Poland: Skilling up the next generation

An analysis of Poland's performance in the Program for International Student Assessment

WORLD BANK GROUP
Education Global Practice
Europe and Central Asia Region

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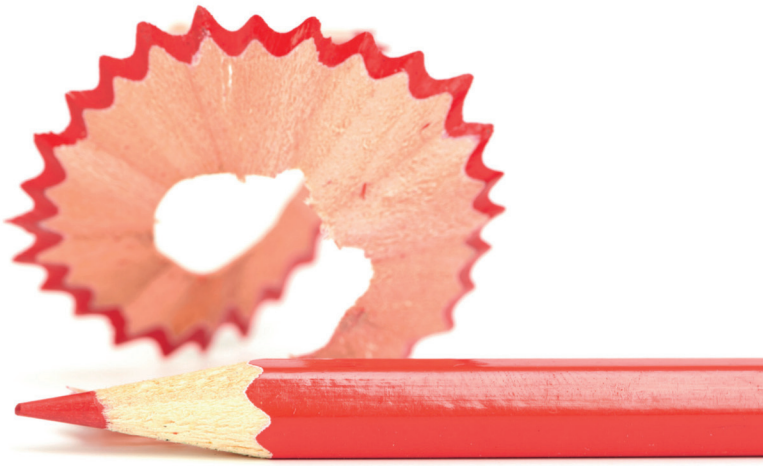

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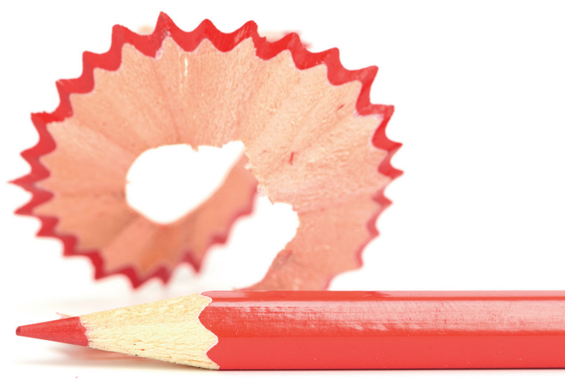
This report was prepared by a World Bank team consisting of Christian Bodewig, Lucas Gortazar, Katia Herrera Sosa, Daniel Kutner, Jeremie Amoroso and Martin Moreno under the overall guidance of Mamta Murthi, Country Director, Central Europe and the Baltics, Marina Wes, Country Manager for Poland and Cristian Aedo, Education Global Practice Manager. The report benefited from comments from peer reviewer Harry Patrinos and from Zbigniew Sawiński, Michał Sitek and Jerzy Wiśniewski. Marc De Francis edited the report.

Abbreviations and Acronyms

ESCS	Economic, Social, and Cultural Status
ECA	Europe and Central Asia
ECE	Early childhood education
EU	European Union
GDP	Gross domestic product
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary least squares
PIAAC	Program for the International Assessment of Adult Competencies
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Student Assessment
RIF	Re-centered influence functions
TIMSS	Trends in International Mathematics and Science Study
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
VET	Vocational education and training

Executive Summary



Executive Summary

Facing the prospects of rapid demographic aging and decline over the coming decades, **Poland needs a highly skilled workforce** to help generate the productivity growth that it needs to fuel continued convergence of its living standards with those of its West European neighbors.

Skilling up the workforce starts with equipping youth with the right cognitive and socio-emotional foundation skills. International research has identified three dimensions of skills that matter for good employment outcomes and economic growth: cognitive skills, such as literacy, numeracy, and creative and critical thinking or problem-solving; socio-emotional skills and behavioral traits, such as conscientiousness, grit, and openness to experience; and job- or occupation-specific technical skills, such as the ability to work as an engineer. Cognitive and socio-emotional skill formation starts early in a person's life. Good cognitive and socio-emotional skills provide a necessary foundation for the subsequent acquisition of technical skills. Put differently, poor literacy and numeracy skills severely undermine a person's ability to benefit from further training and lifelong learning.

An impressive transformation in cognitive skills has occurred among youth in Poland. This report focuses on cognitive skills. It examines results for Poland from the Program for International Student Assessment (PISA), which assesses the mathematics, reading, and science competencies of 15-year-olds. The findings point to an impressive transformation in the cognitive skill set of the youth in Poland between 2000 and 2012. Poland raised its scores in mathematics, reading, and science to the equivalent of what students would have learned in one additional year of schooling. Its PISA scores are now above the OECD average and at the same levels as in countries such as Finland and Germany.

Aggregate gains in quality have gone hand in hand with improvements in educational equity. Poland has seen an increase in the proportion of its students at the top performance level, and the share of its students who are poor performers has declined. Students from poor and well-off socioeconomic backgrounds alike saw performance improvements. All this has been achieved with stable levels of education spending, at about 5 percent of GDP and below the OECD average.

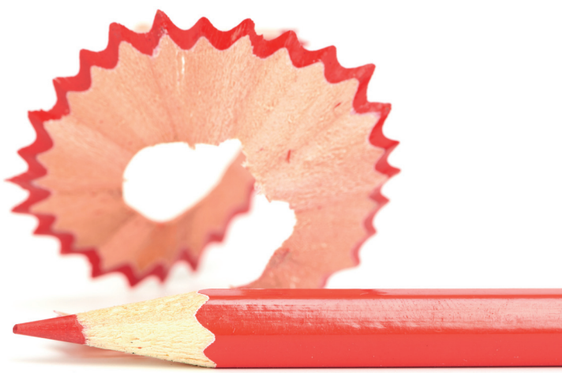
The overall effects of reform on Poland's PISA scores has been positive, although isolating the precise impact of each reform element is difficult. Given the many education (and non-education) reforms in Poland since the early 1990s, it is difficult to isolate the effects of each element of reform on Poland's PISA results. The overall effects are clearly positive. In addition to changes in the accountability arrangements with a strengthening of the role of local governments and the introduction of standardized examinations, the Polish authorities introduced a change to the structure of the education system in 1999, which delayed selection between general and vocational tracks and effectively added one year of exposure to general curriculum content. Taking effect after the first PISA test in 2000, when Poland performed relatively poorly, this change has been rigorously evaluated and shown to have had a significant positive effect on performance.

Despite the many successes, some challenges remain, particularly regarding problem-solving skills and equity in achievement. There is evidence from PISA assessments replicated for older students in upper-secondary education in 2006, 2009 and 2012 that performance gaps previously found between vocational and general schools for

15-year-olds prior to the 1999 reform persist today in upper secondary education, where the performance of students in vocational upper-secondary schools trails that of their peers in general education. Moreover, Poland's performance in problem solving in the 2012 PISA was well below the OECD average. Lastly, equity remains an issue in need of further attention: The difference in mathematics performance between the top and bottom quintiles are the equivalent of nearly three years of schooling – a wider gap than the OECD average and much wider than in other top-performing countries such as Japan and Korea. While Poland's school system today is not very stratified according to the socioeconomic background of its students, socioeconomic background still matters for performance.

Chapter 1

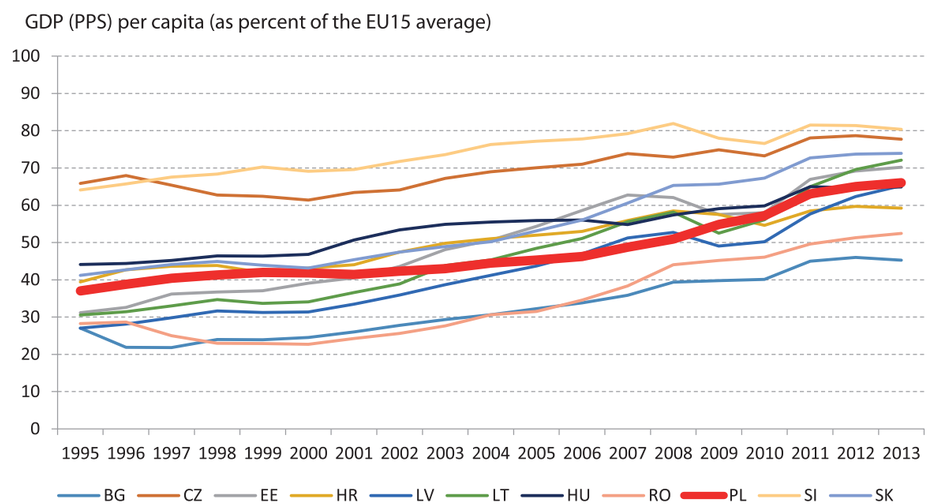
Why Skills Matter for Poland



1. Why Skills Matter for Poland

How can Poland achieve convergence in living standards with its Western European neighbors when its population is aging and shrinking? Poland's income growth over the last two decades has been remarkable, but the country still has a long way to go to catch up with the living standards of its EU15 neighbors. In 1995, Poland's GDP per capita stood at about 37 percent of the EU15 average, and by 2013 it had risen to 66 percent (Figure 1). Looking ahead, Poland's long-term economic growth prospects are put at risk by demographic change: According to United Nations projections, the working-age (ages 15 to 64) share of the population is expected to fall from 69.5 percent in 2015 to 57 percent by 2050. In contrast, the share of the population 65 and above will increase from 15.3 percent in 2015 to 29 percent by 2050.[1] With fewer workers and more old-age dependents, labor productivity improvements will be key to sustained economic growth.

Figure 1. Poland's income convergence, 1995 - 2013: A sizeable catch-up but still a long way to go



Source: World Bank Staff estimates using Eurostat data.

Making the best use of human capital is at the heart of policies that can sustain increases in living standards. Mitigating the risk to economic growth from population aging and decline involves expanding the number of workers and enhancing their productivity. Expanding their numbers means increasing the employment rate at all ages, especially among young and older workers, and encouraging immigration. Enhancing productivity means raising the skills of the current and future workforce, in addition to other measures such as reforms in product and capital markets. According to Eurostat labor force survey data, Poland faces high youth unemployment which, at 24.2 percent in 2014, was above the EU average. In addition to the lost income, poor labor market outcomes at the beginning of a person's professional life may have long-lasting, negative impact on his or her long-term labor market outcomes, limiting the possibilities of young people (Schmillen and Umkehrer, 2013; Kahn, 2010; Gregg and Tominey, 2005).

[1] United Nations Population Projections, 2012 Revision.

But what about skills? This report places a spotlight on the next generation and examines whether Poland's youth are leaving the compulsory education system with the right set of skills needed for further education and training and for productive employment. It finds that Poland has made major strides in raising the skills of the next generation and to prepare them for the demands of a growing and changing economy.

The importance of cognitive skills

International evidence shows how much the skills of a country's workforce matter for economic growth and shared prosperity. International evidence suggests that quality of education is one of the most important determinants of long-term economic growth.[2] Recent research (Hanushek and Woessmann, 2007 and 2012), drawing on student assessment surveys from 1960 onward, estimates that an improvement of 50 points in scores on the Organisation for Economic Co-operation and Development's (OECD's) Program for International Student Assessment (PISA) would imply an increase of 1 percentage point in the annual growth rate of GDP per capita.[3]

Both the share of students achieving basic literacy and the share of top-performing students matter for growth (Hanushek and Woessmann, 2007; OECD, 2010). A recent OECD (2015) report presents economic returns to universal basic skills, defined as all students achieving level 1 skills (420 points) in PISA. While low-income countries with lagging education systems stand to gain the most, advanced middle- and high-income countries can expect a significant boost to long-run economic growth simply by making their education systems deliver better for the weakest students: The report finds that on average, high-income countries could gain a 3.5 percent higher discounted average GDP over the next 80 years if they were to ensure that all students achieved basic skills (as defined above). As will be presented in this report, a declining yet still significant share of Polish 15-year-olds currently perform poorly in PISA. Ensuring universal basic skills in Poland could add 2 percent discounted future GDP.

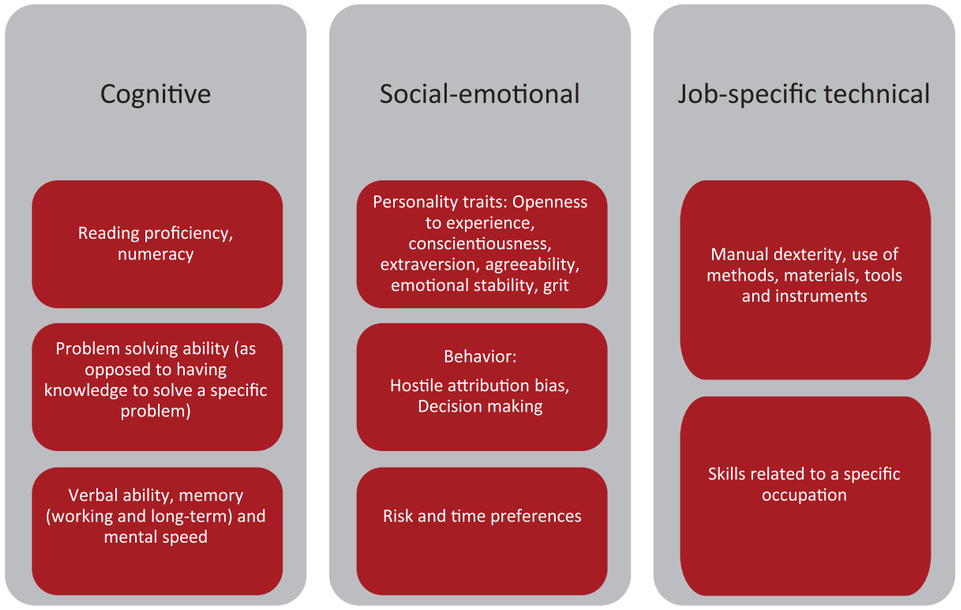
Ensuring basic cognitive skills for all also helps to make growth inclusive. Beyond aggregate economic growth, education improves the living standards of individuals. With more education people are able to acquire more and higher-order skills, making them more productive and employable and extending their labor market participation over their lifetime. That in turn leads to higher earnings and better quality of life.[4] Education is an engine of social mobility: Human capital is a key asset in income generation and hence critical to reducing poverty and increasing shared prosperity (Bussolo and Lopez-Calva, 2014).

"Skills" can be differentiated along separate though mutually reinforcing dimensions: cognitive, socio-emotional, and technical skills. Figure 2 presents the differentiation across the different dimensions. *Cognitive* skills include literacy and numeracy, such as that measured in PISA, but also include competencies like critical thinking and problem-solving. *Socio-emotional* skills capture one's ability to interact with others as well as traits such as determination and focus on getting a job done. *Technical skills* capture one's ability to perform technical tasks

[2] See Sala-i–Martin, Doppelhofer, and Miller (2004).
[3] See Hanushek and Woessmann (2007) and Hanushek (2010). Using these tests as measures of cognitive skills of the population, they show that countries that had better quality of education in the 1960s experienced faster economic growth during the years 1960-2000, controlling for other factors.
[4] See Hanushek (2013).

in any occupation, for example in work as a plumber or engineer. Measuring the level of educational attainment does not automatically mean measuring actual skills. While many countries in Central and Eastern Europe have seen increases in educational attainment (years of education, level of education completed) since the start of the economic transition, they have not necessarily seen improvements in their performance in international student assessments that measure cognitive skills, such as PISA (Sondergaard and Murthi, 2011).

Figure 2. Three dimensions of skills

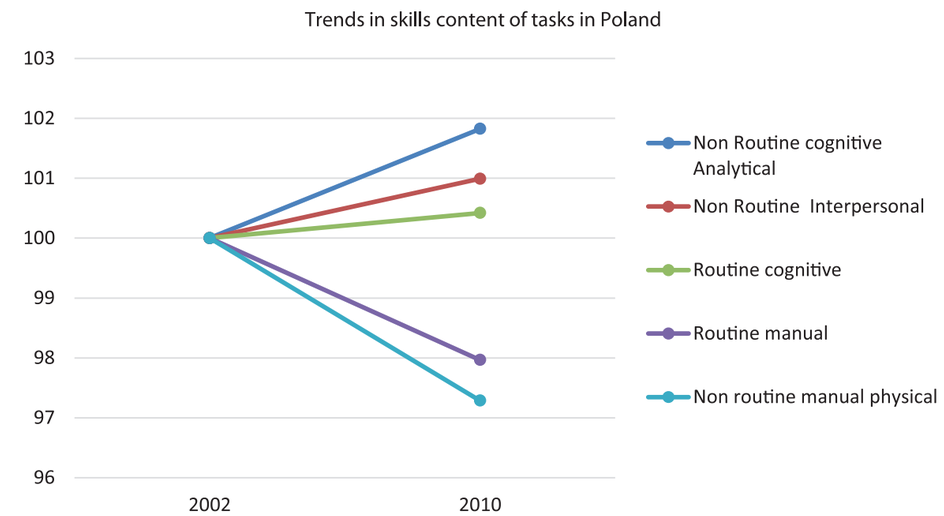


Source: Bodewig and Badiani-Magnusson (2014)

The skills content in the labor market in many economies is changing, and Poland is no exception. In a widely cited study, Autor, Levy and Murnane (2003) show that the demand for non-routine cognitive (analytical and interpersonal) skills has been on the rise in the United States since 1960. A similar change can be observed in Poland. Overall, the skills required for different tasks (or occupations) are starting to include a higher proportion of non-routine cognitive analytical and non-routine interpersonal components than before.[5] Tasks today usually require higher-level skills and are associated with higher value-added. The analysis does not say whether more of these skills are being demanded in Poland but not possessed by available workers or if these skills are in excess supply. However, it does seem to suggest that jobs in the country now favor graduates with higher levels of cognitive, problem solving, and socio-emotional skills (e.g. interpersonal), as compared to the situation a few years ago when the economy was not yet liberalized (Aedo et al., 2013).

[5] While the skills percentages are lower for the Poland data compared to those observed in the original paper of Autor, Levy, and Murnane (for instance, the original article shows about 12 percentage points for non-routine cognitive skills analytical for the USA, compared with an increase of less than 2 percentage points in Poland), the original paper covered 40 years of data (between 1960 and 2000). The data used to construct the Poland analysis covers just eight years, between 2002 and 2010.

Figure 3. A growing intensity of use of non-routine cognitive and interpersonal skills in Poland



Source: Aedo et al., 2013.

This report focuses on cognitive skills and examines evidence from the PISA assessment of mathematics, reading, and science competencies of Polish 15-year-olds. Introduced by the OECD in 2000, PISA is a worldwide study of 15-year-old school students' performance in three different disciplines: mathematics, science, and reading. PISA focuses on the competence of students and their ability to tackle real-life problems in those three disciplines and emphasizes skills that are critical for individuals' personal and professional development. A sample question from mathematics illustrates the applied nature of the PISA tests: "Nick wants to pave the rectangular patio of his new house. The patio has length 5.25 meters and width 3.00 meters. He needs 81 bricks per square meter. Calculate how many bricks Nick needs for the whole patio."[6] In assessing the performance of Polish 15-year-olds, PISA mainly captures those students who are in the third year of lower secondary education (gymnazjum). Given that skills formation is cumulative, scores reflect not just the competencies acquired in those schools but competencies acquired even earlier in the education system. PISA's scoring system is standardized so that the mean score for each discipline among OECD countries in year 2000 (reading), 2003 (mathematics) and2006 (science) is 500 points, with a standard deviation of 100 points.[7] According to OECD, a gain of 40 points in PISA is equivalent to what students learn in one year of schooling.[8] Poland has been participating in all PISA rounds since 2000.

[6] Additional sample questions can be found at Source: http://pisa-sq.acer.edu.au/
[7] PISA results have been comparable for reading since 2000, for mathematics since 2003 and for science since 2006.
[8] PISA 2009 Technical Report (OECD 2012).

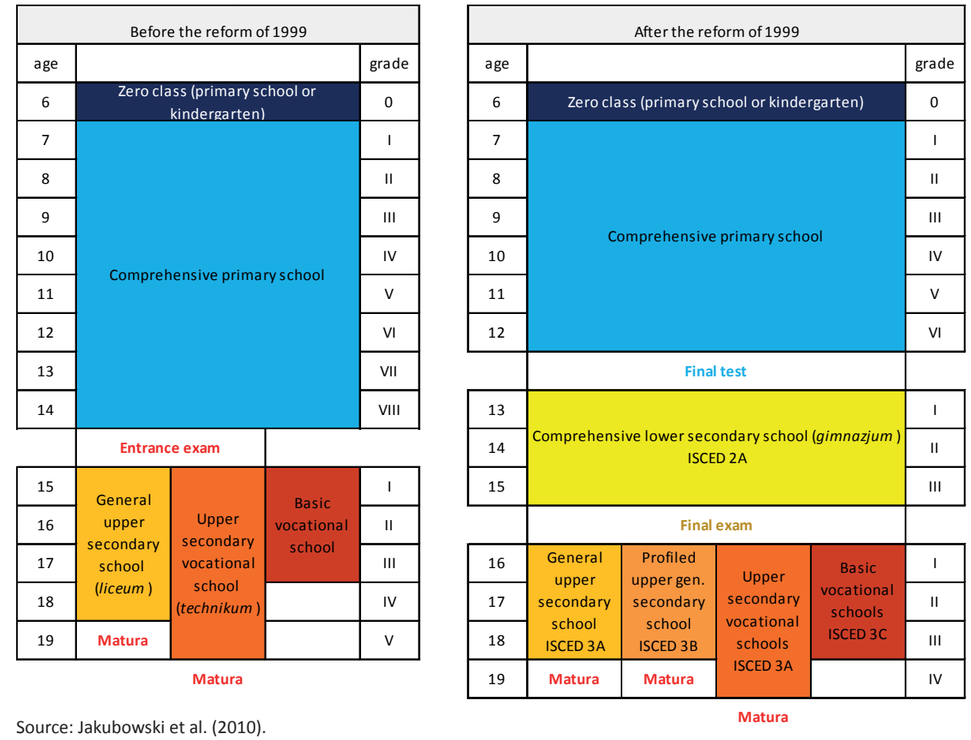
Cognitive skills built in childhood and youth are a necessary foundation for successful acquisition of technical and job-specific skills later in life. The foundations of cognitive (and behavioral) skills are formed early and are the platform upon which later skills are built. The most sensitive periods for building a skill vary across the three dimensions of skills, and skill formation benefits from previous investments and is cumulative. Technical and job-specific skills – often acquired last, through technical and vocational education and training (TVET), higher education, or on-the-job learning – benefit from strong cognitive and behavioral skills acquired earlier in the education system. In other words, the cognitive skills acquired in childhood and youth, such as those measured by PISA, will help workers to continuously update their technical skills during their working lives. This is of particular importance in aging economies such as Poland´s where workers need to adapt to technological progress during their longer working lives.

The report is part of a series of World Bank reports that examine PISA data in depth to analyze education systems and provide policy makers with options for evidence-based reforms. Due to its focus on policy, the series aims to address key challenges in several countries, with a focus on improving education quality and equity. This report provides a snapshot of the performance of Polish 15-year-old students in PISA compared with other peer countries and over time. The report presents: (i) Poland's performance in PISA since 2000 until 2012, (ii) the overall evolution of the system and of socioeconomic conditions of students and schools and its relationship with PISA scores; (iii) the remaining challenges for Poland – improving problem solving skills of its students and addressing remaining equity issues.

Poland's education system

The Polish education systems has high student-population coverage and follows a 6-3-3 education structure. Poland's general education system has undergone a significant transformation since the early 1990s, including a change to its structure in 1999-2000 with the introduction of a comprehensive lower-secondary school, the Gimnazjum (see Box 1 and Figure 4). Primary education lasts six years, followed by three years of lower-secondary school and three years of upper-secondary school (four years in the case of vocational secondary schools, see Figure 4). Since 1999 pre-primary education has been optional at ages three to five, and gross enrolment at ages three, four, and five has increased significantly, rising from 28, 38, and 48 percent (respectively) in 2005 to 51, 65, and 94 percent (respectively) in 2012 (OECD, 2014). In 2012 Poland's enrolment of five-year-olds was on par with the OECD average, while enrolment of three- and four-year-olds was well below average. One year (zero grade) preparatory class for six-year-olds is compulsory before primary education. The net enrollment rate for primary and secondary schools are 97 and 98 percent respectively. As of 2015, preschool at age five will be compulsory and there will be a guarantee of a preschool place for all children ages three and four. Primary school will start from age six (Jakubowski, 2015).

Figure 4. The Polish education system before and after the 1999 reform



Source: Jakubowski et al. (2010).

National assessments take place at the end of each stage of the system. There is an assessment at the end of primary schooling, when students are 12 years old, for system evaluation purposes but not for placement.[9] Until recently, there was an exam at the end of lower secondary, when students are 15 years old, after which students attend a three-year upper secondary general school (lyceum), a technical or professional profile, or a two-year upper-secondary vocational school, but it was phased out. Moreover, there is a high- stakes (Matura) exam after upper-secondary school, when students are 18 years old. It is not compulsory but students need to pass it, in order to qualify for entrance to higher education. Lastly, there is an optional vocational exam for those students attending a basic or technical vocational school.

[9] In principle, the place of residence, and not the outcomes of the assessment, determines the lower secondary school that a student will attend: Schools are supposed to select the students from the catchment area first, but they can also admit other students on the basis of the results of the exam.

Box 1. Reforms to the Polish general education system since the 1990s

The efforts of policy-makers in the early 1990s were focused on increasing cognitive skills in the learning content, and the education system's administration changed from a top-down centralized system to a more democratic system of service delivery. The education reform in 1999 had the purpose of improving the quality of education, making it more equitable, and increasing the progression from lower to upper secondary and higher education. One of the key changes was the introduction of a three-year comprehensive lower-secondary school after primary schooling, followed by a three- (or four-) year upper secondary school, which delayed tracking into vocational schools for one more year (Figure 4). The reform also introduced standardized national assessments and examinations at the end of primary, lower, and upper-secondary. The results of the assessments and examination are made public. There was a substantial transfer of responsibilities from the central to the local governments, and while a new core curriculum was put in place, teachers had the freedom to choose their textbooks. The curriculum changed in favor of more selected topics that promoted thinking skills as opposed to extensive number of topics that emphasized memorization. These reforms provided students more time to spend in the acquisition of skills, opened new pathways for student advancement into higher levels of learning, and provided incentives for teachers to modernize teaching practices, which now emphasize active teaching methods as opposed to rote memorization. Most recent changes included increasing teachers' salaries (by up to 50 percent) between 2008 and 2012. Starting in 2009 the national curriculum has been reformed and, as part of these changes, mathematics has been reintroduced as part of the Matura examination. Table 1 summarizes the main phases of reform.

Table 1: Three waves of reform in Poland's general education system

Early 1990s	Late 1990s	Late 2000s
Competitive recruitment process for hiring school principals. New teaching methods (less rote learning). Increased pedagogical autonomy.	8-year primary converted into 6-year primary education plus 3-year lower-secondary, which led to choice of general vs. vocational track being delayed for a year. System of examination and tests at the end of primary, lower secondary and upper secondary as well as vocational qualitfication exams. New core curriculum for general and vocational education. Curricular standards at national level, but curriculum development at school level. Local governments became responsible for managing primary schools in 1996 and for secondary schools in 1999 Per-capita financing.	National curriculum reform (attention shifting from process to outcomes). Compulsory preschool education for 5-year-olds. Primary starting age reduced to 6 years. Comprehensive general education programme extended for the first grade of upper secondary schools (of all types). More diversity of advanced subjects in upper-secondary. Increase in teachers' salaries (by 50% between 2008 and 2012). New curricula in VET (since 2012).

Source: Authors' compilation drawing on Marciniak (2015) and Jakubowski (2015)

Chapter 2

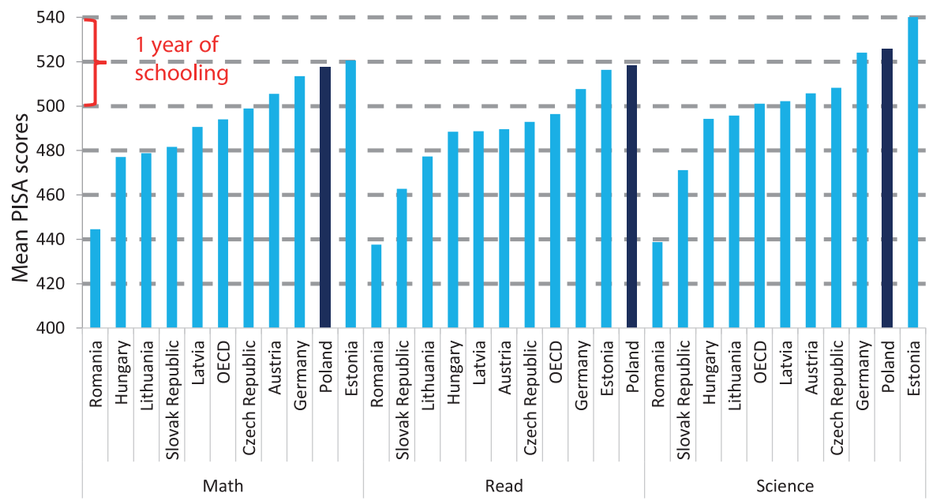
Cognitive Skills of Polish 15-year-old Students

2. Cognitive Skills of Polish 15-year-old Students

Snapshot of Poland's performance in PISA

Poland's 15-year-olds performed strongly in mathematics, reading, and science in 2012. Poland's scores were above the OECD country average in all subjects: mathematics (518 points), reading (518 points), and science (526 points) (Figure 5). Poland scored well above the OECD average in mathematics and at par with countries such as Germany and Finland. These rapid improvements in PISA scores make Poland an interesting case to examine.

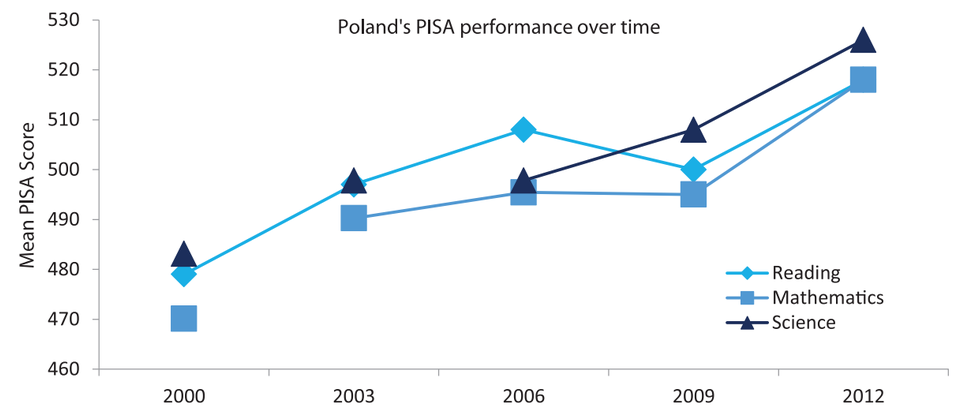
Figure 5. Poland's PISA 2012 scores were above OECD averages and most neighboring countries



Source: World Bank staff estimates using PISA data

The significant gains in Poland's PISA scores have extended across three distinct phases. First, Poland saw significant improvements between 2000 and 2003. Its scores presented a broadly stable picture between 2003 and 2009, followed by another significant jump between 2009 and 2012 (Figure 6). The aggregate increases for reading, mathematics and science across the entire period are around 40 points, the equivalent of one year of instruction. What have been the drivers of the sudden improvements in performance between 2000 and 2003 and between 2009 and 2012? While evidence shows a causal link between the first jump and the 1999 reform, with its extension of general education by one year due to the introduction of the comprehensive lower secondary schools (Jakubowski et al., 2010), no causal evidence has been found to explain the 2009-2012 improvements. However, one credible hypothesis is that the changes in curriculum and student assessment led to improvements in cognitive skills, with students tested in 2012 having completed three years of lower secondary education under the new curriculum (see also Marciniak, 2015, and Jakubowski, 2015).

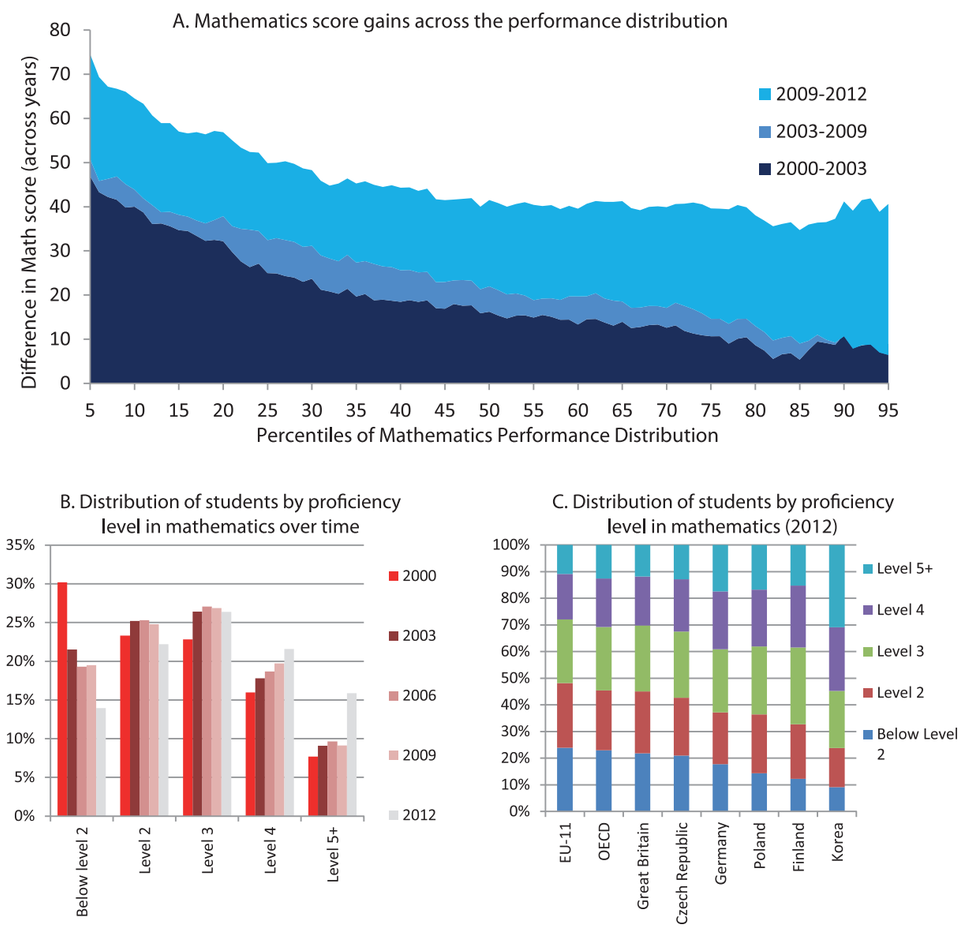
Figure 6. Poland's PISA performance by discipline, 2000-12



Source: World Bank staff estimates using PISA data. Note: PISA results have been comparable for reading since 2000, for mathematics since 2003 and for science since 2006.

Performance in PISA mathematics, science, and reading has increased across the entire performance distribution, accounting for more than one year of schooling in all three subjects (see Figure 7, Panel A, for mathematics; the shapes are similar for reading and science). Low achievers have benefited more than high achievers. PISA categorizes scores in six levels of proficiency; students who score below level 2 in the reading and mathematics tests are considered functionally illiterate and innumerate, respectively. This means that they are not able to understand and solve simple problems, severely limiting their development and subsequent cognitive and technical skill acquisition process. In Poland, the share of students below basic PISA proficiency levels has declined significantly and to levels far below those in neighboring countries (Figure 7, Panels B and C). Conversely, there has been a boost in the share of students performing at the top of the proficiency distribution.

Figure 7. Distribution of students by proficiency level in math: (a) Poland's progress in 2000-2012; (b) Poland and comparators in 2012



Source: World Bank staff estimates using PISA data

Poland's above average PISA performance has come even though below-average public spending. Poland's public spending on education in 2011 was 4.7 percent of GDP (5.5 percent total spending, with 0.8 percent private spending), compared to an OECD public spending average of 5.3 percent of GDP (and 6.1 percent total). The per-student expenditure has increased over the last years, in part due to the declining student population (Table 2). However, PISA performance in 2012 was significantly above what would be expected given the level of public expenditure per student in 2012 (see Figure 8). Poland's aggregate PISA performance is similar to that of countries that invest more than twice as much per pupil, such as Finland, Netherlands, and Belgium. Poland has guaranteed a level of public spending on education over the years to ensure access to a minimum standard of quality and then

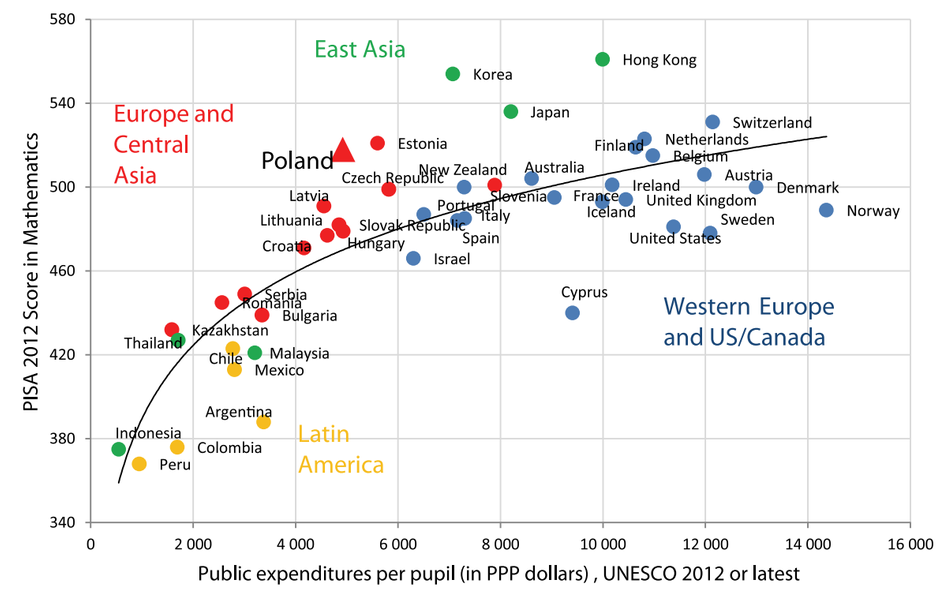
embarked on a sustained reform process since the early 1990s.

Table 1 Poland's public spending on education

	2004	2005	2006	2007	2008	2009	2010	2011
Government expenditure on education								
as % of GDP	5.4	5.5	5.3	4.9	5.1	5.1	5.2	4.9
as % of total government expenditure	12.7	12.6	12	11.6	11.8	11.4	11.4	11.4
Government expenditure per student (in PPP$)								
Primary education		3268.3		4072.5		4986.9		5803.7
Secondary education		3055.7		3678		4597.4		5263.2
Tertiary education	2787	2954.1		2775.1		3603.6		4543.9

Source: UNESCO UIS (2015)

Figure 8. PISA scores in mathematics by public expenditures per student, Poland and other PISA countries



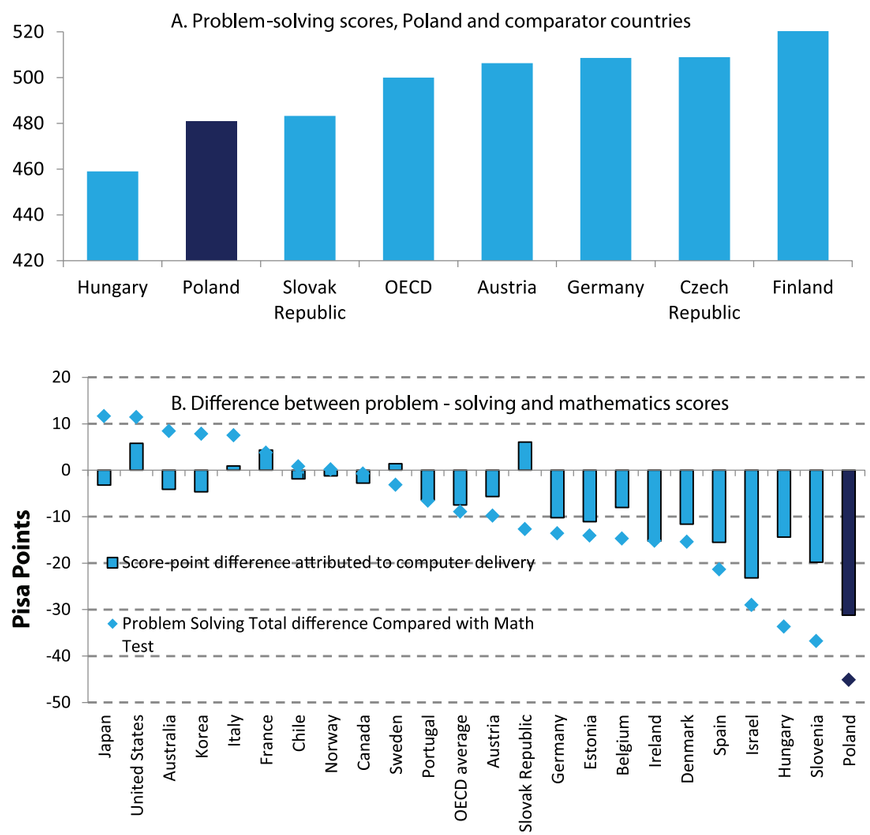
Source: World Bank staff estimations using PISA 2012 data and UNESCO 2012 data. Note: The curve represents a logarithmic approximation of the scatter plots.

However, Polish 15 year-olds performed less well in the problem solving assessment in PISA 2012. In 2012, the OECD introduced a new element of assessment: a problem-solving category that measures students' capacity to respond to non-routine analytical problems in a digital environment. This capacity is deemed essential for students to achieve their potential as constructive and reflective citizens by making use of the new technological tools.[1]

[1] This assessment responds to new demands for skills that people need in order to solve more intensive abstract tasks in their workplace. As computers and computerized machines are being introduced in greater numbers, workers are required to deal with unexpected analytical tasks that require both high-order skills and computer mastery in order to make the best use of the machines. See Autor, Levy, and Murnane (2003) for a detailed description.

While Poland's 15 year-olds score above the OECD averages in reading, mathematics and science, their results in the problem solving test were below OECD averages. Figure 9 presents the evidence on problem-solving (Panel A). It also shows the gap compared to the mathematics assessment and the influence of computer skills on relative performance in problem solving: a significant part of the variation for Poland in this test of 45 points compared to the paper-based mathematics test can be attributed to a lack of computer skills, reflecting a gap in both digital literacy and problem-solving skills (Panel B). Lastly, a look at the mathematics "subscales" in PISA 2012, which measure in more depth mathematical content and mathematical processes, illustrates problem solving-related dimensions of mathematical competencies in which Polish students have deficits (Box 2).

Figure 9. Problem-solving scores and comparison with mathematics scores (PISA 2012)



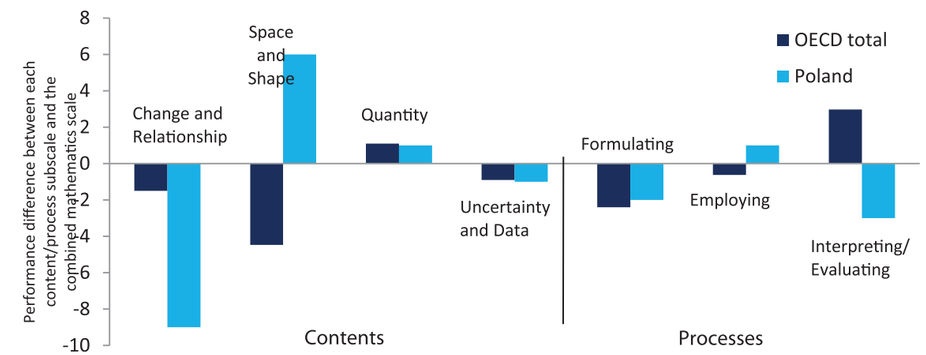
Source: World Bank staff estimations using PISA 2012 data.

Poland's results on the PISA problem-solving test are consistent with those from the Survey of Adult Skills for the younger age cohorts. The Program for the International Assessment of Adult Competencies (PIAAC) conducts the Survey of Adult Skills and measures key cognitive and workplace skills needed for individuals to successfully

participate in society and for the economy to prosper. This survey is useful to gauge how effectively education systems are preparing students with the skills they will need in life and work. Among participating countries, Poland scores the second lowest, below economies like Estonia and the Czech Republic and far below Finland and Korea (OECD, 2013c).

Weaknesses in problem solving among Polish students can also be observed when analyzing the subscales of the mathematics assessment. On the content subscale, students in Poland performed the best in problems related to space and shape; they also performed above the average in algebra and geometry. Polish students did not do as well in problems related to change and relationships (Figure 10). The analysis of the processes subscales suggest that there is room for improvement in the process of interpreting and evaluating mathematical problems, which is key for managing real-life situations that require mathematical skills.

Figure 10. Poland's PISA 2012 performance on mathematics subscales compared to the average mathematics performance



Source: World Bank staff estimations using PISA 2012 data.

Box 2. Digging deeper: Performance in mathematics

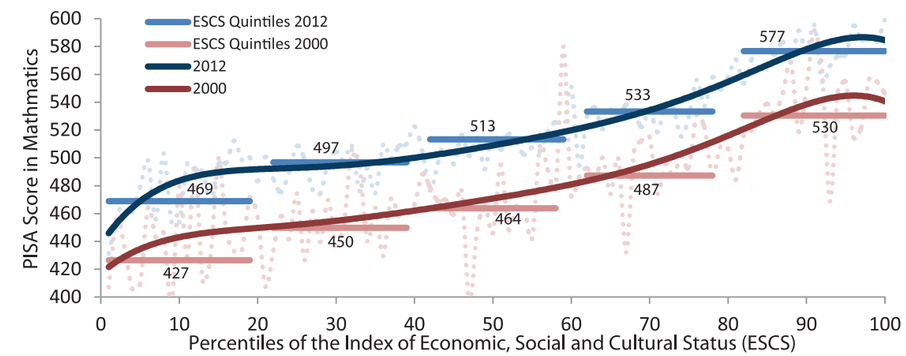
In addition to the overall scores, every PISA round offers the opportunity to explore in detail one subject area. The detailed assessment in PISA 2012 was on mathematics. PISA seeks to measure not just the extent to which students can reproduce mathematical content knowledge, but also how well they can extrapolate from what they know and apply their knowledge of mathematics in new situations. Mathematics literacy as defined by PISA is not a permanent attribute that an individual has or does not have; rather, mathematics skills can be acquired to a greater or lesser extent.

There are "subscales" in PISA that measure mathematical content and mathematical processes. The mathematics contents subscale has four categories: Quantity (incorporating the quantification of attributes of objects, relationships, situations, and entities), uncertainty and data (understanding messages embedded in data, and appreciating variability that is inherent in many real processes), change and relationships (temporary and permanent relations among objects and circumstances), and space and shape (phenomena encountered in patterns, object properties, positions, representations, visual information, navigation, and dynamic interactions). There are three process subscales that relate to the use of knowledge and skills to solve a problem. For instance, in order to solve a problem students first need to translate it into a form that can be solved using mathematics (this process is called formulating situations mathematically); second, students must recognize which elements of their "tool kit" they need to solve the problem (this is called employing mathematical concepts, facts, procedures, and reasoning); finally, students need to interpret the outcomes and make the link to the original situation in which the problem (interpreting, applying , and evaluating mathematical outcomes).

Performance and equity

Poland's overall gains in PISA since 2000 have been equally shared and are underpinned by strong gains among students from disadvantaged backgrounds. PISA results allow one to assess equity in education systems and interactions between student performance and socioeconomic status, because the assessment collects information on both performance and student background information using the OECD's Index of Economic, Social, and Cultural Status (ESCS Index; see Box 3). Figure 11 shows Poland's performance in 2000 and 2012 by percentile of socioeconomic status (as measured by the ESCS index) with a clear overall message: The higher the ESCS, the better the performance. However, the picture clearly depicts a significant and balanced improvement across the entire distribution. The flat lines ("steps") show the average for each quintile of socioeconomic status. For all quintiles, the average improved by 42 to 49 points – the equivalent of more than one year of schooling.

Figure 11. PISA scores in mathematics improved between 2000 and 2012 across every ESCS percentile



Source: World Bank staff estimations using PISA 2012 data. Note: A polynomial of order 6 was used to smooth the dotted line

Box 3: PISA's Index of Economic, Social, and Cultural Status

Created by OECD, PISA's Index of Economic, Social, and Cultural Status (ESCS) is a measure that takes into account information reported by students on their family's wealth and occupational, educational, and cultural background. It is derived from a combination of three other indexes: (i) an index of the highest occupational status of parents, indicating not only labor market status, but also the type of job held by parents; (ii) an index based on the highest level of parental education in years of schooling; and (iii) an index of family home possessions, which itself consists of a combination of the family's possessions (such as cars, bathrooms, or technological devices) and educational resources (such as desks, computers, textbooks, the number of other books), as well as the type of cultural possessions (such as the type and genre of books or works of art). The ESCS Index is the most important determinant of student achievement and is therefore crucial for analysis of the quality of education.

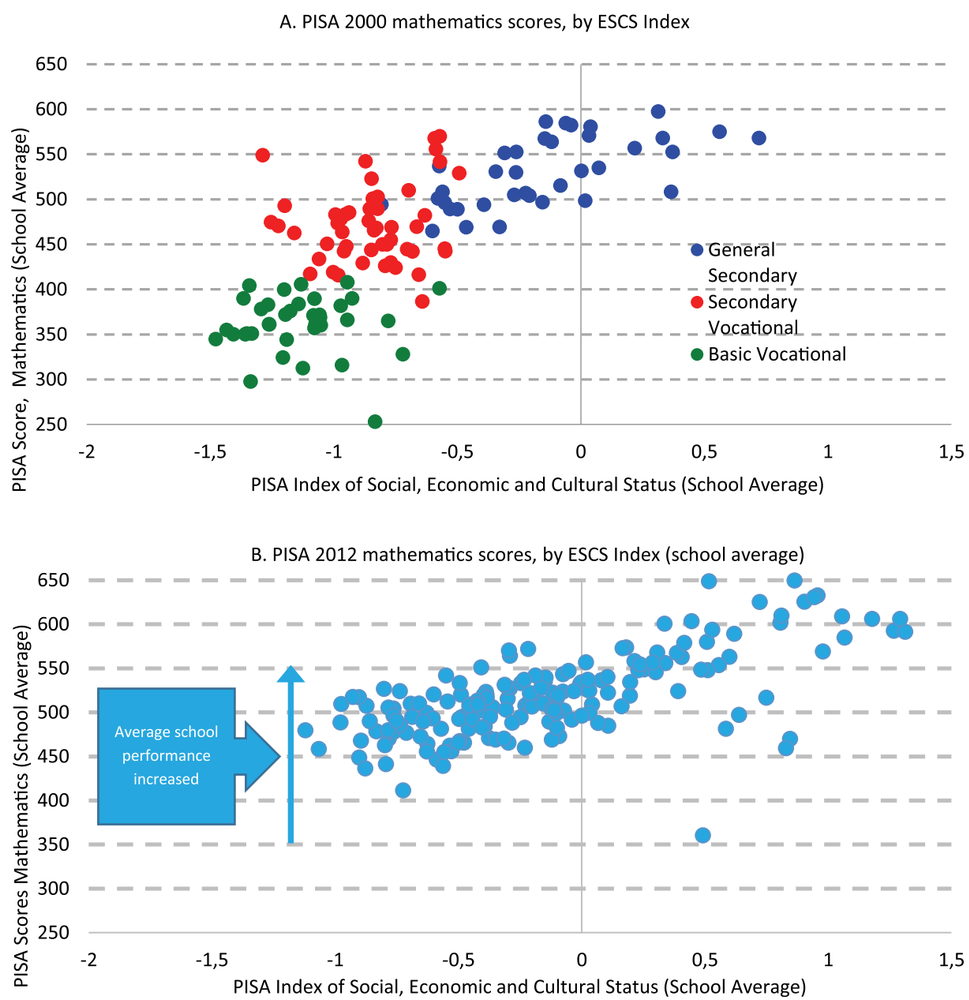
Source: PISA 2012 results (OECD 2012).

The education reform in 1999 introduced a change in the structure of the system with an effective delay of selection between general and vocational tracks by one year. This has paid off in improved aggregate performance. The reform introduced three years of comprehensive, mandatory lower-secondary education, known as *Gimnazjum*. In an analysis of the reform, Jakubowski et al. (2010) found that delaying the year when a student must choose between the general and vocational tracks, which also allowed greater exposure to general curriculum content, had a positive and significant impact on student achievement on the order of one standard deviation.

Poland's general education system prior to the 1999 reform was highly stratified by socioeconomic background, school type, and performance. Panel A in Figure 12 depicts PISA performance by school and the school-specific average ESCS in 2000, just prior to the implementation of the 1999 reform. Three key messages emerge. First, in 2000 PISA performance varied significantly by the student's socioeconomic background. Second, performance varied by type of school. Third, 15 year-olds from socioeconomically disadvantaged backgrounds were

disproportionately in basic vocational schools and vocational secondary schools, where aggregate performance was significantly behind that of general secondary schools. Panel A summarizes the above evidence in a single scatterplot, showing how students from different socioeconomic strata are distributed into different educational tracks and achieve widely differing levels of cognitive skills as measured by PISA.

Figure 12. Improvements in performance and ESCS in Polish schools between 2000 and 2012

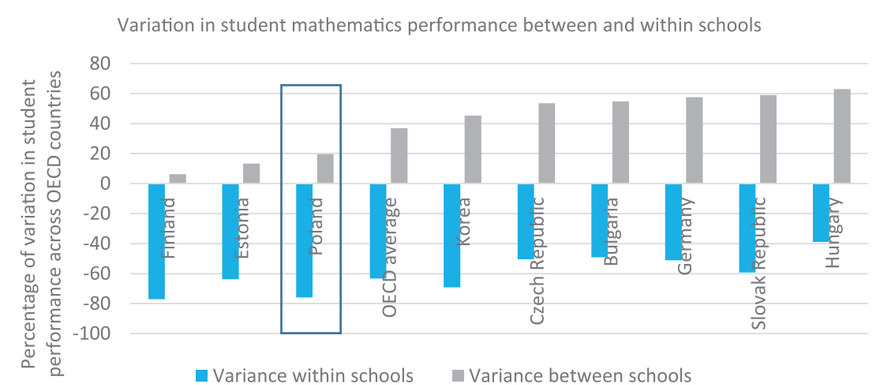


Source: World Bank Staff estimates using PISA 2000 and 2012 data. Notes: OECD average of ESCS index is 0. The ESCS school average is calculated by computing the weighted average of student's ESCS at each school.

In contrast, by 2012 PISA performance in the comprehensive lower-secondary schools had significantly increased. Figure 12 (Panel B) depicts PISA performance by school and the school-specific average ESCS in 2012. First, because of the introduction of a comprehensive lower-secondary school in grades 7-9, the chart only captures one type of school instead of three. Second, compared to 2000, performance improved significantly across the board, especially in schools scoring low on the ESCS index. Third, more schools had an average ESCS index above the OECD average. In sum, in 2012 the Polish education system was performing better overall and students were better off socioeconomically.

Most performance variation in the PISA test at age 15 in Poland today is within and not between schools. The variation in performance between schools is a measure of how big the "school effects"[1] are, and this is closely related to how students are allocated or selected into schools. Poland's variation in performance between schools has substantially decreased since 2000 (OECD, 2013a). Between-school differences in mathematics performance in 2012 accounted for as little as 20 percent of the variation in student performance in Poland. This is significantly below the OECD average (see **Figure 13**) and that of neighboring countries such as Hungary, Slovak Republic, Germany, and Bulgaria – countries with education systems that select students into general and vocational tracks at an earlier stage than Poland does and whose 15 year-olds are in different types of secondary schools compared to Poland's comprehensive lower secondary Gimnazjum – but above that in many countries with similar unitary structures like Poland, e.g. most Nordic countries.

Figure 13: Between-school variance in mathematics performance is limited in Poland



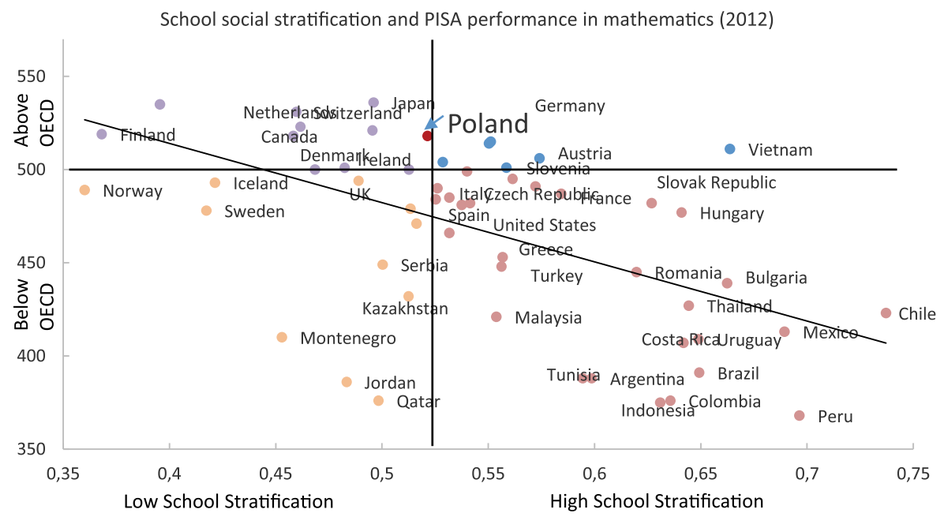
Source: OECD (2014b).

Today's low stratification of performance among lower-secondary schools in Poland goes hand in hand with Poland's moderate socioeconomic stratification. The index of school social stratification is defined as the correlation between the PISA student's socioeconomic status and the school's average socioeconomic status. In a world with little social stratification (thus an index near zero), students from different backgrounds would study together, making schools as diverse as society as a whole. Figure 14 depicts countries participating in PISA according to their index of school social stratification and mean mathematics scores. Poland is in the top left

[1] According to the OECD, school effects are the effect on academic performance of attending one school or another, usually schools that differ in resources or policies and institutional characteristics. See OECD (2013b) for a detailed description.

quadrant of countries, with its PISA mathematics scores being above and its school social stratification index being below the OECD averages. The figure also shows that the highest performing countries in PISA tend to have less socially stratified school systems. Poland is one of them. While Poland's index shifted significantly from 0.48 in 2000 to 0.58 in 2009, it is now back at 0.52 in 2012, just below the OECD average.

Figure 14: Stratification in the education system according to PISA 2012 scores



Source: World Bank staff estimates using PISA 2012 data. Note: PISA mathematics scores on vertical axis. Index of School Social Stratification on horizontal axis. The index ranges from 0 to 1. A higher index indicates a higher correlation between students' and schools' socioeconomic status. OECD mathematics score average 500 points. OECD average Index of School Social Stratification 0.525.

However, there is evidence that performance stratification emerges in upper-secondary education that is similar to the pre-1999 situation. In addition to 15-year-olds in grade 9, the PISA test has also been administered to grade 10 students in upper-secondary education in 2006 and 2009. Analysis using the data for the grade 10 test shows significant performance variation between vocational and general upper-secondary schools and a high share of students in basic vocational secondary schools performing below level 2 in the PISA test (Chłoń-Domińczak and Federowicz (2014). The evidence of a re-emergence of such performance gaps in upper-secondary education was one reason the authorities decided to introduce an identical curriculum in the first year of upper-secondary education for both general and vocational schools.

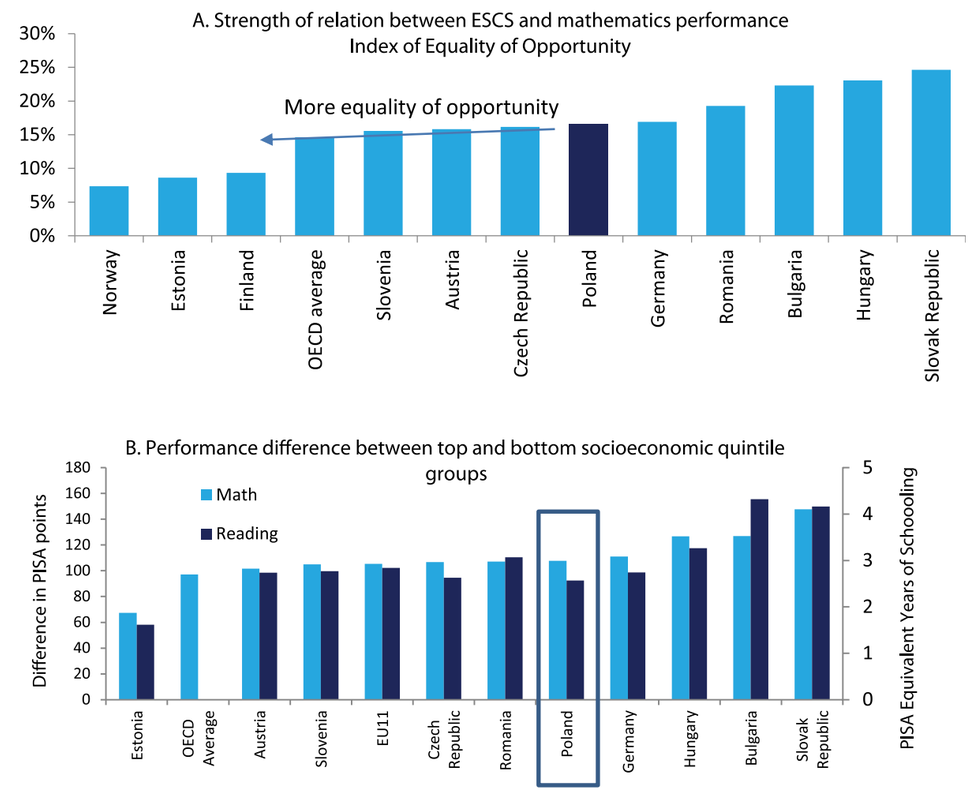
Moreover, while Poland's school system today is less stratified by performance and socioeconomic background, socioeconomic background still matters in predicting PISA performance. There are two measures that are used in this report to examine equity in education: (i) the strength of the relationship between student performance and socioeconomic status, and (ii) the PISA score gap between top and bottom ESCS quintiles.[1] Figure 15 summarizes

[1] The strength is defined as the amount of variation in outcomes in the outcomes (PISA Scores) explained by the ESCS Index, which means the predictive power of ESCS on learning outcomes (the most common measure is R-squared of linear regressions, see Ferreira and Gignoux (2011), who define this measure as "equality of opportunity": a measure of educational opportunity using the share of variance in test scores that is explained by individual predetermined

the evidence from those two measures. Slightly more than 15 percent of the variance in performance in Poland can be explained by socioeconomic status, slightly above the OECD average (Figure 15, Panel A), reflecting a reasonable equality of educational opportunities. Learning in Poland depends less on socioeconomic status than in other countries, giving students from disadvantaged backgrounds a better chance at learning and, with that, better future opportunities. However, there are countries, such as Estonia, that have better performance in PISA and, at the same time, much better equality of opportunities, suggesting that there is still room for improvement.

The difference between the top and bottom ESCS quintiles in PISA reading and mathematics scores remains large. In 2012, the difference between these quintiles was 108 points – the equivalent of almost three years of schooling and larger than the OECD average of 98 points (Figure 15, Panel B). This gap is even more striking when compared with that of other high-achieving education systems such as those in Finland, Japan, and Korea, whose gaps are only 73, 82, and 87 points, respectively.

Figure 15. Index of equality of opportunities: Poland and other countries, 2012

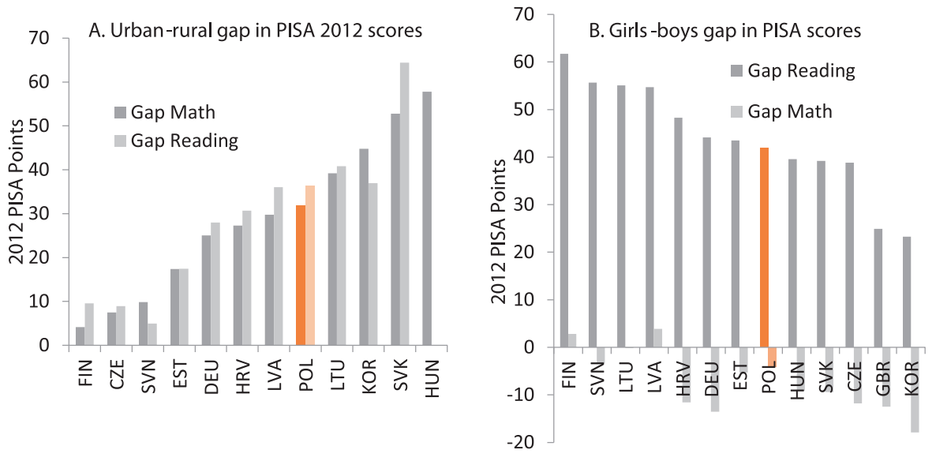


Source: World Bank staff estimations using PISA 2012 data. Note: The index is the percent of the variance in reading scores explained by the

circumstances. If a significant share of the results is explained by these characteristics, then the equality of opportunities is low). Larger differences between top and bottom SES students in PISA scores indicate a greater impact of ESCS on student performance, that is, more inequality (a more general measurement, which is used here, is the performance gap between top and bottom socioeconomic quintile groups). For a broader discussion, see Willms (2006).

Performance gaps also remain between students in urban and rural areas and between girls and boys. Even though performance variance between schools is lower than in other countries within schools, school location still matters: The PISA score gaps between students in urban and rural areas account for the equivalent of almost one year of schooling. Meanwhile, girls outperform boys in reading, but not in mathematics. However, evidence from the Progress in International Reading Literacy Study (PIRLS) in 2006 and 2011 evidence suggests a narrowing of the gap in grade 4.

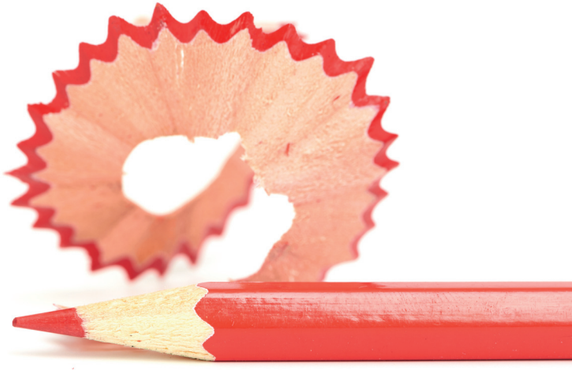
Figure 16. PISA 2012 score gaps by location and gender, Poland and comparator countries



Source: World Bank staff estimations using PISA 2012 data.

Chapter 3

Policy Implications: Remaining Challenges in the Polish Education System



3. Policy Implications: Remaining Challenges in the Polish Education System

Despite Poland's success in improving the cognitive skills of 15-year-olds as measured by PISA since 2000, important challenges remain. There are three issues that will need attention to ensure that the Polish education system continues to provide the adequate skills for future jobs and remains equitable: (i) the re-emergence of performance differentials between students in vocational and general education in upper secondary education, (ii) differences in performance across students from different socioeconomic quintiles, and (iii) relatively poor problem-solving skills.

Addressing performance gaps in upper-secondary education

Students in vocational schools in upper-secondary perform poorly in reading and mathematics. There is evidence from PISA assessments replicated for older students in upper-secondary education in 2006, 2009 and 2012 ("national option") that performance gaps between vocational and general schools for 15-year-olds found prior to the 1999 reform persist today in upper-secondary education (Chłoń-Domińczak and Federowicz, 2014). Despite successes at the lower-secondary level, the performance of students in vocational upper secondary schools trails that of their peers in general education.

Developing a policy response to this phenomenon of performance differentials by school type at the upper-secondary level would benefit from more analysis and research. This should include more in-depth research to understand the nature of the transition from lower to upper-secondary education and the drivers of selection of school types. Depending on the findings of such research, policy options might include further expanding exposure to general curriculum content, teaching practices, and assessment in upper-secondary vocational schools and embedding cognitive skills in vocational subjects, and introducing flexibility for students to switch streams while still allowing them to continue on to higher education.

Improving problem-solving skills

Poland's 15-year-olds perform relatively poorly in the PISA 2012 problem-solving assessment. The increased demand and recognized importance of creative problem-solving skills in the labor market has triggered a discussion worldwide on what types of interventions could help foster these skills. At the center of the discussion is how the curriculum, the assessment system, and classroom and teaching practices can help create learning opportunities to help students solve real-life problems. The curriculum should clearly define the acquisition of cognitive skills, such as problem-solving and creative and critical thinking, as an objective. Teaching practices need to be geared toward achieving this objective (with implications for teacher professional development) and these skills need to be captured in student assessment.

Several countries have started to revise their curricula, teaching practices, and assessment systems to emphasize the importance of problem-solving, and several have started experimentation. Singapore and Korea, the two top performers in the PISA 2012 problem-solving assessment, provide interesting examples. Singapore adopted the "Thinking Schools, Learning Nation" initiative in 1997, which created the ground for a revision of the curriculum and assessment system. It aims to promote active learning and creative and critical thinking in

schools and has involved the teaching of critical thinking and problem-solving skills (Tan and Gopinathan, 2000). In 2009 Singapore developed a 21st century competencies framework, which now guides the development of a new national curriculum (OECD, 2014c). Korea recently adopted a new curriculum that places more emphasis on critical thinking skills and creativity than the previous curriculum. Both Korea and Singapore have also made changes to assessment methods and approaches and use teacher professional development as tools to promote good teaching practices. In Korea, the university entrance exams use essays that test writing and logical thinking, while university admission criteria in Singapore were expanded beyond the secondary graduate certificate and an entrance examination to include project work in schools and extracurricular activities (Bodewig and Badiani-Magnusson, 2014). The Province of Alberta in Canada adopted a new framework for student learning that identifies critical thinking and problem-solving as key competencies across the curriculum. Interestingly, the Alberta framework was developed in a highly consultative process with contributions from students, parents, and employers (OECD, 2014c).

Poland can learn from and adapt emerging international experience and experiment with new approaches. Poland introduced a new curriculum in 2008 to help foster advanced cognitive skills, and it appears to have contributed to improvements in PISA performance in mathematics, reading, and science since 2009. Poland's relatively poor performance in the PISA 2012 problem-solving test suggests the need for continued innovation and experimentation over the coming years in classroom and teaching practices to take advantage of the possibilities that the new curriculum provides. It is also advisable to explore in depth how socio-emotional skills – critical contributors to problem-solving – can be reflected in curriculum and classroom and teaching practices.

Promoting equity

Poland's education equity challenge is different from that of several of its neighbors. Its school system at the lower-secondary level is less stratified by socioeconomic background, and relatively little of the variation in overall performance can be explained by the variation in performance between schools. This suggests that Poland has a more equitable school system than many of its neighbors. However, that is not to say that equity is not an issue in Poland. As shown, variance in mathematics and reading performance between students from the top and bottom ESCS quintiles is large (almost the equivalent of three years of schooling). Students from the bottom two ESCS quintiles are significantly more likely to score at the bottom performance level in mathematics and problem-solving. The association between socioeconomic disadvantage and poor performance points toward a policy response that combines expanding access to quality preschool education and strengthening social assistance to improve the socioeconomic conditions of children and youth.

Early childhood education has been shown worldwide to be a key tool to improve opportunities for disadvantaged children in their education and throughout life. Evidence from PISA is consistent with this: Poland's 15-year-olds who had attended pre-primary education scored 62 points higher in mathematics in 2012 than those who did not (the equivalent of a year and a half of schooling), and they scored 32 points higher after accounting for socioeconomic status. This suggests that Poland's continued emphasis on expanding access to preschool – making preschool at age five compulsory and guaranteeing a preschool place for children ages three and four – is a promising vehicle for ensuring school readiness for disadvantaged children.

Poland's social assistance system for low-income families is under review. Poland's social assistance system comprises a considerable number of permanent and temporary cash and in-kind programs, mostly means-tested and with differing objectives that include poverty reduction, support to families, and support to people with disabilities. There are also significant, well-targeted child tax credits to low-income families. Social assistance overall, as well as the biggest benefit program, the family allowance, are well targeted, but they suffer from low coverage of the poorest households and low adequacy in their benefit levels. As a result, the poverty reduction impact is limited. This suggests the need to examine the overall effectiveness of the social assistance system, especially from the perspective of poor families with children. Poland's Ministry of Finance and Ministry of Labor and Social Policy are in fact engaged in a spending review exercise focusing on strengthening financial assistance to low income families.

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Annex

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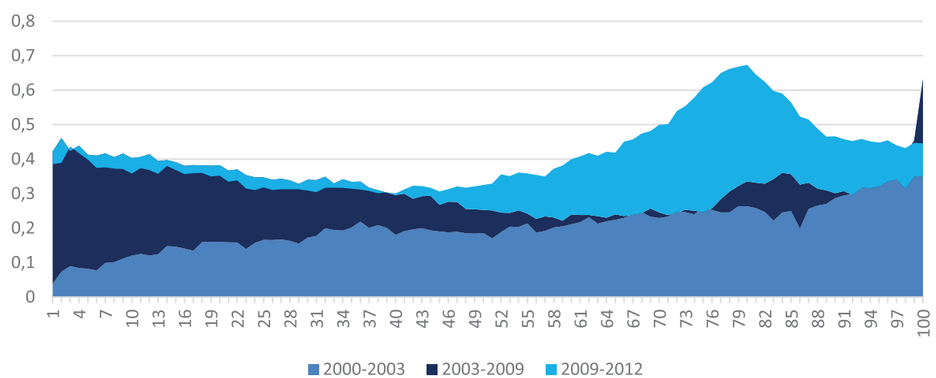
Annex

Figure A1. Evolution of ESCS 2000-2012 by percentiles



Source: World Bank staff estimations using PISA 2012 data.

Table A1. Percent of population aged 15+ by highest level of schooling attained and average years of schooling in Poland, 1990-2010

Year	Highest level attained						Average Years of Schooling			
	Primary		Secondary		Tertiary		Total	Primary	Secondary	Tertiary
	Total	Completed	Total	Completed	Total	Completed				
1990	47.5	41.7	44.9	40.1	5.9	3.4	9.06	6.94	1.94	0.19
1995	34.2	32.1	54.1	47.7	9.6	5.5	9.86	7.14	2.42	0.30
2000	27.3	26.0	59.6	52.8	10.8	6.2	10.26	7.24	2.68	0.34
2005	21.6	20.8	60.7	54.7	16.7	9.8	10.94	7.43	2.98	0.53
2010	17.1	16.1	63.7	58.4	19.0	11.4	11.32	7.39	3.32	0.61

Source: Barro-Lee Dataset (2012)