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The Usefulness of PISA Data for Policy Makers, Researchers and Experts on Methodology

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PISA – AN OVERVIEW

Are students well prepared to meet the challenges of the future? Are they able to analyse, reason and communicate their ideas effectively? Have they found the kinds of interests they can pursue throughout their lives as productive members of the economy and society? The OECD Programme for International Student Assessment (PISA) seeks to provide some answers to these questions through its surveys of key competencies of 15-year-old students. PISA surveys are administered every three years in OECD member countries and a group of partner countries, which together make up close to 90% of the world economy.[1]

PISA assesses the extent to which students near the end of compulsory education have acquired some of the knowledge and skills that are essential for full participation in society. It focuses on student competencies in the key subject areas of reading, mathematics and science. PISA seeks to assess not merely whether students can reproduce what they have learned, but also to examine how well they can extrapolate from what they have learned and apply their knowledge in novel settings, both in school and non-school contexts.

The PISA surveys

PISA focuses on young people's ability to use their knowledge and skills to meet real-life challenges. This orientation reflects a change in the goals and objectives of curricula themselves, which are increasingly concerned with what students can do with what they learn and not merely with whether they have mastered specific curricular content.

Key features driving the development of PISA have been its:

- policy orientation, which connects data on student-learning outcomes with data on students' characteristics and on key factors shaping their learning in and out of school in order to draw attention to differences in performance patterns, and to identify the characteristics of schools and education systems that have high performance standards;
- innovative "literacy" concept, which is concerned with the capacity of students to apply knowledge and skills in key subject areas and to analyse, reason and communicate effectively as they pose, solve and interpret problems in a variety of situations;
- relevance to lifelong learning, which does not limit PISA to assessing students' curricular and cross-curricular competencies, but also asks them to report on their own motivation to learn, their beliefs about themselves, and their learning strategies;
- regularity, which enables countries to monitor their progress in meeting key learning objectives;
- breadth of geographical coverage and collaborative nature, which in PISA 2006 encompasses the 30 OECD member countries and 27 partner countries and economies.

The relevance of the knowledge and skills measured by PISA is confirmed by recent studies tracking young people in the years after they have been assessed by PISA. Studies in Australia, Canada and Denmark display a strong relationship between the performance in reading on the PISA 2000 assessment at age 15 and the chance of a student completing secondary school and of carrying on with post-secondary studies at age 19. For example, Canadian students who had achieved reading proficiency Level 5 at age 15 were 16 times more likely to be enrolled in post-secondary studies when they were 19-years-old than those who had not reached the reading proficiency Level 1 (Knighton and Bussiere, 2006).[2]

PISA is the most comprehensive and rigorous international programme to assess student performance and to collect data on the student, family and institutional factors that can help to explain differences in performance. Decisions about the scope and nature of the assessments and the background information to be collected

are made by leading experts in participating countries, and are steered jointly by governments on the basis of shared, policy-driven interests. Substantial efforts and resources are devoted to achieving cultural and linguistic breadth and balance in the assessment materials. Stringent quality assurance mechanisms are applied in translation, sampling and data collection. Consequently, the results of PISA have a high degree of validity and reliability, and can significantly improve understanding of the outcomes of education in the world's most economically developed countries, as well as in a growing number of countries at earlier stages of economic development.

Although PISA was originally created by the governments of OECD countries, it has now become a major assessment tool in regions around the world. The first PISA survey was conducted in 2000 in 28 OECD countries and 4 partner countries, using written tasks answered in schools under independently supervised test conditions following consistently applied standards. Another 11 partner countries participated in the same survey in late 2001 or early 2002. The second survey was conducted in 2003 in 30 OECD countries and 11 partner countries/economies and in 2006 the third survey included 30 OECD countries and 27 partner countries/economies. In 2009, PISA will be carried out in 30 OECD countries and 37 partner countries/economies. Table 1.1 provides the list of participating countries/economies where PISA 2000, PISA 2003 and PISA 2006 have been conducted and PISA 2009 is planned.

Table 1.1
Participating countries/economies in PISA 2000, PISA 2003, PISA 2006 and PISA 2009

	OECD countries	Partner countries
PISA 2000	Australia; Austria; Belgium; Canada; Czech Republic; Denmark; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Japan; Korea; Luxembourg; Mexico; Netherlands;[a] New Zealand; Norway; Poland; Portugal; Spain; Sweden; Switzerland; United Kingdom; United States	Albania; Argentina; Brazil; Bulgaria; Chile; Hong Kong-China; Indonesia; Israel; Latvia; Liechtenstein; Macedonia; Peru; Romania; Russian Federation; Thailand
PISA 2003	Australia; Austria; Belgium; Canada; Czech Republic; Denmark; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Japan; Korea; Luxembourg; Mexico; Netherlands; New Zealand; Norway; Poland; Portugal; Slovak Republic; Spain; Sweden; Switzerland; Turkey; United Kingdom;[b] United States	Brazil; Hong Kong-China; Indonesia; Liechtenstein; Latvia; Macao-China; Russian Federation; Thailand; Tunisia; Uruguay; Serbia[c]
PISA 2006	Australia; Austria; Belgium; Canada; Czech Republic; Denmark; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Japan; Korea; Luxembourg; Mexico; Netherlands; New Zealand; Norway; Poland; Portugal; Slovak Republic; Spain; Sweden; Switzerland; Turkey; United Kingdom; United States[d]	Argentina; Azerbaijan; Brazil; Bulgaria; Chile; Colombia; Croatia; Estonia; Hong Kong-China; Indonesia; Israel; Jordan; Kyrgyzstan; Latvia; Lithuania; Macao-China; Republic of Montenegro; Qatar; Romania; Russian Federation; Republic of Serbia; Slovenia; Chinese Taipei; Thailand; Tunisia; Uruguay
PISA 2009	Australia; Austria; Belgium; Canada; Czech Republic; Denmark; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Japan; Korea; Luxembourg; Mexico; Netherlands; New Zealand; Norway; Poland; Portugal; Slovak Republic; Spain; Sweden; Switzerland; Turkey; United Kingdom; United States	Albania; Argentina; Azerbaijan; Brazil; Bulgaria; Chile; Colombia; Croatia; Dominican Republic; Dubai (UAE); Estonia; Hong Kong-China; Indonesia; Israel; Jordan; Kazakhstan; Kyrgyzstan; Latvia; Liechtenstein; Lithuania; Macao-China; Republic of Moldova; Republic of Montenegro; Panama; Peru; Qatar; Romania; Russian Federation; Republic of Serbia; Shanghai-China; Singapore; Slovenia; Chinese Taipei; Thailand; Trinidad and Tobago; Tunisia; Uruguay

a. Response rate is too low to ensure comparability. See Annex 3 in OECD (2003), *Literacy Skills for the World of Tomorrow – Further Results from PISA 2000,* OECD, Paris.

b. Response rate is too low to ensure comparability. See Annex 3 in OECD (2004), *Learning for Tomorrow's World – First Results from PISA 2003,* OECD, Paris.

c. For the country Serbia and Montenegro, data for Montenegro are not available in PISA 2003. The latter accounts for 7.9% of the national population. The name "Serbia" is used as a shorthand for the Serbian part of Serbia and Montenegro.

d. Reading results are not available in PISA 2006. See Chapter 6 in OECD (2007), *PISA 2006 – Science Competencies for Tomorrow's World,* OECD, Paris.

Together with the PISA 2000 and PISA 2003 surveys, PISA 2006 completes the first cycle of assessment in the three major subject areas – reading, mathematics and science. PISA is now conducting a second cycle of surveys, beginning in 2009 with reading as the major subject and continuing in 2012 (mathematics) and 2015 (science).

Table 1.2
Assessment domains covered by PISA 2000, PISA 2003 and PISA 2006

	Major domain	Minor domains
PISA 2000	Reading literacy	Mathematical literacy Scientific literacy
PISA 2003	Mathematical literacy	Reading literacy Scientific literacy Problem solving
PISA 2006	Scientific literacy	Mathematical literacy Reading literacy

PISA defines the assessment major domains as follows:

- **Reading literacy**: An individual's capacity to understand, use and reflect on written texts, in order to achieve one's goals, to develop one's knowledge, and potential and to participate in society.
- **Mathematical literacy**: An individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgements and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen.
- **Scientific literacy**: An individual's scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science-related issues, understanding of the characteristic features of science as a form of human knowledge and enquiry, awareness of how science and technology shape our material, intellectual, and cultural environments, and willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen.

Across the world, policy makers are using PISA findings to: gauge the knowledge and skills of students in their own country in comparison with those of other participating countries; establish benchmarks for educational improvement, for example, in terms of the mean scores achieved by other countries or their capacity to provide high levels of equity in educational outcomes and opportunities; and understand relative strengths and weaknesses of their education systems. The interest in PISA is illustrated by the many reports produced in participating countries,[3] the numerous references to PISA results in public debates and the intense media attention shown to PISA throughout the world.

HOW CAN PISA CONTRIBUTE TO EDUCATIONAL POLICY, PRACTICE AND RESEARCH?

PISA does not necessarily answer all questions asked by policy makers, educators or educational researchers. In particular, the following aspects need to be considered, both in terms of restrictions and of potentialities related to the study design:

- PISA is measuring "knowledge and skills" for life and does not have a strong "curricular" focus. This limits the extent to which the study will be able to explore relationships between differences in achievement and differences in the intended or implemented curricula. On the other hand, special consideration is given to the out-of-school factors with a potential of enhancing cognitive and affective learning outcomes.
- PISA students are randomly sampled within schools, not from intact classrooms or courses and therefore come from different learning environments with different teachers and, possibly, different levels of instruction. Consequently, classroom-level variables, including teacher-level variables, can only be collected either at the individual student level or at the school level. PISA does not therefore automatically provide specific recommendations on how teachers should teach.

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- PISA uses an age-based definition of the target population. This is particularly appropriate for a yield-oriented study, and provides a basis for in-depth exploration of important policy issues, such as the effects of a number of structural characteristics of educational systems (*e.g.* the use of "comprehensive" versus "tracked" study programmes, or the use of grade repetition). On the other hand, the inclusion in the study of an increasing number of non-OECD countries (where the enrolment rate for the 15-year-old age group is maybe less than 100%) requires that a proportion of 15-year-olds still in school be taken into account in the analysis of between-countries differences.

Further, educational issues or challenges highly depend on economical and societal contexts; therefore, what is relevant for one country might be totally irrelevant for another country. As contextual questionnaires have a limited length, testing constraints require making choices in the data that will be collected.

Finally, PISA data do not prove causal relationships. Implementing a pedagogical practice or structure in a country based on the observed outcomes in other countries where these practices or structures exist does not guarantee the success of a given reform. Educational systems largely differ and even if some characteristics seem to be associated with higher performance, PISA does not look at the details of policies and practices within schools at a micro level, and therefore cannot describe how these educational features interact.

However, as PISA is designed to provide schools, local communities and countries with an opportunity to identify their own strengths and weaknesses, a large set of pointers can be identified and communicated to policy makers. Through the additional collection of information on students and their educational environments, PISA allows the identification of social, cultural, economic and educational factors that are associated with student performance. Using the data from questionnaires, analyses linking contextual information with student outcomes allows PISA to address differences:

- between countries in the relationships between student level factors (such as gender and socio-economic background) and outcomes;
- across countries in the relationships between school level factors and outcomes;
- in the proportion of variation in outcomes between (rather than within) schools, and differences in this value across countries;
- between countries in the extent to which schools moderate or increase the effects of individual-level student factors and student outcomes;
- in educational systems and national contexts that are related to differences in student outcomes across countries;
- in any or all of these relationships over time.

The OECD has largely been analysing the results of the first three cycles of PISA and their implications for policy makers. The most important key findings are summarised in the next section.

Key results from PISA 2000, PISA 2003 and PISA 2006

Differences between countries

At the education system level, PISA has and will continue to inform countries on their average performance and more importantly, how this performance evolves over time. The PISA initial reports (OECD, 2001, 2004, 2007) show that among OECD countries, only 10% to 15% of the variation in student performance lies between countries. These results may suggest that the major issue is located within countries. However, country differences in performance should not be underestimated. The expected growth in student performance for one year of schooling is usually estimated at about 0.30 standard deviation. For instance, the difference between

the averages of lower grade and upper grade in the Third International Mathematic and Science Study is equal to 0.29 standard deviation (Beaton *et al.*, 1996). In this context, more than two years of schooling separate the top performing OECD countries and the bottom performing OECD countries. Obviously, this difference is large enough for investigating factors that may be associated with higher performance at the country level. A few major features can be identified from the first three data collections of PISA:

- **High performing countries in one domain tend to perform well in other domains**. The correlations between domains at the country level are all above 0.90. Top performing countries in one domain are also among top performing countries in the other domains and the reverse. This result may reflect high or low demanding curricula across domains but may also reflect the effect of economical background, such as gross domestic product (GDP) or the influence of educational structures.
- **Differences in pattern of results according to how students are admitted to schools, grouped across schools and grouped within schools**. In schools systems where students are divided into different school groups at relatively early ages, the socio-economic differences in performance by age 15 are relatively large through school composition effects, while the average level of performance is not higher compared to comprehensive education systems. This is likely one of the most important clear-cut finding of PISA: differentiation at an early age damages equity without any discernible benefit for quality. Equity and quality are not incompatible aims. This result is even reinforced by the longitudinal profile of Poland. In 1999, Poland implemented a massive reform of the schooling system, which now provides a more integrated educational system. Between 2000 and 2003, Poland succeeded in raising the average performance of 15-year-olds for the three domains assessed by PISA. A more detailed analysis also showed that this improvement is mainly attributable to an increase at the lower end of the distribution.
- **Higher performance in schools that keep track of student performance at a public level**. Performance standards can only be maintained if they are consistently implemented and assessed. Different countries use various forms of external assessment, external evaluation or inspection, and schools' own quality assurance and self-evaluation efforts. While there is no single model that best supports school improvement, higher performing countries in PISA have been putting increased emphasis on the monitoring of their schooling systems.
- **Higher performance in countries giving more autonomy to schools to formulate the school budget and to decide on budget allocations within the school even after accounting for other school and system level factors as well as demographic and socio-economic factors**. Similarly, students in educational systems that give more autonomy to schools in educational matters such as textbooks and courses offered, tend to perform better, but this effect is not significant after accounting for some other school and system level factors.

Differences between schools within countries

PISA 2000, PISA 2003 and PISA 2006 showed that the percentage of variation in student performance between schools varies greatly from one country to another. On average, at the OECD level, about 30% of this variation lies between schools. However, northern European countries consistently present across cycle percentages below 20% while in some countries like Belgium, Germany and Austria, more than 50% of variation in student performance lies between schools. A few factors that correlate with school performance have been isolated:

- **The school social intake is the strongest single factor associated with school performance**. It is not just the characteristics of an individual's family but also the characteristics of the families of other students in the school that are closely associated with how well students in the school performed in PISA. On average, students who attend schools with a more advantaged "social profile" are likely to show considerable

higher levels of performance than those attending less advantaged schools. This effect, usually denoted as the "school composition effect" in literature, tends to be higher in countries that differentiate students into various groups or tracks at an early age.

- **Higher performance is found in privately funded schools and in schools that compete for students, but there is no statistically significant effect in either case once the combined effect of individual student socio-economic background and the average socio-economic background of all students in the school are taken into account**. The performance of private schools does not tend to be higher once demographic and socio-economic factors have been taken into account.
- **A modest relationship exists between certain aspects of school resources and student outcomes**. However, much of this relationship disappears when the socio-economic status of the students is accounted for, thus suggesting that there is dependence between school resources and student socio-economic characteristics, *i.e.* students from high socio-economic backgrounds are attending schools with better educational resources.
- **Ability grouping for all subjects within schools appears to have a small negative effect**. Schools which tend to avoid grouping students by ability tend to perform better.
- **The atmosphere created by students and teachers has measurable positive effects**. The PISA results underline the particular importance of school climate as a factor affecting school performance. Its effect is more discernible than the level of school resources. However, school climate also correlates with student background characteristics, showing that the schools with better learning climates are generally attended by students from high socio-economic backgrounds.

Differences between students

Among the numerous relationships identified by PISA at the student level, the findings which are most relevant to policies are:

- **Overall, socio-economic difference is the strongest single factor associated with performance in PISA, accounting for about a fifth of all variation in student scores**.
- **The level of students' engagement at school and in a particular domain is related to educational outcomes**. For instance, those who are habitual readers and who enjoy reading are more likely than others to have high levels of reading literacy. Greater engagement in reading can be a consequence, as well as a cause. A student's overall engagement at school is also a key factor in secondary education. PISA also showed that schools where students perform poorly overall have a tendency to be those where students become disengaged.
- **There are strong relationships between students' attitudes, learning strategies and performance**. The evidence from PISA suggests that students who are more self-confident and highly motivated do better at school largely because they are more inclined to invest in learning strategies that work. These findings suggest that strategies to improve teaching and learning techniques need to do more than just offer students a learning toolkit. Students will only use learning tools if they feel motivated and believe in their capacity to learn.

FURTHER ANALYSES OF PISA DATASETS

As shown by these key findings, PISA offers an inexhaustible source of information for analysing educational issues, and testing hypotheses or educational models that can be translated into policy implications. Even if the initial three PISA and subsequent thematic reports made an extensive use of the PISA data, there are many other possible analyses that may have policy implications.

A substantial amount of variables collected at the student, parent and school levels by PISA are still underused. For example, one of the education issues that significantly interests policy makers and educators is the issue of student's homework. What is the relationship between performance and time spent on homework? Is this relationship consistent across educational systems or does it vary from one system to another? Are there any characteristics of the educational system that relate to the strength of the relationship between homework and performance? To what extent does this relationship interact with student family background and school characteristics? The next section will present a grid that organises contextual variables collected by the PISA surveys and that shows the breadth of information that can address relevant policy issues.

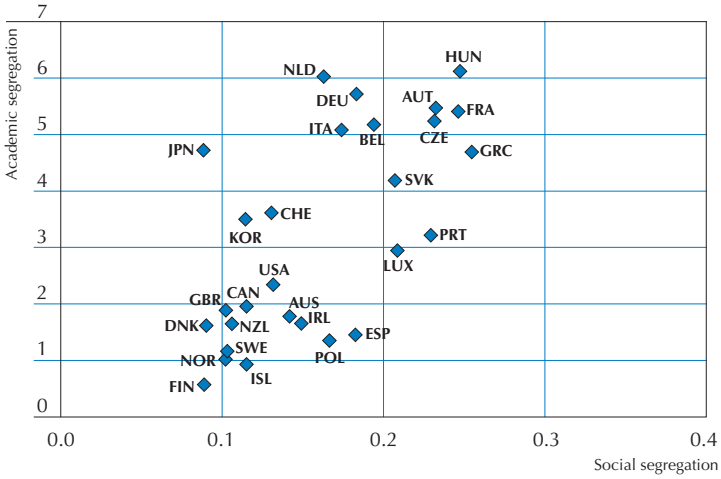
Some other variables, largely used in the OECD initial and thematic reports, also deserve further investigation, to gain a deeper understanding of how these variables are related to performance. Indeed, PISA has identified hundreds of relationships between students, schools and, to a lesser extent, country characteristics and performance. It also showed substantial country variability in the strength of these relationships, but such variation has not yet been fully examined. These data should be scrutinised in relation to the structure of educational systems. Our understanding of how educational systems work will indisputably increase once the variability in relationships is at least partly explained. For instance, PISA 2003 measured several student attitudes such as self-perception, motivation and anxiety in mathematics. As shown in the OECD initial report (OECD, 2004), the strength of the relationship varies extensively from one country to another. While intrinsic motivation explains about 10% of the variation in student performance in mathematics in northern European countries, it only explains 0.4% of the variation in the Netherlands. Does this mean that intrinsic motivation does not matter in the Netherlands? Interestingly, standardising student performance and intrinsic motivation within schools and within grades will substantially raise their respective correlation. Obviously, intrinsic motivation matters in the Netherlands, as in all highly tracked systems. This example illustrates how the structure of educational systems may affect survey outcomes. Furthermore, why is the gender difference in intrinsic motivation the largest in German-speaking countries, *i.e.* Austria, Germany, Liechtenstein, Luxembourg and Switzerland? Is it simply a language-by-item interaction or does it represent a broader cultural effect mediated by teachers? There are obviously economical, cultural and/or geographical similarities between educational systems and these similarities should guide to some extent the analyses conducted to better understand the variation of the strength in the relationships between performance and contextual variables. A better understanding of these variations will facilitate the translation of results into policy recommendations.

Additionally, the increasing diversity of educational systems participating in PISA provides a unique opportunity to measure the relationship between the characteristics of the educational systems and their respective performances or equity in educational opportunity. Quality and equity should be investigated in conjunction as much as possible because they are intimately intertwined. As previously mentioned, the large-scale reform in Poland consisting of the implementation of a comprehensive system has considerably reduced inequities in student performance, while raising the overall quality in education.

Monseur and Lafontaine (2008) have shown that the relationship between academic segregation and social segregation is intertwined (Figure 1.1). Academic and social segregations reflect the importance of grouping practices into different schools according to social or academic criteria. In this example, the academic segregation index is measured by the intraclass correlation, *i.e.* the percentage of variance that lies between schools for student performance in science in PISA 2006 and social segregation is measured by the intraclass correlation for the international socio-economic index of occupational status (HISEI) in PISA 2006. Unfortunately, it is not possible to know whether social segregation is an antecedent or a consequence of academic segregation. For example, in countries with a substantial percentage of students

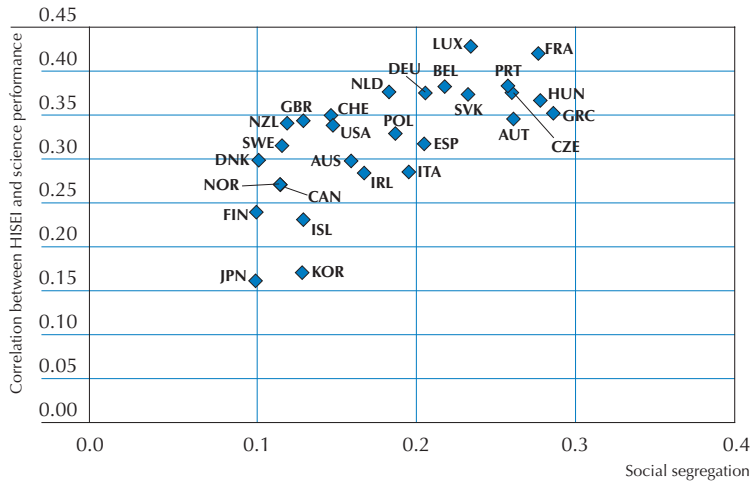
enrolled in private schools with admission fees, one might suspect that academic segregation is partly a consequence of social segregation. In other countries such as Belgium or Germany where students are grouped at an early age mainly by performance, social segregation may be a consequence of academic segregation.

Figure 1.1
Relationship between social and academic segregations



Social and academic segregations, largely mediated through differentiation, have substantial consequences on the equity of the education system. Figure 1.2 shows the relationship between social segregation and equity.

Figure 1.2
Relationship between social segregation and the correlation between science performance and student HISEI



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Countries in which students tend to be grouped according to their social background usually present a higher correlation between performance in science and family socio-economic background. The difference in the strength of the correlations is significant as they range from about 0.15 (Japan and Korea) to slightly less than 0.45 (France and Luxembourg). The structure of educational systems is, therefore, obviously associated with the extent to which students' socio-economic background determines their performance.

The relationship between segregation and social inequities is summarised in Table 1.3.

Table 1.3
Correlation between social inequities and segregations at schools for OECD countries

Difference in performance between the 25th percentile of the most disadvantaged students and the 25th percentile of the most advantaged students

	Reading literacy (PISA 2000)	Mathematical literacy (PISA 2003)	Scientific literacy (PISA 2006)
Academic segregation	0.33	0.66	0.44
Social segregation	0.44	0.47	0.52

Correlation between socio-economic background and performance

	Reading literacy (PISA 2000)	Mathematical literacy (PISA 2003)	Scientific literacy (PISA 2006)
Academic segregation	0.36	0.44	0.40
Social segregation	0.60	0.57	0.70

Source: Monseur, C. & Crahay, M. (in press). Composition académique et sociale des établissements, efficacité et inégalités scolaires: une comparaison internationale. Analyse secondaire des données PISA 2006. Revue française de pédagogie.

The more a country groups students according to their academic performances or socio-economic background, the bigger the difference of performance between the 25% most disadvantaged students and the 25% most advantaged students, and the higher the correlation between socio-economic background and performance. As already stated, this relationship between the structure of the educational system and its social inequities cannot be interpreted as a causal relationship. However, it would be worth analysing how the indicators of social inequities, and in particular the correlation between socio-economic background and performance, will evolve in Poland.

Table 1.3 also reveals the strength of the PISA study. The relationship between a student, a school or an educational system characteristics and its respective performance can be analysed across domains within a data collection or across data collections for one particular domain. This would allow establishing the relationship between commonness and distinctiveness.

Finally, PISA is an outstanding source of data for methodological experts in the context of trend indicators. How stable are these trend indicators? How sensitive are they to the methodological context of the surveys and to the content of the test? These are only a few examples of methodological issues that can be investigated with the PISA data.

Contextual framework of PISA 2006

This section describes the contextual framework of PISA 2006 in order to present the breadth of information collected by PISA that can address relevant policy issues. Figure 1.3 presents a conceptual framework for organising variables collected by the PISA surveys: at the student level (or parent level), at the school level, and at the educational system level through contextual questionnaires. This figure does not present any causal relationships. Figure 1.3 consists of two dimensions: four different levels and three different types (*e.g.* antecedents, processes and outcomes):

- **At the system level**, the macro-economic, social, cultural and political contexts set constraints for the educational policies in a particular country. Outcomes at the system level are not only aggregated learning outcomes but also equity-related outcomes.
- **At the level of the educational institution** (this includes out-of-school providers), characteristics of the educational provider and its community context are antecedents for the policies and practices at the institutional level as well as the school climate for learning. Outcomes at this level are aggregates of individual learning outcomes and also differences in learning outcomes between subgroups of students.
- **At the level of the instructional units**, characteristics of teachers and the classrooms/courses are antecedents for the instructional settings and the learning environment; learning outcomes are aggregated individual outcomes.
- **At the student level**, student characteristics (*e.g.* gender, age, grade) and background (*e.g.* socio-economic status, parental involvement, language spoken at home, peer effects) are antecedents for the individual learning process (*e.g.* perseverance, time on task) and learning outcomes both in cognition and attitude.

Figure 1.3
Conceptual grid of variable types

Antecedents	Processes	Outcomes
Level of the educational system		
Macro-economic, social, cultural and political context	Policies and organisation of education	Outcomes at the system level
Level of educational institutions		
Characteristics of educational institutions	Institutional policies and practice	Outcomes at the institutional level
Level of instructional units		
Characteristics of instructional units	Learning environment	Outcomes at the level of instructional units
Level of individual learners		
Student background and characteristics	Learning at the individual level	Individual learning outcomes

Hypotheses about (at least some of) the relationships between the elements in this two-dimensional grid can be derived from existing conceptual frameworks and subsequent research. Existing conceptual models typically assume antecedents to influence processes, which in turn produce learning outcomes, and conditions on higher levels are usually supposed to impact on those at lower levels.

Some models also expect that outcome variables have an effect on the learning process and thus, allow for a non-recursive relationship between learning process and learning outcomes. For example, positive or negative experiences with subject-matter learning can influence process variables such as habits and attitudes towards the learning of a subject, increase or decrease of the amount of time spent on homework, etc. Another example is long-term interest in a subject or domain, which can be the outcome of learning but can also affect the students' commitment to learning.

It also needs to be recognised that vertical or horizontal relationships may not be the only explanations for differences in learning outcomes. Antecedents at the school level, for example, are often influenced by process variables at the system level, such as educational policies. As another example, the possibility that the socio-cultural context (antecedent at the system level) might have an influence on instructional practices (process at the classroom level) can in turn lead to differences in student outcomes.

Figure 1.4

Two-dimensional matrix with examples of variables collected or available from other sources

	Antecedents	Processes	Outcomes
The education system as a whole	**Cell 1:** Macro-economic and demographic context *For example:* ▪ Gross Domestic Product ▪ Distribution of wealth (Gini index) ▪ Percentage of immigrants	**Cell 5:** Policies and organisation of education *For example:* ▪ Organisation of education (school autonomy, programme structure) ▪ Teacher qualifications and training requirements ▪ School entry age, retention	**Cell 9:** Outcomes at the level of the education system *For example:* ▪ System level aggregates of: reading, mathematical and scientific literacy ▪ Habits in relation to content domains ▪ Attitudinal outcomes ▪ Life skills and learning strategies ▪ Equity related outcomes
Educational institutions	**Cell 2:** Characteristics of educational institutions *For example:* ▪ The involvement of parents ▪ Social intake ▪ Source of funding, location and size ▪ Type of educational provider (*e.g.* out-of-school, educational media programme)	**Cell 6:** Institutional policies and practice *For example:* ▪ Instructional support including both material and human resources ▪ Policies and practices, including assessment and admittance policies ▪ Activities to promote student learning	**Cell 10:** Learning outcomes at the institutional level *For example:* ▪ Institution level aggregates of: reading, mathematical and scientific literacy ▪ Habits in relation to content domains ▪ Affective outcomes (*e.g.* attitudes to mathematics) ▪ Life skills and learning strategies ▪ Differences in outcomes for students of various backgrounds
Instructional settings	**Cell 3:** Characteristics of instructional settings *For example:* ▪ Teacher qualifications ▪ Classroom size	**Cell 7:** Learning environment *For example:* ▪ Ability grouping ▪ Teaching styles ▪ Learning time	**Cell 11:** Learning outcomes at the level of instructional setting *For example:* ▪ Classroom motivation to learn ▪ Average classroom performance
Individual participants in education and learning	**Cell 4:** Individual background *For example:* ▪ Parental occupational status ▪ Parental educational level ▪ Educational resources at home ▪ Ethnicity and language ▪ Age and gender	**Cell 8:** Individual learning process *For example:* ▪ Engagement and attitudes to science ▪ Self-concept and self-efficacy when learning science ▪ Motivation to learn science	**Cell 12:** Individual outcomes *For example:* ▪ Reading, mathematical and scientific literacy ▪ Affective outcomes (*e.g.* attitudes to science)

Hundreds of relationships can be derived from this grid and therefore it would be impossible to represent all of them in a single model. Models would be different depending on the interest of researchers.

Figure 1.4 presents a two-dimensional matrix with examples of variables collected or available from other sources for PISA 2006. As shown earlier, PISA does not limit student outcomes to academic performance. PISA also measures student's self-related cognitions (self-concept, self-efficacy), learning strategies, long-term interest in a subject and educational expectations. Figure 1.4 clearly demonstrates the diversity of information collected by PISA, which can provide empirical support to issues addressed by educators, psychologists, sociologists, economists and so on.

Influence of the methodology on outcomes

The main objectives of the PISA surveys condition the definition of its target population, sampling design, what is to be assessed and, to a lesser extent, the data collection procedures. All these methodological components might affect the survey outcomes and any researchers analysing the PISA data and interpreting the results should always contextualise the results in the survey methodology.

It is not always easy to know beforehand which methodological component will affect the survey outcomes. In PISA, the definition of the target population is certainly one of the methodological components that have such potential influence. Indeed, by selecting an age population, in a number of the participating educational systems (depending on the grade retention policy) target students are enrolled in more than one grade. Moreover, as the target population more or less corresponds to the end of compulsory education, 15-year-olds are, in some countries, distributed in different types of schools. Table 1.4 presents the distribution of students per grade and per International Standard Classification of Education (ISCED) level. With just a few exceptions, 15-year-olds are distributed in both lower secondary and upper secondary education.

Table 1.4

Distribution of students per grade and per ISCED level in OECD countries (PISA 2006)

		Grade 7	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12	Grade 13	ISCED 2	ISCED 3
OECD	Australia	0.0	0.1	9.2	70.8	19.8	0.1	0.0	80.1	19.9
	Austria	0.3	6.4	44.6	48.7	0.0	0.0	0.0	6.7	93.3
	Belgium	0.4	4.4	31.1	63.2	1.0	0.0	0.0	6.8	93.2
	Canada	0.0	1.7	13.3	83.8	1.2	0.0	0.0	15.0	85.0
	Czech Republic	0.6	3.5	44.3	51.5	0.0	0.0	0.0	50.4	49.6
	Denmark	0.2	12.0	85.3	1.4	1.1	0.0	0.0	98.9	1.1
	Finland	0.2	11.7	88.1	0.0	0.0	0.0	0.0	100.0	0.0
	France	0.0	5.2	34.8	57.5	2.4	0.0	0.0	40.0	60.0
	Germany	1.6	12.3	56.5	29.3	0.3	0.0	0.0	97.3	2.7
	Greece	0.5	2.1	5.3	78.8	13.3	0.0	0.0	8.0	92.0
	Hungary	2.2	5.5	65.7	26.6	0.0	0.0	0.0	7.7	92.3
	Iceland	0.0	0.0	0.2	99.2	0.6	0.0	0.0	99.4	0.6
	Ireland	0.0	2.7	58.5	21.2	17.5	0.0	0.0	61.3	38.7
	Italy	0.3	1.5	15.0	80.4	2.8	0.0	0.0	1.7	98.3
	Japan	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0
	Korea	0.0	0.0	2.0	97.3	0.7	0.0	0.0	2.0	98.0
	Luxembourg	0.2	11.8	53.4	34.4	0.1	0.0	0.0	64.2	35.8
	Mexico	2.3	8.1	33.5	48.9	5.1	2.0	0.0	44.5	55.5
	New Zealand	0.0	0.0	0.0	6.2	89.4	4.4	0.0	6.2	93.8
	Norway	0.0	0.0	0.5	99.0	0.5	0.0	0.0	99.5	0.5
	Poland	0.6	3.8	95.0	0.6	0.0	0.0	0.0	99.4	0.6
	Portugal	6.6	13.1	29.5	50.7	0.2	0.0	0.0	50.2	49.8
	Slovak Republic	0.7	2.2	38.5	58.7	0.0	0.0	0.0	38.6	61.4
	Spain	0.1	7.0	33.0	59.8	0.0	0.0	0.0	100.0	0.0
	Sweden	0.0	1.9	95.9	2.2	0.0	0.0	0.0	97.8	2.2
	Switzerland	0.8	16.1	62.6	20.3	0.3	0.0	0.0	82.8	17.2
	Turkey	0.8	4.5	38.4	53.7	2.6	0.0	0.0	5.3	94.7
	United Kingdom	0.0	0.0	0.0	0.9	98.4	0.7	0.0	0.5	99.5
	United States	0.8	1.0	10.7	70.9	16.5	0.1	0.0	12.4	87.6

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In some countries, such as France and Greece, lower education is usually provided in different institutions from upper secondary education. As grade retention presents some interactions with gender, immigration or the student socio-economic background, uneven distribution per level of education will be observed. In France, for example, only 35% of the 15-year-olds still in lower secondary education (in *collèges*) are female while they represent 55% of the 15-year-olds in upper secondary education. Regarding the immigration issue, only 38% of native 15-year-olds are in lower education while 63% of immigrant students are at that level of education. This uneven distribution may influence the effect of school variables, such as the disciplinary climate, on the student or school performance. Caution is, therefore, required in interpreting such effects.

The structure of education systems also affects the school variance and any multilevel regression analyses. Indeed, the distinction between upper and lower secondary education is part of the within-school variance in some countries where both lower and upper secondary education are provided in one educational institution. On the contrary, in other countries where lower and upper secondary education are provided in separate educational institutions (*e.g.* in France), this distinction will contribute to the between-school variance.

Does this mean that PISA provides biased estimates of school variance? Certainly not, but the school variance computed on PISA data could lead to some overstatements such as "the school catchment area in France is useless as it does not reduce inequities between schools", unless the nature of the PISA data and the structure of the educational system are correctly taken into account in interpretation. In interpreting such between-school variance, it always needs to be kept in mind that PISA's target population is 15-year-old students. For instance, if the data is based on a population of 16-year-olds, the variance caused by the difference between the two adjacent grades would contribute to the within-school variance, but not to the between-school variance.

The school variance is also affected by the definition of a school within each participating country. As described in Annex A3 in the PISA 2003 initial report (OECD, 2004) and in Annex A2 in the PISA 2006 initial report (OECD, 2007), in some countries, sub-units within schools were sampled instead of schools, which may affect the estimation of the between-school variance components. In some countries such as Austria and Japan, schools with more than one study programme were split into units delivering each programme. In the Netherlands, for schools with both lower and upper secondary programmes, schools were split into units delivering each programme level.

As previously mentioned, the structure of education systems and the definition of the sampling units have an impact on the interpretation of the between-school variance. It is thus highly recommended that analysts carefully review their outcomes and their policy recommendations in the light of the structures of education systems and the definition of schools as sampling units.

Notes

1. The GDP of the countries that took part in PISA 2006 represents 86% of the 2006 world GDP. Some of the entities represented in this report are referred to as partner economies. This is because they are not strictly national entities.

2. For more information, visit *www.pisa.gc.ca/yits.shtml* (YITS, the Canadian stydy); *http://www.sfi.dk/sw19649.asp* (the Danish study) and *www.acer.edu.au* (the Australian study).

3. Visit *www.pisa.oecd.org* for links to countries' national PISA websites and national PISA reports.

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User's Guide

Preparation of data files

All data files (in text format) and the SAS® control files are available on the PISA website (*www.pisa.oecd.org*).

SAS® users

By running the SAS® control files, the PISA data files are created in the SAS® format. Before starting analysis, assigning the folder in which the data files are saved as a SAS® library.

For example, if the PISA 2000 data files are saved in the folder of "c:\pisa2000\data\", the PISA 2003 data files are in "c:\pisa2003\data\", and the PISA 2006 data files are in "c:\pisa2006\data\", the following commands need to be run to create SAS® libraries:

```
libname PISA2000 "c:\pisa2000\data\";
libname PISA2003 "c:\pisa2003\data\";
libname PISA2006 "c:\pisa2006\data\";
run;
```

SAS® syntax and macros

All syntaxes and macros in this manual can be copied from the PISA website (*www.pisa.oecd.org*). The 17 SAS® macros presented in Chapter 17 need to be saved under "c:\pisa\macro\", before staring analysis. Each chapter of the manual contains a complete set of syntaxes, which must be done sequentially, for all of them to run correctly, within the chapter.

Rounding of figures

In the tables and formulas, figures were rounded to a convenient number of decimal places, although calculations were always made with the full number of decimal places.

Country abbreviations used in this manual

AUS	Australia	FRA	France	MEX	Mexico
AUT	Austria	GBR	United Kingdom	NLD	Netherlands
BEL	Belgium	GRC	Greece	NOR	Norway
CAN	Canada	HUN	Hungary	NZL	New Zealand
CHE	Switzerland	IRL	Ireland	POL	Poland
CZE	Czech Republic	ISL	Iceland	PRT	Portugal
DEU	Germany	ITA	Italy	SVK	Slovak Republic
DNK	Denmark	JPN	Japan	SWE	Sweden
ESP	Spain	KOR	Korea	TUR	Turkey
FIN	Finland	LUX	Luxembourg	USA	United States

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