

## 6. What to do now

### **Educating for an uncertain world**

The backdrop to 21st-century education is our endangered environment. Growing populations, resource depletion and climate change compel all of us to think about sustainability and the needs of future generations. At the same time, the interaction between technology and globalisation has created new challenges and new opportunities. Digitalisation is connecting people, cities, countries and continents in ways that vastly increase our individual and collective potential. But the same forces have also made the world volatile, complex and uncertain.

Digitalisation is a democratising force: we can connect and collaborate with anyone. But digitalisation is also concentrating extraordinary power. Google creates more than a million US dollars for every employee – ten times more than the average American company, showing how technology can create scale without mass, leaving people out of the equation. Digitalisation can make the smallest voice heard everywhere. But it can also quash individuality and cultural uniqueness. Digitalisation can be incredibly empowering: the most influential companies that were created over the past decade all started out with an idea, and they had the product before they had the financial resources and physical infrastructure for delivering that product. But digitalisation can also be disempowering, when people trade their freedom in exchange for convenience and become reliant on the advice and decisions of computers.

But while digital technologies and globalisation can have disruptive implications for our economic and social structure, those implications are not predetermined. As Tom Bentley notes, it is the nature of our collective responses to these disruptions that determines their outcomes – the continuous interplay between the technological frontier and the cultural, social, institutional and economic contexts and agents that we mobilise in response.<sup>1</sup>

In this environment, the Sustainable Development Goals, set by the global community for 2030, describe a course of action to end poverty, protect the planet and ensure prosperity for all. These goals are a shared vision of humanity that provides the missing piece of the globalisation puzzle, the glue that can counter the centrifugal forces in the age of accelerations.<sup>2</sup> The extent to which those goals will be realised will depend in no small part on what happens in today's classrooms. It is educators who hold the key to ensuring that the underlying principles of the Sustainable Development Goals become a real social contract with citizens.

2030 is also the date when today's primary school pupils will be finishing their compulsory schooling. So we need to be thinking about their future in order to shape what primary school pupils are learning today.

In the social and economic sphere, the questions turn on equity and inclusion. We are born with what political scientist Robert Putnam calls “bonding social capital” – a sense of belonging to our family or other people with shared experiences, cultural norms, common purposes or pursuits.<sup>3</sup> But it requires deliberate and continuous efforts to create the kind of “bridging social capital” through which we can share experiences, ideas and innovation, and build a shared understanding among groups with diverse experiences and interests, thus increasing our radius of trust to strangers and institutions. Societies that value bridging social capital and pluralism have always been more creative, as they can draw on the best talent from anywhere, build on multiple perspectives, and nurture creativity and innovation.

Yet there is growing disenchantment with the values of pluralism and diversity. We see this in shifting political landscapes, including the rise of inward-looking populist parties.

Perhaps this should not surprise us. While better integration with the world economy has brought significant improvements in overall standards of living, it has

also widened the gap in job quality between those with better and worse knowledge and skills.<sup>4</sup> The Survey of Adult Skills (PIAAC) shows that there are over 200 million workers in OECD countries who do not even have the most basic foundation skills – in essence, they do not read as well as we would expect a 10-year-old child to read.<sup>5</sup> That is where the education agenda circles back to the agenda of inclusiveness.

How unequal can communities become before trust erodes, social capital weakens and the conditions for a thriving civil society are undermined? Taking advantage of an international labour market, cheap travel and social media networks, many choose to spend their lives in transit, changing jobs and swapping values. Others are forced to leave home by war and poverty: Mexican families heading north into the United States; Eastern Europeans moving west; those fleeing from war-torn Syria; and many hundreds of thousands more. Staying or leaving, millions of people are struggling to adapt to changing environments. Angered and confused by the flux of contemporary living, they wonder about their identity – who they are and where they stand. We will need to redouble our efforts to close the opportunity gap with imagination and innovation rather than simplistic solutions. We need to do better to figure out our common humanity.

Sustainability is another dimension of the challenge. The goal declared by the Brundtland Commission<sup>6</sup> some 30 years ago – calling for development that meets the needs of the present without compromising the ability of future generations to meet their own needs – is more relevant today than ever, in the face of environmental degradation, climate change, overconsumption and population growth. Many of our best minds are already focused on building sustainable cities, developing green technologies, redesigning systems and rethinking individual lifestyles. For the young, the challenges encapsulated in the Sustainable Development Goals are not just urgent, but often also personal and inspiring.

While sustainability aims to put the world into balance, resilience looks for ways to cope in a world that is in constant disequilibrium. Strengthening cognitive, emotional and social resilience and adaptability is perhaps the most significant challenge for modern education, as it affects virtually every part of the education system. It starts with the understanding that resilience is not a personality trait, but a process that can be learned and developed. In the 21st century, education can

help people, communities and organisations to persist, perhaps even thrive, amid unforeseeable disruptions.

There is one more element that is worth considering in this context. As discussed in Chapter 1, the Survey of Adult Skills shows that more education is not only related to better social and economic outcomes, but also to improved social and civic participation and to trust (see **FIGURE 1.2**). 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, governments, public institutions and well-regulated markets, public support for innovative policies is difficult to mobilise, particularly where short-term sacrifices are involved and where long-term benefits are not immediately evident. Less trust can also lead to lower rates of compliance with rules and regulations, and therefore lead to more stringent and bureaucratic regulations. Citizens and businesses may avoid taking risks, delaying decisions regarding investment, innovation and labour mobility that are essential to jump-start growth and social progress.

Ensuring fairness and integrity in policy development and implementation, rendering policy making more inclusive, and building real engagement with citizens all depend upon people having the knowledge, skills and character qualities to participate. Education will be key to reconciling the needs and interests of individuals, communities and nations within an equitable framework based on open borders and a sustainable future.

So we have an obligation to cultivate human potential far more equitably. This is a moral and social obligation; it is also a huge opportunity. A growth model based on human potential can produce a more dynamic economy and a more inclusive society, since talent is far more equally distributed than opportunity and financial capital. As I discussed in Chapter 4, a more equitable distribution of knowledge and skills has a complementary impact on reducing gaps in earnings. And it has this impact while also expanding the size of the economy. More inclusive progress made possible through better skills therefore has tremendous potential to ensure that the benefits of economic and social development are shared more equitably among citizens which, in turn, leads to greater overall social and economic progress.

The times when we could address inequalities mainly through economic redistribution are gone, not just because this is an uphill struggle economically,

but more important, because it does not address the much more pressing issue of social participation, where an increasingly complex world with blurring boundaries between life and work demands high levels of cognitive, social and emotional skills from all citizens. Perhaps one day machines will be able to do much of the work that is now occupying humans and reduce the demand for many skills at work. But the demands on our skills to contribute meaningfully to an increasingly complex social and civic life will keep rising.

Economic and social inequality in much of the world keeps growing, inhibiting progress and tearing societies apart.<sup>7</sup> Equity in opportunity became a fundamental education goal because in the industrial age, everyone was needed and had a role to play, so school systems were designed to deliver the same education for all students, even if they did not deliver on that goal. As Israeli historian Yuval Noah Harari notes, liberalism succeeded because there was abundant political, economic and military sense in ascribing value to every human being.<sup>8</sup> But, as he further explains, humans are in danger of losing their economic value, as biological and computer engineering make many forms of human activity redundant and decouple intelligence from consciousness. So time is of the essence if we want to broaden the goal of equity in education opportunities from providing everyone with the literacy and numeracy skills for employment, towards empowering all citizens with the cognitive, social and emotional capabilities and values to contribute to the success of tomorrow's world.

We need to address the sources of social and economic inequality, and these lie to a significant extent in the ways in which we develop and use people's talents. Every economic age has its core asset. In the agricultural age that asset was land; in the industrial age it was capital; and in our times, it is the knowledge, skills and character qualities of people. This core asset remains largely untapped and undervalued. It's time for us to change that.

## **Education as the key differentiator**

Prior to the Industrial Revolution, neither education nor technology mattered much for the vast majority of people. But when technology raced ahead of education

during that period, vast numbers of people were left behind, causing unimaginable social pain.<sup>9</sup> It took a century for public policy to respond with the gradual push to provide every child with access to schooling. That goal is now within reach for much of the world; but in the meantime, the world has changed, and neither access to schooling nor a degree guarantees success. In the digital age, technology is once again racing ahead of people's skills, and rising unemployment among graduates in much of the industrialised world is raising anxiety.

Some say that accelerating digitalisation will leave the majority of people with nothing to do. At times, it does seem as though we are living in the first age in which technology destroys jobs faster than it creates them. Even where we are creating new jobs, these are not necessarily jobs that humans perform better than machines.<sup>10</sup>

Still, I'm sceptical. When I was in high school, I had to write an essay about *The Weavers*, a play written in 1892 by the German playwright Gerhart Hauptmann. The play portrays a group of Silesian weavers who staged an uprising during the 1840s against the Industrial Revolution. It is true that the Industrial Revolution eliminated the tasks carried out by those weavers, but it did not end employment in the clothing business. In fact, once people were equipped with the new knowledge, skills and mindset needed in the industrial age, there were more and higher-paying jobs in the weaving industry than ever before – and the changes in work allowed more people to have more and better clothes than ever before. History suggests, though it has many dark twists and reversals, that our capacity for imagination and adaptation is unlimited.

However, while education has won the race with technology throughout history, there is no guarantee for that to continue. Those children who grow up with a great smartphone but a poor education will face unprecedented challenges. The least we can do now is use our capacity to reimagine the education they will need.

## **Developing knowledge, skills and character for an age of accelerations**

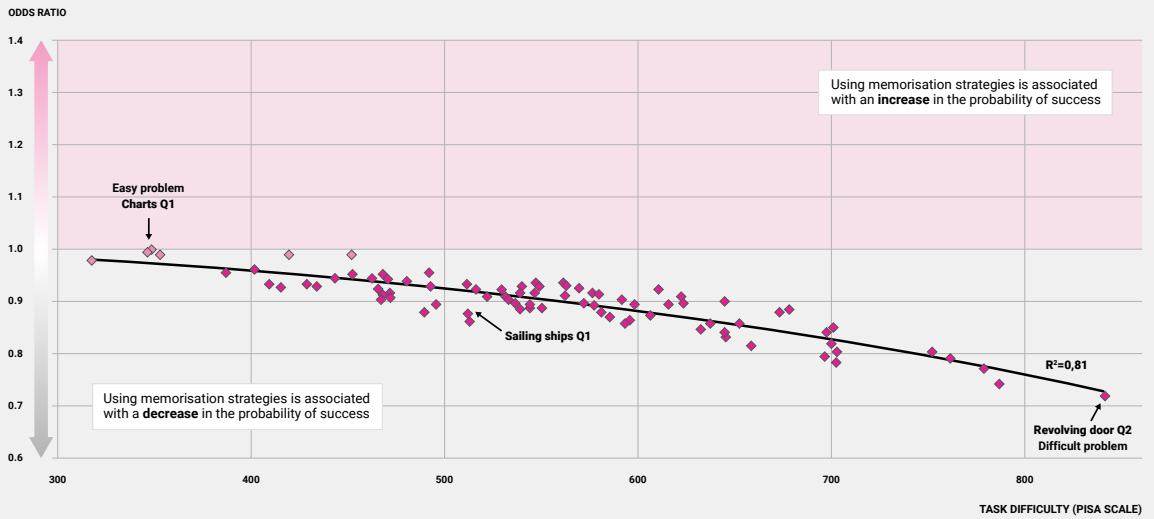
The dilemma for educators is that routine cognitive skills, the skills that are easiest to teach and easiest to test, are exactly the skills that are also easiest to digitise,

automate and outsource. David Autor, professor of economics at the Massachusetts Institute of Technology, has produced impressive data on this.<sup>11</sup> There is no question that state-of-the-art knowledge and skills in a discipline will always remain important. Innovative and creative people generally have specialised skills in a field of knowledge or a practice. As much as “learning-to-learn” skills are important, we always learn by learning something. However, success in education is no longer about reproducing content knowledge, but about extrapolating from what we know and applying that knowledge creatively in novel situations; it is also about thinking across the boundaries of disciplines. Everyone can search for – and usually find – information on the Internet; the rewards now accrue to those who know what to do with that knowledge.

The results from PISA show how learning strategies dominated by memorisation help students less and less as the tasks students are asked to complete become more complex and involve more non-routine analytic skills (**FIGURE 6.1A**)<sup>12</sup> – which is exactly where digitalisation is taking our real-life tasks.<sup>13</sup> In turn, learning strategies framed around elaboration – the process of connecting new knowledge to familiar knowledge, thinking divergently and creatively about novel solutions or about how knowledge can be transferred – are more likely to help students complete the more demanding PISA tasks that are more predictive of tomorrow’s world (**FIGURE 6.1B**).<sup>14</sup>

It is likely that future work will pair computer intelligence with humans’ social and emotional skills, attitudes and values. It will then be our capacity for innovation, our awareness and our sense of responsibility that will enable us to harness the power of artificial intelligence to shape the world for the better. That is what will enable humans to create new value, which involves processes of creating, making, bringing into being and formulating, and can generate outcomes that are innovative, fresh and original, contributing something of intrinsic positive worth. It suggests entrepreneurialism in the broadest sense – of being ready to try, without being afraid of failing. In this light, it is not surprising that employment in Europe’s creative industries, that is, industries that specialise in the use of talent for commercial purposes, grew at 3.6% during the crucial period between 2011 and 2013, a time when many European sectors were shedding jobs or showing stagnant employment rates, at best. In several leading European countries, the growth of creative jobs outpaced job creation in other sectors, including manufacturing.<sup>15</sup>

**FIGURE 6.1A: MEMORISATION IS LESS USEFUL AS TASKS BECOME MORE COMPLEX**



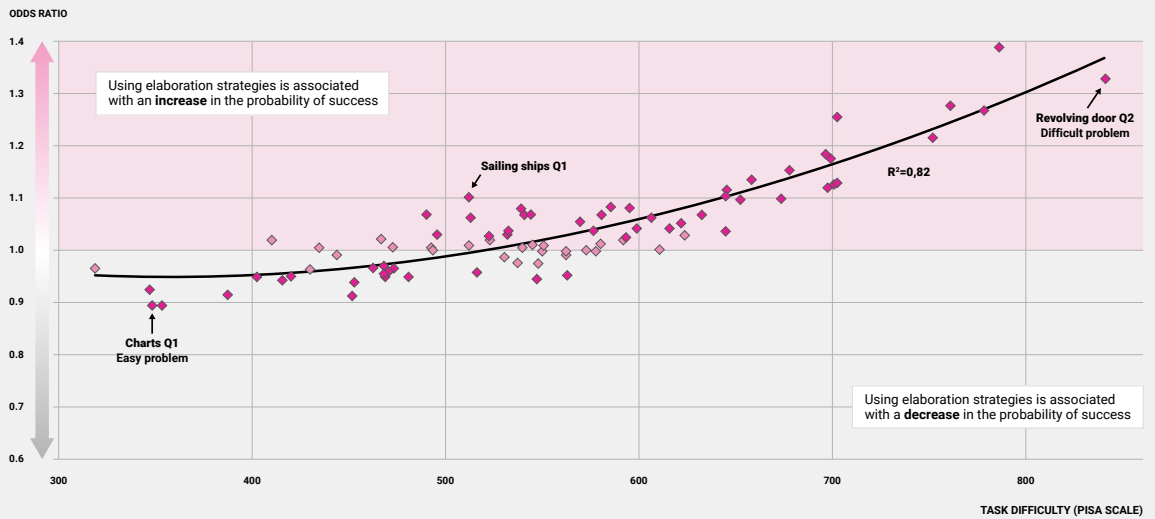
Notes: Average across 48 education systems. Diamonds in a darker tone indicate a statistically significant odds ratio. Memorisation strategies include rehearsal, routine exercises, drills and practice and/or repetition. "Easy problem" refers to the specific task, "Charts Q1", which was the easiest task in the PISA 2012 mathematics assessment. "Difficult problem" refers to the specific task, "Revolving door Q2", which was the most difficult task in the assessment.

Source: OECD, PISA 2012 Database.

StatLink  <http://dx.doi.org/10.1787/888933414854>



**FIGURE 6.1B: ELABORATION STRATEGIES ARE MORE USEFUL AS PROBLEMS BECOME MORE COMPLEX**



Notes: Average across 48 education systems. Diamonds in a darker tone indicate a statistically significant odds ratio. Elaboration strategies for learning include using analogies and examples, brainstorming, using concept maps and seeking alternative ways to find solutions. "Easy problem" refers to the specific task, "Charts Q1", which was the easiest task in the PISA 2012 mathematics assessment. "Difficult problem" refers to the specific task, "Revolving door Q2", which was the most difficult task in the assessment.

Source: OECD, PISA 2012 Database.

StatLink  <http://dx.doi.org/10.1787/888933414903>

Similarly, the more rapidly content knowledge in a subject evolves, the more important it is for students to understand the structural and conceptual foundations of a discipline (“know how”), rather than just master content with a limited shelf life (“know that”). In the field of mathematics, for example, students need to know how and why we study mathematics (epistemic beliefs), be able to think like a mathematician (epistemic understanding) and grasp the practices associated with mathematics (methodological knowledge).

We made epistemic beliefs, knowledge and understanding a focus of the PISA science assessment in 2015, assessing not just what students know, for example in the field of science, but also whether they could think like a scientist and whether they value scientific thinking. The results varied strikingly across countries, and even within regions.<sup>16</sup> For example, students in Chinese Taipei were among the highest performers on the 2015 science assessment, but in relative terms, they were significantly stronger in reproducing scientific content than in demonstrating the ability to think like scientists. Students in Singapore were stronger than their peers in Chinese Taipei in content knowledge, but they were even better on tasks requiring them to think like a scientist than on content knowledge. Students in Austria were stronger in the knowledge of scientific facts than in understanding scientific concepts, while their French counterparts were stronger in conceptual knowledge.

Such variations, even among otherwise similarly performing countries, suggest that education policy and practice can make a difference in student learning. The results should encourage policy makers and educators to reframe curricula and instructional systems so that they place greater emphasis on deep conceptual and epistemic understanding.

None of this is new; in fact, learning that focuses on thinking skills has been with us for thousands of years. In September 2016, I joined Israel’s Education Minister Naftali Bennet on a visit to the Hebron *Yeshiva*. Headed by a handful of orthodox rabbis, including Yosef Hevroni and Moshe Mordechai Ferberstein, this *yeshiva* was considered one of the flagship institutions for those studying traditional Jewish texts and legal codes.

In contrast to conventional classroom learning, in which a teacher lectures and students are the consumers of that knowledge, students at the *yeshiva* learn in

pairs, with occasional advice or guidance from a teacher. Among the 1 400 students who were learning in one giant classroom, I could detect no more than two dozen teachers, so this was all about learning, not about teaching. The learning experiences I saw there asked students to challenge each other, analyse and explain the material together, point out errors in their partner's reasoning, question and develop each other's ideas, and arrive at new insights into the meaning of the text they studied. The word *hevruta* is ancient Aramaic and is translated as "pair" or "couple", so collaborative learning is the essential learning format – except when one *hevruta* fails to crack a challenge or understand a text, in which case it turns to the two people sitting next to it forming a group of four, which could then grow to six or eight – until they resolve the challenge. Then the students return to their original pairs.

Here, the learning was loud and animated, as the study partners debated and argued their points of view. It was the complete opposite of a traditional Western library where only the eyes work in an atmosphere of absolute quiet. The idea is to help students keep their minds focused on learning, sharpen their reasoning powers, organise thoughts into logical arguments, and understand another person's viewpoint, rather than memorising anything. The goal is not to come up with "the correct" interpretation, but rather to develop a deeper understanding about the argument. Why do viewpoints differ? What are the possible outcomes from disagreement? What proofs are offered to substantiate the views? The best students are those who can ask a question that challenges the teacher's ability to respond. In a way, this seems to be the mother of enquiry-based learning and modern pedagogy.

And yet, like so many other innovations in education, this approach to learning has made few inroads into regular classrooms, either in Israel or elsewhere. It remains frozen in time and limited to religious texts and the complex legal codes of traditional Jewish law. That seems to be one of the fundamental difficulties about education reform: education's industrial work organisation helps us get ideas into schools and classrooms, but it is not as good in moving ideas from classrooms and schools into the system as a whole, to scale and spread promising practice.

## ■ Connecting the dots

Innovation and problem solving also depend increasingly on being able to bring together disparate elements, and then synthesise them to create something different and unexpected. This involves curiosity, open-mindedness, and making connections between ideas that previously seemed unrelated. It requires being familiar with knowledge in a range of fields. If we spend our whole life in the silo of a single discipline, we will not gain the imaginative skills to connect the dots and develop the next life-changing invention. Again, the PISA assessment reveals how difficult it is for students to think across the boundaries of school disciplines and solve cross-curricular tasks.

Still, some countries have been trying to develop cross-curricular capabilities. Japan's network of Kosen schools is one example. Its president, Isao Taniguchi, showed me around the Tokyo campus in early 2018. At first sight, the campus looks like a vocational school, since much of the learning is hands-on, collaborative and project-based. But for those who associate hands-on learning with an academically less-rigorous curriculum, Kosen is profoundly different. In fact, the 51 Kosen schools are among Japan's most selective high schools and colleges, and the curriculum is as much about liberal arts as about technical and scientific studies. Some 40% of the graduates will continue studying at university; those who choose to enter the labour market directly can expect an average of 20 job offers as Japan's most sought-after innovators and engineers.

What makes the Kosen schools different is their unique blend of classroom-based and hands-on project-based learning, where learning is cross-curricular and student-centred, and where teachers are mainly coaches and mentors. This is not about the kind of contrived one-week projects that have now become fashionable in many schools around the world; students will typically work for several years on developing and realising their big idea. Riki Ishikawa, a student specialising in electrical engineering, invited me to an amazing virtual-reality experience of white-water rafting. Daisuke Suzuki, a chemistry student, was working on a low-cost solution to purify soil from heavy metal pollution. Unlike most other school projects, the fruits of their work don't typically end up in a bin, but often in an incubator where they find their way to market as one of Japan's many innovations. None of the

students I met knew anyone who had dropped out of this demanding programme. While project-based learning has only recently gained widespread traction, the Kosen schools have been in operation since the early 1960s.

In the late 1990s, Japan tried to introduce a cross-curricular approach to learning in its regular schools too, through the course of integrated studies.<sup>17</sup> Its impact was limited, however, because the course was insufficiently embedded in teachers' practice, particularly in secondary schools where exams focus on knowledge of single disciplines.

More recently, Finland has made project-based and cross-disciplinary learning central to all students' education. Confronted with problems similar to those found in real life, students are required to, for example, think like a scientist, like an historian and like a philosopher, all at the same time.<sup>18</sup> But even teachers in Finland find it difficult to meet this standard. Students will only learn to think in multidisciplinary ways when teachers themselves have sufficient knowledge about different disciplines and can collaborate across them. But the fragmented organisation of school days and teachers' work means that there is often limited room for such collaboration across subjects.

In addition, the world is also no longer divided into specialists, who know a lot about very little, and generalists, who know a little about a lot. Specialists generally have deep skills and narrow scope, giving them expertise that is recognised by peers but not always valued outside their domain. Generalists have broad scope but shallow skills. What counts today are people who are able to apply a depth of knowledge to new situations and experiences, gaining new skills, building new relationships and assuming new roles in the process: people who are capable of constantly learning, unlearning and relearning in a fast-changing world when the contexts change. Helping students develop effective learning strategies and metacognitive abilities, such as self-awareness, self-regulation and self-adaptation, will become increasingly important, and should be a more explicit goal in curricula and instructional practice.

### ■ Learning to be critical consumers of information

The more knowledge that technology allows us to search and access, the more important becomes deep understanding and the capacity to make sense out

of content. Understanding involves knowledge and information, concepts and ideas, practical skills and intuitions. But fundamentally, it involves bringing them together, integrating and applying them, in ways that are appropriate to the learner's context. It also involves the capacity to inform our aspirations for the future with an understanding of the past: the challenges that societies have faced, the solutions they have discovered, and the values they have developed and defended over time.

In the “post-truth” climate in which we now find ourselves, quantity seems to be valued more than quality when it comes to information. Assertions that “feel right” but have no basis in fact become accepted as fact. Algorithms that sort us into groups of like-minded individuals create social media echo chambers that amplify our views, leaving us uninformed of and insulated from opposing arguments that may alter our own beliefs. These virtual bubbles homogenise opinions and polarise our societies; and they can have a significant – and adverse – impact on democratic processes. Those algorithms are not a design flaw; they are how social media work. There is scarce attention, but an abundance of information. We are living in this digital bazaar where anything that is not built for the network age is cracking apart under its pressure.

To what extent should we approach the issue from a consumer-protection angle, that is, restricting providers of information, or from a skills angle, that is, strengthening the capacity of people to better navigate through a tidal wave of information? It is interesting that we haven't touched knowledge products in the same way that we address consumer-protection issues with physical products. People have sued McDonalds when they suffered from obesity or Starbucks when they burned themselves with hot coffee.<sup>19</sup> But it seems very hard to fight against fake news, because tinkering with free speech tends to be regarded as an assault on democratic principles.

Rather than protecting people from information, it may be more fruitful to strengthen people's capacity to sort through the information they receive. Students need to be able to distinguish between credible and untrustworthy sources of information, between fact and fiction. They need to be able to question or seek to improve the accepted knowledge and practices of our times. Literacy in the 20th century was about extracting and processing pre-coded information; in the 21st century, it is about constructing and validating knowledge. In the past, teachers

could tell students to look up information in an encyclopaedia, and to rely on that information as accurate and true. Nowadays, Google, Baidu or Yandex presents us with millions of answers to any question, and the task of readers is to triangulate, evaluate and build knowledge.

The growing complexity of modern living, for individuals, communities and societies, suggests that the solutions to our problems will also be complex: in a structurally imbalanced world, the imperative of reconciling diverse perspectives and interests, in local settings with sometimes global implications, will require young people to become adept in handling tensions, dilemmas and trade-offs. Striking a balance between competing demands – equity and freedom, autonomy and community, innovation and continuity, efficiency and democratic process – will rarely lead to an either/or choice or even a single solution. Individuals will need to think in a more integrated way that recognises interconnections. Underpinning these cognitive skills are empathy (the ability to understand another's perspective and to have a visceral or emotional reaction); adaptability (the ability to rethink and change one's perceptions, practices and decisions in the light of fresh experience, new information and additional insight); and trust.

Dealing with novelty, change, diversity and ambiguity assumes that individuals can “think for themselves”. Creativity in problem solving requires the capacity to consider the future consequences of one's actions, evaluate risk and reward, and assume accountability for the products of one's work. This suggests a sense of responsibility, and moral and intellectual maturity, with which a person can reflect upon and evaluate his or her actions in the light of their experiences and personal and societal goals. The perception and assessment of what is right or wrong, good or bad in a specific situation is about ethics. It implies asking questions related to norms, values, meanings and limits, such as: What should I do? Was I right to do that? Where are the limits? Knowing the consequences of what I did, should I have done it? Central to this is the concept of self-regulation, which involves self-control, self-efficacy, responsibility, problem-solving and adaptability. Advances in developmental neuroscience show that a second burst of brain plasticity takes place during adolescence, and that the brain regions and systems that are especially plastic are those implicated in the development of self-regulation.

## ■ Collaborating with others

We also need to think more about teaching and rewarding collaboration in addition to individual achievement. In today's schools, students typically learn individually, and at the end of the school year we test and certify their individual achievements. But the more interdependent the world becomes, the more we need effective collaborators. Innovation today is rarely the product of individuals working in isolation but an outcome of how we mobilise, share and link knowledge.

To help develop agency among learners, educators need to recognise not just learners' individuality, but also the wider set of relationships – with their teachers, peers, families and communities – that influence student learning. At the heart of this is “co-agency” – the interactive, mutually supportive relationships that help learners progress. In this sense, everyone should be considered a learner, not only students but also teachers, school managers, parents and communities.

We often overlook the fact that collaborative learning is also a great way to inspire self-regulated and enquiry-based learning. For a time, massive open online courses, known as MOOCs, seemed to offer an attractive alternative to expensive instruction; but completion rates for MOOCs have remained dismal. Part of the reason for this is that we have not yet figured out reliable methods of accreditation, so that it is difficult for learners to convert their MOOC experience into qualifications that are relevant in the labour market.

But the bigger part of the problem is the “read-only” mode of many of these online courses: they replicate the lecture format but without the benefit of a motivating teacher. Holm Keller, former vice president of Leuphana University in Germany, developed an interesting collaborative variant of a MOOC for PISA, called PISA4U.<sup>20</sup> He asked potential learners, most of them professional educators, to subscribe to a course and then grouped them based on an algorithm so that members of the group shared common aspirations about their education goals, but were as diverse as possible in virtually every other way. Those diverse groups then identified and worked on problems collaboratively, with each individual supported by an online mentor, and each group supported by an experienced tutor. Over 6 000 teachers from 172 countries took part in piloting PISA4U. Completion rates were high; and most participants said that the key to their enthusiasm was working with people from



different countries and cultures, with different interests and experiences. The pilot was so successful that we are now building a permanent digital platform for it.

In 2015, PISA carried out the world's first international assessment of collaborative problem-solving skills, defined as the capacity of students to solve problems by pooling their knowledge, skills and efforts with others.<sup>21</sup> As one would expect, students who have stronger reading or mathematics skills also tend to be better at collaborative problem solving, because managing and interpreting information, and complex reasoning are always required to solve problems. The same holds across countries: top-performing countries in PISA, like Japan, Singapore and South Korea in Asia, Estonia and Finland in Europe, and Canada in North America, also came out on top in the PISA assessment of collaborative problem solving.

But there are countries where students did much better in collaborative problem solving than what one would predict from their performance in the PISA science, reading and mathematics assessments. For example, Japanese students did very well in those subjects, but they did even better in collaborative problem solving. The same holds for students in Australia, New Zealand and South Korea. Students in the United States also did much better in collaborative problem solving than one would expect from their average performance in reading and science, and their below-average performance in mathematics. By contrast, students in the four Chinese cities and provinces that took part in PISA (Beijing, Shanghai, Jiangsu and Guangdong) did well in mathematics and science, but came out just average in collaborative problem solving. Likewise, in Lithuania, Montenegro, the Russian Federation, Tunisia, Turkey and the United Arab Emirates, students punched below their weight in collaborative problem solving. In a nutshell, while the absence of science, mathematics and reading skills does not imply the presence of social skills, social skills are not an automatic by-product of the development of academic skills either.

The results show that some countries do much better than others in developing students' collaborative problem-solving skills, but all countries need to make headway in preparing students for a much more demanding world. An average of only 8% of students can complete problem-solving tasks with fairly high collaboration complexity. These are tasks that require them to maintain awareness of group dynamics, take the initiative to overcome obstacles, and resolve disagreements and

conflicts. Even in top-performer Singapore, just one in five students attained this level. Still, three in four students showed that they can contribute to a collaborative effort to solve a problem of medium difficulty and that they can consider different perspectives in their interactions.

Similarly, all countries need to do better in reducing gender disparities. When PISA assessed individual problem-solving skills in 2012, boys scored higher than girls in most countries. By contrast, in the 2015 assessment of collaborative problem solving, girls outperformed boys in every country, both before and after considering their performance in science, reading and mathematics. The relative size of the gender gap in collaborative problem-solving performance is even larger than it is in reading.

These results are mirrored in students' attitudes towards collaboration. Girls reported more positive attitudes towards relationships, meaning that they tend to be more interested in others' opinions and want others to succeed. Boys, on the other hand, are more likely to see the instrumental benefits of teamwork, and how collaboration can help them work more effectively and efficiently.

As positive attitudes towards collaboration are linked with the collaboration-related component of performance in the PISA assessment, this opens up one avenue for intervention. Even if the causal nature of the relationship is unclear, if schools foster boys' appreciation of others and their interpersonal friendships and relationships, then they may also see better outcomes among boys in collaborative problem solving.

There seem to be factors in the classroom environment that relate to those attitudes. PISA asked students how often they engage in communication-intensive activities, such as explaining their ideas in science class; spending time in the laboratory doing practical experiments; arguing about science questions; and taking part in class debates about investigations. The results show a clear relationship between these activities and positive attitudes towards collaboration. On average, valuing relationships and teamwork is more prevalent among students who reported that they participate in these activities more often.

Many schools can also do better in fostering a learning climate where students develop a sense of belonging, and where they are free of fear. Students who reported more positive student-student interactions scored higher in collaborative problem

solving, even after considering the socio-economic profile of students and schools. Students who do not feel threatened by other students also scored higher in collaborative problem solving.

It is interesting that disadvantaged students see the value of teamwork often more clearly than their advantaged peers. They tended to report more often that teamwork improves their own efficiency, that they prefer working as part of a team to working alone, and that they think teams make better decisions than individuals. Schools that succeed in building on those attitudes by designing collaborative learning environments might be able to engage disadvantaged students in new ways.

Education does not end at the school gate when it comes to helping students develop their social skills. For a start, parents need to play their part. For example, students scored much higher in the collaborative problem-solving assessment when they reported that they had talked to their parents outside of school on the day prior to the PISA test, and also when their parents agreed that they are interested in their child's school activities or encourage them to be confident.

Collaborative problem-solving skills are, of course, just one facet of a much wider range of social and emotional skills that students need to live and work together throughout their lives. As I discussed in Chapter 1, these skills are related to the character qualities of perseverance, empathy, resilience, mindfulness, courage and leadership.

I gave the opening keynote at the 2016 OEB educational technology conference in Berlin on 21st-century skills.<sup>22</sup> Many fascinating views on the potential role of technology in education were offered at the conference, and sometimes the line between human and computer-based capacities seemed to blur. But Tricia Wang,<sup>23</sup> Global Technology Ethnographer and Co-Founder of Constellate Data, defined that line as the ability to take another person's perspective. She explained how that skill was growing in importance in the tech sector as computers were being asked to – and designed to – handle more and more cognitive tasks.

It's a tall order, but schools need to help students learn to be autonomous in their thinking and develop an identity that is aware of the pluralism of modern living. At work, at home and in the community, people will need a broad comprehension of how others live, in different cultures and traditions, and how others think, as

scientists, mathematicians, social scientists and artists. Not least, the ability to read and understand diversity, and to recognise the core liberal values of our societies, such as tolerance and empathy, may also be one of the most powerful responses to extremism. In short, schools now need to enable students to think for themselves and act with and for others.

All this has motivated us to integrate the concept of global competence into PISA, by assessing a set of capabilities that enable people to see the world through different eyes and appreciate different ideas, perspectives and values. PISA conceives of global competence as a multidimensional, lifelong learning goal. Globally competent individuals can examine local, global and intercultural issues, understand and appreciate different perspectives and world views, interact successfully and respectfully with others, and take responsible action toward sustainability and collective well-being (see Chapter 4).

It is a formidable scientific challenge to measure global competence, as such a construct of social and civic inclusion involves so many varied cognitive, social and emotional components. But the more striking aspect is how difficult it has been to gather political support for the effort among countries that participate in PISA. Only a minority of countries has so far agreed to implement this component of the PISA assessment.

## The value of values

That brings me to the toughest challenge in modern education: how to incorporate values into education. Values have always been central to education, but it is time that they move from implicit aspirations to explicit education goals and practices in ways that help communities shift from situational values – meaning “I do whatever a situation allows me to do” – to sustainable values that generate trust, social bonds and hope. As New York Times columnist Thomas Friedman puts it, “points of view, traditions and conventional wisdom that looked to be as solid as an iceberg, and just as permanent, can now suddenly melt away in a day, in ways that used to take a generation”. And as he notes further, “if society doesn’t build foundations under people, many will try to build walls, no matter how self-defeating that would be.”<sup>24</sup>

In 2011, when I visited the areas of northeast Japan that had been devastated by the tsunami a few months earlier, I saw how well-established cities could disappear overnight, and how people and schools are suddenly confronted with an entirely new set of challenges. But I also saw how strong societal foundations and resilient communities can meet such challenges.

I had been to Japan more than 50 times before, but this visit to Iwate prefecture made a profound impression on me. Driving for hours along the coastline through endless areas where entire villages had been swept away when the tsunami hit on 11 March 2011, I could see nothing left except the foundations of houses. In some places, one ruin after the other was marked with circles and red crosses, signalling where people had lost not just their homes but also their loved ones.

While temporary housing had been erected and public infrastructure repaired at impressive speed, re-establishing civic life proved to be a much greater challenge. The principals of Funakoshi and Ohtsuchi elementary schools, who were running the temporary Rikuchu-Sanriku school, showed the dynamism and creativity that Japan's educators can bring to bear, if they choose to unleash it. In fact, just before I met them I had visited the remains of the old Funakoshi Elementary School, a school that looked like just about any other in the world, with long dark corridors, classrooms and a teachers' room upstairs.

But the Rikucho-Sanriku temporary school was different. The gymnasium hosted three classes in an open learning space and the teachers' rooms faced the "classroom". Together, students and teachers found creative solutions to ease the difficult conditions, fostering mutual respect and responsibility at the same time.

As the head teacher explained, when one class had a music lesson, the others would go outside for sports. The teachers could not preserve much from the old school library, but community groups had chipped in to donate books and whatever else was needed; and there seemed nothing that you couldn't build from cardboard. In some ways, the tsunami had transformed a school of the past into a learning environment for the future.

The most moving reports were those from teachers. Even in normal times, Japan is a country where there seems no boundary between the public and private lives of teachers. Teachers there feel a deep commitment not just to the intellectual

development of their students, but also to their students' social and emotional lives at school and at home. The crisis only amplified this, with teachers taking on an incredible amount of additional responsibility with little material and psychological support.

Many teachers had risked their lives to save their students. One high school teacher recounted how he had reached out to save a child being swept away by the violent floods, but missed the child's hand by just a few centimetres. Another teacher had rescued all the children in the school after the initial earthquake hit and brought them to higher ground. When the parents of one of the children arrived and demanded to take her home, the teacher was not convinced that it was the right thing to do, but didn't refuse. The child and her family died on their way down to the city when the tsunami struck.

I was deeply impressed by the more than 12 000 members of the Japan Teachers' Union who volunteered in the tsunami-hit area. Few people I have met share such a deep commitment to the future of Japan's children than the vice president of the JIU and her colleagues in Iwate prefecture.

The point is that if we want to stay ahead of technological developments, we have to find and refine the qualities that are unique to our humanity, and that complement, not compete with, capacities we have created in our computers.

Trying to limit education to the delivery of academic knowledge carries the risk that education ends up dumbing people down to compete with computers, rather than focusing on core human traits that will enable education to stay ahead of technological and social developments. Ask yourself why it is so much easier for digital technologies to replace today's office workers rather than yesterday's hunter-gatherers. The answer is that in Taylorising work organisation and specialising human skills, we have lost many of the human capabilities that may have no direct instrumental value at work.

In October 2016, I met Josh Yates, from the Institute for Advanced Studies in Culture in Virginia, the United States,<sup>25</sup> who proposes an intriguing framework of the key endowments needed for learning and human development. He speaks about the true (the realm of human knowledge and learning); the beautiful (the realm of creativity, aesthetics and design); the good (the realm of ethics); the just and well-

ordered (the realm of political and civic life); and the sustainable (the realm of natural and physical health).

Singapore was the first country I came across that places values explicitly at the centre of its curriculum framework. It emphasises respect, responsibility, resilience, integrity, care and harmony in school. These values are meant to shape students' character qualities, such as self- and social awareness, relationship management, self-management and responsible decision making. In fact, this framework refers to character qualities as "values in action".<sup>26</sup>

As a whole, the Singaporean curriculum framework is designed to nurture a confident person, a self-directed learner, a concerned citizen and an active contributor. Singapore's schools use the framework to design curricular and co-curricular programmes that will help students develop the requisite competencies. In addition, every student is expected to participate in "Values-in-Action" programmes that help build a sense of social responsibility. Still, even in Singapore, much of this remains an aspiration that is at best only partially reflected in how students actually learn and teachers actually teach.

While the case for creating and implementing a new 21st-century curriculum is strong, there seems to be an equally strong alliance standing in the way of change. Parents who worry that their child will not pass an exam may not trust any approach that promises to achieve more with less. Teachers and their unions may worry that if they are asked to teach more subjective material, such as social and emotional skills, they will no longer be assessed just for what they teach but also for who they are. School administrators and policy makers may feel that they will no longer be able to manage schools and school systems when the metric for success shifts from easily quantifiable content knowledge to certain human qualities that may not reveal themselves in full until well after their students graduate. Developing convincing responses to these concerns will require a courageous approach towards the design of modern curricula and assessments. Devising school curricula for the next generation that move beyond past experience will therefore require extraordinary leadership. It will involve explaining and advocating for study plans and assessments that prioritise depth of understanding, and encourage breadth of engagement in learning across the community.

## The changing face of successful school systems

Many countries have responded to new demands on what students should learn by layering more and more content on top of their curriculum, with the result that curricula have often become a mile wide but just an inch deep. Teachers are ploughing through a large amount of subject-matter content but with little depth. Adding new material provides an easy way to show that education systems are responding to emerging demands, while it is really hard to remove material from instructional systems. Some countries have looked to broaden the learning experience by integrating new subjects, topics and themes into traditional curriculum areas, often under the flag of an interdisciplinary approach. Other countries have reduced the amount of learning material to provide teachers with more space for depth (see also Chapter 3).

What is needed is a careful balance between a “negotiated” and a designed curriculum. In other words, there has to be both wide consultation and compromise in selecting what should be taught and a well-designed end product. That, in turn, will inspire public confidence and the engagement of the profession.

Finding the right balance is not easy. For example: the question many pose in this technology-rich world is whether today’s students should learn coding. There are intriguing examples of schools all around the world that teach coding. But the risk is that we will again be teaching students today’s techniques to solve today’s problems. By the time those students graduate, those techniques may already be obsolete. The larger question this example poses is: how can we strengthen a deep understanding of and engagement with the underlying concepts of digitalisation without being distracted by today’s digital tools?

What is important is to think more systematically about what we want to achieve from the design of curricula, rather than continuing to add more “stuff” to what is being taught. Twenty-first-century curricula need to be characterised by rigour (building what is being taught on a high level of cognitive demand); by focus (aiming at conceptual understanding by prioritising depth over breadth of content); and by coherence (sequencing instruction based on a scientific understanding of learning progressions and human development). Curricula need to remain true to



the disciplines, while aiming at interdisciplinary learning and building students' capacity to see problems through multiple lenses.

Curricula need to balance knowledge of discipline content with knowledge about the underlying nature and principles of the disciplines. To help students address unknown future problems, curricula also need to focus on areas with the highest transfer value, in other words, they need to give priority to knowledge, skills and attitudes that can be learned in one context and applied to others. To bring teachers along with this idea, they need to be explicit about the theory of action for how this transfer value occurs. They need to balance cognitive, social and emotional aspects of learning, and help teachers make shared responsibility among students part of the learning process. They need to frame learning in relevant and realistic contexts, and help teachers use approaches that are thematic, problem-based, project-based and centred around co-creation with their colleagues and their students.

But how do we foster motivated, engaged learners who are prepared to meet the unforeseeable challenges of tomorrow, not to mention those they are confronted with today? In traditional school systems, teachers are dispatched to the classroom with instructions about what to teach. In top-performing school systems, a different model has emerged: teachers are given the tools and the support to create their own path to the same end. There are clear goals for what students should be able to do, but there is an expectation that teachers will use their professional independence to determine how to achieve this.

As I've mentioned many times before, countries need to look outward. It is no longer possible to ignore countries like China. As of this writing, the talent pools of well-educated people in Europe, the United States and China are roughly the same size. But in the next decade, China is going to move far ahead in numbers of well-educated youth. In 2017, eight million students graduated from Chinese universities – a ten-fold increase in just ten years, and twice as many as graduated in the United States. Within the next decade, the population of China's well-educated youth might exceed the number of all young people – well-educated and not – in Europe and North America combined.

It is time to explore the implications of all this for learners, educators and education leaders.

## A different type of learner

The next generation of young citizens will create jobs, not seek them, and collaborate to advance humanity in an increasingly complex world. That will require curiosity, imagination, empathy, entrepreneurship and resilience, the ability to fail constructively, to learn from mistakes. The most obvious implication of a world that requires constant adaptation and growth from learners is the need to build the capacity and motivation for lifelong learning. We used to learn to do the work; now learning is the work – and that will require a post-industrial way of coaching, mentoring, teaching and evaluating that can build passion and capacity for learning.

The concept is not new. I recall a powerful speech given by then Finnish Education Minister Olli-Pekka Heinonen on lifelong learning at an OECD education ministers meeting in 1996. While the concept of lifelong learning was largely theoretical at that time, and gained little traction beyond issues around adult learning and continuing education and training, it now needs to be at the centre of education policy from the first years of life.

Early on in their school career, learners need to be able to appreciate the value of learning well beyond school, beyond graduation; they need to take responsibility for their learning and bring energy to the process of learning. Lifelong learning does not just require people to constantly learn new things but, and this tends to be far more difficult, to un-learn and re-learn when contexts and paradigms change. When I was young, I could eat whatever I liked without gaining weight. It hasn't been easy to quit old habits when I realised that my metabolism had changed.

Lifelong learning also builds on effective learning strategies and aspirations. PISA offers some interesting findings on the relationships – or lack thereof – among academic knowledge, students' learning strategies and students' career expectations. **FIGURE 6.2** shows the percentage of 15-year-old students who expect to work in science-related professional and technical occupations when they are 30 years old. The data show a whole range of countries and economies – Belgium, the four municipalities and provinces in China that participated in PISA, Estonia, Finland, Germany, Japan, Macao, the Netherlands, Poland, South Korea, Switzerland and Viet Nam – with high scores on the PISA science tests, but where students have just

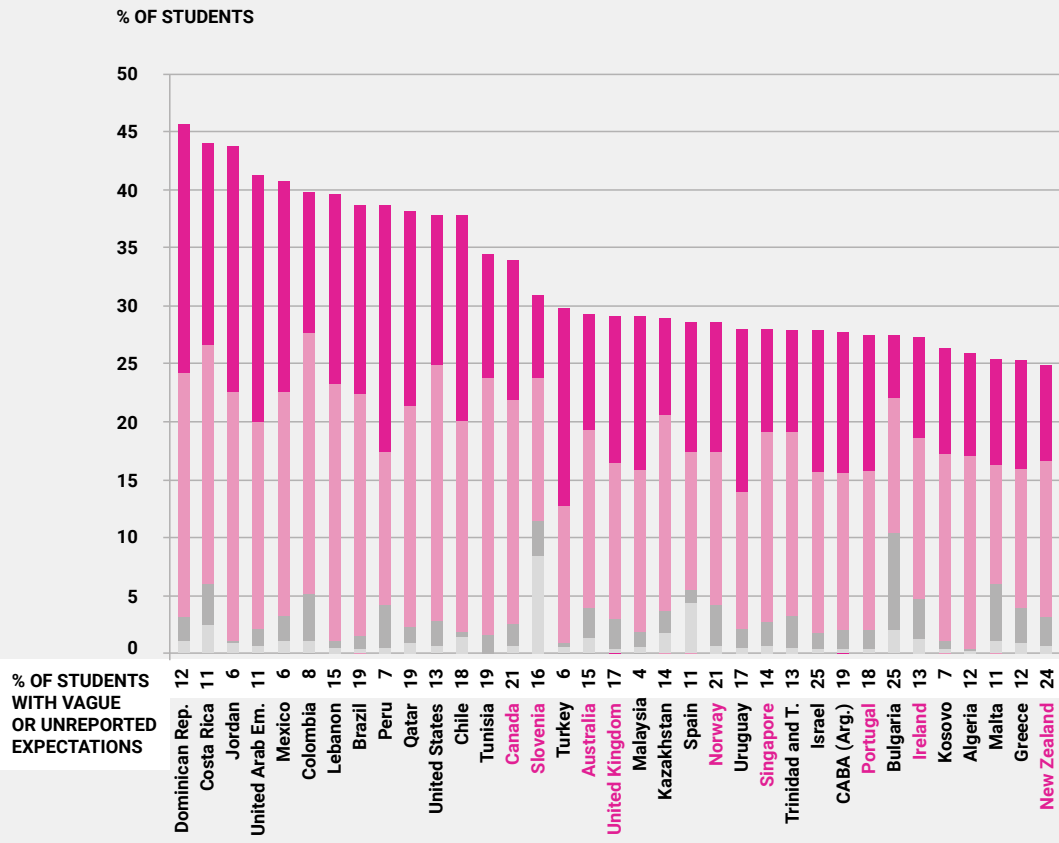
moderate aspirations to make science part of their future lives. In fact, there are just a few countries where students' science knowledge, their belief in scientific methods and the way they see science opening career opportunities align: Canada and Singapore and, among students who scored somewhat lower in science, Australia, Ireland, Portugal, Slovenia and the United Kingdom. Of course, the data also show the flipside of the story. For example, students in Israel, Spain and the United States are open to methods of scientific inquiry and aspire to careers in science, but they lack the scientific knowledge and skills to realise their dreams.

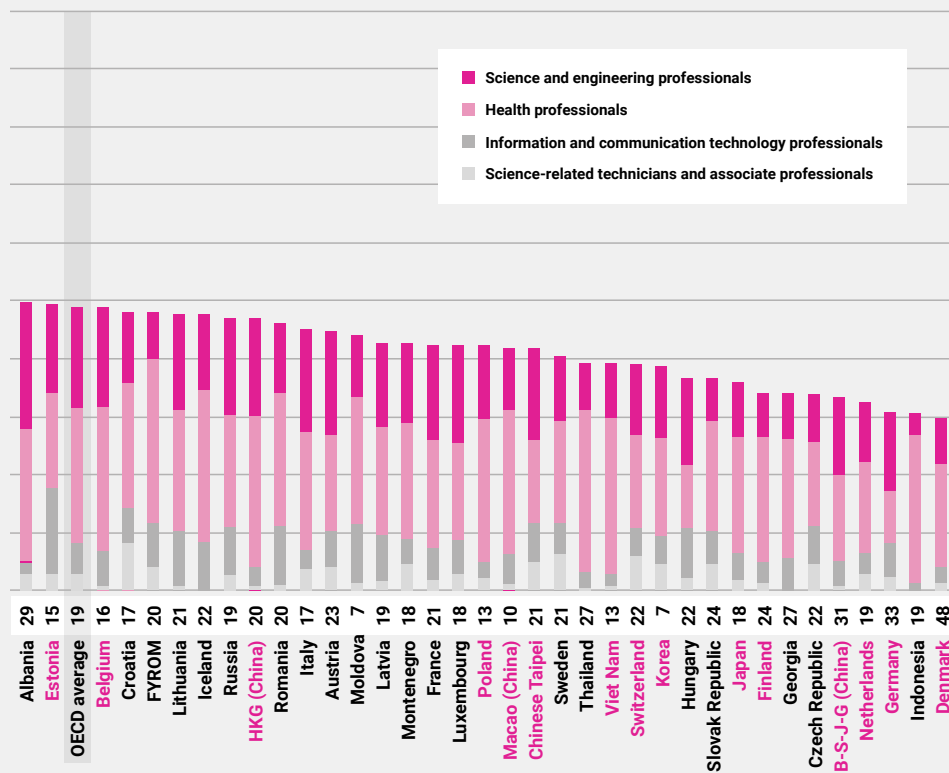
The bottom line is that academic success alone is not sufficient. PISA also offers some interesting insights into the link between knowledge and aspirations. When students do not enjoy learning science, better performance in science translates into only a marginally higher likelihood that these students expect to pursue a career in science (**FIGURE 6.3**). But when students do enjoy learning about science, better learning outcomes are closely linked with students' expectations of a science-related career. Again, this highlights the importance of developing more multidimensional approaches to learning and instructional design, and doing so explicitly rather than just hoping that the focus on improved performance will result in other desired outcomes.

One might be tempted to conclude that lifelong learning means shifting resources from learning during childhood towards learning in adulthood. But OECD data show how learning throughout life is remarkably closely related to learning outcomes at school.<sup>27</sup> Indeed, subsequent learning opportunities tend to reinforce early disparities in learning outcomes. Individuals who failed at school are unlikely to seek out subsequent learning opportunities, and employers are unlikely to invest in learners with weaker foundation skills. In short, lifelong learning as we currently know it does not mitigate, but rather tends to reinforce, initial differences in education. This just underlines both how important it is to get the foundations right, and that we need to become much better at designing effective learning opportunities that meet the diverse interests of adults later in life.

Still, there is a lot that governments and societies can do to help learners adapt. The easiest is telling young people the truth about the social and labour-market relevance of their learning, and to incentivise educational institutions to pay more

**FIGURE 6.2: MOST 15-YEAR-OLDS DO NOT ASPIRE TO WORK IN A SCIENCE-RELATED CAREER**

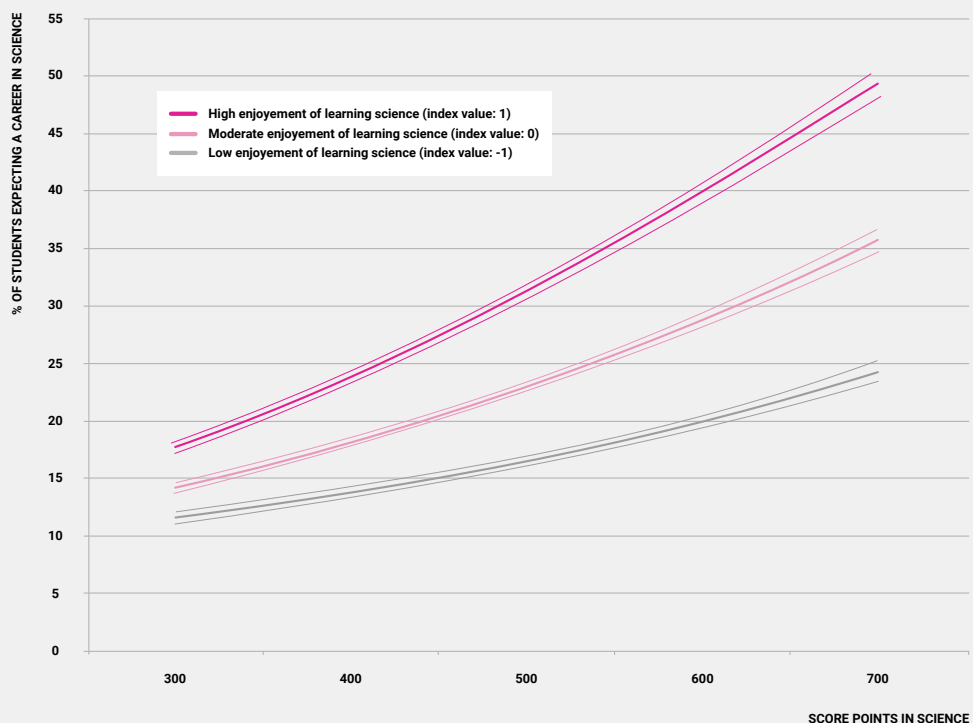




Notes: Percentage of students who expect to work in science-related professional and technical occupations when they are 30. Country/Economy names in dark pink were high performers in science in PISA 2015. CABA (Arg.) refers to Ciudad Autónoma de Buenos Aires (Argentina). Belgium refers only to the French and German-speaking communities. FYROM refers to the Former Yugoslav Republic of Macedonia. B-S-J-G (China) refers to Beijing-Shanghai-Jiangsu-Guangdong (China).

Source: OECD, PISA 2015 Database, Table I.3.10a.

**FIGURE 6.3: WHEN STUDENTS ENJOY LEARNING SCIENCE, BETTER PERFORMANCE IS MORE STRONGLY ASSOCIATED WITH THE EXPECTATION OF PURSUING A SCIENCE CAREER**



Notes: Estimate; OECD average, after accounting for gender and socio-economic status. The lines represent the predicted share of students expecting a career in a science-related occupation, based on a logistic model with the index of enjoyment of science, performance in science, their product, gender, and the PISA index of economic, social and cultural status introduced as predictors. The shaded area around the curves indicates the upper and lower bounds of the 95% confidence interval for these estimates.

Source: OECD, PISA 2015 Database, Table 1.3.13b.

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attention to that too. When education systems help students choose a field of study that resonates with their passions, in which they can excel, and that allows them to contribute to society, they will put students on the path to success. But instead, many universities still focus on marketing study fields that are easy and cheap to provide.

More difficult, but at least equally important, is to shift from qualifications-based certification systems to more knowledge- and skills-based certification systems. That means moving from documenting education pathways towards highlighting what individuals can actually do, regardless of how and where they have acquired their knowledge, skills and character qualities. I am a good example of this. Many years ago, I acquired my degree in physics, and that remains the qualification recorded in my *curriculum vitae*. But if I were sent to a laboratory today, I would fail dismally at the work, both because of the rapid advances in physics since I earned my degree, and because I have lost some of the skills that I have not used for a long time. In the meantime, I have acquired many new skills that have not been formally certified.

## Twenty-first century teachers

### ■ High and growing expectations for teachers

The expectations for teachers are high and rising each day (see Chapter 3). We expect them to have a deep and broad understanding of what they teach, whom they teach and how students learn, because what teachers know and care about makes such a difference to student learning. But we expect much more than what we put into the job descriptions of teachers. We expect teachers to be passionate, compassionate and thoughtful; to make learning central and encourage students' engagement and responsibility; to respond effectively to students of different needs, backgrounds and languages, and to promote tolerance and social cohesion; to provide continual assessments of students and feedback; and to ensure that students feel valued and included and that learning is collaborative. We expect teachers themselves to collaborate and work in teams, and with other schools and parents, to set common goals, and plan and monitor the attainment of goals. Not least, students are unlikely

to become lifelong learners if they do not see their teachers as active lifelong learners, willing to extend their horizons and question the established wisdom of their times.

Teachers of today's "connected" learners must also meet the challenges that have arisen from digitisation, from information overload to plagiarism, from protecting children from online risks, such as fraud, violations of privacy or online bullying, to setting an adequate and appropriate media diet for their students. They are expected to help educate children to become critical consumers of Internet services and electronic media, to make informed choices and avoid harmful behaviours.

But there is more. Most successful people had at least one teacher who made a real difference in their life – because the teacher acted as a role model, or took a genuine interest in the student's welfare and future, or provided emotional support when the student needed it. These aspects of teaching are difficult to compare and quantify, but designing a work organisation and support culture that nurture these qualities will go a long way towards ensuring that every student succeeds.

### ■ **Digital technology in support of teaching**

While people have different views on the role that digital technology can and should play in schools, we cannot ignore how digital tools have so fundamentally transformed the world outside of school. Everywhere, digital technologies are offering firms new business models and opportunities to enter markets and transform their production processes. They can make us live longer and healthier, help us delegate boring or dangerous tasks, and allow us to travel into virtual worlds. People who cannot navigate through the digital landscape can no longer participate fully in our social, economic and cultural life.

Technology should therefore play an important role if we want to provide teachers with learning environments that support 21st-century methods of teaching and, most important, if we want to provide students with the 21st-century skills they need to succeed.

I am pretty relaxed when I hear people argue that digital technologies will make teachers redundant. The heart of teaching has always been relational, and teaching seems to be one of the most enduring social activities. So there will be more, not less, demand for people who are able to build and support learners throughout their life.



The value of teaching as a key differentiator is only bound to rise as digitalisation drives forward the unbundling of educational content, accreditation and teaching that makes up traditional schools. In the digital age, anything that we call our proprietary knowledge and educational content today will be a commodity available to everyone tomorrow. Accreditation still gives educational institutions enormous power, but just think a few years ahead. What will micro-credentialing do to accreditation when employers can directly validate specific knowledge and skills? Or think of employers' rapidly growing capacity to see through the degrees that prospective employees list on their CVs to the knowledge and skills they actually have. In the end, the quality of teaching seems the most valuable asset of modern educational institutions.

Still, as in many other professions, digital technologies are likely to assume many of the tasks now carried out by teachers. Even if teaching will never be digitised or outsourced to other places, routine administrative and instructional tasks that take valuable time away from teaching are already being handed over to technology.

In the health sector, we start by looking at the outcomes, we measure the blood pressure and take the temperature of a patient and then decide what medicine is most appropriate. In education, we tend to give everyone the same medicine, instruct all children in the same way, and when we find out many years later that the outcomes are unsatisfactory, we blame that on the motivation or capacity of the patient. That is simply no longer good enough. Digital technology now allows us to find entirely new responses to what people learn, how people learn, where people learn and when they learn, and to enrich and extend the reach of excellent teachers and teaching.

We need to embrace technology in ways that elevate the role of teachers from imparting received knowledge towards working as co-creators of knowledge, as coaches, as mentors and as evaluators. Already today, intelligent digital learning systems cannot just teach you science, but they can simultaneously observe how you study, how you learn science, the kind of tasks and thinking that interest you, and the kind of problems that you find boring or difficult. These systems can then adapt learning to suit your personal learning style with far greater granularity and precision than any traditional classroom setting possibly can. Similarly, virtual laboratories give you the opportunity to design, conduct and learn from experiments, rather than just learning about them.

Technology can enable teachers and students to access specialised materials well beyond textbooks, in multiple formats and in ways that can bridge time and space. Technology can support new ways of teaching that focus on learners as active participants. There are good examples of technology enhancing experiential learning by supporting project- and enquiry-based teaching methods, facilitating hands-on activities and co-operative learning, and delivering formative real-time assessments. There are also interesting examples of technology supporting learning with interactive, non-linear courseware based on state-of-the-art instructional design, sophisticated software for experimentation and simulation, social media and educational games. These are precisely the learning tools that are needed to develop 21st-century knowledge and skills. Not least, one teacher can now educate and inspire millions of learners and communicate their ideas to the whole world.

Perhaps the most distinguishing feature of technology is that it not only serves individual learners and educators, but it can build an ecosystem around learning that is predicated on collaboration. Technology can build communities of learners that make learning more social and more fun, recognising that collaborative learning enhances goal orientation, motivation, persistence and the development of effective learning strategies. Similarly, technology can build communities of teachers to share and enrich teaching resources and practices, and also to collaborate on professional growth and the institutionalisation of professional practice. It can help system leaders and governments develop and share best practice around curriculum design, policy and pedagogy. Imagine a giant crowdsourcing platform where teachers, education researchers and policy experts collaborate to curate the most relevant content and pedagogical practice to achieve education goals, and where students anywhere in the world have access to the best and most innovative education experiences.

But the reality in classrooms looks quite different from these promises. In 2015, we published a PISA report on students' digital skills and the learning environments designed to develop those skills.<sup>28</sup> The results showed that technology has not yet been widely adopted in classrooms. At the time of our 2012 PISA survey, only around 37% of schools in Europe had high-end equipment and high-speed Internet connectivity, ranging from 5% of schools in Poland to virtually all schools in Norway. But when asked, between 80% and 90% of school principals reported that their schools were

adequately equipped when it comes to computers and Internet connectivity – even principals in the many countries where the equipment was clearly substandard. So is technology not that important? Or were school leaders not aware of the potential of digital technologies to transform learning?

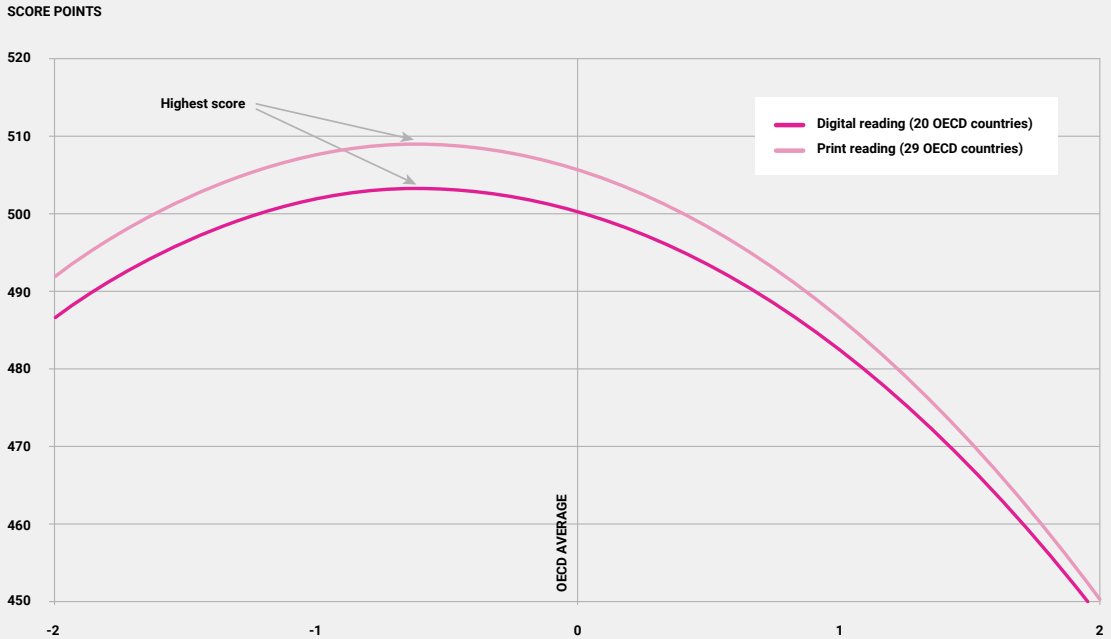
More important, even where such technologies are used in the classroom, their impact on student performance seems mixed, at best. PISA measured students' digital literacy, and the frequency and intensity with which students use computers at school. Students who use computers moderately at school tend to have somewhat better learning outcomes than students who use computers rarely. But students who use computers very frequently at school do a lot worse in most learning outcomes, even after accounting for social background and student demographics (**FIGURE 6.4**). These findings hold for both skills in digital literacy and in mathematics and science.

PISA results also show no appreciable improvement in student achievement in the countries that had invested heavily in digital technology for education. Perhaps the most disappointing finding is that technology has been of little help in bridging the divide in knowledge and skills between advantaged and disadvantaged students. Put simply, ensuring that every child attains a baseline level of proficiency in reading and mathematics still seems to do more to create equal opportunities in a digital world than is currently achieved by expanding or subsidising access to high-tech devices in school.

One interpretation of all this is that building deep, conceptual understanding and developing higher-order thinking requires intensive teacher-student interactions, and technology sometimes distracts from such human engagement. Another is that we have not yet become good enough at the kind of pedagogies that make the most of technology, that adding 21st-century technologies to 20th-century teaching practices in a 19th-century school organisation will just dilute the effectiveness of teaching. If students use Google to copy and paste prefabricated answers to questions, that's certainly a less effective way to learn than through traditional teaching methods.

In short, while digital technologies can amplify great teaching, they rarely replace poor teaching. If we continue to dump technology on schools in a fragmented way, we won't be able to realise technology's potential. Countries need to have a clear plan and build teachers' capacity to make that happen; and policy makers need to become better at building support for such an approach. The future is with teachers who

**FIGURE 6.4: STUDENTS WHO USE COMPUTERS AT SCHOOL THE MOST SCORE THE LOWEST IN READING DIGITAL AND PRINTED TEXT**



Notes: OECD average relationship, after accounting for the socio-economic status of students and schools. The lines represent the predicted values of the respective outcome variable, at varying levels of the PISA index of computer use at school

Source: OECD, PISA 2012 database, Table X.2

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can harness the potential of technology and help students see the value of learning beyond acquiring content knowledge, who are designers of imaginative problem-based environments, and who nurture critical evaluation and metacognition.

### ■ **Creating a culture of sharing**

There is another angle from which to consider technology in education. Big data could support the redesign of education as it has already done in so many other sectors. Imagine the power of an education system that could share all of its collective expertise and experience through new digital spaces.

But throwing education data into the public space does not, in itself, change how students learn, teachers teach and schools operate. That is the discouraging lesson from many administrative accountability systems. People may have data, but they may not do anything with it to change education practice.

Turning digital exhaust into digital fuel, and using data as a catalyst to change education practice requires getting out of the “read-only” mode of our education systems, in which information is presented as if inscribed in stone. This is about combining transparency with collaboration. Too often, educational institutions are run by experts sitting somewhere in a distant administration who determine the content, rules and regulations affecting hundreds of thousands of students and teachers. Few are able to figure out how those decisions were made.

If we could make the data on which those decisions are based available to all, and enable teachers at the frontline to experiment and become creators, then we could use big data to help cultivate big trust. I am always struck by the power of “collaborative consumption”, where online markets are created in which people share their cars, and even their apartments, with total strangers. Collaborative consumption has made people micro-entrepreneurs – and the driving force behind it is trust between strangers. In the business world, trustworthy strangers are connected in all sorts of marketplaces. The reason this works is because behind these systems are powerful reputational metrics that help people know their counterparts and build trust. When we want to buy something from a stranger, we can see how other customers have rated the seller, and at the end of the purchase we can rate the seller ourselves. Similarly, the seller can rate us as trustworthy buyers.

It is worth considering the use of technology in Shanghai, the top-ranked education system in PISA 2012. Teachers there are judicious and selective in using technology in their classrooms, but they embrace technology when it comes to enhancing and sharing professional practice. When I visited Shanghai in 2013, I saw teachers using a digital platform to share lesson plans. That in itself is not unusual; what made it different from other places was that the platform was combined with reputational metrics. The more other teachers downloaded, or critiqued or improved lessons, the greater the reputation of the teacher who had shared them. At the end of the school year, the principal would not just ask how well the teacher had taught his or her students, but what contribution he or she had made to improve the teaching profession and the wider education system.

Shanghai's approach to curated crowdsourcing of education practice is not just a great example of how to identify and share best practice among teachers, it is also so much more powerful than performance-related pay as a way to encourage professional growth and development. It might even be fairer, too, since the assessments are based on the views of the entire profession rather than just on the views of a single superior who may be years removed from actual practice.

In this way, Shanghai created a giant open-source community of teachers and unlocked teachers' creativity simply by tapping into the desire of people to contribute, collaborate and be recognised for their contributions. This is how technology can extend the reach of great teaching, recognising that value is less and less created vertically, through command and control, but increasingly horizontally, by whom we connect and work with.

When parents are surveyed about the quality of their children's schooling, many rate the school system as poor, but the quality of their children's school as good, irrespective of schooling outcomes. We trust our children's schools because we know them, just as we trust the teachers in these schools because we know them. We have less trust in strangers. But the digital age allows us to create much more enriching and valuable social capital. What reputational metrics, such as those used in Shanghai, do is give those strangers faces and identities, and because so many other people are doing the same, we learn whom we can trust.

Obviously, once again, the devil can be in the detail. Successful collaboration depends deeply on relationships, and this may not automatically translate into having

the right number of online badges or stars certifying someone is a good collaborator. There is also the risk that digital sharing platforms may become commercialised, limiting the free sharing of experience.

### ■ **Owning their profession**

The heart of great teaching is not technology, it is ownership. Successful education systems in the 21st century will do whatever it takes to develop ownership of professional practice by the teaching profession. I meet many people who say we cannot give teachers and education leaders greater autonomy because they lack the capacity and expertise to deliver on it. There may be some truth in that. But simply perpetuating a prescriptive model of teaching will not produce creative teachers: those trained only to reheat pre-cooked hamburgers are unlikely to become master chefs.

By contrast, when teachers feel a sense of ownership over their classrooms, when students feel a sense of ownership over their learning, that is when productive teaching takes place. So the answer is to strengthen trust, transparency, professional autonomy and the collaborative culture of the profession all at the same time.

When teachers assume ownership, it is difficult to ask more of them than they ask of themselves. In 2011, I studied how the Netherlands' Ministry of Education was developing teacher-led professional standards. Initially, there were concerns in the government that leaving this to the profession could sacrifice the necessary rigour and result in a set of professional standards based on the lowest common denominator. But the opposite happened. Then-State Secretary for the Ministry of Education, Culture and Science, Sander Dekker, told me later that no government in the Netherlands would have ever been able to impose such demanding standards for the profession as the profession itself had developed. The same holds in other professions: think of barriers to entry in the medical profession or in law. Sometimes professionalism and professional pride seem far better regulators than governments.

I learned many things from this experience. First of all, involving teachers in the development of professional standards is a great way to build professional knowledge. Indeed, for teaching standards to be relevant and owned by the profession, it is essential that teachers play a lead role in designing them. Similarly, as I discussed in Chapter 5, it is essential that teachers participate in designing methods for teacher

appraisal if the appraisal system is to be effective.<sup>29</sup> Inviting teachers to participate is a way of recognising their professionalism, the importance of their skills and experience, and the extent of their responsibilities. Teachers will also be more open to being appraised if they are consulted in the process. Thus designers of appraisal systems need to work with teachers' professional organisations and outstanding teachers from across the system. In the end, teachers, like other professionals, have a genuine interest in safeguarding the standards and reputation of their profession.

But most important, teachers must assume ownership of the profession because of the pace of change in 21st-century school systems. Even the most urgent efforts to translate a government-established curriculum into classroom practice typically drag out over a decade, because it takes so much time to communicate the goals and methods through the different layers of the system, and to build them into teacher-education programmes. When what and how students learn changes so rapidly, this slow implementation process leads to a widening gap between what students need to learn, and what and how teachers teach.

The only way to shorten that timeframe is to professionalise teaching, ensuring that teachers have a deep understanding not only of the curriculum as a product, but of the process of designing a curriculum and the pedagogies that will best communicate the ideas behind the curriculum.

Schools face a tough challenge in responding to what will be valuable for young people in the future. Subject-matter content will be less and less the core and more and more the context of good teaching. Many of today's curricula are designed to equip learners for a static world that no longer exists. Those types of curricula could be delivered with an industrial approach in hierarchical bureaucracies; they do not require teachers to have advanced professional insights into instructional design. But that is no longer good enough. Curricula now need to account for fast-moving flows of knowledge creation.

Paradoxically, the highly standardised industrial work organisation of teaching has often left teachers alone in the classroom. Zero percent school autonomy has meant one hundred percent teacher isolation behind closed classroom doors.

As the prescriptive approach weakens, the position of the classroom practitioners needs strengthening. While governments can establish directions and curriculum



goals, the teaching profession needs to take charge of the instructional system, and governments need to find ways to enable and support professionalism. However, increased professional autonomy also implies challenging idiosyncratic practice. It means moving away from every teacher having his or her own approach towards the common use of practices agreed by the profession as effective, making teaching not just an art but also a science. That is what the above example of teacher collaboration in Shanghai is really about.

We should not take freedom as an argument to be unconventional for its own sake. If you were a pilot, and you would announce to your passengers you were taught to land against the wind but, this time, you want to try to land with the wind, your passengers would start to feel rather anxious. Of course, it is not easy for school leaders to balance the fact that teachers may feel that landing with the wind is a good idea, on the one hand, and promoting their autonomy and ownership over the profession, on the other. Because so many areas of teaching do not yet have clear standards of practice, teachers may infer that there should be complete autonomy in all areas, even in those where the evidence base is well established. So when there is not common agreement on professional practice, teachers may feel disempowered when leaders steer them towards selected evidence.

Finding out which pedagogical approaches work best in which contexts takes time, an investment in research, and collaboration so that good ideas spread and are scaled into the profession. Achieving that will require a major shift from an industrial work organisation to a truly professional work organisation for teachers and school leaders, in which professional norms of control replace bureaucratic and administrative forms of control. In turn, more professional discretion accorded to teachers will allow them greater latitude in developing student creativity and critical thinking skills that are central to success in the 21st century, and that are much harder to develop in highly prescriptive learning environments. Supporting such a shift is what we should expect from 21st-century education policy.

## Encouraging innovation in and outside of school

When other sectors see flat-lining productivity they look to innovation; that is happening in education too. Comparisons point to levels of innovation in education that are pretty much in line with those in other sectors of the economy.<sup>30</sup> But the issue is less the volume of innovation than its relevance and quality, and the speed from idea to impact. Innovation is happening, but too little of it focuses on the heart of learning; when it does, it spreads too slowly.

Innovative change can be more difficult in hierarchical structures that are geared towards rewarding compliance with rules and regulations. One policy approach to foster innovation in education has been to increase autonomy, diversity and competition among educational institutions. But evidence of the benefits of this approach remains patchy.

To reconcile flexibility and innovation with equity, school systems need to devise checks and balances that prevent choice from leading to inequity and segregation, and do whatever it takes so that all parents can choose the school of their preference. That means government and schools must invest in developing their relationships with parents and local communities, and help parents make informed decisions. As I discussed in Chapter 4, the more flexibility there is in the school system, the stronger public policy needs to be. While greater school autonomy, decentralisation and a more demand-driven school system seek to devolve decision making to the frontline, public policy needs to maintain a strategic vision and clear guidelines for education, establish effective mechanisms for mobilising and sharing knowledge, and offer meaningful feedback to local school networks and individual schools. In other words, only through a concerted effort by central and local education authorities will school choice benefit all students.

Innovation in governance is one challenge, innovation in the instructional system another. There is a long history of introducing new methods in education – whether it was television, video, digital whiteboards or computers – in the hope of radically improving teaching and the effectiveness of schooling, only to find, at best, incremental change achieved at higher cost and complexity. I have asked myself many times why education has not kept up with innovation in other areas. I have

found no good answers except, perhaps, that it would disrupt the current business model of governments, academia and textbook publishers.

It may also be that the education industry is too weak and fragmented to accept this particular challenge. Keep in mind that public health-research budgets in OECD countries are 17 times larger than education-research budgets.<sup>31</sup> That says a lot about the role that we expect knowledge to play in advancing practice.

But the bigger issue is that, even where good education research and knowledge exists, many practitioners just do not believe that the problems they face can be solved by science and research. Too many teachers believe that good teaching is an individual art based on inspiration and talent, and not a set of skills you can acquire during a career. Yet it would be a mistake to blame just teachers for that. This problem often goes back to policy, because there is a lack of incentives and resources to codify professional knowledge and knowhow. In many countries, the room for non-teaching working time is far too limited for teachers to engage in knowledge creation. Because education has not been able to build a professional body of practice or even a common scientific language as other professions have, practice remains unarticulated, invisible, isolated and difficult to transfer. Investing in better knowledge – and disseminating that knowledge widely – must become a priority; it promises to deliver huge rewards.

It is also important to create a more level playing field for innovation in schools. Governments can help strengthen professional autonomy and a collaborative culture where great ideas are refined and shared. Governments can also help with funding, and can offer incentives that raise the profile of, and demand for, what works. But governments alone can only do so much. Silicon Valley works because governments created the conditions for innovation, not because governments do the innovating. Similarly, governments cannot innovate in the classroom; they can only help by opening up systems so that there is an innovation-friendly climate where transformative ideas can bloom. That means encouraging innovation within the system and making it open to creative ideas from outside. More of that needs to be happening.

Policy makers often view education industries as providers of goods and services to schools. They tend to underappreciate that innovation in education is also

changing the very environment in which schools operate. In particular, technology-based innovations open up schools to the outside world, both the digital world and the social environment. They also bring new actors into the system, including the education industries with their own ideas, views and dreams about what a brighter future for education could hold.

It is difficult for education systems to treat industry as a valuable partner. Fears of a perceived “marketisation” of education, or the displacement of teachers by computers, often endanger what could be a fruitful dialogue. At the same time, we should be more demanding of the education industry. Most of our children would not voluntarily play with the kinds of software that companies are still able to sell to schools. Is innovation in the education industry as dynamic as it should or could be? Can we break the cartel of a few large suppliers of educational resources who use an army of salespeople to sell their services to a fragmented market? Can we overcome the slow sales cycles, where buyers have to deal with layers and layers of people all “in charge”?

Is it possible to create a business culture for managing innovation in school systems? At the moment, it is so much easier for administrators to buy new tools and systems, and use existing staff because this costs them “nothing”. The treatment of teacher time as a sunk cost means people see no benefit to saving this time. It is worthwhile to explore how industry can help the education sector close the productivity gap with new tools and new practices, organisations and technology.

It is surprising to me how entrepreneurship in the education sector remains so limited. Yes, there are large organisations producing textbooks, learning materials and online courses, and there are countless private schools and universities. But these are highly fragmented. It was not until June 2013 that I met Indian entrepreneur Sunny Varkey,<sup>32</sup> who had the ambition to transform the education sector by shifting gears from private-versus-public to private-with-public. What makes his mission different from others is that it is not about education as part of something else, but about putting education first.

Perhaps we should stop seeking the “killer app” or the “disruptive” business model that will somehow turn existing practices upside down. Perhaps, instead, we should learn how to identify, interpret and cultivate a capacity for learning across

the entire ecosystem that produces education outcomes. To deliver on the promises offered in the digital age, countries will need much more convincing strategies to build teachers' capacity to use the new tools; and policy makers will need to become better at building support for this agenda. Given the uncertainties that accompany all change, educators will often opt to maintain the status quo. To mobilise support for more innovative schools, education systems need to become better at communicating the need and building support for change. Investing in capacity development and change-management skills will be critical; and it is vital that teachers become active agents for change, not just in implementing technological innovations, but in designing them too (see Chapter 5).

Education systems need to better identify key agents of change and champion them; and they need to find more effective ways of scaling and disseminating innovations. That is also about finding better ways to recognise, reward and celebrate success, to do whatever is possible to make it easier for innovators to take risks and encourage the emergence of new ideas. One of the most devastating findings from our first survey of teachers (TALIS) was that three in four teachers in the industrialised world consider their workplace an environment that is essentially hostile to innovation.<sup>33</sup> Nothing will change if we don't change that perception.

## **Cultivating effective system leadership**

Changing education bureaucracies can be like moving graveyards: it is often hard to rely on the people out there to help, because the status quo has so many protectors. The bottom line is that school systems are rather conservative social systems. Everyone supports education reform – unless it affects their own children. Parents may measure the education of their children against their own education experiences. Teachers may teach how they were taught, rather than how they were taught to teach. But the real obstacle to education reform is not conservative followers but conservative leaders: leaders who exploit populism to preserve the status quo; leaders who stick to today's curriculum rather than adapt pedagogical practice to a changing world, because it is so much easier to stay within everybody's comfort

zone; leaders who invest in popular solutions, like smaller classes, rather than take the time to convince parents and teachers of the benefits of spending money more effectively, including through investing in greater teacher professionalism.

Effective leadership is central to virtually every aspect of education, particularly when there is little coherence and capacity. While there are many amazing teachers, schools and education programmes in every education system, it takes effective leadership to build a great education system. As Michael Fullan, an authority on education reform, notes, programmes do not scale; it is culture that scales, and culture is the hallmark of effective leadership. Culture is about system learning, system-wide innovation, and purposeful collaboration that can lead to large-scale and ongoing improvement. If you want to effect real and lasting change, do not ask yourself how many teachers support your ideas, ask yourself how many teachers are capable of and engage in effective co-operation.

The education crisis, reflected in flat education outcomes despite rising investment, is partly a leadership crisis. Finding adequate and forward-looking responses to the inter-related changes in technology, globalisation and the environment is ultimately a question of leadership. Effective leadership is vital to creating an environment where institutions, educators, researchers and other innovators can work together as professionals. These kinds of leaders should help people recognise what needs to change, mobilise support and share leadership responsibilities throughout the system.

As Michael Fullan explains, leaders who want to make forward-looking changes in their school systems have to do more than issue orders and try to impose compliance. They need to build a shared understanding and collective ownership, make the case for change, offer support that will make change a reality, and remain credible without being populist. They need to focus resources, build capacity, change work organisations, and create the right policy climate with accountability measures designed to encourage innovation and development, rather than compliance. And they need to go against the dynamics of turf and hierarchical bureaucracies that still dominate educational institutions.

System leaders need to tackle institutional structures that too often are built around the interests and habits of educators and administrators rather than learners.

Most of our school systems are designed to sort and weed out people, not to open opportunities and address the diverse needs of learners. That might have been an efficient and effective approach for the industrial age, when education was about finding and training a small minority of leaders, and equipping everyone else with just basic knowledge and skills. But in a modern society, where we need to capitalise on everyone's talents and ensure equitable access to learning, such an approach is a barrier to success. Incentives and support are needed so that schools can meet the needs of all of their pupils, rather than gain an advantage by shifting difficult learners elsewhere.

For schools to be entrepreneurial and able to adapt, system leaders need to be able to mobilise the human, social and financial resources needed for innovation. They need to be able to build strong linkages across sectors and countries, and establish partnerships with government leaders, social entrepreneurs, business executives, researchers and civil society.

It will be important for education policy to get beyond the unproductive wrangling between forces pushing for greater decentralisation and those aiming for greater centralisation of the school system. That debate detracts from the real question of what aspects of education are best managed at what level of the education system, and the overriding principle of subsidiarity, where every layer of the school system should continuously ask itself how it can best support learners and teachers at the frontline.

That also means that teachers, schools and local authorities recognise that certain functions, particularly those regarding the establishment of curriculum frameworks, course syllabi, examinations and teaching standards require a critical mass of capacity, and therefore tend to be best supported by some level of centralisation. The test of truth is a coherent instructional system that is available to all students, and in which world-class education standards feed into well-thought-out curriculum frameworks that guide the work of teachers and publishers of education materials.

Countries with an unregulated market for textbooks, where schools or districts are choosing what is taught in classrooms, will consider Japan's approach, where the Ministry of Education takes a strong role in guiding the development and review of textbooks, as overly centralised. But ask Japanese teachers about this, and they will tell

you about the years of consultation and involvement of the profession that precede the development and publication of that textbook. They will also tell you about the extensive professional development that builds capacity around interpreting and implementing the goals of the curriculum. The result can be far greater ownership by the profession and far greater autonomy at the frontline than an approach where schools or districts purchase a textbook that is then handed to teachers to deliver in the classroom. In short, we need to stop considering centralisation and decentralisation as opposing ends of one spectrum.

System leaders need to be aware of how organisational policies and practices can either facilitate or inhibit transformation. They need to be ready to confront the system when it inhibits change. They need to be able to recognise emerging trends and patterns and see how these might benefit or obstruct the innovation they want to achieve. They need to be politically savvy in working with other organisations and people. They need to use their knowledge about what motivates people to convince others to support their plans for change; and they need to use their understanding of power and influence to build the alliances and coalitions needed to get things done.

Singapore's success in education, for example, is a story about leadership and alignment between policy and practice; setting ambitious standards; building teacher and leadership capacity to develop vision and strategy at the school level; and about a culture of continuous improvement that benchmarks education practices against the best in the world.

At the institutional level, both policy coherence and fidelity of implementation are brought about by a strategic relationship between the Ministry of Education, the National Institute of Education, which educates teachers, and the schools. Those aren't just words. The reports I received from policy makers, researchers and teachers in Singapore were always consistent, even where they represented different perspectives. The leader of the National Institute of Education meets the education minister every few weeks. Its professors are regularly involved in ministry discussions and decisions, so it is easy for the Institute's work to be aligned with ministry policies; and school principals learn about major reform proposals directly from the minister. In April 2014, I spoke at one of the regular meetings where Singapore's then-Education Minister, Heng Swee Keat, discussed plans for school reform with all



of Singapore's secondary school principals. It would never have occurred to him to announce an education reform through the media; he was well aware that nothing would get done until school leaders owned the goals and methods of the envisaged changes.

What I learned from this is how important it is for education leaders to be transparent with teachers and school leaders about where reform is heading and what it means for them. Success depends on having an inclusive style of leadership that fosters collaboration and allows staff to take risks. That encourages staff to have the confidence to see problems from multiple perspectives and come up with new solutions. This is about achieving consensus without giving up on reform.

As a physicist, I found it at first challenging to recognise the different approach needed for system design in education. In physics, we tend to understand the world through complex models and then examine how altering one part of the model modifies the outcome. But education systems have become so fluid that that is no longer good enough. The strongest education systems will be those that can make their own constant adaptations to changing demands, mobilising, sharing and spreading the knowledge, insights and experience of students and teachers.

Many teachers and schools are ready for that. To encourage their growth, policy needs to inspire and enable innovation, and identify and share best practice. That shift in policy will need to be built on trust: trust in education, in educational institutions, in schools and teachers, in students and communities. In all public services, trust is an essential part of good governance. Successful schools will always be places where people want to work, and where their ideas can be best realised, where they are trusted and where they can put their trust.

We know too little about how trust is developed in education and sustained over time, or how it can be restored if broken. But trust cannot be legislated or mandated; that is why it is so hard to build into traditional administrative structures. Trust is always intentional; it can only be nurtured and inspired through healthy relationships and constructive transparency. That is the lesson we can all learn from Finland, where opinion polls consistently show high levels of public trust in education. At a time when command-and-control systems are weakening, building trust is the most promising way to advance and fuel modern education systems.

## Redesigning assessment

The way students are tested has a big influence on the future of education too, because it signals the priorities for the curriculum and instruction. Tests will always focus our thinking about what is important, and they should. Teachers and school administrators, as well as students, will pay attention to what is tested and adapt the curriculum and teaching accordingly.

Some maintain that assessments are limiting as they only capture selected dimensions of learning outcomes. That is obviously true, but it is also true for any other form of measurement, including observation. Ask police investigators about divergences among the testimonies of witnesses, or consider teacher biases about gender or social background and you will see how limiting and subjective even direct observation can be.

The question is rather how we can get assessment right and ensure that it is one of several perspectives on student learning that can help teachers and policy makers track progress in education. Assessments need to be redesigned as curricula and instructional practices are reformed.

The trouble is that many assessment systems are poorly aligned with the curriculum, and with the knowledge and skills that young people need to thrive. Large parts of today's school tests can be answered in seconds with the help of a smartphone. If our children are to be smarter than their smartphones, then tests need to look beyond whether students can reproduce information to determine, instead, whether they can extrapolate from what they know, and apply their knowledge creatively to novel situations. Assessments also need to be able to reflect social and emotional skills.

As of this writing, most tests do not allow students to connect to the Internet, based on the fear that students may look up the answers to the test questions. The challenge for future assessments is whether they can encourage students to go on line to connect with the world's most advanced knowledge without jeopardising the validity and reliability of results.

Similarly, one of the worst offences in test taking is to consult with another student. But given that innovation is now more often based on sharing knowledge,

future tests should not disqualify students for collaborating with other test-takers, but find ways that they can do so. The PISA assessment of collaborative problem-solving skills showed clearly that proficiency in individual problem solving only partially predicts the ability to work with others to solve problems (see above).

When designing assessments, we often trade gains in validity for gains in efficiency, and relevance for reliability. We do that because it makes results seemingly more objective and thus reduces the risk that they will be contested. Some education ministers have lost their job because of disputes around examination results; few have been challenged for poor validity and relevance in test results.

But prioritising reliability and efficiency has a price. The most reliable test is one where we ask students similar questions in a format that allows for little ambiguity – typically a multiple-choice format. A relevant test is one where we test for a wide range of knowledge and skills that is considered important for success in education. To do this well requires multiple response formats, including open formats, which elicit more complex responses. Necessarily, such formats may introduce variations in interpretation that require more sophisticated marking processes. Similarly, if the number of students to be assessed is large and/or if we want to test students frequently, efficiency becomes important, which again favours simple response formats that are easy to code.

For these reasons, one of the first decisions we took for PISA was to limit the assessment to a sample of schools and students, and not report results at the level of individual students or schools where the stakes become high. That has allowed us to prioritise validity and relevance in the assessments. The comparatively small sample sizes allow us to use more complex and expensive response formats.

Beyond that, assessments need to be fair, technically sound and fit for purpose. They also need to ensure adequate measurement at different levels of detail so they can serve decision-making needs at different levels of the education system. International assessments, like PISA, face the added challenge of ensuring that the outcomes are valid across the cultural, national and linguistic boundaries over which they are conducted, and that samples of schools and students from the participating countries are comparable. PISA has invested significant time and effort to ensure these standards are met.<sup>34</sup>

We also need to work hard to bridge the gap between summative and formative assessments. Summative assessment usually means testing students at the end of a course unit; formative assessment is a more diagnostic approach, carried out while students are studying and intended to show what needs to be improved at that moment.

We need to find more creative ways to combine elements of both approaches to testing, as it is now possible to create coherent multi-layered assessment systems that extend from students to classrooms to schools to regional to national and even international levels. Good tests should provide a window into students' thinking and understanding, and reveal the strategies a student uses to solve a problem. Digital assessments, such as PISA, now make that possible, in that they do not just measure the degree to which students' responses are correct, they also show the paths students have taken to arrive at their solutions.

Assessments should also provide productive feedback, at appropriate levels of detail, to fuel improvement decisions. Teachers need to be able to understand what the assessment reveals about students' thinking. School administrators, policy makers and teachers need to be able to use this assessment information to determine how to create better opportunities for student learning. Teachers will then no longer see testing as separate from instruction, taking away valuable time from learning, but rather see it as an instrument that adds to learning.

### ■ **How PISA evolves**

Of course, all of this also applies to PISA. While the results from PISA have no immediate consequences for individual students, teachers or schools, PISA is viewed as an important measure of the success of school systems. As such, PISA needs to lead education reform, not hold it back by being constrained with too limited a range of metrics. So it is no surprise that there is considerable debate among the countries that participate in PISA, at both policy and technical levels, about the extent to which PISA can and should evolve.

Some argue that if a test is to measure progress and change in education, then we cannot change the measure. They argue for the test to be a fixed point. But PISA has taken a different tack, recognising that if we do not continually develop the measures, we will wind up evaluating students by what was considered important at

some point in the past, rather than measuring students against what they will need to thrive in their future.

The use of computer-delivered assessment for PISA means that a wider range of knowledge and skills can now be tested. The PISA 2012 assessment of creative problem-solving skills, the PISA 2015 assessment of collaborative problem-solving skills, and the PISA 2018 assessment of global competencies are good examples of this. It will be more challenging to measure social and emotional skills. But even in these domains, new research shows that many of their components can be measured meaningfully.<sup>35</sup>

PISA is also seeking to make results more open and more local. To that end, PISA has begun developing open-source instruments that schools can use to develop their own PISA scores. This new PISA-based test for schools<sup>36</sup> provides comparisons with other schools elsewhere in the world, schools that are similar to them or schools that are very different.

Schools are already beginning to use that data. In September 2014, I opened the first annual gathering of schools in the United States that had taken this test. It was encouraging to see how much interest there was among schools in comparing themselves not just with their neighbouring schools but with the best schools internationally. In Fairfax County, Virginia, ten schools had started a year-long discussion among principals and teachers based on the results of the first reports. With the help of district offices and the OECD, they were digging deeper into their data to understand how their schools compared with each other and with other schools around the world. Those principals and teachers were beginning to see themselves as teammates, not just spectators, on a global playing field. In other words, in Fairfax County, big data had begun to build big trust.

As the number of countries joining PISA keeps rising, it has also become apparent that the design needs to evolve for a more diverse set of participants, including a growing number of middle- and low-income countries. To make PISA more relevant to this wider range of countries, PISA is developing the test instruments to better measure a wider range of student capabilities; revising the contextual questionnaires so they are more relevant to low-income contexts; tackling financial and technical challenges through partnerships with donors and by capacity building; and extending

outreach to local stakeholders in developing countries. This initiative, known as PISA for Development,<sup>37</sup> was successfully piloted in nine countries during 2016 and 2017.

## Looking outward while moving forward

If I would add one more quality to the profile of responsive and responsible education leaders, particularly after considering assessment, it is the ability to look not just forward but also outward. It is not surprising that a strong and consistent effort to carry out international benchmarking and to incorporate the results of that benchmarking into policy and practice is a common characteristic of the highest-performing education systems.

This is not about copying and pasting 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 and applying it consciously.

Finland was benchmarking itself against the performance and practices of other education systems in the run-up to its own dramatic emergence as one of the world's top performers. Japan acquired its long-running status as one of the world's leading performers when its government, during the Meiji Restoration, visited the capitals of the industrialising West and decided to bring to Japan the best that the rest of the world had to offer. It has been doing so ever since.

In the latter half of the 20th century, Singapore did exactly what Japan had done a century earlier, but with even greater focus and discipline. Singapore's Economic Development Board, the nerve centre of the Singaporean government, is staffed with many engineers who view the government and administration of Singapore as a set of design challenges. Whenever Singapore seeks to create a new institution, it routinely benchmarks its planning against the best in the world. All of Singapore's educational institutions - from the National University of Singapore to individual schools - are encouraged to create global connections in order to develop "future-ready Singaporeans". They have never stopped learning from other countries as systematically as possible.

When Deng Xiaoping took the helm in China and began preparing for his country's re-emergence on the world stage, he directed China's educational institutions to form partnerships with the best educational institutions in the world, and to bring back to China the best of their policies and practices.

When Dalton McGuinty, then Premier of Ontario, visited us at the OECD in 2008, he made a point of saying that his own views about the right strategy for Ontario were shaped by the visits he made to other countries with successful education systems.

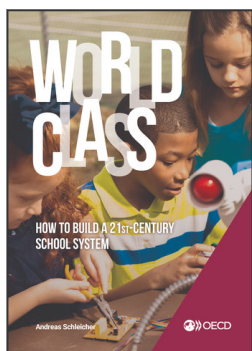
So a consistent effort to look outward and incorporate the results of that learning into policy and practice seems a common denominator of many high-performing countries.

Contrast this outward-looking attitude with that of those countries that prefer to cast doubt about PISA when test results show that their education system has been outperformed, and that consider it humiliating to make comparisons with what is happening in other countries.

This is likely to be a key distinction between the countries that will make progress in education and those that will not. The distinction may be between those education systems that feel threatened by alternative ways of thinking and those that are open to the world and ready to learn from and with the world's education leaders.

In the end, the laws of physics apply. If we stop pedalling, not only will we not move forward, our bicycles will stop moving at all and will fall over – and we will fall with them. Against strong headwinds, we need to push ourselves even harder.

But in the face of challenges and opportunities as great as any that have gone before, human beings need not be passive or inert. We have agency, the ability to anticipate and the power to frame our actions with purpose. I understood that when I saw the 10% most disadvantaged students in Shanghai outperforming the 10% wealthiest American students on the PISA 2012 mathematics assessment. I decided to write this book when I saw children from the poorest neighbourhoods of Shanghai learning – with joy – from Shanghai's best teachers. It was then that I realised that universal high-quality education is an attainable goal, that it is within our means to deliver a future for millions of learners who currently do not have one, and that our task is not to make the impossible possible, but to make the possible attainable.



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