	0.0008	.561	0.0011	.440
Thailand	0.0012	.013	0.0013	.011
United Arab Emirates	0.0001	.875	0.0004	.270
Tunisia	0.0009	.465	0.0007	.518
Turkey	0.0016	.007	0.0015	.007
United Kingdom	-0.0022	.259	-0.0016	.355
United States	-0.0031	.000	-0.0030	.000
Uruguay	0.0012	.210	0.0013	.214
B-S-J-G (China)	0.0007	.049	0.0008	.025

The analyses show that in most societies, 32, the effect of the CPS context on wellbeing at school is positive. In 16 of them the effect is statistically significant. Surprisingly, in two of these cases, Hungary and the United States, the effects are negative. At the same time, the effect of Science school index is very similar to the effect of CPS school index and stronger in more than half of the cases. Only in Bulgaria and Turkey the effects of CPS school index are statistically significant and stronger than the effects of the Science school index, but even in

these two cases the differences are close to zero. These results, taken together, suggests that the specific part of the CPS at the school level does not have a positive effect on wellbeing in school.

WHAT THE RESULTS OF RESEARCH ON COLLABORATIVE SKILLS IMPLY FOR POLICY AND PRACTICE

Collaborative skills are key resources for students with and without disabilities, with diverse socio-economic and cultural background. This section presents several recommendations that might lead to improved skills and attitudes towards collaboration, and to lower gaps between vulnerable categories and the rest of the students.

Collaborative skills incorporate both cognitive and non-cognitive components. Whereas the effects of cognitive traits have been studied over more than one century, there is a rapidly growing body of evidence showing that some of the non-cognitive skills are at least as effective in predicting in later-life success. Since studies that focus specifically on collaborative skills are relatively recent, the first part of my recommendations will draw upon empirical results regarding those non-cognitive attributes that have been shown to spur cooperation and collaboration and that have been included in long time research agendas.

The main findings from the literature can be summarized as follows:

■ The predictive power of non-cognitive skills exceeds that of cognitive skills for many important outcomes. Conscientiousness and self-regulation are among the most widely predictive, playing a significant role in explaining poverty reproduction. Moreover, conscientiousness tends to have stronger positive effects on attainments at lower levels of parental SES.

■ Non-cognitive skills and academic achievement can have positive reciprocal relationships at both individual and group level. Therefore, investment in non-cognitive skills can enhance both non-cognitive and cognitive skills.

■ The results of the international large-scale assessments, including PISA, are influenced by a mixture of cognitive skills, non-cognitive skills and incentives.

■ The early years are important in shaping all skills and in laying the foundations for successful investment in the later years. During the early years, both cognitive and non-cognitive skills are highly malleable. During the adolescent years, non-cognitive skills are more malleable than cognitive skills.

■ There is ample evidence showing that generalized trust is one of the key attributes, both at individual and contextual level, that promote collaboration.

■ Analyses at the country level show that the main determinants of the mean scores of collaboration competency among countries in PISA 2015 are generalized trust and inequality between schools. At the same time, generalized trust is a positive determinant of the specific component of collaboration in PISA 2015.

■ Despite of the growing awareness on the potential negative effects of wealth inequality on education outcomes, the vast majority of studies rely on society level measures of inequality, which offer only a partial view on disparities experienced by students. In particular, inequality inside schools and, especially that between schools, have been shown to have negative effects on educational outcomes.

■ Recent studies regarding the role of personality on collaborative problem-solving performance found that openness and agreeableness tend to have positive effects.

These results lead to the following recommendations:

■ There is solid evidence in favour of developing teaching approaches that enhance levels of conscientiousness and self-regulation, with a focus on vulnerable categories of students. Interventions such as Perry Preschool programme, in which participants were taught social skills in a daily "plan-do-review" sequence and also learned to work with others when problems arose (Heckman & al 2013), as well as Career Academies and European apprenticeship programmes, which expose students to career-oriented activities, including job shadowing, career fairs, job search workshops, resume preparation, and work together in teams (Kemple and Willner 2008), were shown to have long lasting positive effects.

■ The interpretation of the results of international large-scale assessments should aim to take into account the contributions of each of the cognitive and non-cognitive components to the individual scores, as well as existing knowledge about what components can be shaped by school education, to what extent and when.

■ When explaining changes of the mean scores between waves of assessment in a particular country, the focus should be on (1) policy changes that might have affected cognitive skills during the early childhood of the respondents, as well as on (2) policy changes with potential effects on non-cognitive skills, which took place over the entire life time of the respondents.

■ The existing findings suggest that raising education levels and fostering civics and citizenship education are effective measures to promote generalized trust.

■ Since exposure to cultural and socio-economic diversity in school is likely to have a negative effect on generalized trust, it is important that teaching approaches that have the potential to alleviate these effects are developed and adopted.

■ Policies that address growing inequality and polarisation in most societies are expected to alleviate or even reverse the erosion of generalized trust, which in turn would have a positive effect on collaboration

■ It is important to develop and use better measures of wealth inequality, including measures of inequality inside schools, of inequality experienced by students in their communities and their societies.

■ Given the relatively immature state of existing explanations for the development of generalized trust within the school setting, further theoretical development, better behavioural measures of generalized trust, better measurement of school context and teaching interventions, and a move towards employing research designs with greater leverage for drawing causal inference, are warranted.

■ Behavioural measures of trust should take into account the key structural variables that were found to affect the likelihood of cooperative behavior, including the number of participants involved, the types of benefits, the heterogeneity of participants, face-to face communication, the shape of productive function, and how individuals are linked.

■ Although evidence is still limited, it seems likely that students would benefit from teaching approaches that aim to enhance openness and agreeableness. Grading methods have been shown to influence these two personality dimensions, along with neuroticism, and therefore it should receive utmost attention.

Despite the wide agreement that it is important to cultivate collaborative skills among students, there are serious challenges in effectively assessing and teaching these skills. One problem is the lack of consensus on how to operationalize CPS and how to measure it effectively. Throughout the CPS literature, there have been a large variety of proposed instruments, with different strengths and weaknesses in terms of validity and reliability. The main findings from the literature regarding the CPS instruments are the following:

■ Human-to-agent approaches (H-A), as applied in PISA 2015, have the advantage of offering standardized assessment conditions, which are especially crucial for student comparisons on the individual level and for conducting quantitative studies on large samples. However, such conditions are likely to suffer from the artificial setting in which interaction takes place.

■ Human-to-human (H-H) approaches, such as ATC21S, provide better representations of natural collaboration. However, they lack controllability, and the H-H logfiles with natural speech information are too complex to analyze in large-scale assessments.

■ Although CPS instrument used in PISA 2015 aimed to measure both cognitive and non-cognitive aspects of collaboration, the strong correlations with science, mathematics and reading instruments at individual and society level suggest that cognitive component is highly dominant at the expense of the social (non-cognitive) component.

■ Many of the adolescent programmes that focus on developing skills were shown to be only successful in the short run although the short-term results appeared often to be spectacular (Kautz, Heckman, Diris, Weel and Borghans 2014). It is not clear if interventions aiming to enhance collaborative skills could be exceptions, since there is no solid evidence to confirm their long-term effects.

The ensuing implications are the following:

■ There is a need to develop new CPS instruments that build on the strengths of PISA 2015, ATC21S, as well as other H-A and H-H approaches. One direction is to include voice communication with avatars. Another one is to create better representations of natural collaboration and to use natural language processing (NLP). It is important that future instruments will be designed in order to capture the non-cognitive component of the collaboration skills with greater precision than the current ones.

■ Long-term evaluations of early childhood programmes and interventions in school are required in order to assess their effectiveness.

The analyses conducted in this paper on what influences CPS scores in PISA 2015 data found that overall, the determinants of the non-cognitive component of collaboration differ to those of the cognitive one. The main findings of these analyses can be summarized as follows:

■ The students who were born in a different country than the one of testing, as well as students speaking a minority language, received similar CPS scores with the rest of the students in the vast majority of societies, whereas students with low ESCS values tend to be associated with low values of CPS scores in all countries.

■ The specific part of collaboration has fewer negative determinants among the four variables that measure minority status than the overall CPS measure. Even when statistically significant, the effects on CPS are much weaker than in the absence of control for Science.

■ The analyses on how parents' views on schools and education of their children are associated to CPS scores, based on 11 societies from four continents, found that students learning in schools where parents feel welcomed, as well as students in schools where parents who report that know by name many friends, tend to have higher CPS scores.

■ There is a long tradition of assessing the impact of diversity on cooperation and collaboration, and PISA 2015 data provides novel opportunities to extend testing to the school context. The analyses in this paper show that the effects of variables that measure diversity at the school level on students' CPS scores tend to be negative, but display very diverse configurations. The exposure to high proportions of students with low SES at the school level, as well as high proportions of students who report that speak a minority language, tend to diminish collaborative skills among students in most countries. In contrast with these results, the effects of diversity measures on the non-cognitive part of CPS are more often positive than negative: ESCS diversity, proportion of students with migration background and proportion of students having migrant parents have higher proportions of positive effects, whereas the other four variables have close to even proportions between positive and negative effects.

■ Developing collaborative skills in school is a goal by itself, but also a mean for making a positive learning environment. The analyses in the previous section showed that a school that is collaborative tends to have a positive effect on CPS scores of students, even when controlling for the effect of Science score and Science scores of the school, in the vast majority of countries. Moreover, in all countries but eight the effect of the collaborative school environment on individual non-cognitive component of CPS is greater among poor students than among others. Similarly, collaborative school environment has a positive and statistically significant effect on Science scores of students, even when controlling for the effect of CPS score, in almost all countries, as well as positive effects on students' attitudes toward school.

These findings on PISA 2015 lead to the following recommendations:

■ There is a need to develop teaching approaches based on increased awareness on the benefits of collaboration, along with new knowledge about how to assess and how to develop CPS in students. At the same time, there is a risk that increased focus on collaboration will create a new type of gap between disadvantaged groups and the rest, similar to the existing ones regarding the standard types of achievement. Therefore, the new interventions should be designed as inclusive as possible. Educational systems in countries where the non-cognitive component of CPS among disadvantaged groups are higher than those of the majority, such as Colombia, Luxembourg, Mexico and the UK for students with migrant background, and Japan for students with low ESCS, should be further investigated, and if the results hold, could be used to provide suggestions about policy changes elsewhere.

■ Since schools that cultivate good relationships with parents and between parents and students tend to be a resource for collaboration skills of the students, these types of practices should be encouraged more.

■ Given the limited evidence and divergent patterns between countries regarding the links between types of diversity and collaboration skills, further theoretical development, better measures of diversity within the school context, a better mapping of teaching interventions for accommodating diversity, and a move towards employing research designs with greater leverage for drawing causal inference, are warranted.

■ Given the importance of developing collaborative environment in school and the difficulty to create CPS instruments at individual level that are valid and reliable, it is worth to attempt designing instruments for measuring CPS at the class and school level.

It is surprising that the non-cognitive component of a skill that has been shown to have significant payoff over the lifetime it is so uniformly distributed across disadvantaged and non-disadvantaged groups. Moreover, collaborative skills have been found to be positively correlated with generalized trust, which tends to be more prevalent among youth with high socio-economic status and no immigration background. One possible explanation could be that teaching that places emphasis on creating skills that result in high scores in mathematics, science and reading, tends to be less efficient on developing pro-social abilities. It is also possible that some of the students who struggle in cognitive subjects are more interested in activities in physical education class, which require individuals to work together in groups to achieve a common goal. Indeed, data do show that students who attend physical education class once or twice per week score highest in collaborative problem solving, and that after accounting for performance in the three core PISA subjects, students who attend between zero and three days of physical education class per week score similarly, and score above students who attend four or more days per week (OECD 2015 p.165). However, there is wide variation across countries in what is emphasised in physical education class (European Commission/EACEA/Eurydice, 2013) and, unfortunately, cross-sectional data from PISA cannot indicate which approach is more effective at developing collaboration skills.

At the same time, we cannot exclude the possibility that PISA 2015 CPS instrument does not capture some of the relevant collaborative abilities, which would have uneven distributions across various categories of students.

The resultant recommendations are the following:

■ There is a need to assess to what extent the non-cognitive components of CPS instruments take into account generalized trust and norms of reciprocity, and to adjust them if necessary.

■ The existing findings suggest that certain school activities, including physical education, apprenticeships and traineeships, have significant potential to foster collaborative skills, whereas cognitive subjects can have the opposite effects. Given the limited evidence and divergent patterns between countries regarding these links, a better mapping of teaching interventions that encourage and discourage pro social attitudes and norms, and a move towards employing research designs with greater leverage for drawing causal inference, are necessary.

CONCLUSIONS

One of the memorable maxims credited to Albert Einstein, that “not everything that counts can be counted, and not everything that can be counted counts.”, is almost certain misattributed. Instead, the most likely source is William Bruce Cameron, who in his 1963 text “Informal Sociology: A Casual Introduction to Sociological Thinking” wrote the following passage:

> “It would be nice if all of the data which sociologists require could be enumerated because then we could run them through IBM machines and draw charts as the economists do. However, not everything that can be counted counts, and not everything that counts can be counted.”

The analyses in this paper argue that collaboration skills count and deserve to be considered as one of the key educational outcomes. One important consequence is that any definition of inclusive education that does not recognize the importance of collaborative relationships

among students with and without disabilities, with diverse socio-economic and cultural background, is incomplete. This paper also evaluates the extent to which collaboration skills can be counted. The conclusions can be summarized as follows:

■ The predictive power of non-cognitive skills exceeds that of cognitive skills for many important outcomes. In addition, non-cognitive skills and academic achievement can have positive reciprocal relationships at both individual and group level. Therefore, investment in non-cognitive skills can enhance both types of skills.

■ Collaborative problem solving (CPS) skills are a mixture of cognitive and non-cognitive skills that play an important role in initiating and sustaining cooperation and collaboration.

■ There is ample evidence showing that generalized trust is one of the key attributes, both at individual and contextual level, that promote collaboration. In addition, openness and agreeableness tend to have positive effects on CPS.

■ Raising education levels and fostering civics and citizenship education are effective measures to promote generalized trust. Since exposure to cultural and socio-economic diversity in school is likely to have a negative effect on generalized trust, it is important that teaching approaches that have the potential to alleviate these effects are developed and adopted.

■ Policies that address growing inequality and polarisation in most societies are expected to ease or even reverse the erosion of generalized trust, which in turn would have a positive effect on collaboration.

■ Although CPS instrument used in PISA 2015 aimed to measure both cognitive and non-cognitive aspects of collaboration, the strong correlations with science, mathematics and reading instruments at individual and society level suggest that the cognitive component is highly dominant at the expense of the non-cognitive component. It is also unclear if its non-cognitive component includes generalized trust and norms of reciprocity. Therefore, there is a need to develop new CPS instruments that are able to capture the non-cognitive component of the collaboration skills with greater precision than the current ones.

■ The students who were born in a different country than the one of testing, as well as students speaking a minority language, received similar CPS scores with the rest of the students in the vast majority of societies, whereas students with low ESCS values tend to be associated with low values of CPS scores in all countries. At the same time, the non-cognitive collaboration skills have fewer negative determinants among the variables that measure minority status than the cognitive collaboration skills.

■ There is a need to develop teaching approaches based on increased awareness on the benefits of collaboration, along with new knowledge about how to assess and how to develop CPS skills. The new interventions should be designed as inclusive as possible.

■ Schools that cultivate good relationships with parents and between parents and students tend to be a resource for collaboration skills of the students.

■ Developing collaborative skills in school is not only a goal, but also an effective mean for making a positive learning environment. Given the importance of developing collaborative environment in school and the difficulty to create CPS instruments at individual level that are valid and reliable, it is worth to attempt designing instruments for measuring CPS at the class and school level.

■ There is wide variation across countries in what are the effects of membership and exposure to vulnerable categories on collaboration skills, both cognitive and social, and, unfortunately, cross-sectional data from PISA cannot give clear indication on which policies and teaching approaches are more effective at alleviating negative outcomes. Given the limited evidence

and divergent patterns between countries regarding these links, a better mapping of teaching interventions that encourage pro social attitudes and norms among vulnerable students, and a move towards employing research designs with greater leverage for drawing causal inference, are necessary.

BIBLIOGRAPHY

Allen, D. & Fraser, B.J. 2007. Parent and student perceptions of classroom learning environment and its association with student outcomes. *Learning Environ Res*. (2007) 10: 67. https://doi.org/10.1007/s10984-007-9018-z

Allen, Debra & Fraser, Barry J. 2007. Parent and student perceptions of classroom learning environment and its association with student outcomes, *Learning Environ Res*, 10: 67.

Banderia, Oriana, Iwan Barankey, and Imran Rasul. 2005. Cooperation in collective action. *Economics of Transition* 13(3): 473-498.

Bourguignon, François. 2015. *The Globalization of Inequality*. Princeton: Princeton University Press.

Coleman, J. 1994. *Foundations of social theory*. Cambridge, Mass.: Belknap Press of Harvard University Press

Colquitt, Jason A., Brent A. Scott, Jeffrey A. LePine. 2007. Trust, trustworthiness, and trust propensity: a meta-analytic test of their unique relationships with risk taking and job performance. *Journal of Applied Psychology* 92 (4), 909-927.

Dal Bó, Pedro, Andrew Foster, and Louis Putterman. 2010. Institutions and Behavior: Experimental Evidence on the Effects of Democracy. *American Economic Review*, 100 (5): 2205-2229.

Damian, Rodica Ioana, Su, R., Shanahan, M, Trautwein, U, Roberts, W. 2015. Can personality traits and intelligence compensate for background disadvantage? Predicting status attainment in adulthood. *Journal of personality and social psychology.* vol. 109,3 (2015): 473-89. doi: 10.1037/pspp0000024

Davier, Matthias von, Eugenio J. Gonzalez, and Dirk Hastedt. 2009. What are plausible values and why are they useful? In Davier, Matthias von and Dirk Hastedt (eds.) *IERI Monograph Series: Issues and Methodologies in Large-Scale Assessments: Volume 2*: 9-36.

Dewey, John. 1916. *Democracy and Education: An Introduction to the Philosophy of Education*. New York: Macmillan.

Dinesen, Peter T. and Kim M. Sønderskov. 2012. Trust in a time of increasing diversity: on the relationship between ethnic heterogeneity and generalized trust in Denmark from 1979 until today. *Scandinavian Political Studies* 35 (4): 273-294.

Fuje, H. and Tandon, P. 2018. When Do In-Service Teacher Training and Books Improve Student Achievement? Experimental Evidence from Mongolia (August 2018). *Review of Development Economics*, Vol. 22, Issue 3, pp. 1360-1383, 2018. Available at SSRN: https://ssrn.com/abstract=3240116

Fukuyama, Francis. 1995. Trust: The Social Virtues and the Creation of Prosperity. New York: Free Press.

Granovetter, Mark. 1973. The strength of weak ties. American Journal of Sociology, 78:1360-80.

Heckman, J. J., R. Pinto, and P. A. Savelyev. 2013. Understanding the mechanisms through which an influential early childhood program boosted adult outcomes. American Economic Review 103 (6), 1–35.

Herborn, K, Stadler, M., Mustafić, M, Greiff, S. 2018. The assessment of collaborative problem solving in PISA 2015: Can computer agents replace humans? *Computers in Human Behavior*. Available online 24 July 2018, In Press, Corrected Proof

Kemple, J. and C. Willner. 2008. Career Academies: long-term impacts on labour market outcomes, educational attainment, and transitions to adulthood. Report 06/2008, MDRC.

Keohane, Robert and Elinor Ostrom, eds. 1995. Local Commons and Global Interdependence: Heterogeneity and Cooperation in Two Domains. London: Sage.

Kreiner, Svend and Karl Bang Christiansen. 2014. Analyses of model fit and robustness. A new look at the PISA scaling model underlying ranking of countries according to reading literacy, *Psychometrica* 79(2): 210-31.

Lichback, Mark. 1995. The Rebel's Dilemma. Ann Arbor: University of Michigan Press.

Lichback, Mark. 1996. The Cooperator's Dilemma. Ann Arbor: University of Michigan Press.

Mudde, Cas. 2013. Three decades of populist radical right parties in Western Europe: So what? European Journal of Political Research 52(1): 1-19.

Negru-Subtirica, Oana, Eleonora Ioana Pop, Elisabetta Crocetti, Wim Meeus. 2019. Social comparison at school: Can GPA and personality mutually influence each other across time? Journal of Personality. doi:10.1111/jopy.12510

OECD. 2017a. *PISA 2015 Results (Volume III): Students' Well-Being*, PISA, OECD Publishing: Paris. http://dx.doi.org/10.1787/9789264273856-en

OECD. 2017b. *PISA 2015 Results (Volume V): Collaborative Problem Solving*, PISA, OECD Publishing: Paris. http://dx.doi.org/10.1787/9789264285521-en

Olson, Mancur. 1965. The Logic of Collective Action: Public Goods and the Theory of Groups. Cambridge, Mass.: Harvard University Press.

Ostrom, Elinor. 1998. A behavioral approach to the rational choice theory of collective action. American Political Science Review, 92 (1): 1–22.

Ostrom, Elinor. 2009. Collective Action Theory. in Carles Boix and Susan C. Stokes (eds.) The Oxford Handbook of Comparative Politics. Oxford University Press

Piketty, Thomas. 2015. *About Capital in the Twenty-First Century*. *American Economic Review*, 105 (5): 48-53.

Schroeder, J., Kardas, M., & Epley, N. 2017. The humanizing voice: Speech reveals, and text conceals, a more thoughtful mind in the midst of disagreement. *Psychological Science*, 28, 1745-1762.

Shapiro, Susan P. 1987. The social control of interpersonal trust. American Journal of Sociology 93(3): 623-658.

Sirin, Selcuk R. 2005. Socio-economic status and academic achievement: A meta-analytic review of research, *Review of Educational Research* 75(3): 417-453.

Sum, Paul, Bădescu, Gabriel, 2018. Does inequality erode cooperation in the classroom? Evidence from PISA 2015. Center for the Study of Democracy Working Paper Series. May 2018

Tim Kautz & James J. Heckman & Ron Diris & Bas ter Weel & Lex Borghans. 2014. Fostering and Measuring Skills: Improving Cognitive and Non-cognitive Skills to Promote Lifetime Success, *OECD Education Working Papers 110*, OECD Publishing.

UNESCO. 2016. Implementation of Standard-Setting Instruments: Part I – General Monitoring. Paris, UNESCO.

UNESCO. 2018. Concept note for the 2020 Global Education Monitoring Report on inclusion

United Nations, Department of Economic and Social Affairs. Population Division. 2019. International Migrant Stock 2019 (United Nations database, POP/DB/MIG/Stock/Rev.2019).

Uslaner, E. 2012. *Segregation and Mistrust: Diversity, Isolation, and Social Cohesion*. Cambridge: Cambridge University Press. doi:10.1017/CBO9781139026758

Uslaner, Eric M. 2002. *The Moral Foundations of Trust*. Cambridge: Cambridge University Press