1. Education, through the eyes of a scientist

In 2015, almost one in two students – representing around 12 million 15-year-olds – was not able to complete even basic reading, mathematics or science tasks[1] in the global test known as PISA (the Programme for International Student Assessment) – and these were students living in 70 high- and middle-income countries that participated in the test. Over the past decade, there has been virtually no improvement in the learning outcomes of students in the Western world, even though expenditure on schooling rose by almost 20% during this period. In many countries, the quality of the education a student acquires can best be predicted by the student's or his or her school's postal code.

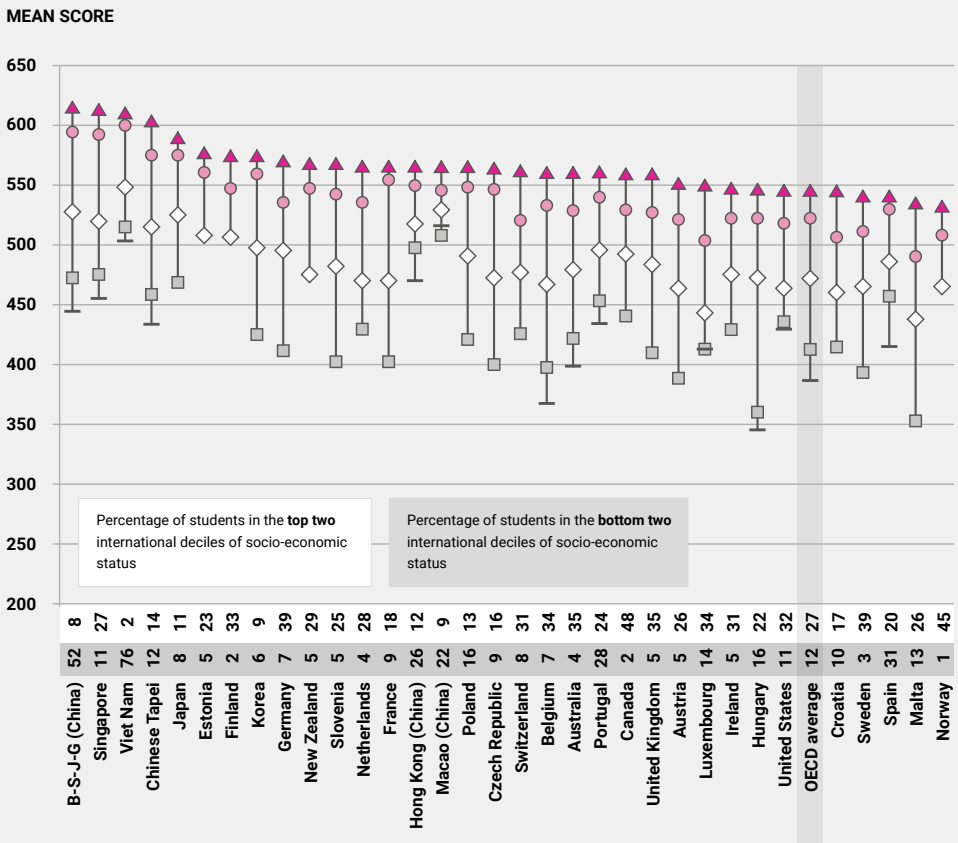
You might be tempted to drop this book, and any further thought about improving education, right about now. Impossible, you're already thinking, to change anything as big, complex and entrenched in vested interests as education.

But I want to urge you to keep reading. Why? Consider that the learning outcomes among the 10% most disadvantaged Vietnamese and Estonian students now compare favourably with those among the 10% wealthiest families in most of Latin America, and are on a par with those of the average student in Europe and the United States (***FIGURE 1.1***). Consider that in most countries we can find excellence in education in some of the most disadvantaged schools. And consider that many of today's leading education systems have only recently attained these top positions. So it can be done.

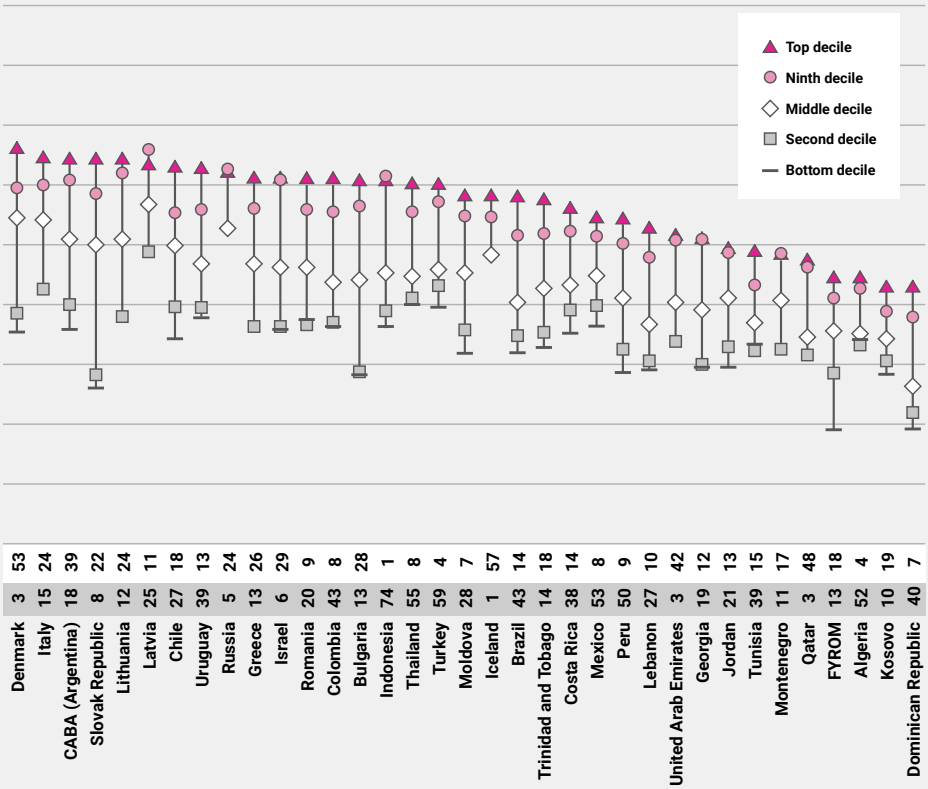
And it must be done. Without the right education, people will languish on the margins of society, countries will not be able to benefit from technological advances,

FIGURE 1.1: POVERTY NEED NOT BE DESTINY

Student performance on the PISA 2015 science test, by international decile on the PISA index of economic, social and cultural status



Notes: International deciles refer to the distribution of the PISA index of economic, social and cultural status across all countries and economies. Only countries and economies with available data are shown. B-S-J-G (China) refers to Beijing-Shanghai-Jiangsu-Guangdong (China). CABA (Argentina) refers to Ciudad Autónoma de Buenos Aires (Argentina). FYROM refers to the Former Yugoslav Republic of Macedonia.



Countries and economies are ranked in descending order of the mean science performance of students in the highest decile of the PISA index of economic, social and cultural status.

Source: OECD, PISA 2015 Database, Table I.6.4a.

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and those advances will not translate into social progress. We simply cannot develop fair and inclusive policies and engage all citizens if a lack of education prevents people from fully participating in society.

But change can be an uphill struggle. Young people are less likely to invest their time and energy in better education if that education seems irrelevant to the demands of the "real" world. Businesses are less likely to invest in their employees' lifelong learning if those workers might move away for a better job. And policy makers are more likely to prioritise the urgent over the important – even if the latter includes education, an investment in the future well-being of society.

I have been fortunate to be able to observe outstanding teaching and learning in more than 70 countries. I have accompanied education ministers and other education leaders in their efforts to design and implement forward-looking education policies and practices. While educational improvement is far easier to proclaim than to achieve, there are many successes from which we can learn. This is not about copying prefabricated solutions from other countries; it is about looking seriously and dispassionately at good practice in our own countries and elsewhere to become knowledgeable of what works in which contexts.

But the answers to tomorrow's educational challenges don't all lie in today's school systems, so following the path of today's education leaders is not enough. The challenges ahead have also become far too big to be solved by any one country on its own. This is leading educators, researchers and policy makers from around the world to join forces in the search for better answers.

In a nutshell, the kinds of things that are easy to teach have become easy to digitise and automate. The future is about pairing the artificial intelligence of computers with the cognitive, social and emotional skills, and values of human beings. It will be our imagination, our awareness and our sense of responsibility that will enable us to harness digitalisation to shape the world for the better.

The algorithms behind social media are sorting us into groups of like-minded individuals. They create virtual bubbles that amplify our views and leave us insulated from divergent perspectives; they homogenise opinions while polarising our societies. Tomorrow's schools will need to help students think for themselves and join others, with empathy, in work and citizenship. They will need to help students develop a

strong sense of right and wrong, a sensitivity to the claims that others make on us, and a grasp of the limits on individual and collective action. At work, at home and in the community, people will need a deep understanding of how others live, in different cultures and traditions, and how others think, whether as scientists or artists. Whatever tasks machines may be taking over from humans at work, the demands on our knowledge and skills to contribute meaningfully to social and civic life will keep rising.

For those with the right knowledge and skills, digitalisation and globalisation have been liberating and exciting; but for those who are insufficiently prepared, they can mean vulnerable and insecure work, and a life without prospects. Our economies are shifting towards regional hubs of production, linked together by global chains of information and goods, but concentrated where comparative advantage can be built and renewed. This makes the distribution of knowledge and wealth crucial, and that is intimately tied to the distribution of education opportunities.

But while digital technologies can have disruptive implications for our economic and social structure, they don't have predetermined implications. We have agency, and it is the nature of our collective and systemic responses to these disruptions that will determine how we are affected by them.

To transform schooling at scale, we need not just a radical, alternative vision of what's possible, but also smart strategies and effective institutions. Our current schools were invented in the industrial age, when the prevailing norms were standardisation and compliance, and when it was both effective and efficient to educate students in batches and to train teachers once for their entire working lives. The curricula that spelled out what students should learn were designed at the top of the pyramid, then translated into instructional material, teacher education and learning environments, often through multiple layers of government, until they reached and were implemented by individual teachers in the classroom.

This structure, inherited from the industrial model of work, makes change in a fast-moving world far too slow. The changes in our societies have vastly outpaced the structural capacity of our current education systems to respond. Even the best education minister can no longer do justice to the needs of millions of students, hundreds of thousands of teachers and tens of thousands of schools. The challenge is to build on the expertise of our teachers and school leaders and enlist them in

the design of superior policies and practices. This is not accomplished just by letting a thousand flowers bloom; it requires a carefully crafted enabling environment that can unleash teachers' and schools' ingenuity and build capacity for change. It requires leaders who tackle institutional structures that too often are built around the interests and habits of educators and administrators rather than learners, leaders who are sincere about social change, imaginative in policy making, and capable of using the trust they earn to deliver effective reforms.

Not less of an art, but more of a science

I entered the world of education with a different perspective from most. I had studied physics and worked for some years in the medical industry. Physicists communicate and collaborate across national and cultural boundaries around accepted principles and an established professional practice. By contrast, educators try to look at every child individually, and often with a fair bit of scepticism towards comparisons that necessarily involve generalisations.

But the biggest difference I discovered between the medical industry and education was the way in which the professions owned their professional practice. People entering the medical profession expect their practice to be transformed by research. Medical doctors would not think of themselves as professionals if they did not carefully study the most effective procedures so far developed to deal with the presenting symptoms, nor would they think of developing their own drugs.

In the medical field, the first thing we do is take the patient's temperature and diagnose what treatment will be most effective. In education, we tend to teach all students in the same way, give them the same treatment, and at times, diagnose at the end of the school year the extent to which that treatment was effective.

At Philips Medical Systems, where I had my first job, my superiors were adamant that I devote sufficient attention to testing and validating every development and piece of equipment, knowing full well that our customers might sue us for any fault they may find with our work. Meanwhile, education policy makers at the time

were putting one layer of education reform on top of the previous one, with little experimentation or quality assurance, and little public accountability.

Yet I found the world of education fascinating and understood the power of education to transform lives and societies. I also saw an opportunity to make education reform not necessarily less of an art, but more of a science.

I owe this insight to three distinguished scholars, Torsten Husen, John Keeves and, most important, Neville Postlethwaite, with whom I worked at the University of Hamburg. Neville was not only a distinguished education scholar, he also had an extraordinary capacity to initiate and conduct large-scale research projects, bringing together leading researchers from around the world to advance the field of education.

I met Neville in 1986, when I strayed, out of curiosity, into his seminar on comparative education. From the very first day, I was inspired by the ways in which he would readily share his knowledge, experience and contacts, and how he would not leave a question unanswered, as long as you had sufficiently thought about it in advance.

After a few weeks Neville asked me what I had published so far. I had to admit that I had really nothing to offer. "So", he said, "let's get started on your first paper." He taught me the methodologies of cluster analysis; he provided the data to analyse; he reviewed, corrected and discussed every page; and he convinced a publisher to publish the result. Then he put my name on the final product. Those in academia know that this process usually works the other way around.

Over the following years, as we worked together in Hamburg and in many other places, Neville became like a second father to me. He was someone who derived satisfaction from helping others grow. Even after I left the University of Hamburg to join the Organisation for Economic Co-operation and Development (OECD) in Paris, Neville would read and comment on every paper and article I sent him.

The origins of PISA

It was the idea to apply the rigours of scientific research to education policy that nudged the OECD to create PISA in the late 1990s. I remember my first meeting of senior education officials at the OECD in 1995. There were representatives from 28

countries seated around a table in Paris. Some of them were boasting that they had the world's best school system – perhaps because it was the one they knew best. When I proposed a global test that would allow countries to compare the achievements of their school systems with those of other countries, most said this couldn't be done, shouldn't be done, or wasn't the business of international organisations.

I had 30 seconds to decide whether to cut our losses or give it one more try. In the end, I handed my boss, Thomas J. Alexander, then director of the OECD Education, Employment, Labour and Social Affairs Directorate, a yellow post-it note saying: "Acknowledge that we haven't yet achieved complete consensus on this project, but ask countries if we can try a pilot." The idea of PISA was born – and Tom became its most enthusiastic promoter.

Of course, the OECD had already published numerous comparisons on education outcomes by that time, but they were mainly based on measures of years of schooling, which isn't always a good indicator of what people are actually able to do with the education they have acquired.

Our aim with PISA was not to create another layer of top-down accountability, but to help schools and policy makers shift from looking upward within the bureaucracy towards looking outward to the next teacher, the next school, the next country.

In essence, PISA counts what counts. It collects high-quality data and combines that with information on wider social outcomes; and it makes that information available to educators and policy makers so they can make more informed decisions.

The transformational idea behind PISA lay in testing the skills of students directly, through a metric that was internationally agreed upon; to link that with data from students, teachers, schools and systems to understand performance differences; and then to harness the power of collaboration to act on the data, both by creating shared points of reference and by leveraging peer pressure. Today, PISA is not only a comparison of countries through representative sample-based tests, but thousands of individual schools have voluntarily joined the separate school-based version of PISA to see where they stand globally.

We tried to make PISA different from traditional assessments in other ways too. In our view, education is about promoting passion for learning, stimulating the imagination, and developing independent decision makers who can shape the

future. So we did not mainly want to reward students for reproducing material they learned in class. To do well in PISA, students had to be able to extrapolate from what they knew, think across the boundaries of subject-matter disciplines, and apply their knowledge creatively in novel situations. If all we do is teach our children what we know, they might remember enough to follow in our footsteps; but if we teach them how to learn, they can go anywhere they want.

Some people argued that our tests were unfair, because we confronted students with problems they had not encountered in school. But then life is unfair, because the real test in life is not whether we can remember what we learned at school yesterday, but whether we will be able to solve problems that we can't possibly anticipate today. The modern world no longer rewards us just for what we know, but for what we can do with what we know.

Of course, the downside of a pilot was that we had very little money. In fact, in the first two years, there was no budget allocation for work on PISA. But that turned out to be probably our greatest strength. The way you would normally mount an assessment is that you plan something and then you hire the engineers to build it. That's how you create a test that costs millions of dollars and that is owned by an organisation – but not by the people you need to change education.

We turned that on its head. Soon the idea of PISA attracted the world's best thinkers and mobilised hundreds of educators and scientists from the participating countries to explore what we should expect from students and how we could test that. Today, we would call that crowdsourcing; but whatever you call it, it created the ownership that was critical for success.

There was another way in which building global comparisons from the bottom up turned out to be an advantage. When our first global league tables came out in 2001 and the French didn't see their schools come out well, many observers in that country concluded there must have been something wrong with the test. But Raymond Adams, the principal architect of the methodologies of PISA and co-ordinator of the PISA Project Consortium at the Australian Council for Educational Research, had an answer to this. He used the PISA test questions that had been prepared or rated highly by the French for their cultural and curricular relevance in France and compared the world through the lens of what the French viewed as most important in education.[2] (We also realised we could do this for every country.) When

those results came out in remarkably similar ways, the dispute about cross-cultural relevance and the reliability of the testing process died down quickly.

Over the years, PISA established itself as an influential force for education reform. The triennial assessment has helped policy makers lower the cost of political action by backing difficult decisions with evidence. But it has also raised the political cost of inaction by exposing areas where policy and practice were unsatisfactory. Two years after that first meeting around a table in Paris, 28 countries signed on to participate. Today, PISA brings together more than 90 countries, representing 80% of the world economy, in a global conversation about education.

"PISA shock" and the end of complacency

The first results from PISA were published on 4 December 2001 and they immediately sparked heated debate. The education landscape revealed by the test results was very different from what many had thought they knew.

What made the impact even greater was that this was one of the times when an international organisation released the complete information, without whitewashing the results. We had designed a system through which countries would know their own performance scores before agreeing that we would publish those results, but they would not know how their results compared with those of other countries. It meant that when countries decided whether to be included or to withdraw from the publication of results, they did not know how they had performed compared with other education systems.

We also used a process of anonymising the data so that we and our researchers would evaluate and analyse the results without being influenced by how our own or other countries were performing.

But that was just the beginning. With each successive PISA assessment, the results attracted more attention and triggered more discussion. The controversy reached a climax with the release of the results from the 2006 assessment in December 2007, when we examined not just where countries stood at that moment in time, but, with the availability of three data points, how things had changed since the PISA test was first conducted in 2000.

It is easy to explain why one country might not perform as well as another; it is much harder for policy makers to acknowledge that things have not improved, or that improvement has been slower than elsewhere. Inevitably, political pressures ensued. When I briefed our Secretary-General, Angel Gurría, shortly after his arrival at the OECD in 2006, he immediately saw the potential for PISA to transform education policy and he was prepared to fight for its success.

One of the most important insights from PISA was that education systems could be changed and made to improve. It showed there was nothing inevitable or fixed about how schools performed. The results also showed that there is no automatic link between social disadvantage and poor performance in school.

These results challenged anyone who remained complacent. If some countries could implement policies to raise achievement and could close the social divide in school results, then why shouldn't other countries be able to do the same?

In addition, some countries showed that success can become a consistent and predictable education outcome. These were education systems where schools were reliably good. In Finland, for example, the country with the strongest overall results in the first PISA assessment, parents could rely on consistently high performance standards in whatever school they chose to enrol their child.

The impact of PISA was naturally greatest when the results revealed that a country performed comparatively poorly, whether in absolute terms or in relation to a country's expectations. In some countries, PISA raised public awareness to the extent that it created a strong momentum for change. The biggest outcry was heard when test results contradicted the public's perception of the education system. If the public and politicians thought that their schools were among the best in the world, it came as a real jolt when PISA comparisons showed a very different picture.

In my home country, Germany, the education policy debate that followed publication of the PISA 2000 results was intense. Confronted with lower-than-expected results in student performance, policy makers suffered what came to be known as "PISA shock". That shock triggered a sustained public debate about education policy and reform that dominated the news in the country's newspapers and on television for months.

Germans took for granted that learning opportunities were equal across schools, as significant efforts had been devoted to ensuring that schools were adequately and equally resourced. But the PISA 2000 results revealed large disparities in education outcomes, depending on whether the schools were socio-economically advantaged or not. Also, the evidence of consistency across schools in Finland, where performance differences between schools accounted for only 5% of the variation in student performance, left a deep impression in Germany, where performance differences between schools accounted for close to 50% of the variation in student performance. In other words, in Germany, it very much mattered in which particular school you enrolled your child.

Traditionally, the German school system separates children into different tracks at the age of 10, with some expected to pursue an academic path leading to careers as knowledge workers, while the others are routed to vocational pathways and expected to end up in jobs working for the knowledge workers. PISA showed that this selection process largely reinforced the existing social class structure. In other words, the PISA analyses suggested that German students from more privileged socio-economic backgrounds were systematically directed into the more prestigious academic schools, which yield superior education outcomes, while students from less privileged backgrounds were directed into less prestigious vocational schools, which yielded poorer education outcomes.

For many educators and experts in Germany, the disparities that PISA revealed were not entirely surprising. But it was often taken for granted – and deemed beyond the scope of public policy to change – that disadvantaged children do badly in school. What was shocking about the PISA results was that they showed that the impact of socio-economic status on students and school performance varied considerably across countries, and that other countries appeared to reduce that impact much more effectively than Germany did. In effect, PISA showed that improvement was possible, and provided the necessary spur for change.

PISA helped establish a new attitude towards evidence and data in Germany. Remarkably, in a country where the federal government usually has little to say about school education, it was Federal Minister of Education and Research, Edelgard Bulmahn, who showed exceptional leadership in laying out a long-term vision that could transform education in Germany.

Germany virtually doubled federal spending on education in the early 2000s. But beyond money, the debate inspired a wide range of reform efforts in the country, some of which have been transformative. Early childhood care was given a stronger educational dimension, national education standards were established for schools (something that had been hard to imagine in a country where the autonomy of the *Länder* [states] had always been sacrosanct), and greater support was given to disadvantaged students, including students with an immigrant background. Nine years later, in 2009, Germany's PISA results looked much better, showing significant improvements both in quality and equity.

Germany was not the only country that improved its education system in a relatively short time. South Korea's average performance was already high in 2000, yet the Koreans were concerned that only a narrow elite had achieved levels of excellence in the PISA reading assessment. Within less than a decade, South Korea was able to double the share of top-performing students.

A major overhaul of Poland's school system helped reduce the variations in performance between schools, turn around the lowest-performing schools, and raise overall performance by the equivalent of more than half a school year. Portugal was able to consolidate its fragmented school system and improve overall performance, as did Colombia and Peru. Even those who claim that the relative standing of countries in PISA mainly reflects social and cultural factors now had to concede that improvement in education is, indeed, possible.

Estonia and Finland became popular destinations for educators and policy makers in Europe. In these two countries students enter school after the age of six and attend class for fewer hours per year than students in most other countries. But by the time they are 15, students from across the socio-economic spectrum in these countries are among the highest performers in the world. And with virtually no variation in performance among schools, these countries also manage to cultivate both excellence and equity throughout their school systems.

In the early rounds of PISA, most of the high-performing and rapidly improving education systems were found in East Asia. These results challenged conventional wisdom in the West, which had often attributed success in those Asian countries to

high pressure on students or to rote learning, sometimes because observers wrongly describe as drill and practice what is instead the consolidation of learning.[3]

To succeed in PISA, rote learning is not enough. When PISA introduced its first assessment of creative problem-solving skills in 2012, many observers predicted these would reverse the league tables, or at least show East Asia scoring at much lower levels of performance. But it was Singapore that came out on top – the country that had transformed itself from a developing country to a modern industrial economy in one generation.

When I presented these results in Singapore in March 2014, Heng Swee Keat, Education Minister at that time, underlined how much importance Singapore attached to nurturing creative and critical thinking, social and emotional skills, and character qualities. While our image of Singapore may still be shaped by limited civil society engagement and political participation, education in Singapore has gone through a silent revolution almost entirely unnoticed in the West. The country is now leading the way in the quality of its educational institutions and in the participation of its educators in designing and implementing innovative education policies.

Japan has been one of the strongest performers in PISA, but the results revealed that while students tended to do very well on tasks that require reproducing subject content, they did much less well on open-ended tasks requiring them to apply their knowledge in novel settings. Conveying that to parents and a general public who are used to multiple-choice university entrance exams was a challenge. The policy response in Japan was to incorporate "PISA-type" open-constructed tasks into the national assessment. That modification seems to have been reflected in a change in instructional practice. Between 2006 and 2009, Japan saw the most rapid improvement on open-ended tasks among OECD countries. I found this improvement most significant because it shows how a change in public policy in response to a weakness can lead to a change in what happens in the classroom.

In the West, we still often underestimate the drive East Asia has to change lives through education. When I spoke at the Asia-Pacific Economic Cooperation Leaders' Meeting in Vladivostok, Russia, in September 2012, I saw how this wasn't just of interest to educators, but how much attention this agenda was getting at the highest levels of government.

In the United States, the first PISA assessments received comparatively little attention. That changed with the release of results from the 2006 assessment. Former Governor of West Virginia, and President of the Alliance for Excellent Education, Bob Wise, had gathered together the National Governors Association, the Council of Chief State School Officers, the Business Roundtable and the Asia Society on 4 December 2007 at the National Press Club to hear the results.

A couple of months later, in February 2008, I spoke about PISA at the National Governors Association's Winter Meeting and saw great interest in international comparisons among state leaders. That same month I sat with the late Senator Edward Kennedy in his Washington office and showed him how Poland had been able to halve the share of poorly performing students within six years. His eyes lit up. My appointment with him, which had been scheduled for 20 minutes, lasted for almost three hours. In May of that year, then US Senate Majority Leader Harry Reid and Senator Kennedy scheduled a special lunch where I discussed the PISA results with some 20 senators.

Interest in PISA was gathering momentum. At a retreat with the US House Committee on Education and the Workforce in August 2009, which I attended as an external expert, there were lively discussions on policy lessons the United States could learn from the world's education leaders. One month later, I accompanied state education leaders to Finland, on a retreat hosted by the Council of Chief State School Officers.[4] No longer were we engaging in abstract discussion; American leaders were travelling to engage with their peers in the highest-performing education systems in the world.

But it was only after the following round of PISA, in 2009, that the federal government paid real attention to the results, with Arne Duncan, US Education Secretary from 2009 through 2015, in the lead. His "Race to the Top" initiative[5] was not merely about stimulating competition among US states, but about inducing states to look outwards to the best-performing education systems internationally. I served on the advisory committee of this initiative for the state of Massachusetts, generally viewed as the education posterchild in the United States. The discussions in this committee were squarely focused on how Massachusetts could close the still-significant gap between its results and those of the highest-performing education systems in the world.

Serving on the validation committee for the Common Core education standards,[6] which sought to design a framework for what students should know at each grade, I saw the impact that comparisons with high-performing education systems around the world were having on the goals for what American students should be learning in the 21st century.

Not surprisingly, PISA's impact around the world has grown thanks to extensive media coverage. (Germany even created a television programme around PISA[7] that became remarkably popular.) This has transformed a specialised debate about education into a public debate about the link between education, society and the economy.

Some governments have used PISA findings as a starting point for a peer review to study policies and practices in comparison with those in other countries that have similar challenges but are getting better results. Such peer reviews, each resulting in a set of specific policy recommendations for improvement, have become the hallmark of our work at the OECD.

PISA has stimulated peer learning not just among policy makers and researchers but also, and perhaps most important, among practitioners, including teachers' organisations and teachers' unions.

Last but not least, PISA has prompted the public to demand better education services. Parents' organisations in many countries have played an active role. In addition to contributing to parliamentary hearings in Germany, Italy, Japan, Mexico, Norway, Sweden, the United Kingdom, the United States and in the European Parliament, I have also had meetings with many organisations and industry leaders, who were not simply seeing education as a factory for the production of future workers for their companies, but who recognised the fundamental role that education plays in shaping the societies in which we live and work.

Raising the cost of political inaction

In 1997, when we embarked on PISA, I received a call from the office of Brazil's president: Brazil was interested in joining PISA. Brazil was the first country that was not a member of the OECD that expressed an interest in joining PISA and, in a way, I was surprised. Then-President Fernando Henrique Cardoso must have been aware

that his country would come out at the bottom of the global league tables. But when I discussed that with him later, he told me that the biggest obstacle for improving Brazil's education system at that time was not a lack of resources or capacity, but the fact that students were getting good marks despite low standards. Nobody thought that improvement was needed or possible. President Cardoso felt it was important for people to understand the truth. So Brazil did not just publish a national PISA score, but provided every secondary school with information on the level of progress that would be needed to score at the OECD average level on PISA by 2021.

Since then, Brazil's improvement in PISA has been remarkable. Nine years after it participated in PISA for the first time, Brazil stood out as the country with the largest improvement in reading since the first PISA assessment was conducted in 2000.

Mexico had a similar experience. In the 2007 Mexican survey of parents, 77% of parents reported that the quality of education services provided by their children's school was good or very good even though, as measured by the PISA 2006 assessment, roughly half of Mexico's 15-year-olds were enrolled in schools that scored at or below the lowest level of proficiency established by PISA. There could be many reasons for such a discrepancy between the perceived quality of education and performance in international comparisons. For example, the schools Mexican children attend now might be of higher quality than those their parents had attended.

But the point here is that it isn't easy to justify an investment of public resources when there is no public demand for it. In February 2008, I met Mexico's then-President Felipe Calderón who was considering establishing a PISA-based international performance benchmark for secondary education in Mexico. This performance target would highlight the gap between national performance and international standards. Improvements to narrow this gap, which included incentives for teaching staff and better access to professional development, would be closely monitored.

Many countries followed suit with similar PISA-based performance targets. What this shows is that countries no longer measure the effectiveness of their education systems solely by comparing learning outcomes against past achievements. They now set their goals, and measure their progress towards those goals, against what is achieved in the world's highest-performing education systems.

What's at stake

Education and the well-being of individuals and nations

How a society develops and uses the knowledge and skills of its people is among the chief determinants of its prosperity. The evidence from the Survey of Adult Skills, a product of the OECD Programme for the International Assessment of Adult Competencies (PIAAC), which grew out of PISA, shows that individuals with poor skills are severely limited in their access to better-paying and more-rewarding jobs. Digitalisation is now amplifying this pattern; as new industries rise, others will fall. It is the education available to people that provides a buffer to weather these shocks. When I met Sweden's Prime Minister Stefan Löfven in May 2016, he put his finger on this point by remarking that the only thing that can help people accept that their job may disappear is the confidence that they have the knowledge and skills to find or create a new one.

If there are large sections of the adult population with poor skills, it becomes more difficult to improve productivity and make better use of technology – and that becomes a barrier to raising living standards. But this is about far more than earnings and employment. Our research from the Survey of Adult Skills shows that people with low skills are not just more vulnerable in a changing job market, they are also more likely to feel excluded and see themselves as powerless in political processes (***FIGURE 1.2***).

The Survey of Adult Skills also shows that hand-in-hand with poorer skills goes distrust of others and of institutions. While the roots of the relationship between education, identity and trust are complex, these links matter, because trust is the glue of modern societies. Without trust in people, public institutions and well-regulated markets, public support for innovative policies is difficult to mobilise, particularly when short-term sacrifices are involved and long-term benefits are not immediately evident.

Educators naturally prefer to argue for education on moral grounds, but the link between the quality of education and the performance of an economy is strong. It is not just a hypothesis; it is something that can be measured. Calculations by Eric Hanushek, economist and senior fellow at the Hoover Institution of Stanford University, suggest that OECD countries[8] could lose USD 260 trillion in economic

output over the lifetime of the generation born this year because school systems in the industrialised world are not delivering what the best-performing education systems show can be achieved[9] (see Chapter 4 for more details). In other words, deficiencies in our education systems have an effect equivalent to a major economic recession, and this effect is permanent.

Preparing students for their future, not our past

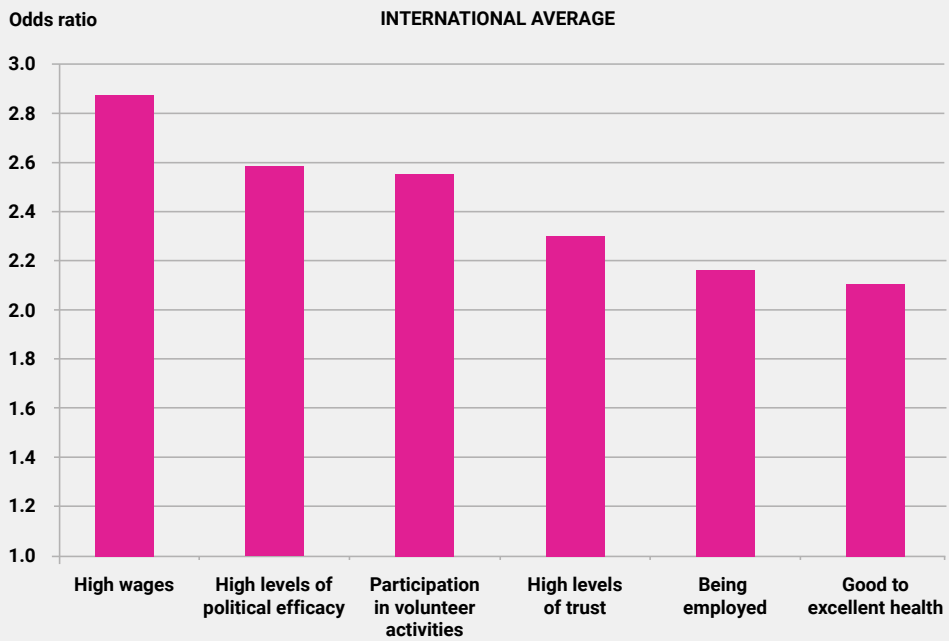
Since Confucius and Socrates, educators have recognised the double purpose of education: to impart the meaning and significance of the past, and to prepare young people for the challenges of the future. When we could still assume that what we learn in school will last for a lifetime, teaching content knowledge and routine cognitive skills was rightly at the centre of education. Today, when we can access content via search engines, and when routine cognitive tasks are being digitised and outsourced, the focus must shift to enabling people to become lifelong learners.

Lifelong learning is about constantly learning, unlearning and relearning when the contexts change. It entails continuous processes of reflection, anticipation and action. Reflective practice is needed to take a critical stance when deciding, choosing and acting, by stepping back from what is known or assumed and by taking different perspectives. Anticipation mobilises cognitive skills, such as analytical or critical thinking, to foresee what may be needed in the future or how actions taken today might have consequences for the future. Both reflective practice and anticipation contribute to the willingness to take responsible actions, in the belief that it is within the power of all of us to shape and change the course of events. This is how agency is built. So modern schools need to help students constantly evolve and grow, and to find and adjust their right place in a changing world.[10]

Schools now need to prepare students for more rapid change than ever before, to learn for jobs that have not yet been created, to tackle societal challenges that we can't yet imagine, and to use technologies that have not yet been invented. And they need to prepare students for an interconnected world in which students understand and appreciate different perspectives and world views, interact successfully and respectfully with others, and take responsible action toward sustainability and collective well-being.

FIGURE 1.2: HIGHLY LITERATE ADULTS ARE MORE LIKELY TO HAVE POSITIVE SOCIAL AND ECONOMIC OUTCOMES

Increased likelihood (odds ratio) of adults scoring at Level 4/5 in literacy reporting high earnings, high levels of trust and political efficacy, good health, participating in volunteer activities and being employed, compared with adults scoring at or below Level 1 in literacy.



Notes: Odds ratios are adjusted for age, gender, educational attainment, and immigrant and language background. High wages are defined as workers' hourly earnings that are above the country's median.

Source: Survey of Adult Skills (PIAAC) (2012, 2015), Tables A5.13, A5.14.

StatLink *http://dx.doi.org/10.1787/888932903633*

By strengthening cognitive, emotional and social resilience, education can help people, organisations and systems to persist, perhaps even flourish, amid unforeseeable disruptions. It can provide communities and institutions with the flexibility, intelligence and responsiveness they need to thrive in social and economic change.

Of course, state-of-the-art knowledge will always remain important. Innovative or creative people generally have specialised skills in a field of knowledge or a practice. As important as it is to learn how to learn, we always learn by learning something. But success in education is no longer mainly about reproducing content knowledge; it is about extrapolating from what we know and applying that knowledge creatively in novel situations. Epistemic knowledge – e.g. thinking like a scientist, philosopher or mathematician – is taking precedence over knowing specific formulae, names or places. So schooling today needs to be much more about ways of thinking (involving creativity, critical thinking, problem solving and judgement), ways of working (including communication and collaboration), tools for working (including the capacity to recognise and exploit the potential of new technologies) and about the capacity to live in a multi-faceted world as active and responsible citizens.[11]

The conventional approach in school is often to break problems down into manageable bits and pieces and then to teach students how to solve these bits and pieces. But modern societies create value by synthesising different fields of knowledge, making connections between ideas that previously seemed unrelated. That requires being familiar with and receptive to knowledge in other fields.

In today's schools, students typically learn individually and at the end of the school year, we certify their individual achievements. But the more interdependent the world becomes, the more we need great collaborators and orchestrators. Innovation is now rarely the product of individuals working in isolation, but rather an outcome of how we mobilise, share and integrate knowledge. The well-being of societies depends increasingly on people's capacity to take collective action. Schools therefore need to become better at helping students learn to develop an awareness of the pluralism of modern life. That means teaching and rewarding collaboration as well as individual academic achievement, enabling students both to think for themselves, and to act for and with others.

The reality is that students sit most of the time behind individual desks and there is limited time for collaborative learning. That was made plain – and surprisingly so – in the results from the first PISA assessment of collaborative problem-solving skills in 2015. On average across OECD countries, fewer than one in ten 15-year-old students could complete problem-solving tasks that required them to maintain awareness of group dynamics, take actions to overcome obstacles and resolve disagreements with others, even when the content of these tasks was relatively simple[12] (see Chapter 6 for more details).

More generally, changing skill demands have elevated the role of social and emotional skills. Such skills are involved in achieving goals, living and working with others, and managing emotions. They include character qualities such as perseverance, empathy or perspective taking, mindfulness, ethics, courage and leadership. In fact, developing those kinds of characteristics was what distinguished many of the elite schools that I have visited. But for the majority of students, character formation in school remains a matter of luck, depending on whether it is a priority for their teacher, since there are very few education systems that have made such broader goals an integral part of what they expect from students.

Social and emotional skills, in turn, intersect with diversity in important ways. They can help students live and work in a world in which most people need to appreciate a range of ideas, perspectives and values, and collaborate with people of different cultural origins, often bridging space and time through technology; and a world in which their lives will be affected by issues that transcend national boundaries. Effective communication and appropriate behaviour within diverse teams are also keys to success in many jobs, and will remain so as technology continues to make it easier for people to connect across the globe. Employers increasingly seek to attract learners who easily adapt, and are able to apply and transfer their skills and knowledge to new contexts. Work-readiness in an interconnected world requires young people to understand the complex dynamics of globalisation, and be open to people from different cultural backgrounds.

Engaging with different perspectives and world views requires individuals to examine the origins and implications of others' and their own assumptions. This, in turn, implies a profound respect for and interest in who the other is, their concept

of reality and their perspectives. Recognising another's position or belief is not necessarily to accept that position or belief. However, the ability to see through multiple lenses provides opportunities to deepen and question one's own perspectives and to make more mature decisions. Where we are not successful with this, we are building our education systems on sand. The bottom line is that we can try to assert boundaries, but we cannot hold them against the reality of interdependence.

The challenge is that developing these cognitive, social and emotional capabilities requires a very different approach to learning and teaching and a different calibre of teachers. Where teaching is about imparting prefabricated knowledge, countries can afford low teacher quality. And when teacher quality is low, governments tend to tell their teachers exactly what to do and exactly how they want it done, using an industrial organisation of work to get the results they want. Today the challenge is to make teaching a profession of advanced knowledge workers who work with a high level of professional autonomy and within a collaborative culture. They work as competent professionals, ethical educators, collaborative learners, innovative designers, transformational leaders and community builders.

But such people will not work as exchangeable widgets in schools organised as Taylorist workplaces that rely mainly on administrative forms of accountability, and bureaucratic command-and-control systems to direct their work. To attract the people they need, modern school systems need to transform the type of work organisation in their schools to one in which professional norms of control replace bureaucratic and administrative forms of control. The past was about received wisdom; the future is about user-generated wisdom.

The past was also divided – with teachers and content divided by subjects and students separated by expectations of their future career prospects; with schools designed to keep students inside, and the rest of the world outside; with a lack of engagement with families and a reluctance to partner with other schools. The future needs to be integrated – with an emphasis on the inter-relation of subjects and the integration of students. It also needs to be connected, so that learning is closely related to real-world contexts and contemporary issues, and open to the rich resources in the community. Effective learning environments are constantly creating synergies and finding new ways to enhance professional, social and cultural capital

with others. They do that with families and communities, with higher education, with businesses, and especially with other schools and learning environments. This is about creating innovative partnerships. Isolation in a world of complex learning systems will seriously limit potential.

Instruction in the past was subject-based; instruction in the future needs to be more project-based, building experiences that help students think across the boundaries of subject-matter disciplines. The past was hierarchical; the future is collaborative, recognising both teachers and students as resources and co-creators.

In the past, different students were taught in similar ways. Now school systems need to embrace diversity with differentiated approaches to learning. The goals of the past were standardisation and compliance, with students educated in age cohorts, following the same standard curriculum, all assessed at the same time. The future is about building instruction from students' passions and capacities, helping students personalise their learning and assessments in ways that foster engagement and talent. It's about encouraging students to be ingenious.

School systems need to better recognise that individuals learn differently, and in different ways at different stages of their lives. They need to create new ways of providing education that take learning to the learner and that are most conducive to students' progress. Learning is not a place, but an activity.

In the past, schools were technological islands, with technology often limited to supporting existing practices, and students outpacing schools in their adoption and consumption of technology. Now schools need to use the potential of technologies to liberate learning from past conventions and connect learners in new and powerful ways, with sources of knowledge, with innovative applications and with one another.

In the past, the policy focus was on providing education; now it needs to be on outcomes, shifting from looking upward in the bureaucracy towards looking outward to the next teacher, the next school and the next education system. In the past, administrations emphasised school management; now the focus needs to be on instructional leadership, with school leaders supporting, evaluating and developing high-quality teachers and designing innovative learning environments. The past was about quality control; the future is about quality assurance.

The challenge is that such system transformation cannot be mandated by government, which leads to surface compliance, nor can it be built solely from the ground up.

Governments cannot innovate in the classroom, but they can help build and communicate the case for change, and articulate a guiding vision for 21st-century learning. Government has a key role as platform and broker, as stimulator and enabler; it can focus resources, set a facilitative policy climate, and use accountability and reporting modifications to encourage new practice.

But education needs to better identify key agents of change, champion them, and find more effective approaches to scaling and disseminating innovations. That is also about finding better ways to recognise, reward and give exposure to success, to do whatever is possible to make it easier for innovators to take risks and encourage the emergence of new ideas. The past was about public versus private; the future is about public with private.

These challenges look daunting, but many education systems are now well on their way towards finding innovative responses to them, not just in isolated, local examples, but also systemically.

Looking outward for inspiration

There is a story about a driver who, on a dark night, finds out that he has lost his car key when getting back to his car. He keeps looking below a streetlight – and when someone asks him if that is where he dropped the key, he says no, but that is the only place he can see anything.

In education too, there is a deep-rooted instinct to look at what is closest to hand and easiest to see. It may not be the best place to look, but it is where there are familiar questions and answers. Often we review progress in education by what is easiest to measure rather than by what is most important. And debates on education are often based only on what's going on within a country's or a region's own schools, rather than on comparisons with what is achieved elsewhere.

While globalisation is having such a profound impact on economies, the workplace and everyday life, education remains very local and often inward-looking. Education systems have a habit of building "walls" that separate teachers, schools or the

systems themselves from learning from each another. The way schools are organised and the way information is managed can make it difficult for schools and teachers to share knowledge about their work. While those who run education systems may have access to knowledge about their strengths and weaknesses, those who provide education services at the frontline – school principals and teachers – often do not, or they may not know how to translate that knowledge into more effective practices.

Similar walls separate the education systems of different countries, with few opportunities for countries to look outward to education policies developed and implemented beyond their borders. In other words, there is not much learning from other countries' experiences. This is particularly unfortunate since, in the field of education, there is an ethical component to experimenting with alternative policies and practices, since they will involve the lives and futures of real young people.

That is why international comparisons are so important. They can show what is possible in education, in terms of the quality, equity and efficiency of services achieved by the world's leaders in education. They can help policy makers set meaningful targets based on measurable goals, and they can foster better understanding of how different education systems address similar problems. Perhaps most important, an international perspective provides an opportunity for policy makers and practitioners to have a much clearer view of their own education systems, one that reveals more of the beliefs and structures, strengths and weaknesses that underlie their systems. An education system has to be profoundly understood before it can be changed and improved.

International comparisons also reveal the pace of change in educational development. Take the examples of the United States and South Korea. In the 1960s, the United States had the world's highest rate of young people successfully completing high school.[13] As well as being an economic and military superpower, the United States was an education superpower, benefiting from the "first-mover advantage" of providing universal access to schooling. This investment in universal schooling had helped build its economic success.

But in the 1970s and 1980s, other countries began to catch up. By the 1990s, instead of being in first place in high school graduation rates, the United States was ranked 13th. While the United States remains well ahead of most other nations in the

proportion of 55-64 year-olds with both high school and university qualifications,[14] the proportion of graduates among younger age groups has slipped towards the average. The United States didn't go backwards, but it failed to move forward quickly enough, as more and more countries surpassed the United States' average level of education.

By contrast, in the 1960s, South Korea had a standard of living on a level with Afghanistan's today, and it was among the lowest performers in education. Now South Korea has the world's largest proportion of teenagers who successfully complete secondary school.[15] South Korea has transformed itself into a high-tech economy – built on a foundation of education. (One can argue that the high performance of South Korea and other East Asian education systems has come at a cost to students, who often report low levels of satisfaction with life. But according to results from the latest PISA assessment, some high-performing education systems, including Estonia, Finland, the Netherlands and Switzerland, are able to achieve good learning outcomes even as their students report high satisfaction with life – a lesson for East Asia.)

Of course, international assessments have their pitfalls. Designing reliable tests poses major challenges. The criteria for success have to be defined in ways that are both comparable across countries and meaningful at the national level. Tests must be carried out under the same conditions to yield comparable results. Beyond that, policy makers tend to use the results selectively, often in support of existing policies rather than as an instrument to explore alternatives.

Just before the results from the latest PISA assessment were published in December 2016, people from all over the world called me to find out what the major surprises in the global PISA league tables would be. But there are no surprises in international comparisons like PISA. Quality and equity in education are the result of deliberate, carefully designed and systematically implemented policies and practices. In the face of evidence from PISA of the rapid improvements that some school systems have made, even those who claim that education can only be improved on a geological timescale, or that the relative standing of countries mainly reflects social and cultural factors, must concede that it is possible to improve education systems. The most amazing lesson from PISA is that, despite their many

differences, high-performing schools and education systems share certain features that transcend cultural, national and linguistic borders. That's why it is worthwhile studying education from a global perspective.

It is time that we ask ourselves: What can we learn from the world's most advanced school systems? How can their experiences help students, teachers and school leaders in other countries? How can politicians and policy makers draw upon lessons from countries facing similar challenges and make better-informed decisions? Even when there are international examples to follow, why has it often proved difficult to learn from them and stop repeating the same mistakes? Such questions have never been more urgent to ask – and answer.