STUDY ON EMPLOYABILITY SKILLS

IN THE IB DIPLOMA PROGRAMME

AND CAREER-RELATED PROGRAMME CURRICULA

Michaela Horvathova

Center for Curriculum Redesign

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Summary

This paper examines how the main global trends will transform today's workforce up until 2030, and the skills workers will have to acquire to adapt. Furthermore, it reports on the curriculum mapping and gap analysis conducted to identify which skills are currently covered in the DP and CP programmes as well as provide an overview of effective employability skills teaching and learning models.

For analysis, fourteen IB documents were reviewed and the occurrence of competencies was identified based on the degree of competency contribution in each document and divided into: high, medium or low contribution.

The category which received the highest contribution is 'skills' since competencies within this category are represented the most across all the IB's CP and DP reviewed documents. The competencies that received high contribution were communication, ethics, mindfulness and critical thinking. For example, communication is represented across twelve different documents with large contribution, one document with medium contribution and one document with low contribution. On the other hand, the category of 'character' is less represented with gaps in coverage of certain competencies (e.g., curiosity, resilience). Among the four least represented competencies were growth mindset, curiosity, courage and resilience.

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Introduction

The International Baccalaureate (IB) Organization
The (IB) is a non-profit educational foundation, motivated by its mission to develop inquiring, knowledgeable and caring young people who help create a better and more peaceful world through intercultural understanding and respect. The organization has built a hard- earned reputation for quality, high standards and pedagogical leadership in the field of international education, encouraging students across the world to become engaged world citizens who are active, compassionate and lifelong learners.

Founded in 1968, the IB currently works with more than 4,700 schools in 151 countries to develop and offer four programmes to over one million students aged 3 to 19 years. The organization also provides professional development workshops for more than 75,000 teachers and administrators annually.

The IB Diploma Programme (DP)
The DP is an academically challenging and balanced programme for students aged 16-19. It aims to develop students who: 1) have excellent breadth and depth of knowledge; 2) flourish physically, intellectually, emotionally and ethically; 3) study at least two languages; 4) excel in traditional academic subjects; and 5) explore the nature of knowledge through the programme's unique theory of knowledge course. The DP curriculum is made up of six subject groups — Studies in language and literature, Language acquisition, Individuals and societies, Sciences, Mathematics, and The arts; and the DP core — Theory of knowledge (TOK), Extended Essay (EE), and Creativity, Action, Service (CAS). The programme is currently offered in 3,000 schools globally.

The IB Career-related Programme (CP)
The CP is designed for students aged 16-19. The CP is a framework of international education that incorporates the values of the IB into a unique programme addressing the needs of students engaged in career-related education. The programme leads to further/higher education, apprenticeships or employment. CP students undertake a minimum of two IB Diploma Programme (DP) courses, a core consisting of four components and a career-related study. For CP students, DP courses provide the theoretical underpinning and academic rigour of the programme; the career-related study further supports the programme's academic strength and provides practical, real-world approaches to learning; and the CP core helps them to develop skills and competencies required for lifelong learning. The programme is currently offered in 141 schools in 23 countries.

The Rationale

The global economy is currently going through more rapid change than at any other time since the Industrial Revolution.[1] Technology's exponential growth is rapidly compounding the problems via automation and offshoring which are affecting the labour market. The polarization of labor markets has made industrial economies more unequal, not just in terms of outcomes, but has also contributed to growing inequality of opportunity. Technological unemployment, despite of its unknown magnitude, might be a significant threat. Meanwhile, aging populations and a shrinking labor force in the industrial world will put pressure on workers to become more productive, while increasing the demand for health care and the retraining of workers later in life.

The aim
The aim of this project is to explore how fit for purpose IB skills teaching is in preparing graduates for future employment and a rapidly changing world. To execute this vision, the study will aim to answer following research questions as stated below:

1. What does education research identify as the most pertinent skills that high school graduates need to be effective employees in the 21st century?
   ➢ Provide an overview of global trends impacting the labour market and identify a set of relevant skills for employment

2. Which of these skills are addressed in the DP and CP curricula and related documentation and which, if any, are lacking?
   ➢ Analyse current structure of the IB's DP and CP curriculum as well as features of an IB education, and identify which skills are addressed and which are missing

3. What are effective models of best practice employability skills teaching? How do IB DP and CP curriculum models for employment-related skill development compare with best practice employability skills teaching?
   ➢ Review best teaching practices of employability skills and compare them with IB DP and CP curriculum models.

Findings from the latest and most relevant research in foresight studies, labour economics, learning sciences, pedagogy, and development psychology and a literature review of the relevant literature on key skills for employment, and their corresponding teaching practices, have informed this analysis.

The structure
The paper consists of five main parts. The first part offers a summary of the main trends impacting the labour market ranging from digitalization, through inequality to demographic shifts. In the second part, the paper provides an overview of the skills demands according to

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[1] *Frey & Osborne (2015)* Technology at Work: The Future of Innovation and Employment, Oxford Martin Programme on Technology and Employment

the O*NET database. These skills and their importance are explained in the third part of this paper. The fourth part describes outcomes of the curriculum content mapping and gap analysis which was an exercise focused on reviewing the characteristic DP and CP curriculum documents and identifying the extent to which employability skills are integrated in them. Lastly, the main themes across effective teaching of employability skills are discussed in the fifth part of the paper.

Part I. Global trends and their impact on the labour market

1. *Digital Disruption: The Future of Technology and Skills*

1.1 The impact of communication technology on employment

Flexibility
Using ubiquitous broadband connections and other technology, many interaction jobs can be concluded virtually, whether from the road, remote offices or a worker's home. This gives employers unprecedented flexibility in how they use labour and they can change where and when jobs are carried out. Managing employees and contract workers across the Internet, companies now have the ability to make labour more of a variable cost, rather than a fixed one, by engaging workers on an as-needed-basis. Across the OECD countries, part-time and temporary employment among prime age workers has risen 1.5 to 2 times as fast as total employment since 1990. There is a range of new intermediaries emerging to supply high-skill talent for short-term assignments and to tap lower-cost pools of talent in less costly locations.

Offshoring
Migration of jobs overseas for the purpose of lowering labour costs is another trend affecting employment. According to Blinder, movement of service sector from the United States and other rich countries to other (mostly poorer) nations is likely to become a major one in the coming decades, likely to be referred to as a new industrial revolution.[2] He estimates that roughly 25% of all the jobs in the United States are potentially offshorable, with majority in the service sector jobs. While migration of manufacturing jobs is a common phenomenon, offshoring service sector jobs is a recent trend caused mainly by rapid advances in computerized telecommunications technology (e.g., the Internet). In terms of empirical findings, offshorability appears to be particularly prevalent in production work and in office and administrative jobs. By industry group, it is most common in manufacturing, finance and insurance, information services, and professional and technical services. As Figure 1 shows, more educated workers appear to hold somewhat more offshorable jobs.[3]

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[2] Alternative Measures of Offshorability: A Survey Approach by Alan S. Blinder, Princeton University Alan B. Krueger, Princeton University CEPS Working Paper No. 190 August 2009
[3] Alternative Measures of Offshorability: A Survey Approach by Alan S. Blinder, Princeton University Alan B. Krueger, Princeton University CEPS Working Paper No. 190 August 2009

Figure 1. Offshorability by Educational Level

Offshorability by Educational Level		Self-classified	Inferred	Externally Coded
Education Level	Percent of all respondents	Percent offshorable	Percent offshorable	Percent offshorable
No high school diploma	9.4	18.6	14.3	11.8
High School diploma or GED	30.2	17.3	19.8	19.3
Some college (no degree)	13.9	22.4	22.1	23.8
Vocational/Technical/Associate degree	11.4	22.9	22.8	17.1
Bachelor's degree	21.6	34.6	42.8	26.4
Advanced degree or professional school	13.5	37.0	38.5	16.9

The key attribute to consider while offshoring is not the level of skill required for the job, but whether the service can be delivered to its user electronically over long distance. Thus, jobs that can be broken down into simple, routine tasks are easier to offshore than jobs requiring complex thinking, judgement and human interaction. Nevertheless, there are complex jobs such as statistical analysis or computer programming requiring high level of skills and human judgement that can also be offshored. Hence, personal/impersonal distinction is more relevant to the offshoring issue than is the routine nature of tasks. The shift toward service offshoring is a potentially dramatic labor market transformation and since ICT keeps getting better and cheaper, the scope for offshoring is estimated to increase consistently. In a summary, low-skill routine types of jobs with impersonal of delivery are most vulnerable to be offshored and automated. (Figure 2).

Figure 2. Types of jobs most vulnerable to be offshored and automated

Sources: Blinder/Krugman for X-axis, Levy/Murnane/Autor for Y-axis

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1.2 Job Automation and the Threat of Technological Unemployment

Technologists, economists and historians have warned of large-scale unemployment, caused by automation from Artificial Intelligence (AI) and other emerging technologies.[4] However, there remains significant uncertainty regarding the real impact of technological unemployment. This section provides a review of the available evidence on technological unemployment.

Current discussions of mass unemployment taking place exemplify the phenomenon of technological unemployment. John Maynard Keynes coined the term in 1930[5], defining 'technological unemployment' as *"unemployment due to our discovery of means of economising the use of labour outrunning the pace at which we can find new uses for labour".* Contrary to many existing popularizations of the concept, this simple definition captures both pressures at play: the displacement of workers by technological means ("displacement effect"), and the absence of replacement of these idle workers in novel occupations or jobs (absence of a "productivity effect"). These two pressures shape the current research field.

This specific issue is brewing today in the context of AI and robotics. Being able to predict whether and how the displacement and productivity effects will offset each other is therefore

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[4] Concern about widespread unemployment has been raised by leading AI researchers including Andrew Ng (Google, Baidu, Stanford) and Stuart Russell (UC Berkeley), and leading economists including Joseph Stiglitz (Columbia), Jason Furman (Harvard), Daron Acemoglu, Erik Brynjolfsson and Andrew McAfee (MIT), Laura Tyson (UC Berkeley) Robert Shiller (Yale), and most recently historian Yuval Noah Harari (Hebrew University of Jerusalem) among others.

[5] Keynes, J.M. 1930. *Economic Possibilities for our Grandchildren*, in Keynes, J.M. 1931 *Essays in Persuasion.* London: MacMillan & Company

a crucial question for policymakers and educational leaders. Several economists have attempted to holistically capture the impact of automation on the job market. Acemoglu & Restrepo (2017)[6] used a local labour market approach that allowed them to capture both the displacement and the productivity effects of industrial robots in the US economy between 1990 and 2007. They found that for every one industrial robot per thousand workers, employment to population ratio decreases by 0.18-0.34 percentage point and wages by 0.25-0.50 percentage points[7].

Additionally, the effect on employment is 1.5-2 times larger for male employment than for female employment. The negative employment effect of robotisation is also concentrated on manufacturing industries, especially these industries that rely more on robots. Looking at the effect per occupation, the authors find substantially more negative effects for routine manual occupations, blue-collar workers, operators and assembly workers, and machinists and transport workers. Across levels of education, they find that only workers with higher than university level education are spared from the negative wage and employment effects of robotization.

However, it is also important to note that not all highly educated and skilled workers are impacted equally. A study done by the Institute for Fiscal Studies in the United Kingdom reports on impact of degrees on early-career earnings once accounted for differences in pre-university characteristics. Not all degrees are the same, and *subject choice appears to be a very important determinant of returns*. For men, studying creative arts, English or philosophy results in lower earnings on average at age 29 than people with similar background characteristics who did not go to higher education institutions at all. The study estimated the average impact of attending higher education on earning at age 29 to be 26% for women and 6% for men.[8] For men, there are 12 institutions (accounting for 4% of male students) for which we estimate statistically significantly negative returns at age 29 on average, while there are 18 universities with average positive? returns of more than 20%.[9]

McKinsey Global Institute (MGI) offers one of the most authoritative assessments of the scale of the potential displacement effect[10]. MGI estimated the automation potential across industries and shows that accommodation and food services are the most vulnerable to automation, with 73% of time spent by this sector's workers spent on automatable tasks across the United States. Manufacturing comes second with 60%, Agriculture is third with 58% and Transportation and warehousing comes close behind, with 57%. Other industries that have automation potential of between 40 and 57% include retail trade, mining, other non-classified services, construction, utilities, wholesale trade, finance and insurance, art &

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[6] Acemoglu, D., & Restrepo, P. 2017. *Robots and Jobs: Evidence from US Labor Markets.* NBER Working Paper 23285

[7] It is important to note that over 1990-2007, there has been ±1 additional robot per thousand workers in the US

[8] UK Report Measures Value-Add of Degrees on Early Career Earnings; Institute for Fiscal Studies report on impact of degrees on early career earnings after accounting for individuals' pre-university characteristics.

[9] UK Report Measures Value-Add of Degrees on Early Career Earnings; Institute for Fiscal Studies report on impact of degrees on early career earnings after accounting for individuals' pre-university characteristics.

[10] McKinsey Global Institute 2017. *A Future that Works: Automation, Employment and Productivity*

entertainment, and real estate. The global heatmap (cf. figure 3) shows there is some heterogeneity across countries in terms of vulnerability to automation.

Figure 3: Employee weighted overall % of activities that can be automated by adapting currently demonstrated technologies
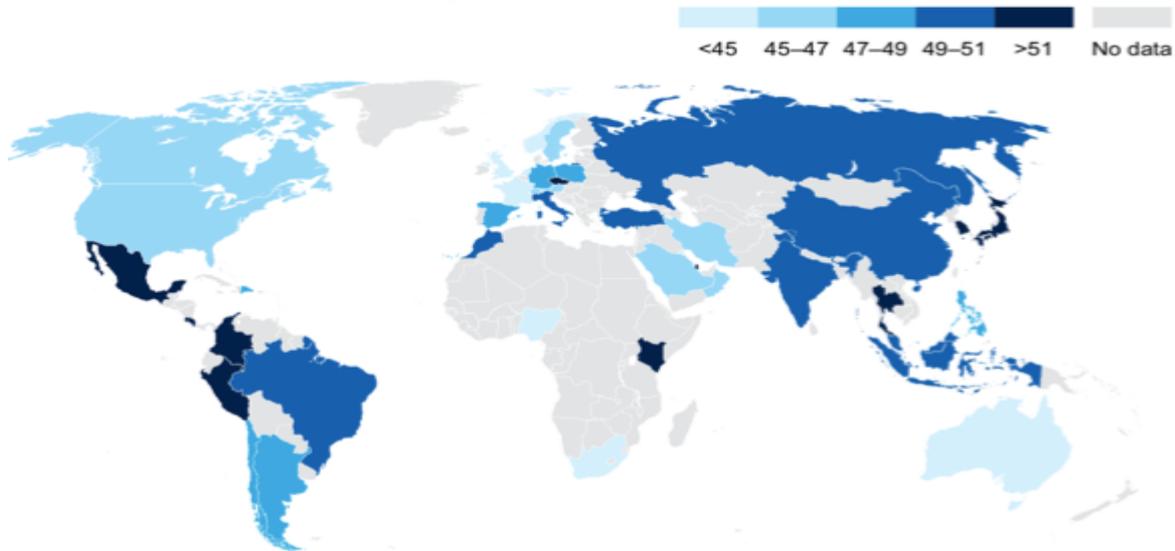
Source: McKinsey Global Institute

For the US, Frey & Osborne (2013) estimated 47% of jobs to be automatable, Chui et al. (2017) found that 49% of the jobs in United Arab Emirates are susceptible to be automated[11]. However, the OECD used a more refined methodology, leveraging task-level data instead of job-level data to show much smaller magnitudes for the displacement effect: overall, they estimate 9% of jobs in OECD countries are automatable[12]. Rather than relying on the task-level methodology, estimates relying on job-level data tend to overestimate the potential job displacement effects.

Using a similar methodology, Dauth et al. (2017)[13] find that for Germany between 1994 and 2014, the displacement effect of industrial robots has been fully offset by the productivity effect in the aggregate. Using extensive longitudinal microdata, the authors find that the displacement takes place not by firing workers, but by not replacing workers who retire. They also find that highly skilled workers (in managerial and scientific roles) tend to enjoy wage growth, while medium skilled workers (doing routine and manual tasks) are fully hit by wage cuts.

Another important fact to mention is that the threat of labor shortages is more acute in blue-collar and low-pay services occupations than in more highly educated white-collar

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[11] Chui, M., J. Manyika, and M. Miremadi 2017. *The Countries Most (and Least) Likely to be Affected by Automation.* Harvard Business Review

[12] Arntz, M., T. Gregory and U. Zierahn 2016. *The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis.* OECD Social, Employment and Migration Working Papers, No. 189, OECD Publishing, Paris.

[13] Dauth, W., Findeisen, S., Südekum, J. and Wößner, N. 2017. *German robots: The impact of industrial robots on workers.* CEPR Discussion Paper No. DP12306

occupations, the exact opposite of the prevailing trends in recent decades. It is expected that by the end of 2019, the labor market will be historically tight.[14] Industries that employ large shares of blue-collar workers, such as agriculture, mining, utilities, construction, manufacturing, transportation, accommodation and food services, repair, maintenance, and personal care services, are strongly affected by rising wages and shrinking supply. While the labor white-collar market is also tight, wage growth for the 40 percent of workers in management, professional, and related occupations is slow to accelerate. Sales and office workers, most of whom do not have a bachelor's degree, are in shorter supply than management and professional workers. Threats of automation have been hyped up short-term but are still a concern long-term.

There is also a wide geographic variation in potential for automation. In ASEAN, for example, the ILO estimates that 70% of jobs in Vietnam are at 'high risk' of automation from technology, compared to 44% in Thailand. The differences depend on the prevalence of low skill or routine work in employment. Jobs at high risk include shop and salespersons, office clerks, food service, and sewing machine operators. Jobs with lower risks of automation include general managers, teachers, house builders and handicraft workers. Moreover, there are gender and demographic differences in potential for automation. The ILO report finds that women, immigrants, and workers with less education are more vulnerable to automation. This is due to higher concentrations of these groups in low-skilled, routine work in ASEAN regions. Lastly, it is notable that the ILO methodology replicates the Frey & Osborne method which considers automation of whole jobs rather than tasks.[15]

However, these estimates do not account for several relevant factors. Importantly the relative cost of capital over the cost of labour will be a key stabilisation mechanism: as workers in a certain industry are replaced by robots, there will be a downward pressure on wages which will slow down further displacement as it now becomes more advantageous to employers to turn to cheaper labor rather than AI-empowered tools. This effect has been noted by Dauth et al. (2017) in Germany's robotisation.

Moreover, there are frictions in technology adoption within firms and the economy, such as knowledge gaps and regulatory uncertainty.[16] Few legislative frameworks worldwide have yet been updated to account for the rise of AI-empowered technologies. These legislative frameworks will be key to determine the economic incentives to automate production using AI.

While there is very active research on this topic, both main avenues to investigate this phenomenon are currently insufficient for policymaking. Meanwhile, as computing power and availability of data grow geometrically,[17] and top young minds head to high-paying and prestigious jobs in AI, the field will develop rapidly and the threshold for which tasks and jobs

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[14] Gad Levanon, Ph.D., Frank Steemers 2018. *Blue-Collar Worker Shortages: Navigating a Business Environment of Higher Labor Costs,* The Conference Board.

[15] ILO, 2016. *ASEAN in Transformation - the Future of jobs at risk of automation*

[16] McKinsey Global Institute 2017. *A Future that Works*. Also: Capgemini Digital Transformation Institute, 2017. *State of AI survey.*

[17] Singularity.com, Exponential Growth of Computing, 1900-2100. http://www.singularity.com/charts/page70.html

are 'automatable' will fall. Whether, with AI, "this time is different", is yet to be determined. We are only left with untestable arguments on both sides of the debate.

"No, this time is not different"

Those saying that this AI revolution will not lead to major unemployment generally argue that past technological advancement did not lead to long-term unemployment. For example, MIT Economist David Autor argues that humans have inherently non-automatable skills, such as interpersonal care, and that consumers' insatiable demand for products will create new products and industries.[18] Skeptics of technological unemployment also argue that technology will create new jobs, like social media bloggers today i.e. that the productivity effect has always dominated. Additionally, we are notoriously bad at predicting how technology develops - so the claims that future technologies will lead to massive unemployment are dubious because they said technology could fail to materialize itself. These claims also allude to the possibility of another AI winter, when the hype fades away. The World Economic Forum's recent report on the future of employment shows that emergence of new jobs is hard to predict as it identified the top ten jobs that did not exist a decade ago (figure 4). [19]

Figure 4. Emergence of new jobs

Emergence of New Jobs

Job	Pay level
App developer	*High*
Driverless car engineer	*High*
Cloud computing specialist	*High*
Big data analyst/data scientist	*High*
Social media manager	Medium
Sustainability manager	Medium
YouTube content creators	Medium
Millennial generational expert	Medium
Drone operators	Medium
Uber driver	Low

Source: World Economic Forum "Future of Jobs"

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"Yes, this time is different"

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[18] David Autor 2016. *Why there are still so many jobs.* TEDx Cambridge https://www.youtube.com/watch?v=LCxcnUrokJo.
[19] The Future of Jobs Report 2018, Centre for the New Economy and Society, World Economic Forum, February 2018

Those who predict mass technological unemployment point out that AI will automate jobs requiring intelligence, contrary to past technological development. They posit that AI is an alternative to the very notion of what makes humans different from other species, that is our cognitive abilities to think, reason, communicate and change. They also argue that the creation of new jobs to absorb the displaced workers is not supported by evidence. According to a study using data from the US Bureau of Labor Statistics, 80% of occupations present in 2014 already existed in 1914. Moreover, 90% of employees in 2014 worked in these same occupations.[20] In a separate study conducted by PwC in the UK, only 6% of jobs today did not exist in 1900.[21]

While autonomous vehicles threaten to replace millions of drivers, Amazon swaps out humans for robots in warehouse and retail jobs.[22] AI also automates high-skilled work, including 'legal discovery' in law firms, medical diagnostics, finance operations, and even creative tasks including music composition. Arguably, with increasingly expanding capabilities of AI, there may be no "non-automatable skills" remaining in the near future. The experts predicting mass technological unemployment also claim that so far, statements about technology failing to do something, such as AI beating humans at chess or Go have been proven untrue.

All in all, none of the arguments on either side can easily be disregarded without more evidence. An additional layer of complexity arises because there may be domains where humans or human-machine teams retain employment. Recent findings[23] have shown that algorithms helped by human insights sometimes perform better than algorithms left on their own. This means that some aspects of the technology are actually complementary and that the incentives to fire and hire labour will shift in even more complicated ways than models currently account for. Taken altogether, this shows how complex it will be to predict the technological unemployment generated by AI.

To summarize, there are four tangled possibilities:
- Outright substitution (occupation-level)
- Partial substitution (task-level)
- Partial augmentation (task-level)
- New occupations

This uncertainty leads to one certainty: we must be vigilant when it may come to the reduction of human autonomy due to the deployment of AI and we should be focusing much more energy on the quality of jobs and the meaning of human activity in general.[24]

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[20] U.S. Bureau of Labor Statistics. https://www.bls.gov/cps/cpsaat11.htm. Originally retrieved from Chace, C. 2016. *The Economic Singularity: Artificial intelligence and the death of capitalism.* Three Cs Kindle Edition.
[21] Financial Times, 2015. *Digital Economy Transforms UK workforce.* https://www.ft.com/content/5ac2e590-c741-11e4-9e34-00144feab7de
[22] Quartz. 2017. *There are 170,000 fewer retail jobs in 2017—and 75,000 more Amazon robots.* https://qz.com/1107112/there-are-170000-fewer-retail-jobs-in-2017-and-75000-more-amazon-robots/
[23] NVIDIA. 2016. *Deep Learning Drops Error Rate for Breast Cancer Diagnoses by 85%.*
[24] Hvarda, M. 2019, Discussion on the Global Governance of Artificial Intelligence at the World Government Summit.

1.3 Skills in an Age of Computers

Over recent decades, computer-controlled equipment has replaced workers in a wide range of jobs that consists of routine work—that is, tasks that follow well-defined procedures that can easily be expressed in computer code. As shown in Figure 5, most routine work such as repetitive calculating, typing or sorting, as well as production tasks that revolve around performing repetitive motions, have been automated away since the early 1980s. At the same time, starting in the late 1970s, the demand for non-routine interpersonal and analytical skills increased dramatically. The explanation is straightforward: as computer technologies have displaced labor in routine tasks, they have also created new employment opportunities for workers with non-routine social and cognitive abilities.

Figure 5. The task content of employment
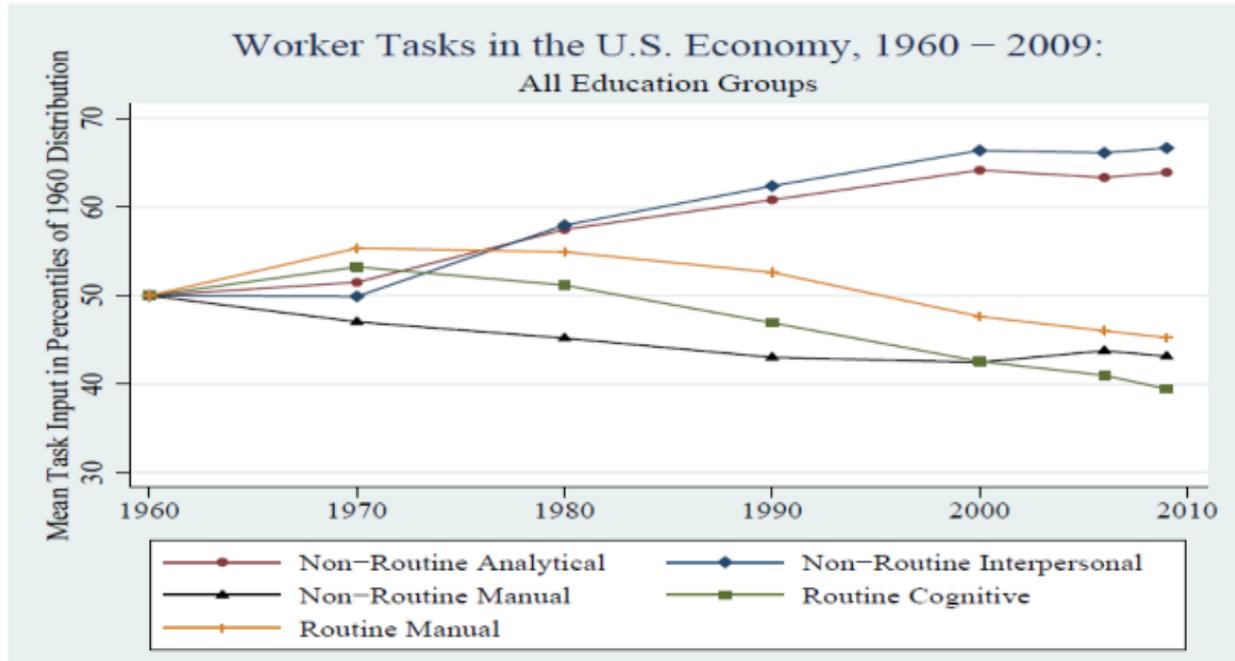
Source: Autor, Levy and Murnane (2013)

The scope of automation has however recently expanded and will inevitably continue to expand. By turning complex tasks into well-defined problems, many tasks that we used to characterize as non-routine are today automatable. A decade ago, for example, Frank Levy and Richard Murnane predicted that mimicking the subtleties of human perception—a then non-routine task—would be nearly impossible, so that a computer would never be able to navigate a car without human input.[25] Yet in 2011, Google proved the feasibility of automated vehicles and today major car manufacturers such as General Motors (GM) and Toyota have built near-autonomous vehicles that are still improving by the day.

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[25] Levy, F. and Murnane, R.J. (2004). The new division of labor: How computers are creating the next job market. Princeton University Press.

This is not an isolated example. In a wide range of industries, technological breakthroughs are already pervasively transforming labor markets. Take the example of health care where IBM's Watson computer has been retrained as a doctor. With access to two million pages of text from medical journals, 600,000 medical evidence reports and 1.5 million clinical trials and patient records, Watson can reference a patient's symptoms against her genetics and medical history to identify the treatment with the highest probability of success.[26] Following these developments, a computer was recently able to identify potential drug candidates and identify those that potentially can treat diseases.[27] Furthermore, while a human chemist can screen some 10-20 chemicals in a year, a computer can screen 10,000 in a single day.

Advances in additive manufacturing, biotech and nanotechnology will similarly transform a wide range of processes in development, design and production. Meanwhile, commercial service robots are becoming better at performing complex tasks in commercial cleaning, health care and food preparation, and are already able to perform simpler household services.[28] Many workers in administrative and office support occupations will also be made redundant as algorithms become more efficient at handling tasks that revolve around accessing or storing information. Finally, a wide range of jobs in transportation and logistics are at risk, reflecting the development of autonomous vehicles and cheaper sensors. Taken together, such advances will profoundly affect the demand for skills by 2030.

The critical question is therefore: what type of skills will still be in demand by 2030? The study conducted by Frey & Osborne[29] sheds some light on this. Workers in jobs that require originality—that is, "the ability to come up with unusual or clever ideas about a given topic or situation, or to develop creative ways to solve a problem"—are substantially less likely to see themselves replaced by computer-controlled equipment, reflecting the current limitations of automation (Figure 6a). Art Directors, Fashion Designers and Microbiologists are thus unlikely to be out of work soon. Furthermore, although a wide range of low-skill production, sales and service jobs are likely to be displaced, some relatively simple tasks, such as assisting and caring for others, are unlikely to be automated (Figure 6c), while workers that perform tasks that require manual dexterity, such as iron and steel workers or aircraft mechanics, are more likely to be displaced (Figure 6b). In other words, although computers are making inroads to domains previously confined to human workers, they are unlikely to replace jobs that require complex social interactions, such as persuasion and negotiation, as well as creative work involving the creation of new ideas and knowledge of human heuristics. Thus, in order to adapt to recent trends in technology workers will have to acquire creative and social skills.

[26] Nusca, A. (2013). 'After a year of medical school, IBM's Watson passes first milestone'. Big Data Analytics, 8 February 2013. https://www.zdnet.com/article/after-a-year-of-medical-school-ibms-watson-passes-first-milestone/

[27] Williams (2015). Williams, D. (2015) 'Robot Scientist to Discover Drugs Dramatically Faster'. Web & Techs, 4 February 2015. http://webandtechs.com/2015/02/robot-scientist-to-discover-drugs-dramatically-faster-1/)

[28] Robotics-VO (2013). A Roadmap for US Robotics. From Internet to Robotics. 2013 Edition. Robotics in the United States of America.Cohn, J. (2013). The robot will see you now. The Atlantic, February 20.

[29] Frey, C.B. & Osborne, M. (2013) The Future of Employment: How Susceptible are Jobs to Computerisation? Oxford Martin School Working Paper.

Figure 6. What tasks are susceptible to computerisation?

(a) Originality   (b) Manual dexterity   (c) Assisting and caring for others
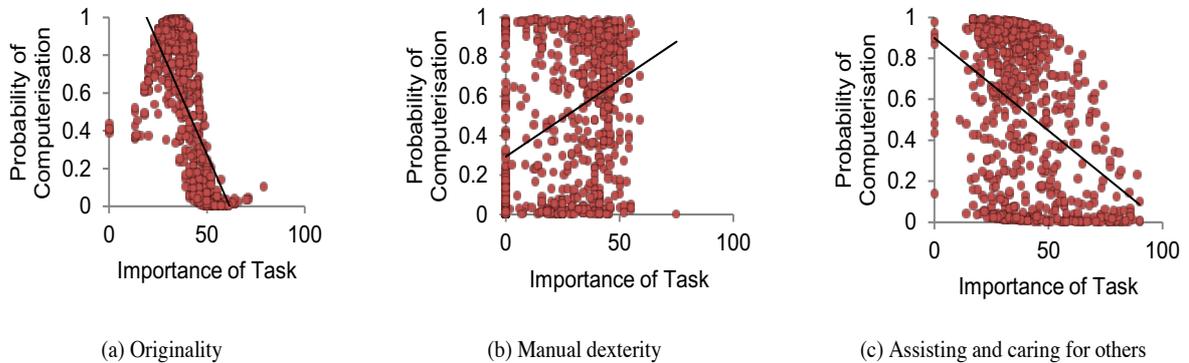
Source: Frey & Osborne (2013)

Another study done by Foundation for Young Australians (FYA) to uncover the clusters of work in Australia, analysed 4,600 unique skills requested by employers across 2.7 million online job advertisements.[30] Using a clustering algorithm, over 1,000 occupations were grouped based on whether employers demanded similar skills from candidates. For example, The Carers cluster of work comprises jobs that seek to improve the mental or physical health or well-being of others, including medical, care and personal support services. The 131 occupations currently in this job cluster include GPs, social workers, childcare workers, fitness instructors, surgeons, counsellors and beauty therapists. The algorithm groups these occupations together into one cluster based on their common skills including both the top technical skills (like computer-aided drafting, accountancy, or case management) and the top enterprise skills (like problem solving, communications, and project management). The 7 job clusters in Australia's workforce (Figure 7) are: 'The Generators', 'The Artisans', 'The Carers', 'The Coordinators', 'The Designers', 'The Informers' and 'The Technologists'.

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[30] The New Work Mindset, 7 new job clusters to help young people navigate the new work order, FYA, 2016

Figure 7. Main job clusters in Australia's workforce

Robust Jobs

Policy analysts
Statisticians
Physicists
Economists
Lab managers
Human resource
OH&S advisers
Financial brokers
Solicitors
Technical writers
Actuaries
Detectives
Psychologists
Market researchers
Journalists
School teachers
Programmers
Software engineers
Web developers
DB administrators
Web designers

'The Artisans'
'The Designers'
'The Generators'
'The Informers'
'The Coordinators'
'The Technologists'
'The Carers'

General practitioners
Nurses
Podiatrists
Dental technicians
Pharmacists
Veterinarians
Radiographers
Physiotherapists
Tour guides
Beauty therapists
Make-up artists
Community workers
Massage therapists
Cardiac technicians
Childcare workers
Special Ed teachers
Fitness instructors
Psychiatrists
Paramedics
Surgeons
Social workers

Source: FYA

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While there are some *enterprise skills*[31] that are commonly sought across these job clusters, such as communication skills, writing, training others, digital literacy and problem solving, employers in different clusters of work demand some enterprise skills more often than others. For example, The Artisans job cluster focuses primarily on the capacity to train others, problem solve and manage time, whereas The Informers job cluster requests skills related to writing, problem solving, research, creativity and team work. Currently, the enterprise skills most demanded by job cluster are summarised in Figure 8.

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[31] Enterprise skills are transferable skills that enable young people to engage with a complex world and navigate the challenges they will inherit. Enterprise skills are not just for entrepreneurs; they are skills that are required in many jobs. They have been found to be a powerful predictor of long-term job success. The terms used to describe these skills vary across different contexts: sometimes called generic, soft, or 21st century skills.

Figure 8. What enterprise skills are most commonly demanded by employers?

Job cluster	The cluster focuses on skills related to...	Enterprise skills commonly requested in the cluster:
'The Generators'	customer service and	• Communication skills, building effective relationships, customer service
	organisational skills	• Planning, time management, digital literacy
'The Artisans'	organisational skills and	• Detail-orientation, planning, problem solving, digital literacy
	interaction skills	• Capacity to train others, communication skills, team work
'The Carer'	Interaction skills,	• Communication skills, team work, teaching, customer service
	problem solving and	• Problem solving, research
	organisational skills	• Planning, time management, detail-orientation
'The Coordinators'	organisational skills and	• Time management, detail-orientation, digital literacy
	customer service	• Communication skills, team work, customer service
'The Designers'	problem solving and	• Problem solving, digital literacy
	project management skills	• Planning, Quality assurance, project management, time management
'The Informers'	interaction skills,	• Communications skills, written communication, teaching
	problem solving and	• Problem solving, creativity, research
	detail-orientation skills	• Detail-orientation, project management, digital literacy
'The Technologists'	interaction skills and	• Communication skills, customer services, team work,
	detail-orientation skills	• Detail-orientation, planning, quality assurance, project management

Source: Center for the Future of Work (2017)

Interestingly, digital literacy is demanded across most job clusters, as it is a core transferable skill but demanding technical skills related to building information technology form part of the Technologists job cluster. Therefore, acquiring and maintaining a portfolio of digital skills will become gradually important for the vast majority of workers (Figure 9). A crucial task for governments across the OECD is therefore to meet the growing demand for digital or ICT-related skills. Since the IT revolution of the 1990s, most OECD countries have witnessed the share of ICT employment increase, with some exceptions, including Austria, Ireland and the US.[32] Predictions by the OECD further suggest that employment in ICT industries will continue to increase as advances in 'smart-grid' technology reshapes the management of energy systems, infrastructure and transportation.[33] According to the European Commission, the demand for workers with specialist digital skills is already growing by about 4% each year.[34]

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[32] OECD (2015a) Key ICT Indicators. http://www.oecd.org/internet/broadband/oecdkeyictindicators.htm
[33] OECD (2013b) 'Skills for the Digital Economy'. OECD Skills Strategy Spotlight No. 4.
http://skills.oecd.org/developskills/documents/skillsforthedigitaleconomy.html
[34] European Commission (2014). Digital Inclusion and Skill, Digital Agenda Scoreboard 2014. https://ec.europa.eu/digital-agenda/en/news/scoreboard-2014-digital-inclusion-and-skills-eu-2014

Figure 9. Digital technology is becoming increasingly common in the workplace
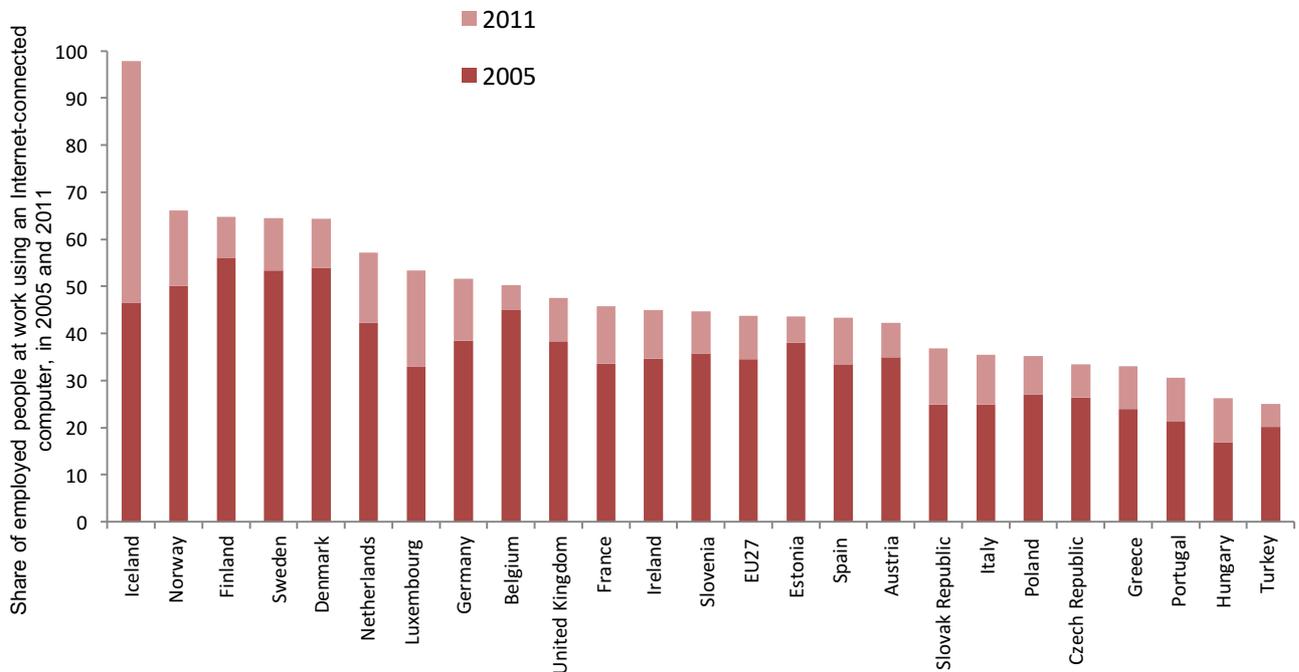
Source: OECD, 2013

While the demand for digital skills is projected to increase by 2030, there are signs that there will be a shortage of such skills. According to a recent Capgemini survey as many as 77% of firms consider the lack of digital skills a barrier to their digital transformation, and by 2020 there may be as much as 900,000 vacancies in ICT jobs according to estimates by the European Commission.[35] Globally, according to the most recent Manpower Talent Shortage Survey, specialist ICT workers—particularly programmers and developers—are some of the hardest jobs to find suitable employees for.[36]

At the same time, however, *many OECD countries have seen the share of graduates in science, technology, engineering and mathematics (STEM) fields stagnate or decline*. Although ICT industries employ a third of all business sector researchers, less than 3% of tertiary graduates are in the field of computer sciences.[37] In 2013, more than 60% of European workers reported that their digital skills were insufficient to apply for a new job.[38] A non-negligible share of workers even lack the most basic digital skills: 4.9% of workers in the OECD's Survey of Adult Skills failed to perform fundamental tasks such as scrolling through a web page or using a mouse, although there are substantial cross-country differences (Figure 10).

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[35] Campgemini (2014). The Digital Talent Gap. Capgemini Consulting.
[36] Manpower (2014). Manpower Talent Shortage Survey.
[37] OECD (2014a), *Measuring the Digital Economy: A New Perspective*, OECD Publishing.
[38] OECD (2014a), *Measuring the Digital Economy: A New Perspective*, OECD Publishing.

Figure 10. Digital skills vary widely across countries
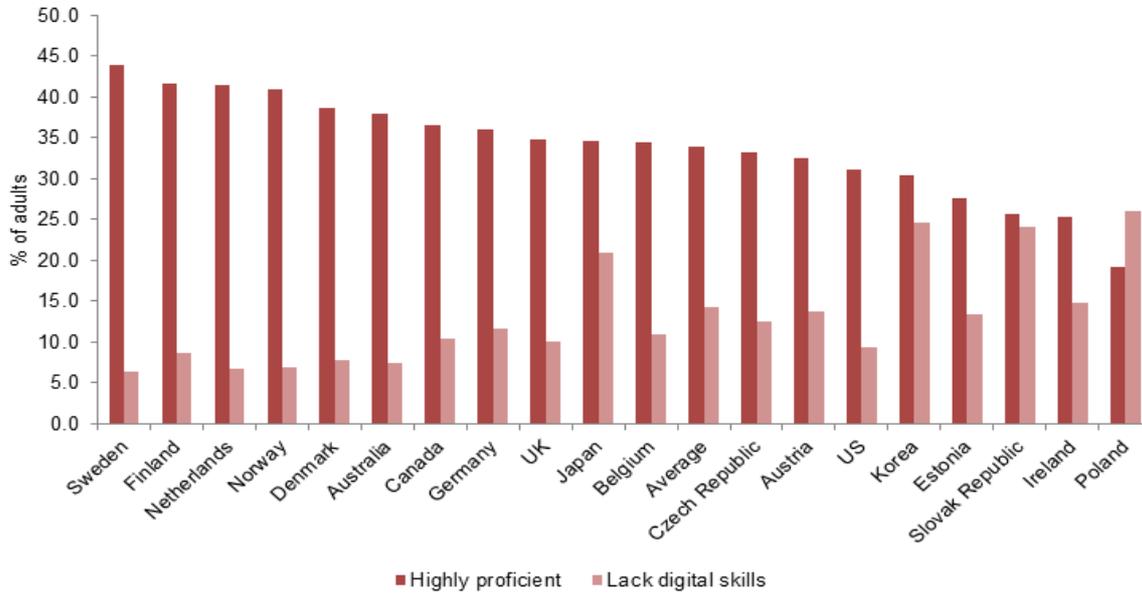
Source: OECD (2013)

For workers without these basic digital skills, such as the ability to use standard computer software, navigate the internet and conduct basic programming, it will be difficult to adapt to the rapid pace of change. Over the past three years, about 30% of workers in the OECD report that new processes or technologies were introduced at their workplaces.[39] As the workplace continues to undergo substantial restructuring in response to new technologies becoming available, many skills will rapidly become outdated.

Thus, to remain competitive, workers will constantly need to acquire new skills, requiring flexibility, an attitude towards life-long and life-wide learning, and curiosity. Modular approaches to education that allow workers to constantly update their digital skills portfolio will be crucial to meet the rising demand by 2030. At the same time, workers would do well in not acquiring too narrow skill sets that will eventually become obsolete. While ICT specialists will be needed, a combination of skillsets that make workers adaptable to technological change will be even more important. The educational efforts should focus on fusion skills— that is, the combination of creative, entrepreneurial and technical skills—allowing workers to shift into new occupations as they emerge.

1.4 New and Emerging Occupations

A central concern is whether new job creation will be sufficient to replace the many employment opportunities that have recently disappeared. ICT employment in the OECD, for

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[39] OECD (2013a) OECD Skills Outlook 2013, First Results from the Survey of Adult Skills, Paris: OECD, 2013.

example, has yet to recover to its 2001 peak of 4.1% of total employment.[40] Although high-tech employment has grown and spread across Europe over the past decade, only about 10% of workers in the EU-27 are employed in high-tech industries.[41]

Job creation in new occupations and industries has been even sparser: according to our estimates about 0.5% of US workers are employed in tech industries that have been created since the turn of the century.[42] While Kodak for example employed some 145,000 workers at its peak, with many more employed indirectly as subcontractors and retailers; Instagram employed 15 people in 2010 and was acquired by Facebook for $1 billion two years later. One explanation for the sluggish rate of job creation is the low investment demand associated with tech start-ups: in the digital economy only few workers are needed to build up the capital that allows companies to reach global markets.[43]

Nevertheless, computer technologies have created a wide range of new occupations in the past. Following the Computer Revolution of the 1980s, about 1,500 new job titles appeared in the US labor market, many resulting directly from new technologies: jobs such as web designers, database administrators and software engineers, for example, were created as a direct result of the introduction and diffusion of the personal computer and the World Wide Web. [44] More recently, several new job titles have also emerged as a result of advances in nanotechnology, medicine and robotics (figure 11). Furthermore, advances in green technology have increased the demand for chemical engineers, electricians and zoologists, and created a range of entirely new occupations.

[40] OECD (2014a), *Measuring the Digital Economy: A New Perspective*, OECD Publishing.

[41] Goos, Maarten, Alan Manning, and Anna Salomons. (2014). "Explaining Job Polarization: Routine-Biased Technological Change and Offshoring." American Economic Review, 104 (8), 2509–2526.

[42] Berger, T., and Frey, C.B. (2014a) Technology Shocks and Urban Evolutions: Did the Computer Revolution Shift the Fortunes of U.S. Cities?. Oxford Martin School Working Paper.

[43] Frey, C.B. (2015a). The End of Economic Growth? How the Digital Economy Could Lead to Secular Stagnation Scientific American, Vol. 312, No. 1.

[44] Lin, J. (2011). Technological Adaptation, Cities, and New Work. Review of Economics and Statistics, 93(2), 554–574.

Figure 11. Examples of New and Emerging Jobs

Occupation	Description	Examples of Skills	Example of Knowledge	Example of Character
Robotics Engineers	Research, design, develop, or test robotic applications.	Critical Thinking; Complex Problem Solving; Quality Control Analysis.	Engineering and Technology; Robotics; Design.	Exploration; precision; observation.
Biostatisticians	Develop and apply biostatistical theory and methods to the study of life sciences.	Inductive Reasoning; Oral Expression; Mathematical Reasoning.	Mathematics; English Language; Education and Training.	Project/program management; execution; inquisitiveness.
Fuel Cell Engineers	Design, evaluate, modify, or construct fuel cell components or systems for transportation, stationary, or portable applications.	Judgment and Decision Making; Writing; Critical Thinking.	Physics; Mathematics; Chemistry.	Focus; reliability; feedback.
Solar Sales Representatives and Assessors	Contact new or existing customers to determine their solar equipment needs, suggest systems or equipment, or estimate costs.	Active Listening; Persuasion; Social Perceptiveness.	Sales and Marketing; Engineering and Technology; Customer and Personal Service.	Accountability; focus; results-orientation.
Video Game Designers	Design core features of video games. Specify innovative game and role-play mechanics, story lines, and character biographies. Create and maintain design documentation. Guide and collaborate with production staff to produce games as designed.	Programming; Critical Thinking; Complex Problem Solving.	Design; Communications and Media; Psychology.	Inquisitiveness; playfulness; passion.

Source: O*NET (http://www.onetonline.org/find/bright?b=3&g=Go)

Thus, most new jobs have one thing in common: they are substantially more skilled than jobs of the past. While this is a trend that has been going on for several decades, many new jobs now even require an advanced degree.[45] Among Biostatisticians, for example, 48% of the workers surveyed responded that their job required at least a doctoral degree. More importantly, many of these jobs require a combination of technical knowledge coupled with skills and character qualities. Core work activities for a Robotics Engineer, for example, include research and design coupled with two central skill requirements which are critical thinking and complex problem solving.

2. Mind the Gap: The Future of Inequality

2.1 Inequality Among the 99%

In tandem with rapid technological progress, most OECD countries have experienced a rise in income inequality.[46] In particular, as the price of computing has fallen, problem-solving skills—where college educated workers have a comparative advantage—have become relatively more productive, explaining the growing return to education.

Although skill-biased technological change can explain the growing demand for educated workers, it is silent on an important feature of most labor markets in the OECD: job

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[45] Berger & Frey (2014a). In addition, studies have shown that almost the entire increase in the return to education reflect an increase in returns to cognitive skills (Ingram & Neuman 2006).
[46] Acemoglu, D. (2002). Technical change, inequality, and the labor market. Journal of Economic Literature, vol. 40, no. 1, pp. 7–72. Goldin, C. and Katz, L.F. (2009). The race between education and technology. Harvard University Press.

polarization. As has been persuasively shown by Autor et al. (2003), however, computer technologies have also displaced workers in a wide range of routine work, including many clerking and manufacturing jobs—work that is typically concentrated at the middle of the income distribution. Accompanied with employment growth both at the top and bottom of the skill and income distribution, the automation of routine work has contributed to a hollowing-out of labor markets across the industrial world.[47] The share of hours worked in middle-income occupations has declined in all 16 European countries between 1993 and 2010, while jobs at the top and bottom of the wage distribution have experienced rapid employment growth. Furthermore, studies of the US, Japan and Europe show that industries that implemented ICT also shifted the demand from middle-educated workers to skilled workers, with technology accounting for about a quarter of these shifts.[48]

Figure 12. Low-income jobs are more likely to be computerised
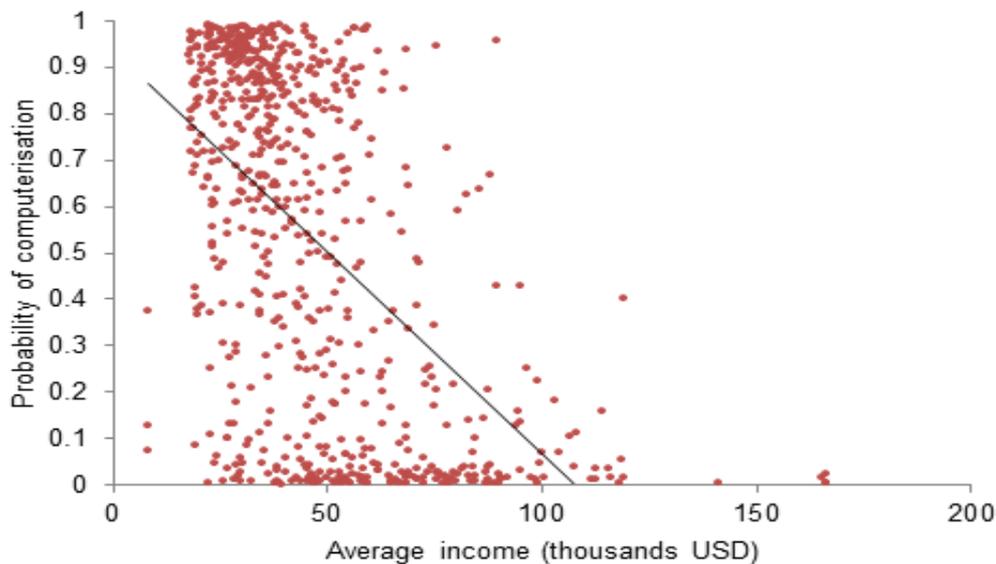
Source: Frey & Osborne (2013)

The future of income inequality will thus largely be determined by the direction of technological change. As low-income and low-skill workers are now for the first time at risk of automation (Figure 12), while new and emerging occupations are largely confined to skilled workers, the recent surge in inequality is likely to further be exacerbated. To avoid such an outcome, governments will need to manage the reallocation of workers from existing low- and middle-skilled jobs to relatively skilled emerging occupations. Unless investments are made into skills development to allow workers to shift into new employment opportunities,

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[47] Autor, D., Levy, F., and Murnane, R. J. (2003). The skill content of recent technological change: An empirical exploration. The Quarterly Journal of Economics, 118(4), 1279–1333.; Goos, M. and Manning, A. (2007). Lousy and lovely jobs: The rising polarization of work in Britain. The Review of Economics and Statistics, vol. 89, no. 1, pp. 118–133.

[48] Michaels, Guy, Ashwini Natraj, and John Van Reenen. 2014. "Has ICT Polarized Skill Demand? Evidence from Eleven Countries over Twenty-Five Years." Review of Economics and Statistics 96 (1): 60–77.

income inequality among the 99% is likely to continue to increase through 2030, as an increasing scope of low-skilled jobs are at risk of being displaced.

2.2 The Top 1% and the Labor Share of Income

The top 1% has become the theme of the 21st century.[49] While the first half of the 20th century witnessed a sharp decline in the share of GDP accruing to the top 1%, the convergence between the top 1% and the 99% came to a halt during the 1950s. More recently, this process reversed with an increasing fraction of incomes accruing to the top 1%. In virtually all countries, the top 1% income share has increased dramatically since the early 1980s, coinciding with the liberalization of financial markets, a decline in marginal tax rates, as well as the dawn of the computer revolution. This trend has been the most pronounced between the late 1970s and 2012 in the United States when the top percentile of US households more than doubled their share of national income from 10.0% to 22.5%.[50]

While the impact of technology on inequality among the 99% is evident, the link between technology and the concentration of income among the 1% is less clear. A commonly held view, however, is that globalization and technological advances together have created a 'winner-take-all' economy, where reduced barriers to trade and an increasingly digitized economy allow leading firms and entrepreneurs to capture the entire market. For example, as has been pointed out by Brynjolfsson et al. (2014): "digital copies can be made at virtually zero cost and transmitted anywhere in the world almost instantaneously, each an exact replica of the original." This feature of the digital economy allows companies like Twitch, a live streaming video platform, to employ some 170 workers, while serving the world market.

At the same time, a growing body of work has pointed at digital technologies as a key driver behind the declining labor share of GDP across the industrial world.[51] Crucially, as companies are becoming increasingly automated, gains in productivity have not translated into wage growth, but have shifted incomes from labor to owners of capital. According to a recent study, 42 out of the 59 countries examined experienced a decline in the share of GDP accruing to labor over recent decades, mainly as a result of cheaper technologies becoming available[52]. Estimates by the OECD even suggest about 80% of the drop in the labor share is accounted for by reductions in the price of computerized equipment and robots, creating incentives for firms to replace workers with machines.[53]

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[49] Piketty (2014). Capital in the Twenty-First Century. Translated by Arthur Goldhammer.
[50] Autor, D.H. (2014), Skills, education, and the rise of earnings inequality among the "other 99 percent" Science 23 May 2014: Vol. 344 no. 6186 pp. 843-851
[51] Furthermore, between 2000 and 2011, revenues of internet firms in the OECD grew by 30%; while employment expanded by 15% (OECD, 2013b).
[52] Karabarbounis, L. and Neiman, B. (2013). The Global Decline of the Labor Share, NBER Working Papers 19136, National Bureau of Economic Research, Inc
[53] The Economist (2013). Labor Pains. Oct 31st 2013. http://www.economist.com/news/finance-and-economics/21588900 all-around-world-labor-losing-out-capital-labor-pains

As incomes have been shifted from workers to capital owners, wealth inequality has also soared. In the US, for example, the wealth share of the 160,000 families that constitute the top 0.1% more than tripled between 1979 and 2012, from 7% to 22%.[54] Similarly, over the past decade, the combined net worth of the 400 richest Americans has more than doubled, from $2.5 to $5.7 trillion, according to Forbes Magazine. As the price of robots is expected to decline further, there are good reasons to believe that the labor share of GDP will continue to fall over the decades leading up to 2030. Thus, in the absence of other shocks or policy interventions, owners of capital are likely to capture a growing share of GDP.

Nevertheless, while digital technologies are likely to continue substituting for an even broader range of workers, technological progress may also help boost the labor share of GDP as workers acquire skills that are complementary to the technologies that are being developed. For example, while registered nurses in the United States earn on average 66,220 USD per year, informatics nurse specialists, focused on the design and implementation of computerized health care systems, earn 81,190 USD annually. Thus, investments into skills that complement the arrival of new digital technologies may not only reduce inequality among the 99% but could also help boost wages and increase the labor share of GDP.

2.3 Inequality and Opportunity: The Impact on Social Mobility

The hollowing-out of labor markets and the potential future displacement of low-skilled workers are fuelling an already growing concern that as societies become more unequal, there will be less opportunity for the children of low- and middle skilled workers to advance up the economic ladder. As has been extensively documented, however, much of the surge in income inequality stems from the increasing returns to education. This, in turn, has implications for social mobility. Evidence from the OECD's Survey of Adult Skills unambiguously shows that adults from socio-economically disadvantaged backgrounds have lower skills proficiency, and that parental education is a key predictor of a child's skills.

As many elementary occupations, that have previously provided a stepping-stone to better paid work, have disappeared over recent decades, and a growing share of low-skilled workers are now susceptible to automation, a central challenge for many workers will be to upgrade their skills---including skills such as creative thinking, social perceptiveness, negotiation, persuasion, the ability to care for others, and depth of perception---allowing them to transition into meaningful and better-paying jobs that are less susceptible to computerisation. Investments to broadly improve the skills of the workforce are thus not only likely to pay long-term dividends in terms of productivity gains but would also contribute to a more equal distribution of skills, in turn equalizing incomes and boosting upward mobility. This is supported by evidence showing that those least well-off have a higher probability of experiencing upward mobility in places that invest in schooling.[55] *In particular, as socio-*

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[54] Saez, E. and Zucman, G. (2014). Wealth Inequality in the United States since 1913: Evidence from Capitalized Income Tax Data, NBER Working Papers 20625, National Bureau of Economic Research, Inc.
[55] Chetty, R., Hendren N., Kline, P. and Saez, E. (2014). Where is the Land of Opportunity? The Geography of Intergenerational Mobility in the United States. NBER Working Paper 19843, National Bureau of Economic Research, Inc.

emotional skills among children shape their future development of cognitive skills, investments in such skills during the school years will be of crucial importance (see Figure 13 for examples of associated social and emotional skills that will be required).[56]

Figure 13. Social-emotional skills required for specific various jobs

Skill	Description of Skill	Examples of Knowledge	Examples of Character	Examples of Occupations
Assisting and Caring for Others	Providing personal assistance, medical attention, emotional support, or other personal care to others such as coworkers, customers, or patients.	Biology; Medicine and Dentistry; Therapy and Counseling	Care; Kindness; Respect for others	Hospitalists; Music Therapists; Psychiatrists
Persuasion	Persuading others to change their minds or behavior.	Communications and Media; Psychology; Sales and Marketing	Determination; Energy; Interconnectedness	Arbitrators; Mediators; Sales Engineers
Social Perceptiveness	Being aware of others' reactions and understanding why they react as they do.	Administration and Management; Customer and Personal Service; Psychology	Compassion; Decency; Insight	Clergy; Clinical Psychologists; Psychiatrists

Source: O*NET (http://www.onetonline.org/find/bright?b=3&g=Go).

3. Demographic Shifts: The Future of Populations

3.1 A Declining Population: Dividend or Deficit?

One of the major achievements of the twentieth century has been the substantial increases in life expectancy across the industrial world. Improvements in nutrition, disease prevention and medicine allow individuals to live substantially longer, healthier and more fulfilling lives. Over the next decades, new technological advances are likely to increase life expectancy even further, to above 100 years in many OECD countries.[57]

Longer life spans have also contributed to the growth of the world's population, increasing from about 1.7 to 6 billion over the course of the twentieth century. In the twentieth century, however, declining fertility has meant that the industrial world is entering a period of stagnating and even declining populations.[58] Crucially, recent declines in fertility largely stem from more women acquiring an education, in turn increasing the female labor force participation, although cultural shifts in the desired number of children and better access to contraceptives provide additional important explanatory factors. While the average number of children born per woman (aged 15 to 49) was 2.8 across the OECD in 1970, the equivalent

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[56] Cunha, F. and J.J. Heckman (2008), Formulating, identifying and estimating the technology of cognitive and noncognitive skill formation, Journal of Human Resources, Vol. 43, No. 4, pp. 738-782. and OECD (2015b) Skills for Social Progress: The Power of Social and Emotional Skills, OECD Skills Studies, OECD Publishing.

[57] Vaupel, J. W. (2010) Biodemography of human ageing. Nature 464, 536–542.

[58] While whether a decline in populations is desirable or not is still being intensely debated, the world population is set to peak between 9 and 10 billion by 2050 (Goldin, 2014).

figure is now 1.7.[59] Today, nearly all OECD countries have total fertility rates below 2.1—that is, the rate needed to sustain a stable population. According to UN projections, most industrial countries are also expected to exhibit fertility rates below-replacement levels over the forthcoming decades, although there are substantial differences across regions. In Europe, fertility rates are projected to increase from 1.6 to 1.7 by 2030; in Asia, they are expected to fall from 2.1 to 2.0; whereas in the US, they are projected to remain at 2.0.[60]

Figure 14. UN Population Growth Forecasts
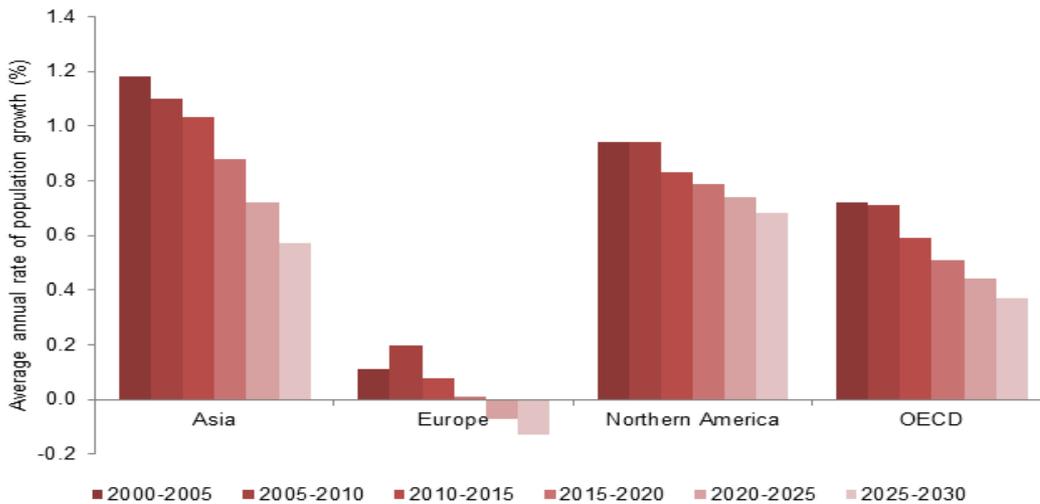
Source: UN (2012)

This tendency means that populations will stabilize and eventually decline. The European population is projected to fall from about 743 million today, to 736 million by 2030, and the population of Japan is already in decline (Figure 14).[61] In the OECD as a whole, the population is expected to increase only slightly, from about 1.28 to 1.37 billion over the same period. Most population growth is thus expected to come from the developing world, boosting the world's population from about 7.3 to 8.4 billion.

As population growth tapers off in the industrial world, the age composition of nations and regions will change dramatically: the median age in Europe, for example, is projected to increase from 41.4 to 44.7. Similarly, in Asia and Northern America, the median age is expected to increase from 30.2 to 35.4, and 37.9 to 39.8, respectively.[62] Along with this trend, the share of people aged above 65 will increase substantially: in the OECD, one in five people will be 65 or older by 2030. Accordingly, nearly every industrial country will experience

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[59] OECD (2014b), Total fertility rates, in *OECD Factbook 2014*, OECD Publishing, Paris.
[60] UN (2012) *World Population Prospects: The 2012 Revision*, http://esa.un.org/unpd/wpp/index.htm Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat.
[61] UN (2012) *World Population Prospects: The 2012 Revision*, http://esa.un.org/unpd/wpp/index.htm Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat.
[62] UN (2012) *World Population Prospects: The 2012 Revision*, http://esa.un.org/unpd/wpp/index.htm Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat.

increases in the elderly dependency ratio by 2030 (Figure 15), with considerable effects on growth and the skills of the workforce.

Figure 15. Elderly dependency ratios will increase by 2030
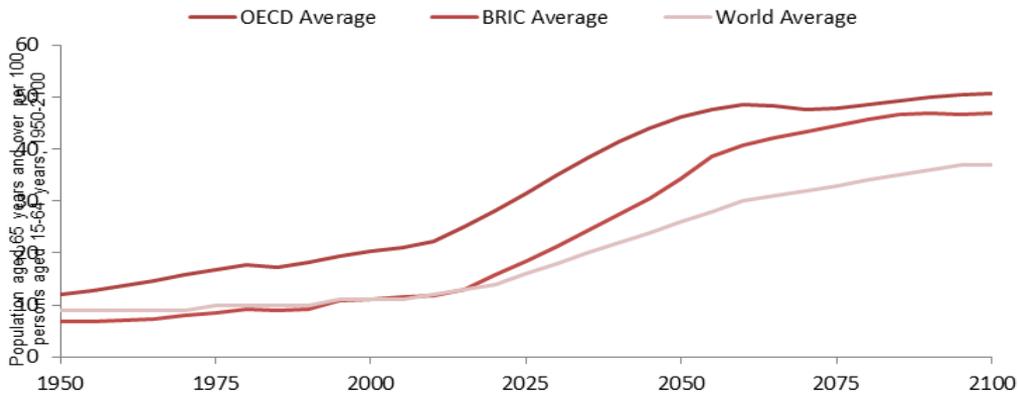
Source: OECD (2013c).

As populations age, the demand for health care will continue to increase. This is reflected in the wide range of new and emerging health care-related occupations (Figure 16), requiring character qualities such as caring, sociability and respect as well as service orientation and social perceptiveness skills.[63] While acute care nurses and hospitalists require a higher degree of social perceptiveness to understand emotional patterns and interact with patients, geneticists and pathologists require a higher degree of knowledge about science and critical thinking. Furthermore, even in health care, digital skills are becoming more important: informatics nurse specialists, for example, focus on the design and implementation of computerized health care systems, requiring being able to work with computers.

[63] OECD (2015b) Skills for Social Progress: The Power of Social and Emotional Skills, OECD Skills Studies, OECD Publishing.

Figure 16. Aging and emerging occupations in health care

Occupation	Description	Examples of skills	Example of Knowledge	Example of Character
Acute Care Nurses	Provide advanced nursing care for patients with acute conditions such as heart attacks, respiratory distress syndrome, or shock. May care for pre- and post-operative patients or perform advanced, invasive diagnostic or therapeutic procedures.	Service Orientation; Social Perceptiveness	Medicine and Dentistry; Psychology; English Language.	Respect for others; patience; sensibility.
Hospitalists	Provide inpatient care predominantly in settings such as medical wards, acute care units, intensive care units, rehabilitation centers, or emergency rooms. Manage and coordinate patient care throughout treatment.	Service Orientation; Social Perceptiveness	Biology; Customer and Personal Service; Biology.	Care, kindness, compassion.
Geneticists	Research and study the inheritance of traits at the molecular, organism or population level. May evaluate or treat patients with genetic disorders.	Critical Thinking; Science	Chemistry; Mathematics; Biology.	Diligence; focus; exploration.
Pathologists	Diagnose presence and stage of diseases using laboratory techniques and patient specimens. Study the nature, cause, and development of diseases. May perform autopsies.	Complex Problem Solving; Science	Medicine and Dentistry; Administration and Management; Computers and Electronics.	Precision; dealing with ambiguity; accountability.
Neurologists	Diagnose, treat, and help prevent diseases and disorders of the nervous system.	Complex Problem Solving; Social Perceptiveness	Psychology; Therapy and Counseling; Psychology.	Goal-orientation; exploration; commitment.
Informatics Nurse Specialist	Apply knowledge of nursing and informatics to assist in the design, development, and ongoing modification of computerized health care systems. May educate staff and assist in problem solving to promote the implementation of the health care system.	Systems Analysis; Critical Thinking	Customer and Personal Service; Medicine and Dentistry; Education and Training.	Feedback; project/program management; cooperation.

Source: O*NET (http://www.onetonline.org/find/bright?b=3&g=Go).

3.2 Populations and the Workforce: Implications for Growth and Skills

As people grow older they are also more likely to drop out of the labor force. Across the OECD the average labor force participation rate for those aged 25-54 is 81.5%, but only 59.7% among individuals aged 55-64. Thus, an aging population will reduce the percentage of productive workers in the economy, as long as the current age of retirement remains. To counter this trend a wide range of skills will be required, including flexibility, life-long learning, perseverance, entrepreneurial ability and curiosity.

Crucially, educated workers are substantially more likely to remain active in the labor market later in life, reflecting both their higher opportunity costs of leaving work and better health. In Europe, for example, 50% of workers aged 60-64 with a degree remain in the labor force, whereas only 25% of low-skilled workers are still in employment. Past studies further suggest that about half of the increase (from 35 to 44%) in US labor force participation among those aged 60-74 over the past 25 years is the result of rising educational attainment among older workers.[64] Although there is substantial variation in labor force participation among older workers across economies, this is a trend that is prevalent in many countries.

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[64] Burtless, G. (2013). The Impact of Population Aging and Delayed Retirement on Workforce Productivity. WP#2013-11, Center for Retirement Research at Boston College.

The implications of these demographic shifts are potentially severe: a shrinking labor force will mechanically reduce economic growth unless it is offset by productivity gains among younger workers that remain in the labor force. Had the projected population changes through 2050 occurred between 1960 and 2005, for example, the average annual growth rate for the OECD country would have been 0.7% lower (2.1% rather than 2.8%).[65] Other estimates suggest that Japan's shrinking workforce has reduced average annual GDP growth by roughly 0.6 percentage points, and in Germany growth has been 0.5 percentage points slower as a result.[66]

Alarmist views of the economic impact of population aging are, however, based on the assumption that age-specific behavior will remain constant over time, which is problematic since individuals may adapt to further increases in life expectancy. Investing in an education is more attractive the longer that investment pays off and looking forward to a larger share of their life in retirement, workers may adapt by saving more during their active working lives. More fundamentally, these demographic projections are uncertain themselves: according to the UN's predictions for 2030, the world population may be anything between 7.9 and 8.9 billion.

At the same time, it is important not to understate the challenge ahead. In essence, governments will be faced with three main options to mitigate the effects of aging populations by 2030: harnessing the skills of older workers, encouraging immigration, attracting more women into the labor force, and embracing automation. Although the immigration option may offset age imbalances in the labor force it is unlikely to bridge the skills gap: immigrants have substantially lower proficiency on average, even when adjusting for a number of other factors.[67] Furthermore, immigration will require the workforce to develop entirely new skills. In particular, a recent UNESCO report has pointed at the importance of promoting skills such as tolerance, knowledge of other cultures and empathy, to create a better understanding for people from different backgrounds.[68] Similarly, Delors (1996) points towards the importance of learning to live together by developing "an understanding of others and their history, traditions and spiritual values and, on this basis, creating a new spirit which, guided by recognition of our growing interdependence and common analysis of these risks and challenges of the future, would induce people to implement common projects or to manage the inevitable conflicts in an intelligent and peaceful way."

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[65] Bloom, D.E., Canning, D. and Fink, G. (2011). Implications of Population Aging for Economic Growth, NBER Working Papers 16705, National Bureau of Economic Research, Inc.

[66] The Economist (2014). Age invaders. Apr 24th 2014. http://www.economist.com/news/briefing/21601248-generation-old people-about-change-global-economy-they-will-not-all-do-so

[67] OECD (2013a) OECD Skills Outlook 2013, First Results from the Survey of Adult Skills, Paris: OECD, 2013.

[68] United Nations, Department of Economic and Social Affairs, Population Division (2014). World Urbanization Prospects: The 2014 Revision, CD-ROM Edition.

Figure 17. Problem-solving skills decline with age
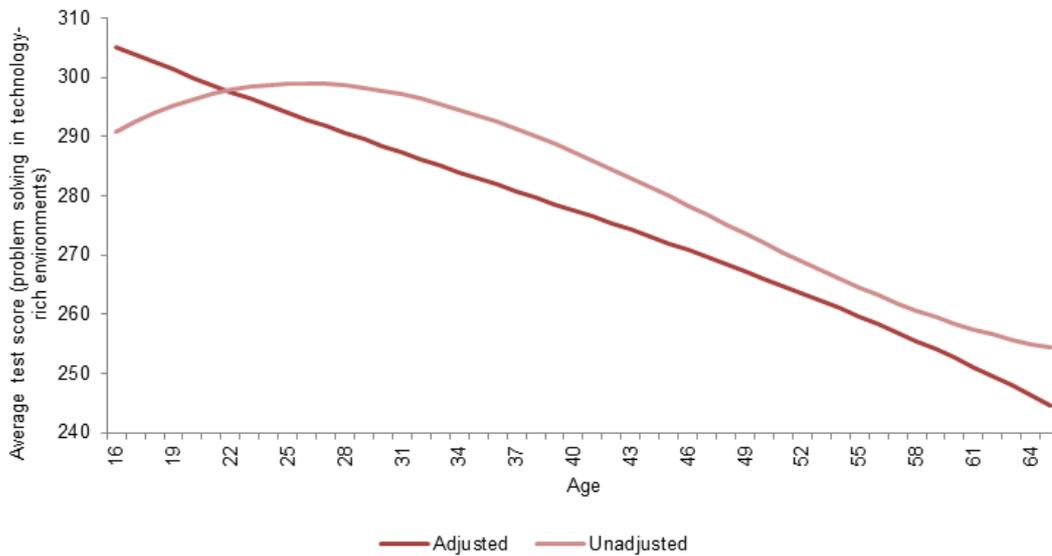
Notes: The adjusted series take account for educational attainment and foreign-language.
Source: OECD (2013a).

Thus, some substantial skill upgrading of the workforce will be required to adapt to these demographic shifts. In particular, as populations gradually age, providing opportunities for upgrading or re-skilling later in life will become increasingly important. Older workers are typically less proficient than their younger counterparts, reflecting a lack of opportunities to maintain, refine and update skills over their careers as well as biological aging. Problem-solving skills, for example, peak around the age of 30 and decline thereafter.[69] In addition, as digital skills are becoming increasingly important, a key concern is that older workers use digital technologies substantially less and will require more intensive training to maintain their employability. With a larger share of older workers in the labor force, flexible and skills-orientated learning must therefore be made available to workers throughout their careers. Fortunately, digital technologies can also help transform education to expand the opportunities for aging workers to maintain and upgrade their skills. Distance learning and massive open online courses (MOOCs) promise a flexible and cheaper way for workers to learn; in 2013, 9.3% of the Internet users in the OECD took part in an online course.[70] Approaches to distance learning will also become more important, as exemplified by the emerging occupation of Distance Learning Coordinators that train instructors in the use of distance learning applications.

Furthermore, the expanding scope of automation can help offset some of the decline in population growth as computers are now able to perform many tasks that have previously been confined to human labor. At the same time, low- and mid-skilled workers will have to

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[69] Yet, differences in skills proficiency between the old and young differ widely between countries, suggesting a scope for policy makers (OECD 2013a).
[70] OECD (2014a), *Measuring the Digital Economy: A New Perspective*, OECD Publishing.

reallocate to jobs that are less susceptible to automation. Countries that successfully upskill their workforce, making their skills complementary to digital technologies, will also experience further productivity gains as a result. Job automation and upgrading/re-skilling thus need to go hand-in-hand.

Other demographic shifts will also influence the skills of the workforce. Over the past four decades, marriage rates have plummeted from about eight per 1000 people to five, divorce rates have tripled since 1980, and 15% of children now live in single-parent households.[71] As evidence from the PISA study shows that students from single-parent families perform substantially worse relative to other students, this provides a challenge for skills development. Similarly, across local labor markets in the US, there is a considerable negative relationship between average test scores and the stability of family structures, proxied by the fraction of children living with single mothers (Figure 18). Investing in developing skills among the most disadvantaged would thus likely yield large benefits, both in terms of individual welfare and economic growth.

Figure 18. Test scores are lower in places with weaker family structures
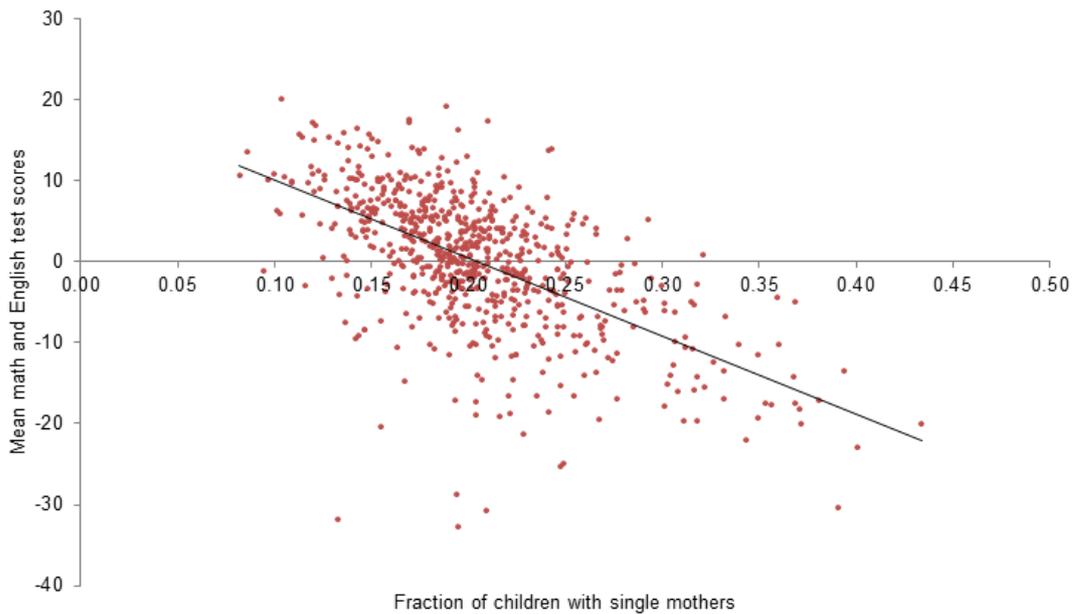
Notes: Test scores correspond to mean test scores in English and math adjusted for differences in household income per capita.
Source: Chetty et al. (2014).

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[71] OECD (2011) "The Future of Families to 2030" International Futures Programme, OECD.

4. Urbanization and Innovation

As famously proposed by Lucas (1988), cities across the industrial world provide "the engines of growth". Despite recent claims that the death of distance facilitated by improvements in information and communications technology would make geography less important, leading to the decline of cities, the opposite has happed.[72] Today, a larger part of the world's population is living in cities than a decade ago—a trend that is likely to continue. According to projections by the UN, the share of the population living in urban areas is expected to grow even further across high-, middle- and low-income countries over the forthcoming decades (Figure 19).

Figure 19. Urbanization is increasing everywhere by 2030
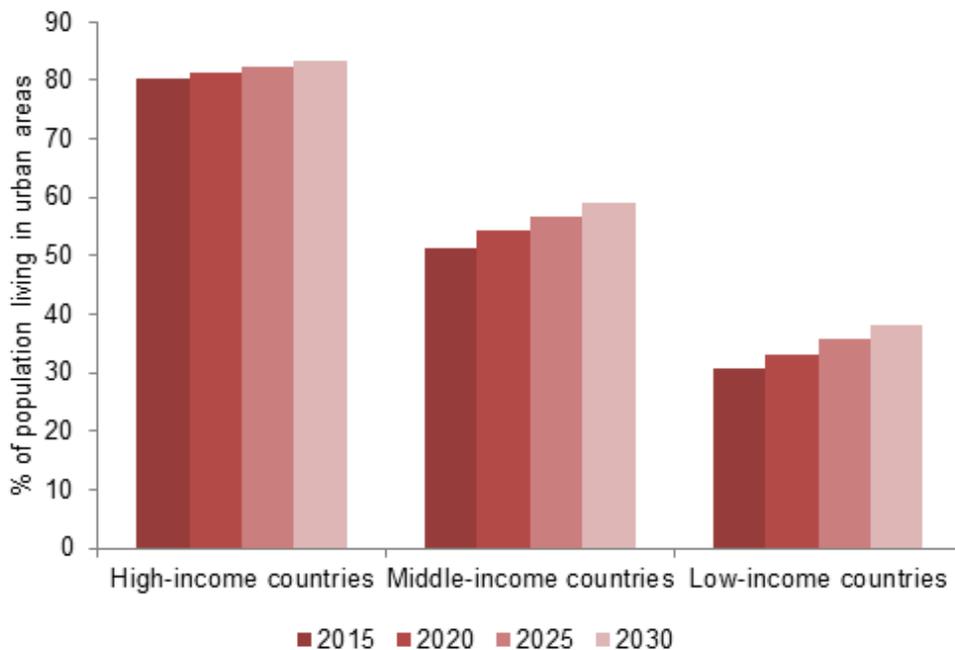
Notes: Percentage of the population that lives in urban areas.
Source: United Nations, Department of Economic and Social Affairs, Population Division (2014).

This concentration of economic activity, following the migration from rural areas to cities, posts important challenges for societies. At a time when growth rates across nations are converging, disparities within countries are growing, both in terms of education and incomes:[73] while computer technologies have made the skills that are prevalent in many rural areas and older manufacturing cities redundant, the shift towards technology industries, where knowledge transmission is particularly important, has made new occupations and

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[72] Glaeser, E.L. (1998). Are Cities Dying?, Journal of Economic Perspectives, 12(2): 139-160.
[73] Berry, C. R. and Glaeser, E. L. (2005). The divergence of human capital levels across cities. Papers in regional science, 84(3), 407–444.

industries cluster in skilled cities. For example, the continuous renewal of clusters like Silicon Valley, which has attracted the higher share of new industries since the turn of the century, is largely the result of workers frequently switching jobs, leading to the creation of new companies and industries. While some older cities such as Boston and London have also successfully managed this renewal process to become innovation hubs, many places have experienced declines both in relative and absolute terms: Detroit, Liverpool and Bremen for example are today all smaller cities than they once were.

Figure 20. New jobs are created in cities with cognitive skills
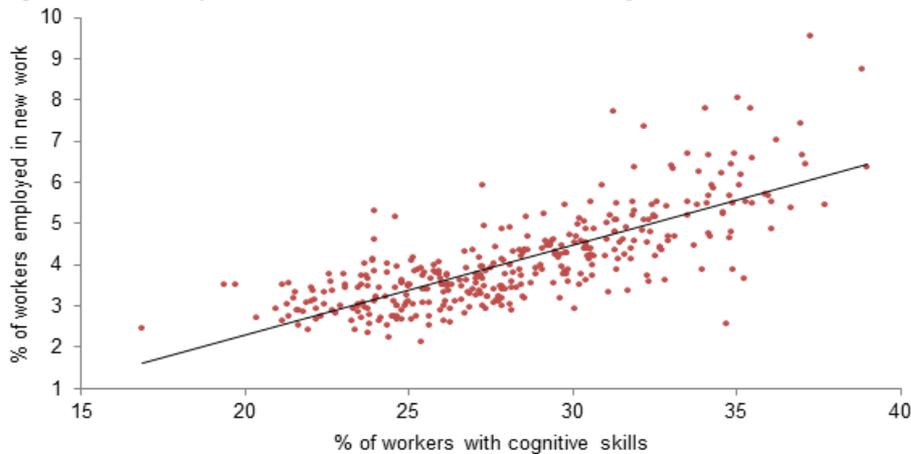
Notes: This figure shows the percentage of workers in US cities that were employed in jobs that appeared for the first time between 1990 and 2000, and the percentage of workers with cognitive skills.
Source: Berger & Frey (2014a).

Importantly, a city's ability to reinvent itself is determined by its resilience to the arrival of new technologies and its capacity to innovate, which in turn is a function of the skills of its workers.[74] In particular, over recent decades, cities' with more cognitive skills have been better at incorporating new technologies into new types of jobs reflecting the rising importance of such skills in advanced economies. Because skill levels differ widely within countries, so do the future prospects of reinvention across cities. For example, differences in education between certain cities within the US are larger than differences in average educational levels between the US and developing countries such as India or Peru.[75] Furthermore, as older workers are less likely to transition into new occupations and industries, which tend to cluster in skilled cities, an age divide across location is likely to emerge, leading to a decline in the technological dynamism of aging cities.[76] As shown in Figure 21, patenting

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[74] Saez, E. and Zucman, G. (2014). Wealth Inequality in the United States since 1913: Evidence from Capitalized Income Tax Data, NBER Working Papers 20625, National Bureau of Economic Research, Inc.; Frey, C.B. (2014). How 21st-Century Cities Can Avoid the Fate of 20th-Century Detroit, Scientific American, August 22, 2014.

[75] Moretti, E. (2014) "Are cities the new growth escalator?" World Bank Policy Research working paper ; no. WPS 6881.

[76] Lin, J. (2011). Technological Adaptation, Cities, and New Work. Review of Economics and Statistics, 93(2), 554–574.; Berger, T., and Frey, C.B. (2014a) Technology Shocks and Urban Evolutions: Did the Computer Revolution Shift the Fortunes of U.S. Cities?. Oxford Martin School Working Paper.

rates in US cities with the youngest populations are more than twice as high as those in the oldest cities.

Figure 21. Younger cities are more innovative
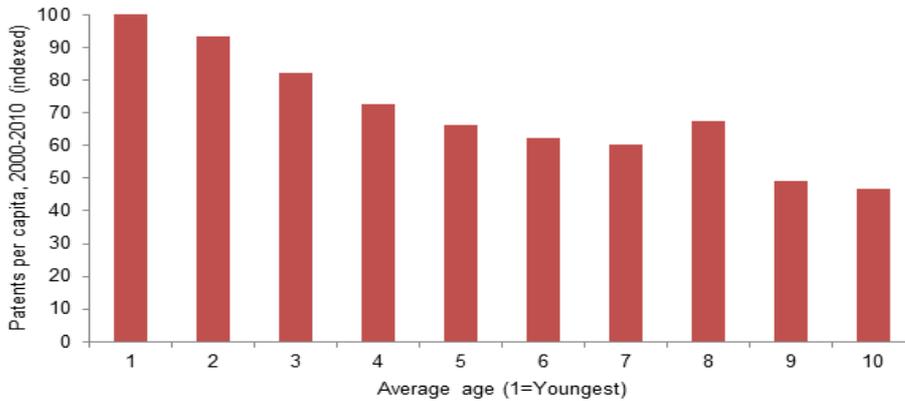
Source: See Berger & Frey (2014b).

Thus, inequality across cities is likely to continue growing, unless action is taken to upskill/re-skill aging populations, and efforts are made to support the diffusion of cognitive skills across cities and regions. At the same time, the clustering of entrepreneurs and educated workers in skilled cities is still likely to continue being the main driver of innovation and new job creation over the next decades, leading to further increases in property prices in prime locations. While rising costs of land and housing reflect productive advantages, finding ways to curb price increases that keep workers and entrepreneurs out are crucial. The easiest way to meet such a challenge would be to increase the supply of housing in skilled cities, which could have substantial effects on national growth rates. Expanding the supply of housing, in places where skilled workers cluster, would make cognitive skills (figure 22), such as complex problem solving and critical thinking, more productive, while facilitating spillovers to less skilled workers.

Figure 22. Emerging Skills

Skill	Description of Skill	Examples of Knowledge	Examples of Character	Examples of Occupations
Active Learning	Understanding the implications of new information for both current and future problem-solving and decision-making.	English Language; Education and Training; Psychology	Engagement; Patience; Self-direction	Astronomers; Biochemists and Biophysicists; Teachers
Complex Problem Solving	Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.	Design; Engineering and Technology; Mathematics	Execution; Exploration; Flexibility	Chief Executives; Physicists; Surgeons
Critical Thinking	Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.	English Language; Mathematics; Philosophy	Open-mindedness; Inquisitiveness; Vision	Anesthesiologists; Judges, Magistrate Judges, and Magistrates; Mathematical Technicians

Source: O*NET (http://www.onetonline.org/find/bright?b=3&g=Go).

Over the next decades skilled cities will remain the driver of innovation and the creation of new occupations and industries. Over the long-run, this is also likely to benefit other cities and regions: gradually, as the new work becomes "old" work, it tends to diffuse to other locations. In other words, while we expect that new types of work will be concentrated in skilled cities, where entrepreneurs, innovators and early adopters experiment with new technologies,[77] other regions will benefit as new work migrates from skilled locations.[78] In the United Kingdom, for example, new job creation is initially overwhelmingly concentrated to Central London but also benefits neighbouring regions as it diffuses over time.[79] Regional development strategies that aim at breaking up existing clusters to smoothen new job creation are thus likely to be counterproductive. Instead, investments in transportation and communications technology that facilitate the diffusion of innovations and skills across locations, including disadvantaged areas, are more likely to help. Furthermore, supporting links between local universities and businesses can be of crucial importance: since William Hewlett and David Packard, two Stanford students, formed Hewlett-Packard (HP) in 1938, Stanford alumni alone have created some 39,900 companies and about 5.4 million jobs.[80] Although it is notoriously difficult to replicate successful clusters, governments and educational institutions should focus on supporting skills development locally by investing in skills associated with complex problem solving; science, mathematical reasoning, creative thinking entrepreneurial ability and curiosity, while building the infrastructure to support the diffusion of knowledge and skills across locations.

In a summary, this section on 'Global trends and its impact on the labour market' examined how future shifts and shocks will transform the workforce and with it the demand for skills. The findings build on a growing body of research, suggesting that the global workforce is facing several transformative challenges. The expanding scope of automation is reducing the demand for labor in several domains, while making the skills of many workers redundant, contributing to the recent surge in inequality. Digital technologies are less capital-absorbing relative to innovations of the past, leading to a reduced investment demand and sluggish job creation.[81] Together with the concentration of incomes among individuals with lower marginal propensities to spend, an aging population and a shrinking labor force are likely to reduce demand even further, potentially leading to a period of secular stagnation.

With the right policies and interventions such an outcome can be avoided. By upskilling the workforce, gains in productivity could offset the decline in growth associated with a shrinking labor force, while making workers less vulnerable to automation. Furthermore, the diffusion

[77] Lin, J. (2011). Technological Adaptation, Cities, and New Work. Review of Economics and Statistics, 93(2), 554–574.; Berry, C. R. and Glaeser, E. L. (2005). The divergence of human capital levels across cities. Papers in regional science, 84(3), 407–444.

[78] Duranton, G. and Puga, D. (2001). Nursery cities: Urban diversity, process innovation, and the life cycle of products. American Economic Review, pages 1454–1477.

[79] Frey, C.B. (2015b). New job creation in the UK: which regions will benefit most from the digital revolution? In: PwC UK Economic Outlook March 2015.

[80] Eesley, C. and Miller, W.F. (2012). Stanford University's Economic Impact via Innovation and Entrepreneurship. Stanford Alumni Innovation Survey.

[81] Frey, C.B. (2015a). The End of Economic Growth? How the Digital Economy Could Lead to Secular Stagnation Scientific American, Vol. 312, No. 1.

of skills and knowledge provides the most important force of convergence, thereby reducing inequality and potentially boosting spending. While it is extremely difficult to predict the type of jobs that will emerge in the future, the skills requirements of new and emerging occupations are suggestive of the type of skills that will be needed. Occupations such as nanotechnology engineers, solar energy engineers, web developers, and biostatisticians, all involve complex problem solving and creative thinking. Furthermore, with an aging population the demand for care will continue to increase. Related skills, such as assisting and caring for others as well as social perceptiveness and emotional intelligence, will thus become more important. As recent research suggests that computer technologies are least likely to substitute for creative and social skills, there is a strong case for investing not only in technical skills. In fact, most future challenges are likely to require fusion of skills--- thus a combination of knowledge such as science, mathematics and computer programming and skills such as theoretical reasoning and critical thinking will be essential, but also a wide range of character qualities including resilience, adaptability and curiosity will be important.

Part II: Skills demands according to O*NET and OECD

O*NET is widely considered to be the most detailed and comprehensive assessment of skills used in employment that exists. [82] It has been developed by the Bureau of Labor Statistics in the United States and, as such, is geared towards the occupational content of jobs in the labour market in the US. O*NET has been regularly used for the analysis of the United States but also countries other than the US.

As previously mentioned, even though it is difficult to foresee the type of jobs that will arise in the future, the skills demand for new and emerging jobs can serve as an indicator of what might be needed in the future. The OECD skill needs indicators[83] provide a novel strategy to quantitatively estimate skill shortages and surpluses using O*NET database. The information contained in the indicators is provided to ensure comparability across countries of regularly updated results.

Another major strength of these indicators lies in the detailed mapping that is made from results of occupations in shortage to measures of skills required in each occupation considered. This mapping is carried out by attaching to occupational results the information provided by O*NET on both the level and importance of different skill dimensions for each of the occupations analysed.

O*NET covers both cognitive and non-cognitive skill requirements, as well as tasks, work context and work activities. The database is updated annually for new and emerging occupations. Despite possible challenges involved in using the O*NET database, this remains

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[82] Beblavý, Miroslav, and Brian Fabo. 2016. 'Impact of Student Workers on the European Labor Markets'. *Human Resource Management* 6: : 27-41.
[83] Getting skills right: Skills for Jobs Indicators, OECD 2017

the most comprehensive assessment of skills in employment that exists and it is, undoubtedly, a crucial source of information for mapping occupations to skill needs.

The O*NET database contains detailed information for occupations on a range of dimensions related to worker characteristics, worker requirements, experience requirements, occupational requirements, workforce characteristics and occupation-specific information. The OECD Skills for Jobs Database used the following dimensions:

- Abilities (52 categories): Enduring attributes of the individual that influence performance (e.g. originality, depth perception, finger dexterity).
- Knowledge types (33 categories): Organised sets of principles and facts applying in general domains (e.g. business and management, engineering and technology, mathematics and science).
- Skills (35 categories): Developed capacities that facilitate learning or performance, including basic skills (e.g. active listening, writing, critical thinking) and cross-functional skills (e.g. negotiation, programming, time management).
- Work styles (15 categories): Personal characteristics that can affect how well someone performs a job (e.g. persistence, leadership, attention to detail).

Each knowledge, skill and ability dimension in O*NET is codified by assigning categorical values to their "importance" for the job and "level" by which the dimension is used, while work styles and contexts are classified solely based on "importance". The degree of shortage and surplus in a wide range of skill types is calculated for European countries and South Africa.

This section provides an overview of a selection of the imbalances for knowledge, skills and abilities. Blue cells in the figure 23 indicate shortages and grey cells surpluses, with darker colours reflecting bigger imbalances in both dimensions.

The most common *knowledge* shortages are found in computers and electronics, education and training as well as in some mathematics and science fields (e.g. geography, biology) and in the healthcare field (i.e. therapy and counselling, psychology and medicine and dentistry; see Figure 23). For these knowledge types almost all countries have shortages. Shortages of this kind are most common in Finland, the Netherlands but also Ireland and Belgium. Surpluses, on the other hand, are mainly found for transportation, manufacturing and production, building and construction, and mechanical knowledge. While these technical knowledge types are in surplus in most countries, shortages of these knowledge types can be observed in countries like France, Denmark, Iceland and Lithuania. [84]

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[84] Getting skills right: Skills for Jobs Indicators, OECD 2017

Figure 23. Knowledge needs across European countries and South Africa
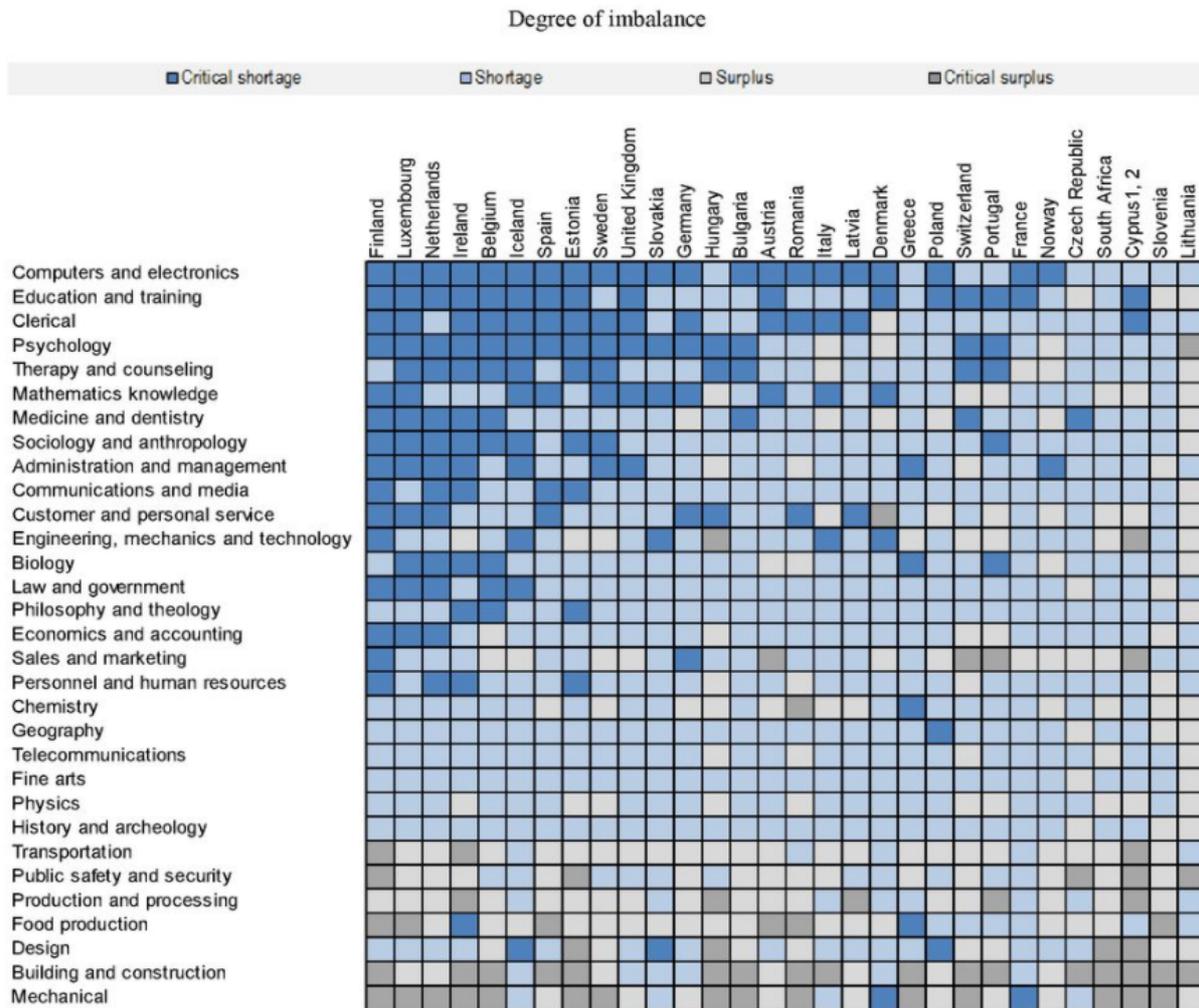
Skill shortages are concentrated among content skills (e.g. reading comprehension, writing, speaking and active listening), process skills (e.g. critical thinking and active learning), complex problem solving skills and social skills (e.g. instructing, social perceptiveness). The shortages are biggest in Finland, Luxembourg, the Netherlands, Spain or Germany while smaller (or even in surplus) in Switzerland, Hungary, Cyprus or South Africa (Figure 24). Surpluses are more common for technical skills, such as equipment maintenance and repairing. While some skills are in shortage in all countries, there are no skills that are in surplus across all countries. Some technical skills are in surplus in the majority of countries, but in some, like for example France, Denmark, the Czech Republic, the Slovak Republic, Portugal, Romania and Lithuania a range of them are also found to be in shortage. [85]

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[85] Getting skills right: Skills for Jobs Indicators, OECD 2017

Figure 24. Skill needs across European countries and South Africa
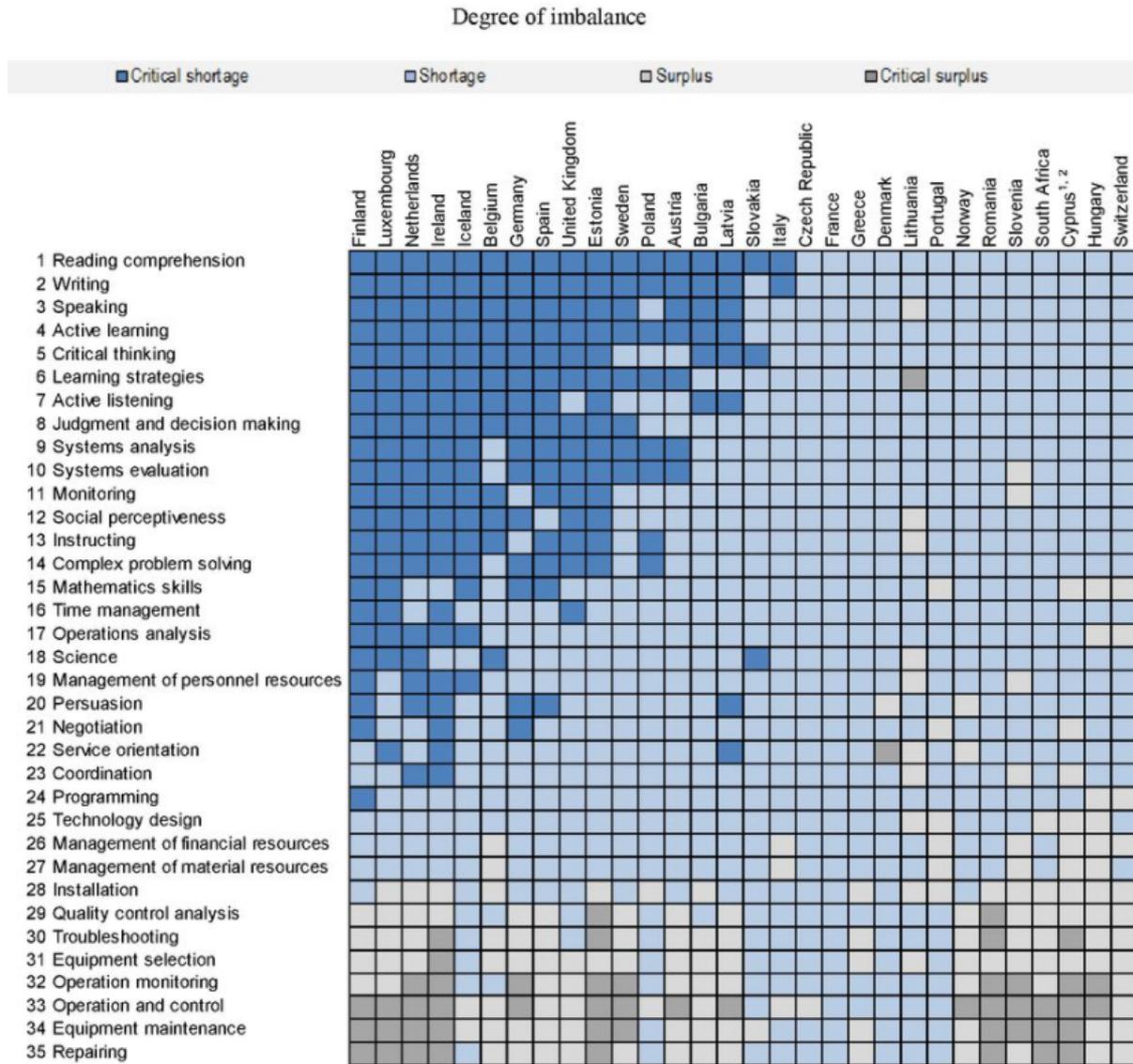
The shortage in *abilities* in most countries occurs mainly for cognitive abilities, as well as auditory and speech abilities (Figure 25). These shortages are biggest in Spain, Luxembourg, Finland and Germany. Surpluses are mainly found for physical (e.g. endurance, physical strength) and psychomotor (e.g. fine manipulation, control movement) abilities. While all countries have surpluses of physical abilities, some countries have some degree of shortage for multiple psychomotor abilities (i.e. France, Denmark, Portugal and Lithuania). Overall, ability imbalances are more similar across countries than the imbalances observed for skills and knowledge.

Figure 25. Abilities needs across European countries and South Africa
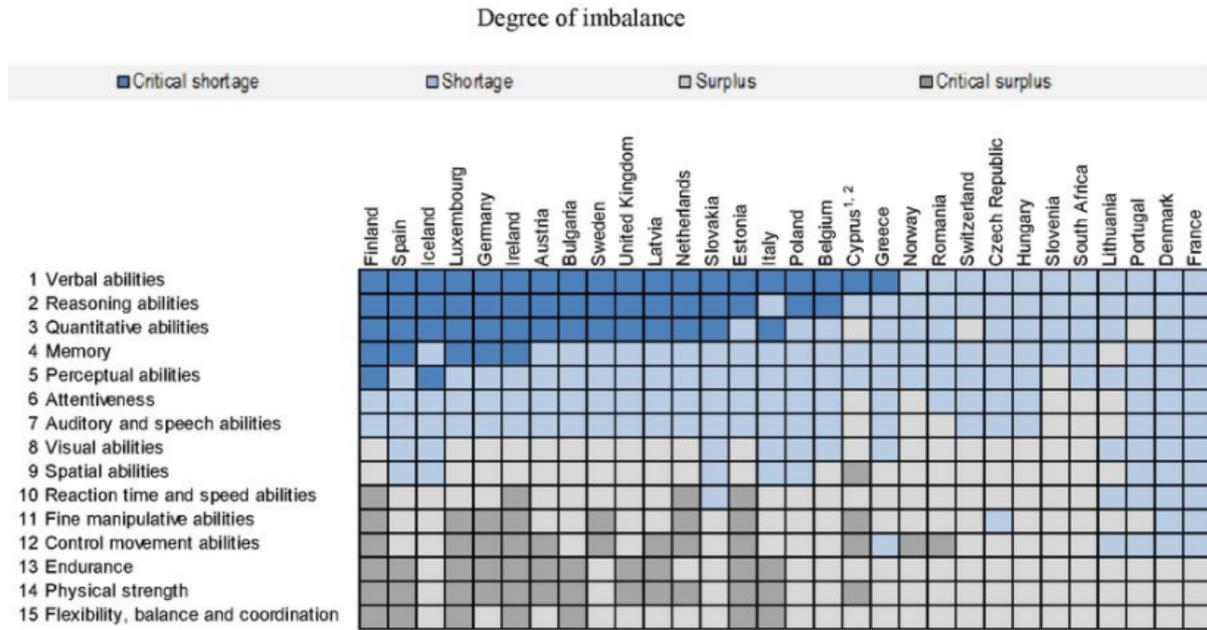
The projection about skills imbalances uses a large number of parameters that are important for the occupations and can inform us about the future skills demands. In order to synthetize these findings, the CCR used its framework as a filter and concatenated[86] down the list to the 12 most essential competencies. (Figure 26.)

One major conclusion from the CCR analysis is that Knowledge, albeit critical, is not sufficient, and that occupations also require skills, character and meta-learning abilities.

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[86] The concatenation engine can be explored at https://curriculumredesign.org/onetexplorer_ccr/

Figure 26. O*NET+BLS Demand mapped to CCR
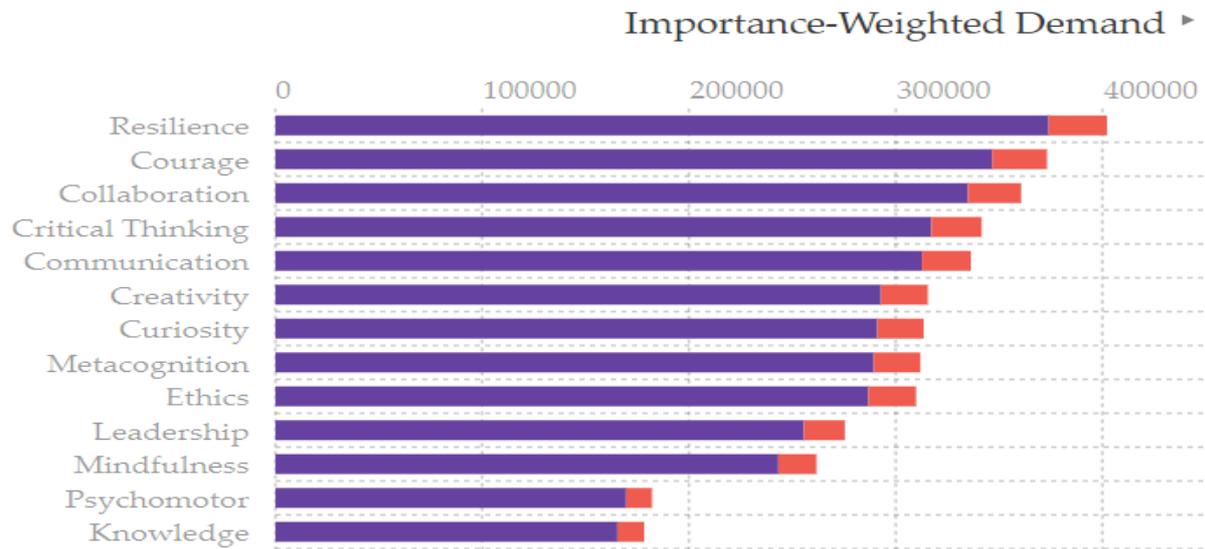
Source: Center for Curriculum Redesign

The Brookings Institute independently identified the most essential 21st century skills across 30 countries worldwide and came to similar conclusion of three essential skills (which were its focus): communication, creativity, critical thinking/problem solving.[87] Furthermore, the Business Industry Advisory Committee to the OECD conducted a survey among the member countries and found that employers consider the following character qualities as being of 'very high' importance to the workplace (in descending order)[88]:

1. Ethics
2. Leadership
3. Resilience = Curiosity
4. Mindfulness
5. Courage.

Another insight from research on labour market demands pointed out that the requirements of professional and personal life are not particularly different anymore. At the individual level, 21st century millennial workers want to have the Maslow hierarchy of needs satisfied. Therefore, acquiring the above-mentioned competencies is important for a person's work and life well-being.

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[87] Brookings 2016 – "Visualizing the Breadth of Skills Movement across Education Systems (Esther Care, et al)
[88] BIAC Survey 2015: Character Qualities for the Workplace

Part III. The Case for 21st Century Education & Competencies

In collaboration with the OECD's Education 2030 project[89], CCR tabulated, analysed and synthetized thirty-two frameworks[90] from around the world, and found that there is general agreement on these four dimensions of goals for a 21st century education. Figure 27 highlights the commonalities among some of the most significant frameworks, and shows CCR's framework in relation to those for comparison.

The CCR framework synthesizes existing research with the overarching complementary goals of addressing the needs of the 21st century education while maximizing both accuracy and clarity.

Figure 27. CCR Framework

© Center for Curriculum Redesign
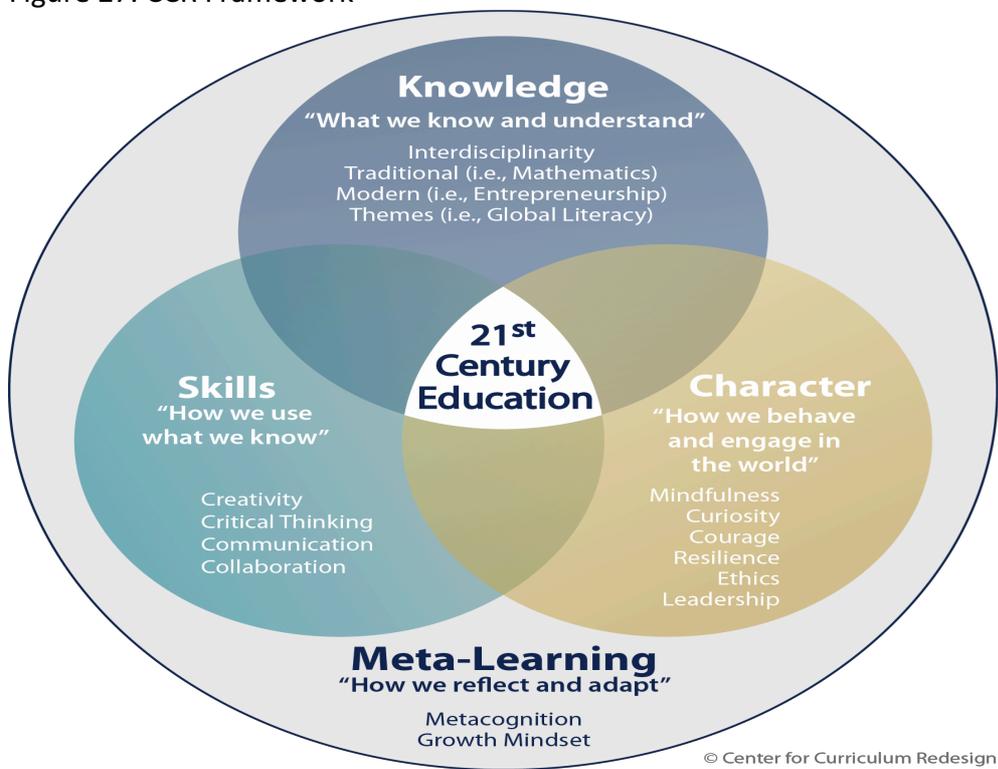
Adapting to 21st century needs means revisiting each dimension and their interplay:

3.1 Knowledge — What we know and understand.

Knowledge is the dimension most emphasized in the traditional view of curriculum and content. Yet as collective knowledge increases, curriculum has not successfully kept up. The current curriculum is often *relevant* neither to students (reflected in their disengagement and

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[89] Education 2030: the OECD Key Competencies Framework
[90] OECD Skills for Innovation, OECD DeSeCo, OECD Social & Emotional Skills, OECD PISA, OECD PIAAC, EU Reference Framework Key Competencies, UNESCO Global Citizenship Education, P21, etc.

lack of motivation) nor to societal and economic needs. Thus, there is a profound need to rethink the significance and applicability of *what* is taught, and simultaneously to strike a better balance between the theoretical and the practical.

Traditional disciplines (Maths, Science, Languages - domestic & foreign, Social Studies, Arts, etc.) are of course essential. Tough choices must be made about what to pare back in order to allow for more appropriate areas of focus (for instance in Maths, more statistics & probabilities, and less trigonometry), including concomitant depth that will cultivate the other three dimensions (Skills, Character, Meta-Learning). Modern disciplines (such as Technology & Engineering, Media, Entrepreneurship & Business, Personal Finance, Wellness, Social Systems, etc.) respond to present and future demands and must be accommodated as a normal part of the curriculum, not as supplementary or optional activities.

Interdisciplinarity is a strong binding mechanism within and between traditional and modern disciplines, and the practices it requires have the potential to impact the Skills, Character and Meta-Learning dimensions as well as accentuate knowledge transfer. Interdisciplinary approaches to knowledge will help learners make connections between concepts, facilitating deeper learning.

3.2 Skills[91] — How we use what we know

Higher-order skills (such as the "4 C's" of Creativity, Critical thinking, Communication, Collaboration,) are essential for deeply learning Knowledge as well as for demonstrating understanding through performance. Yet the curriculum is already overburdened with content, making it harder for students to acquire (and teachers to teach) skills. Additionally, there is a lack of support for educators in combining knowledge and skills in robust pedagogies and deeper learning experiences. There is, however, a reasonable global consensus on what the skills are at the broadest level, and how different pedagogies (such as projects) can affect their acquisition.

Creativity
As Csikszentmihalyi said, without creativity, mankind would not progress.[92] Organizations and individuals' hope for the future lies in finding creative solutions to pressing problems as innovation is what drives the economy today. OECD cross-country analysis finds that employment in less productive firms tends to decline, while more productive firms create additional jobs. In the long run, innovation and employment creation go hand in hand, contributing to an inclusive and high-employment economy.[93] According to the P21 research, nearly three quarters of respondents (73%) expect creativity and innovation to increase in importance for future graduates. Employers' focus on creativity/innovation as an increasingly important future skill corresponds with numerous reports that emphasize the capacity to

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[91] There is no word that works equally well in all languages to convey the meaning of "Skills", which ends up being the best compromise. It could be "competencies", "savoir-faire", "proficiencies", etc.   Trilling, B. & Fadel, C. (2009).
[92] Csikszentmihalyi, Mihaly (1996). Creativity: Flow and the psychology of discovery and invention, Harper Perennial Publisher.
[93] (OECD, 2010).

innovate as the single most important element in maintaining economic growth and competitiveness.

Collaboration

Collaboration drives innovation. As Sawyer (2007) observed, every business success, from trendy companies in Silicon Valley through manufacturing firms to highly technical research labs, was based on collaboration.[94] The most radical breakthroughs such as television, the airplane, e-mail emerged from a collaborative network of people. And today's innovations emerge from ever more complex organizations and interacting teams. According to Sawyer, lone genius is a myth; instead it is a group genius that generates breakthrough innovation. When people collaborate, creativity unfolds across the team and the whole is greater than the sum of its parts. Thus, teamwork is imperative for the current interconnected work environment.

Critical thinking

Critical thinking is highlighted in almost every discussion of key competencies for the 21st century. Critical thinking includes inductive and deductive reasoning, as well as making correct analyses, inferences, and evaluations. These competencies are important for deeply understanding academic content, and they also relate to later career performance. Research suggests that for a company to compete in the global economy, it needs workers who will think about how to continuously improve its products, processes, or services. According to many executives, the heart of this continuous improvement process is knowing the right questions to ask[95], a function of critical thinking. Economists Frank Levy and Richard Murnane have described the new world of work in which the most desirable jobs and the ones least likely to be automated or outsourced are the ones that require expert thinking comprised of critical thinking and problem-solving skills.[96]

Communication

Communication is identified as a vital 21st century competency by almost all the surveyed organizations. Communication is vital to facilitate teamwork and lies at the core of empathy, trust, conflict resolution, and negotiation.[97] For instance, effectiveness with clients often hinges on effective communication and the teamwork necessary to produce a superior product. Communication skills are especially important in the expanding service economy where relationships with customers and fellow employees are of vital importance. At the same time, as technology gives rise to global work teams that span time zones, nations and cultures, it is more imperative than ever that future graduates will be effective communicators. The importance of communication in the workforce has generated increased focus on these skills in schools.

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[94] Sawyer, 2007. Group Genius: The Creative Power of Collaboration (2007)
[95] Wagner 2010
[96] Autor, D. (2013). The Changing Task Composition of the US Labor Market: An Update of Autor, Levy, and Murnane (2003), MIT and NBER, Brendan Price, MIT, June 21 2013.
[97] Pellegrino and Hilton (2013)

3.3 "Character" — How we behave and engage in the world

Increasingly, the need for the development of qualities beyond knowledge and skills is being highlighted around the world. There are three commonly cited, broad purposes of character education—it can:

- Build a foundation for lifelong learning
- Support successful relationships at home, in the community, and in the workplace
- Develop the personal values and virtues for sustainable participation in a globalized world.

This dimension has very different nomenclature in different spheres, making consensus challenging. The dimension of Character encompasses these terms: agency, attitudes, behaviors, beliefs, dispositions, mindsets, personality, temperament, values, social and emotional skills, non-cognitive skills, and soft skills. Character, although sometimes charged with non-educational connotations, is nevertheless a concise and inclusive term that is recognizable by all cultures. As already mentioned above, CCR has synthesized more than 32 frameworks, research and feedback from around the world to arrive at six essential character qualities, each encompassing a broad range of related terms. These qualities are: Mindfulness; Curiosity; Courage; Resilience; Ethics; and Leadership, in which all other qualities and concepts can be fitted. Therefore, in addition to six core character qualities we have identified the associated qualities (figure 28).

Figure 28. Top character qualities and associated qualities

Top Qualities	Associated Qualities and Concepts (non-exhaustive)
Mindfulness	Wisdom, self-awareness, self-management self-actualization, observation, reflection, consciousness, compassion, gratitude, empathy, caring, growth, vision, insight, equanimity, happiness, presence, authenticity, listening, sharing, interconnectedness, interdependence, oneness, acceptance, beauty, sensibility, patience, tranquility, balance, spirituality, existentiality, social awareness, cross-cultural awareness, etc.
Curiosity	Open-mindedness, exploration, passion, self-direction, motivation, initiative, innovation, enthusiasm, wonder, appreciation, spontaneity etc.
Courage	Bravery, determination, fortitude, confidence, risk taking, persistence, toughness, zest, optimism, inspiration, energy, vigor, zeal, cheerfulness, humor etc.
Resilience	Perseverance, grit, tenacity, resourcefulness, spunk, self-discipline, effort, diligence, commitment, self-control, self-esteem, confidence, stability, adaptability, dealing with ambiguity, flexibility, feedback, etc.
Ethics	Benevolence, humaneness, integrity, respect, justice, equity, fairness, kindness, altruism, inclusiveness, tolerance, acceptance, loyalty, honesty, truthfulness, authenticity, genuineness, trustworthiness, decency, consideration, forgiveness, virtue, love, helpfulness, generosity, charity, devotion, belonging, civic-mindedness, citizenship, equality, etc.
Leadership	Responsibility, abnegation, accountability, dependability, reliability, conscientiousness, selflessness, humbleness, modesty, relationship skills, self-reflection, inspiration, organization, delegation, mentorship, commitment, heroism, charisma, followership, engagement, leading by example, goal-orientation, focus, results orientation, precision, execution, efficiency, negotiation, consistency, socialization, social intelligence, diversity, decorum, etc.

Mindfulness

Research suggests that mindfulness training can enhance attention and focus, and improve memory, self-acceptance, self-management skills, and self-understanding.[98] It has also been associated with "higher positive emotional affect, vitality, life satisfaction, self-esteem, optimism, and self-actualization," as well as with "higher autonomy, competence, and relatedness."[99] It has also been proposed as a mechanism to address oppression and a way to combat global crises, and the inability to respond to these overwhelming issues due to a lack of easy ways to translate knowledge into personal and collective action.[100] Even brief mindfulness meditation trainings have been shown to reduce fatigue and anxiety, and improve visual-spatial processing, working memory, and executive functioning.

Curiosity

Curiosity helps to motivate and drive people towards continuous learning. Often what students know is not as important as what they want to know. High test scores academic achievement is preceded by intellectual curiosity which is arguably the better indicator of success. The desire to learn is one of the most important determinates of how successful people will be in school, in work and in life. Intellectual curiosity is one the top traits employers look for among their hires. A person who will hardly adopt a new database is not as attractive as one who is truly passionate about learning new things. The ability to solve problem and continued dedication to learning new technologies or solutions that will continue to advance in the changing workplace is more important than specific expertise.

Courage

Courage can be thought of as the ability to act despite fear or uncertainty, in risky situations, or when we are feeling vulnerable.[101] While courage can be taken to extremes, with potentially devastating consequences, it is still true that a healthy dose of courage can be quite helpful in one's professional, social, and personal life. A commonly cited professional example is entrepreneurship. While studies have not found entrepreneurs to be significantly more risk-taking on self-rated measures, they have found they are courageous. Multivariate tests revealed that entrepreneurs categorized equivocal business scenarios significantly more positively than did other subjects, and univariate tests demonstrated that these perceptual differences were consistent and significant—that is, entrepreneurs perceived more strengths as compared to weaknesses, opportunities as compared to threats, and potential for performance improvement as compared to deterioration in the business scenarios.[102] In fact, one paper describes organizational failures as the consequences of "failures of courage," since

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[98] I.E. Fodor, and K. E. Hooker. "Teaching Mindfulness to Children," *Gestalt Review* 12, no. 1 (2008): 75–

[99] K. W. Brown and R. M. Ryan, "The Benefits Of Being Present: Mindfulness And Its Role In Psychological Well-Being," *Journal of Personality and Social Psychology* 84, no. 4 (2003); 822–848.

[100] H. Bai, ("Beyond Educated Mind: Towards a Pedagogy of Mindfulness," in *Unfolding Bodymind: Exploring Possibilities Through Education*, eds. B. Hockings, J. Haskell, and W. Linds (Brandon, VT: The Foundation for Educational Renewal, 2001), 86–99.

[101] Brené Brown, *Daring Greatly: How the Courage to be Vulnerable Transforms The Way We Live, Love, Parent, and Lead* (New York: Penguin, 2012).

[102] L. E. Palich and D. Ray Bagby, "Using Cognitive Theory To Explain Entrepreneurial Risk-Taking: Challenging Conventional Wisdom," *Journal of Business Venturing* 10, no. 6 (1995): 425–438, doi:10.1016/0883-9026(95)00082-J

none of the people responsible acted to prevent it.[103] It is well established that risk-taking is higher in adolescents than in children or adults,[104] and higher in males than in females.[105] It is also clear that the capacity for courage is not fixed, and can be developed through appropriate learning experiences. Courage can be considered a subjective experience, where an individual overcomes fear and chooses to take action in the face of uncertainty. In the courageous mindset there are three positive intrapersonal traits that one must develop: openness to experience, conscientiousness, and self-evaluation strategies that promote self-efficacy.[106]

Resilience

In its most basic form, resilience can be thought of as an ability or set of qualities that allow one to overcome obstacles. It often refers to the abilities of certain individuals to succeed where others in their circumstances could not. In a paper about the history of resilience and the continuing discussion on its nature, resilience is defined as "a dynamic process encompassing positive adaptation within the context of significant adversity."[107] The designation "dynamic process" highlights the fact that resilience is a word used for a multitude of factors that all influence whether or not someone will succeed in the face of adversity. One of the contributing elements of resilience is the notion of grit. In her seminal study regarding grit—defined as "perseverance and passion for long-term goals"—Angela Duckworth and her colleagues found that "grit accounted for an average of 4% of the variance in success outcomes."[104] The three main factors that have been identified in schools, communities, and social support systems as positively influencing resilience in youth are: 1. Caring relationships. 2. Communication of high expectations. 3. Opportunities for meaningful involvement and participation.

Ethics

It is now, when confidence in business is undermined and individuals distrust one another, essential more than ever that businesses restore their relations with customers and employees by stepping up to the ethical plate. In the book 'Five Minds for the Future' Howard Gardner talks about the competencies young people need to have in the 21st century and going forward. He emphasizes the importance of cultivating an ethical mind if individuals, businesses and society are to thrive. As young people go into business today, the temptation to skirt ethics is mounting as we live in a time of intense pressure on individuals and organizations to cut corners, pursue their own interests, and forget about the effect of their behaviour on others. The real test of an individual's—or a company's—ethical fibre is what

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[103] C. R. Rate and R.J. Sternberg, "When Good People Do Nothing: A Failure Of Courage," *Research Companion to the Dysfunctional Workplace.* (Edward Elgar Publishing Limited, 2007): 3–21

[104] L. Steinberg, "Risk Taking in Adolescence: New Perspectives From Brain and Behavioral Science," *Current Directions in Psychological Science* 16, no. 2, (2007): 55–59

[105] J. P. Byrnes, D. C. Miller, and W. D. Schafer, "Gender Differences in Risk Taking: A Meta-Analysis," 125 no. 3 (1999): 367–383.

[106] S. T. Hannah, P. J. Sweeney, and P. B. Lester, "Toward A Courageous Mindset: The Subjective Act And Experience Of Courage," *The Journal of Positive Psychology* 2, no. 2 (2007): 129–135

[107] S. S. Luthar, D. Cicchetti, and B. Becker, "The Construct of Resilience: A Critical Evaluation and Guidelines for Future Work," Child Development 71 (2000): 543–562.

happens when there are potent pressures. Therefore, it is important to develop students' sense of integrity and cultivate their ethical compass to help them navigate through numerous dilemmas they will face in the working environment.

Ethics as a teachable character quality is informed in large part by the literature on moral development, pioneered by Jean Piaget and John Dewey, and expanded by Lawrence Kohlberg and Carol Gilligan. The main idea is that children naturally progress through stages of moral reasoning, from pre- conventional (obedience and punishment, self-interest orientations), through conventional (interpersonal accord and conformity, authority and social-order maintaining), to post-conventional (social contract orientation, universal ethical principles).[108] John Dewey proposed that "education is the work of supplying the conditions which will enable the psychological functions to mature in the freest and fullest manner."[106] Environments that successfully encourage moral development are those that provide opportunities for group participation, shared decision-making, and the assumption of responsibility for the consequences of actions.[109]

Leadership
Employers increasingly report that leadership skills are more highly valued than academic achievement. Research shows that high-school leaders are more likely to occupy managerial occupations as adults, and leadership skills command a higher wage premium within managerial occupations than in other jobs. These results suggest that leadership skill has a component that is determined before high school entry, as well as a component that is fostered by occupying leadership positions during high school. The need for organizations to have effective leaders is undisputed, however the notion of what is leadership is shifting. Jim Collins, who has spent twenty years studying how some companies achieve superlative performance and focused on leadership, found out that successful leaders do not fit the traditional model of a 'charismatic hero'. Rather they are individuals that blend personal humility with intense professional will and enormous ambition not for themselves but for the organization.

3.4 Meta-Learning — How we reflect and adapt

The fourth and final dimension of the CCR framework is one that lies overarching to the other three. Meta-Learning concerns the processes related to reflecting on and adjusting one's learning. It includes metacognition (predicting, monitoring, and evaluating one's learning), as well as internalizing a Growth Mindset about one's capacities. At the moment, the OECD's PISA governing board is contemplating meta-learning as the fourth dimension because learning how to learn is one of the most important thing employers are looking for. [110]

Meta-Learning is essential for creating lifelong learning habits and the learning of the other

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[108] L. Kohlberg, *The Philosophy Of Moral Development: Moral Stages And The Idea Of Justice (Essays On Moral Development, Volume 1)* (San Francisco: Harper and Row, 1981)
[109] L. Kohlberg, "Moral Stages, Moralization: the Cognitive Developmental Approach," In: T. Lickona, ed. *Moral Development And Behavior* (New York: Holt, Rinehart, Winston, 1976),
[110] PISA Governing Board meeting, 2018, OECD Paris. (Quote by Charles Fadel).

three dimensions and ensuring the transfer of learning beyond its original context. The most successful students very often already engage in a productive virtuous cycle of Meta-Learning, and explicitly encouraging this dimension can help all students in all areas of learning, throughout their lifetimes and across their careers. In a world requiring constant and increasingly fast adaptation, deliberately highlighting this dimension – rather than subsuming it and thus often neglecting it – is critical.

Metacognition

The best hedge against continuous changes is metacognition, the awareness of one's own learning, reflection and cognitive ability. It is essential for activating transference, building expertise, and establishing lifelong learning habits. Metacognition for learning, often called 'learning to learn', refers to a student's ability to determine how to approach a problem or task, monitor his or her own comprehension, and evaluate progress toward completion.[111] It underpins all the dimensions of knowledge and skills mentioned above. David Conley ties metacognition directly to college readiness and uses the term to encompass many of the other competencies[112]. Learning how to learn broadly includes related competencies, such as self-regulation, which has been shown to predict achievement, attainment, and workforce success.[113] There has been consensus among CCR, DeSeCo and EU reference frameworks about the importance of metacognition for future success. As Alvin Toffler said, the illiterate of the 21st century won't be those who cannot read and write but those who cannot learn, unlearn and relearn[114]. Therefore, it is vital that schools develop students into lifelong learners that are constantly seeking new knowledge.

Growth Mindset

According to Carol Dweck's research, there are two broad categories of these mental models for success.[115] In a fixed mindset, people believe their basic qualities, like their intelligence or talent, are simply fixed traits. They spend their time documenting their intelligence or talent instead of developing them. They also believe that talent alone creates success—without effort. This leads to self-defeating patterns of behavior that the students aren't even aware they are engaging in. In a growth mindset, on the other hand, people recognize that talent is just the starting point, and believe that abilities can be developed through hard work. This view creates a love of learning for the sake of learning, and a resilience that is essential for success in large endeavours.

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[111] (Landine and Stewart 1998; Vrugt and Oort 2008).
[112] Learning Strategies as Metacognitive Factors: A Critical Revie, Conley, (2013).
[113] Redefining College Readiness, Conley, (D. 2007)
[114] Powershift: Knowledge, Wealth, and Power at the Edge of the 21st Century, Toffler, A. (1990).
[115] Mindset: The New Psychology of Success, Dweck, C. (2007).

Part IV. Curriculum Content Mapping (CCM) and Gap Analysis

The curriculum content mapping (CCM) is the process of reviewing a curriculum to identify and address academic gaps, redundancies, and misalignment for purposes of improving the overall coherence of a course of study and, by extension, its effectiveness. [116]

Building on the trends analysis and identification of employability competencies based on it, the CCM exercise has been designed to explore how Competencies, "skills" (e.g., critical thinking, collaboration, creativity, communication), "character" (e.g., resilience, curiosity, ethics, etc.) and "meta-learning" (e.g., metacognition, growth mindset) are addressed in the CP and DP curricula.

Furthermore, it is expected that the CCM will support IB's curriculum development/redesign processes by illustrating how particular competencies are more/less central to core parts of the DP and CP programmes. Following the mapping process, IB might be able to use the data:

- To consider the extent (ie, breadth and depth) to which their curricula foster different aspects of competencies considered essential for work and life in the future,
- For comparative analysis when considering how different parts of the programmes include particular aspects of competencies in their learning areas/subjects,
- As a valuable resource to inform future curriculum development/redesign initiatives.

4.1. Methods

This part of the paper describes in further details how was the curriculum content mapping and gap analysis conducted. Initially, the studied competencies were selected during the literature review of global trends. The 'competencies' part below outlines the identified competencies. Thereafter, the key IB documents for both DP and CP were selected and analysed with aim to identify the extent with which the main competencies are included in it. The 'content area' lists all the selected and reviewed documents and 'education level' provides more information about the studied education level. Lastly, the 'process' part presents more information about the each of the three phases of the process and gives more information about what was done in each phase.

Competencies

The CCM process will enable the IB Diploma and Career-related programmes to identify the extent to which 21st century competencies (specific skills, character and meta-learning) are included in their curriculum. The scope of the competencies in focus for this exercise (ie, particular aspects of skills, character and meta-learning which students need to be equipped with to thrive in and shape the world in future) was selected based on the literature review of global trends and their impact on the labour market outlined in the first section of this report.

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[116] Curriculum Analysis: Draft Proposal, EDU2030, OECD (2016).

Therefore, the selected priority competencies to be studied in this exercise were:
- Creativity
- Critical thinking
- Communication
- Collaboration
- Mindfulness
- Curiosity
- Courage
- Resilience
- Ethics
- Leadership
- Metacognition
- Growth Mindset

Content areas

The work on reviewing the different IB curricular documents was undertaken to systematically identify the appearance of the selected competencies listed above. Terms with the same meaning or evaluated as similar in nature were analysed and calculated towards the final heat map based on their level of contribution.

The documents reviewed for both DP and CP are part of the respective core curricula and were selected because they are followed by all students, while other subjects are elected and differ in uptake. The most relevant documents across IB philosophy, DP and CP were included and reviewed. The types of documents include guides, teacher support materials (TSM) and *From principles into practice*. Guides are used as a framework for planning, teaching and assessment of the courses. TSMs aim to assist the coordinators in organizing the programme, clarify the learning outcomes and serve as support teacher materials. *From principles into practice* focuses on the programmes as a whole; it explores the educational principles and practices that need to be nurtured in schools so that a solid foundation for a successful DP and CP can be established and maintained.

The following documents were reviewed:

IB Philosophy (applicable for both programmes):
- IB Approaches to teaching and learning (ATL)
- IB learner profile

Diploma Programme (DP):
- Diploma Programme: From principles into practice
- Creativity, activity, service guide (CAS)
- Creativity, activity, service teacher support material (TSM)
- Extended essay guide
- Theory of knowledge guide (TOK)
- Theory of knowledge teacher support material

Career-related Programme (CP):
- Career-related Programme: From principles into practice
- Personal and professional skills guide
- Reflective project guide
- Reflective project teacher support material
- Service learning guide
- Language development guide

Education level

The scope of the target education level was secondary education with focus on the DP and CP curricula. However, these competencies might be also developed in earlier stages, through the Middle Years (MYP) and Primary Years (PYP) Programmes which might differ in terms of the type of competencies and intensity with which they are being developed. Since certain competencies might be better acquired/developed at certain ages/grades as part of a sequence of learning (coherence of curriculum), it might be important to consider what is the 'intended sequencing' of development of these competencies throughout these various programmes in the future.

Process

The CCM exercise is a three-phased process. These phases are:
- *Phase 1*: Reviewing the DP and CP curriculum
- *Phase 2*: Mapping the core aspects of the DP and CP curriculum CP to identify the extent to which the different areas foster employability skills
- *Phase 3*: Report and synthetize findings

Phase 1 - Reviewing the DP and CP curricula

There are several criteria that were taken into consideration when selecting the documents for review in both programmes. The criteria include:
- to ensure that accurate and comparable information is obtained from the mapping process in both programmes
- to ensure the analysis is undertaken at an appropriate level of specificity in recognition that various areas might differ in composition across programmes.

Phase 2 – Curriculum content mapping (CCM)

This phase involved mapping of the various learning areas to identify the extent to which the selected competencies are addressed in each document and respective programme. Three levels of degree in the inter-relationship were considered (Figure 29). To classify into these three levels, the following criteria were taken into consideration.

Figure 29. Degree of a competency contribution

Degree	Contribution	Criteria
Degree 3	**Large contribution**	Main target of the learning area; the competency is clearly written/spelled out as the main development target.
Degree 2	**Medium contribution**	Sub target of the learning area, the competency or associated competency is written as a part of the development target.
Degree 1	Low contribution	Not targeted in this learning area, the competency is not specifically included as a development target.

The data obtained from this analysis are represented through the 'heat map' below (Figure/ 30). This map is used to illustrate the breadth and depth that selected employability competencies are fostered in and across learning areas of both DP and CP curricula. Such competency specific heat map provides a useful overview of specific learning areas across IB curriculum landscape.

Phase 3 - Report and synthetize

This phase aims to summarize the findings of the CCM and report the results in the section below. It outlines in further detail each competency and the extent in which they are imbedded in both DP and CP.

4.2. Results

The IB documents were analysed and the occurrence of competencies was identified based on the degree of competency contribution in each document which resulted in the heat map below (Figure 30). Moreover, quantitative breakdown of types of contribution gives an overview of the extent with which these competencies are covered in both DP and CP documents. This section also describes in detail how specific competencies are expressed in each reviewed document.

Figure 30. Large, medium contribution and low contribution in coverage

| | Employability Skills | | | | | | | | | | | |
| | Skills | | | | Character | | | | | | Meta-Learning | |
	Creativity	Critical thinking	Communication	Collaboration	Mindfulness	Curiosity	Courage	Resilience	Ethics	Leadership	Metacognition	Growth Mindset
DP Programme												
DP from principles to practice	X	X	X	X					X			X
DP Creativity, activity, service guide	X	x	x	X	X		x		X	X	X	
TSM CAS	X			x	X		x		X	x	x	
DP Extended essay guide	x	X	X	X		X		x	x			
DP Theory of Knowledge Guide	x	X	X	x	x				X	x	X	
TSM TOK	x	X	X	x							X	
CP Programme												
CP from principles to practice		X	X		X				X			x
CP personal and professional skills guide	x	X	X	x	X			x	X	x	x	x
CP reflective project guide	x	X	X		X				X		X	
TSM reflective project guide		x	X						X		X	
CP service learning guide				X	X		x	x	X	X	X	
CP language development guide	x		X		X				x		x	
IB core												
Approaches to teaching and learning (ATL	x	X	X	X	X	x	x	x	x		X	x
IB Learner profile	x	X	X		X	x	x		X			

Figure 30 provides an overview of types of competencies fostered the most, as well as the type of category being the most represented. The two are evidently correlated and the category which is mainly represented is 'skills' due to the fact that competencies within this category are represented the most (eg, communication, creativity). On the other hand, the category of 'character' is less represented with gaps in coverage of certain competencies (eg, curiosity, resilience).

The quantitative breakdown (Figure 31) provides an overview of how many times and how extensively each competency is represented across all the reviewed documents in both DP and CP. For example, communication is represented across twelve different documents with large contribution, one document with medium contribution and one document with low contribution (as per the contribution definition in Figure 29)*.

Figure 31. Quantitative breakdown of types of contribution

	Competencies	Large contribution	Medium contribution	Low contribution
Top 4	Communication	12	1	1
	Ethics	11	3	1
	Mindfulness	10	1	4
	Critical thinking	10	2	3
Middle 4	Metacognition	7	3	5
	Collaboration	5	4	6
	Creativity	3	9	3
	Leadership	2	3	10
Bottom 4	Growth Mindset	1	3	11
	Curiosity	1	2	12
	Courage	0	6	9
	Resilience	0	4	11

4.2.1 Large contribution – Top four competencies

Communication and ethics are two skills that appear to be the most represented across all 15 documents reviewed, equally included in both DP and CP. For communication, 12 out of 15 documents have clearly spelled out the aim to develop this competency while for ethics it has been 11 out of 15 documents.

Communication

Communication skills are not only important in IB programmes but are also an essential part of a wider dynamic in the learning community: they help to form and maintain good relationships between students, and between students and adults. Furthermore, being able to communicate well contributes to the development of students' self-confidence and enhances their prospects, as communication skills are a critical ingredient of success in working life.

DP

Core elements of the Diploma Programme are the extended essay, creativity, activity, service (CAS) and theory of knowledge (TOK) which are mandatory for all the students going through this programme.

The extended essay course requires students to demonstrate their ability to communicate on a research topic of their choice in a specific way: in an academic paper. They will need to formulate arguments clearly and coherently, as well as draft and proofread their own work and thus develop strong written communication skills. In developing their 'researcher's reflection space' students can use a range of different communication techniques to record

their thoughts, ideas, progress, timelines and arguments. These may include mind maps, blogs, annotated articles or images so students become well versed in using various communication techniques to express their ideas.[117]

The **creativity, activity, service (CAS)** part of the programme provides a framework that enables students to develop their ability to communicate and collaborate with others. Students can show the evidence of participating in CAS through forms of documentation such as photos, files, planning documents, emails, meeting minutes, certificates, videos, art, music and journals.[118]

In the **Theory of knowledge (TOK)** course, students are required by the TOK assessment tasks to communicate their understanding and perspective in both oral and written form. Students also study the language that is used to develop a body of knowledge, so they learn what gives language its power as well as what may cause failures of communication. [119]

CP

The course on **personal and professional skills** includes a specific theme on effective communication. This theme explores a variety of skills and literacies to broaden students' capabilities as communicators in personal and professional situations and contexts such as for example interpersonal skills, literacies and self-expression. Part of interpersonal awareness is active listening and within literacies there are for example media and digital literacy. As part of self-expression there is: writing for purpose, presentation skills and interview skills.[120]

The **reflective project** is intended to promote high-level research, writing and extended communication skills, as well as present a structured and coherent argument. The theme is again effective communication with a focus on interpersonal communication, writing, presentation and IT skills in order to strengthen students' ability to present a structured and coherent project. Students are then assessed based on the following criteria: the way in which the student presents a structured and coherent project through their communication style, using appropriate terminology accurately and consistently, assisting to convey ideas and concepts clearly.[121]

IB Philosophy

Communication skills are also imbedded in the **approaches to teaching and learning (ATL)** and make one of the five main categories. The document outlines several simple strategies that teachers can use to help students develop their communication skills such as for example

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[117] Extended essay guide, International Baccalaureate Organization 2015
[118] Creativity, activity, service guide, International Baccalaureate Organization 2015
[119] Diploma Programme Core: Theory of Knowledge, International Baccalaureate Organization 2014
[120] Personal and professional skills guide, International Baccalaureate Organization
[121] Reflective project guide, International Baccalaureate Organization, 2016

asking open-ended questions, having informal conversations, challenging hurtful comments, encouraging physical cues and modelling a good conversation.

The IB learner profile also aims to develop communicators who understand and express ideas and information confidently and creatively in more than one language and in a variety of modes of communication. [122]

Ethics

DP

In the **CAS guide**, the emphasis is on helping students to develop their own identities, in accordance with the ethical principles embodied in the IB mission statement and the IB learner profile. CAS provides students with opportunities to engage with the learner profile of being principled. One of the learning outcomes within CAS is to develop students' ability to recognize and consider the ethics of choices and actions. [123] At the end of the programme, students are expected to explain the social influence on their ethical identity, take into account the cultural context when making a plan or ethical decision, identify what is needed to know in order to make an ethical decision, articulate ethical principles and approaches to ethical decisions. They are asked as well to show accountability for choices and actions, being aware of the consequences of choices and actions regarding self, others and the community and integrate the process of reflection when faced with ethical decisions.

The **CAS teacher support material (TSM)** supports teachers in guiding students to develop strong service learning through creating for example an environmental community group, getting involved in a beach club, providing peer tutoring to junior students or visiting an orphanage with regularity. Students are expected to demonstrate engagement with issues of global significance, get involved in CAS projects and address global issues in a local, national or international context.

In **TOK**, ethics is one of the eight main areas of knowledge (AOK); it is considered to be 'shared knowledge' along with arts. Some potential areas of study mentioned within TOK is ethical dilemmas, theory of ethics (Kantian ethics, virtue ethics, utilitarian), emotion and reason in ethics, ethical language. Practitioners of AOK are encouraged to consider ethical limits on the sort of investigations they undertake and experiments they perform. Within natural sciences students need to ask a question: Should there be ethical constraints on the pursuit of scientific knowledge?[124]

In **the extended essay** course, students must also ensure that they are aware of any IB policy related to ethical practice (e.g., academic honesty) when undertaking research. [125]

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[122] The IB Learner Profile, International Baccalaureate Organization 2013
[123] Creativity, activity, service guide, International Baccalaureate Organization 2015
[124] Diploma Programme Core: Theory of Knowledge, International Baccalaureate Organization 2014
[125] Extended essay guide, International Baccalaureate Organization 2015

CP

The Career-related Programme provides an excellent opportunity for ethical education conceived as involving principles, attitudes and codes of behaviour. While ethical principles are also embodied in the IB mission statement and learner profile, the programme's core emphasis is on helping students to develop their own identities and beliefs.

The CP utilizes the **personal and professional skills** course for the exploration and application of ethics which aims to support students' understanding of ethics. Through this course students are introduced to ethical dilemmas and case studies in applied and professional ethics, become aware of and respond effectively to ethical dilemmas and explore what is right and wrong.[126]

In the **reflective project**, one of the goals of the programme is to engage in personal inquiry, action and reflection on a specific ethical dilemma. Students are assessed on their ability to select and explore an ethical dilemma involved in an issue, which they are meant to be contextualized in light of their career-related study, through careful formulation of a focused and systematic research question. Students are also required to collect evidence related to the issue. [127]

The aim of **service learning** is to develop a sense of caring about, and a responsibility for, others. Students are asked to contribute to society by improving the lives of people or assisting the environment or animals. Students are encouraged to be civically engaged which refers to becoming involved in community issues and developing pro-social behaviours. This can lead to an increased awareness of community connections, community problems, citizenship and social responsibility, which in turn allows the students to develop an understanding of the relationships between local and global concerns.[128]

IB Philosophy

The **IB approaches to learning** document makes a reference to the ethical dimension by referring to students 'being "thinkers"' which is explicitly identified as one of the IB learner profile attributes. It is defined in terms of exercising initiative in applying thinking skills critically and creatively to recognize and approach complex problems, and make reasoned, ethical decisions.

In the **IB learner profile**, the goal outlined is to develop 'principled' students, who act with integrity and honesty, with a strong sense of fairness, justice and respect for the dignity and the rights of people everywhere. They take responsibility for their own actions and the

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[126] Personal and professional skills guide, International Baccalaureate Organization
[127] Reflective Project Guide, International Baccalaureate Organization 2016
[128] Service Learning Guide, International Baccalaureate Organization 2016

consequences that accompany them. In addition to principles, the IB learner profile also aims to develop 'caring' students who show empathy, compassion and respect towards the needs and feelings of others and have a personal commitment to service. [129]

Mindfulness and critical thinking are two other competencies that are strongly represented overall. However, there is larger contribution to mindfulness in the CP in which it appears in five out of six reviewed documents as opposed to DP programme where the large contribution occurs only in two out of six documents. On the other hand, all three documents reviewed within IB philosophy have clearly spelled out the development of mindfulness and critical thinking as a main goal. Across both the CP and DP, critical thinking seems to be more or less equally represented.

Mindfulness

As Figure 28 above suggests, the character quality mindfulness is related with many associated qualities and concepts such as for example self-awareness, self-management and self-actualization among others. This broader understanding of mindfulness was taken into consideration when interpreting its inclusion in DP and CP.

DP

CAS course provide a framework that enables students to increase self-awareness and enhance their personal and interpersonal development. It serves as a journey of discovery of self and others that develops personality and drives personal growth. For many students, CAS is a profound and life-changing experience. Each individual student has a different starting point and different needs and goals. Throughout CAS, students are guided to recognize the value of reflection, so they can capture their experience with more meaning and personal connection. [130]

The **CAS TSM**, guides teachers to heighten student awareness and remind students that they need to enjoy life while developing international-mindedness. Students need to see that the world needs them to connect outside of the classroom away from their books. Students are given an opportunity to be involved in the school's UNESCO club, where they are introduced to different worldwide and local events. Students are also encouraged to join the Model United Nations trips abroad.

To support teachers in delivering CAS, IB has developed a framework of six learning outcomes that assists with the assessment of the associated competencies. A first learning outcome is connected to mindfulness and calls for an awareness of students' own strengths and weaknesses and an identification of areas for growth. It is detailed out in the following way:

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[129] The IB Learner Profile, International Baccalaureate Organization 2013
[130] Creativity, activity, service guide, International Baccalaureate Organization 2015

The student:

- is aware of own strengths and weaknesses
- is open to improvement and growth opportunities
- is able to propose experiences according to own interests and talents
- is willing to participate in different experiences
- is able to undertake a thoughtful self-evaluation
- is able to see themselves as individuals with various abilities and skills, some more developed than others.

Learning outcome 6 asks students to demonstrate engagement with issues of global significance and recognize the global implications of local issues.

As **the extended essay** is an independent task, it requires students to self-manage by developing organization and affective skills, including mindfulness, perseverance, resilience and self-motivation. The process of researching and writing the extended essay represents the learner profile in action. The extended essay provides students with the opportunity to become more internationally minded by engaging with the local and global communities on topics of personal inquiry. [131]

The **TOK TSM** fosters international mindedness and as part of adapting an international perspective is taking into consideration that being part of a certain group shapes our perspective on the world that could be quite different if we were a member of a different group. In TOK, the ways of knowing (sense perception, emotion, language, reason, imagination, faith, intuition and memory), are a central part of the course and influence each and every reflection that students make.[132]

CP

In the document **Career-related Programme: From principles into practice**, IB mentions its aim to develop thoughtful and active citizens and active participants in their own intercultural learning.[133]

The course in **personal and professional skills** recognizes personal strengths and identify ways to overcome challenges within the personal development theme. Part of personal development is also self-awareness and self-management. The theme of Intercultural understanding emphasizes the importance of cultural identity, diversity and engagement in a range of personal and professional situations and contexts. Part of intercultural understanding is cultural identity, adversity and engagement. The combination of the self-awareness and intercultural understanding themes fosters the development of mindfulness.

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[131] Extended essay guide, International Baccalaureate Organization 2015
[132] Theory of knowledge teacher support material, International Baccalaureate Organization, 2014
[133] Career-related Programme: From principles into practice, International Baccalaureate Organization, 2014

The **reflective project** aims to develop an engagement with local and/or global communities. The theme of intercultural understanding directly links with students' need to develop an appreciation of how cultural contexts may affect different perspectives on an ethical dilemma. Part of it is also an assessment of the ability to analyse different perspectives, showing an awareness and understanding of the impact of the dilemma on a global or local community. [134]

The **service learning component** provides opportunities for students to understand their capacity to make a meaningful contribution to their community and society and gain a deeper understanding of themselves through meaningful reflection. Service learning fosters civic development which refers to becoming involved in community issues and developing pro-social behaviours. This can lead to an increased awareness of community connections, community problems, citizenship and social responsibility. This allows the students to develop an understanding of the relationships between local and global concerns. [135]

IB philosophy

In the **ATL** course, mindfulness is included under self-management skills which consists of organization skills and affective skills (eg, managing state of mind, self-motivation, resilience, mindfulness, etc.)[136] One of the teaching ideas is to explore the possibilities for improving students' concentration through training in mindfulness or other similar techniques. The rationale behind this is that in helping students learn how to "stay in the moment" can help them to overcome distractions, increase attention and improve concentration. Of all the skills students should develop, learning to concentrate is singled out to be one of the most important and it may be worthwhile putting some training into developing.

The **IB learner profile** mentions the importance of developing 'reflective' students and gives thoughtful consideration to students' own learning and experience. They should be able to assess and understand their strengths and limitations in order to support their learning and personal development. [137]

Critical thinking

DP

The **Diploma Programme: From principles into practice** guide promotes critical reflection and thinking through analysis, synthesis and evaluation. [138]

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[134] Reflective Project Guide, International Baccalaureate Organization 2016
[135] Service Learning Guide, International Baccalaureate Organization 2016
[136] Approaches to teaching and learning in the International Baccalaureate (IB) Diploma Programme, International Baccalaureate Organization 2014
[137] The IB Learner Profile, International Baccalaureate Organization 2013
[138] The Diploma Programme: From principles into practice, Published April 2009 International Baccalaureate

CAS course continues to develop students' ability to engage in critical reflection, offering increasingly sophisticated opportunities for students to analyse their own thinking, effort and performance. Some reflection questions include: How does this CAS experience allow me to become a genuine inquirer? To what extent do my CAS experiences encourage creative and critical thinking?[139]

The extended essay course is perhaps the most inquiry-based activity that students will undertake, especially given that it is a completely open-ended task, directed by student interest. Through their research, students can learn not only about the topic of their research, methodology, and critical thinking, but they can also learn important transferable skills such as time management, perseverance, resilience, and decision-making. The extended essay embodies the essence of an IB education in developing inquiring, critical, lifelong learners. One of the assessment criteria for the extended essay is critical thinking (eg, research, analyses, discussion and evaluation). [140]

TOK is a course about critical thinking and inquiring into the process of knowing, rather than about learning a specific body of knowledge. It is a core element which all Diploma Programme students undertake and to which all schools are required to devote at least 100 hours of class time.[141]

CP

The **personal and professional skills** course contributes to the development of thinking processes. This theme provides an opportunity for students to explore and apply a variety of thinking processes to a range of personal and professional situations and contexts including critical thinking, creative thinking and application of thinking. Part of critical thinking is to compare, analyse and synthetize, and evaluate. There is also application thinking which consists of practical thinking, problem solving, implementing and adapting.

The **reflective project** also contributes to development of critical thinking skills. The topics of ethical thinking, critical thinking, creative thinking, problem-solving and lateral thinking have direct application to the ways in which students learn and engage with the reflective project. It also assesses the student's ability to select and apply appropriate research methods and collect and select relevant information from a variety of sources, showing an understanding of bias and validity. This criterion assesses the student's logical reasoning, the ability to interpret, analyse and evaluate material, and the student's ability to synthesize and make connections, linking ideas and evidence and weighing them up as necessary. It assesses also the student's reasoning processes and the ability to present a coherent and sustained

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[139] Creativity, activity, service guide, International Baccalaureate Organization 2015

[140] Extended essay guide, International Baccalaureate Organization 2015

[141] Diploma Programme Core: Theory of Knowledge, International Baccalaureate Organization 2014

argument and personal voice. Finally, it assesses the appropriateness of findings and opinions related back to the research question.[142]

IB philosophy

Within **ATL,** DP subjects place a premium on the development of higher-order thinking skills rather than on simple memorization of content.[143] This is clearly apparent in the aims of DP courses; for example, one of the aims of all Individuals and Societies courses is to "develop in the student the capacity to identify, to analyse critically and to evaluate theories, concepts and arguments about the nature and activities of the individual and society". The higher- order thinking skills DP subjects foster can be seen in the command terms used in DP examination papers, where students are asked to "analyse", "evaluate", "compare", and so on. Most DP subject guides provide a list of command terms, and it is important that teachers familiarize students with these terms so that students have a clear understanding of what they are expected to demonstrate in their responses. [144]

The **IB learner profile** also mentions an intention to develop students into 'thinkers'. Thinkers exercise initiative in applying thinking skills critically and creatively to recognize and approach complex problems, and make reasoned, ethical decisions. [145]

4.2.2 Medium contribution – Middle four competencies

Metacognition and collaboration are both represented in a moderate degree across the DP and CP. While metacognition is represented in a slightly stronger manner in the CP, collaboration is more salient in the DP. Out of three main documents reviewed regarding IB philosophy metacognition and collaboration have been clearly spelled out only through the IB Approaches to teaching and learning (ATL).

Metacognition
DP

The term thinking skills refers to a cluster of a large number of related skills, and in the DP particular focus is placed on skills such as metacognition, reflection and critical thinking.

In **CAS**, students learn how to set challenging goals and develop the commitment and perseverance to achieve them. The CAS stages provide a framework that enables students to learn about learning and employ different learning styles. Through imbedded reflection, students describe what happened, express feelings, generate ideas, and raise questions.

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[142] Reflective Project Guide, International Baccalaureate Organization 2016
[143] Approaches to teaching and learning in the International Baccalaureate (IB) Diploma Programme, International Baccalaureate Organization 2014
[144] Approaches to teaching and learning in the International Baccalaureate (IB) Diploma Programme, International Baccalaureate Organization 2014
[145] The IB Learner Profile, International Baccalaureate Organization 2013

Reflection can occur at any time during CAS to further understanding, to assist with revising plans, to learn from the experience, and to make explicit connections between their growth, accomplishments, and the learning outcomes for personal awareness. Reflection may lead to new action. Having established an effective understanding of the four elements of reflection, students develop higher- order thinking skills by critically examining thoughts, feelings and actions, thereby synthesizing their learning and fostering their metacognitive processes. [146]

The **CAS TSM** mentions that IB have recently begun to open up the doors of reflection by asking students to use other methods besides written reflections to provide evidence of their experiences, such as using photography and other media. The aim is for students to engage in reflection by choice, with a sense of purpose and a frequency that allows them to better understand and recognize personal development and accomplishment.

In **TOK** students examine thinking in order to understand what constitutes good thinking and also to recognize potential flaws in thought processes. Students also think about what thinking is required in a variety of situations, as well as how thinking relates to emotional processing and intuition. TOK provides students with critical thinking skills to develop and extend their reflections. For example, in WOK (ways of knowing) they consider their emotions, ability to reason and how to use language. [147]

CP

The **personal and professional skills** course aims to develop reflective and lifelong learners who can adapt to diverse situations and part of self-awareness is reflection.

In the **reflective project**, the personal development theme forms the basis for self-reflection and explores the skills required to organize and manage time, make decisions and manage change. Students require all of these to complete the reflective project successfully. They are assessed on engagement and reflection. This criterion assesses how the student has engaged in discussions with their supervisor in the planning and progress of their research; the student's ability to reflect on and refine the research process, and react to insights gained through the exploration of their research question; and how well the student has been able to evaluate decisions made throughout the research process and suggest improvements to their own working practice. [148]

Through the **service learning** component, students should gain a deeper understanding of themselves, their community and society through meaningful reflection. Students develop the following skills: learn about learning, enjoy the learning process through purposeful experiences and employ different learning styles. [149]The overarching intention of reflection in service learning includes the opportunity for students to:

- deepen learning

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[146] Creativity, activity, service guide, International Baccalaureate Organization 2015
[147] Diploma Programme Core: Theory of Knowledge, International Baccalaureate Organization 2014
[148] Reflective Project Guide, International Baccalaureate Organization 2016
[149] Service Learning Guide, International Baccalaureate Organization 2016

- consider relevance of experience
- explore personal and group values
- recognize the application of knowledge, skills and attributes
- identify strengths and areas for development
- gain a greater understanding of self and others
- place experience in a larger context
- generate relevant ideas and questions
- consider improvements in individual and collective choices and actions
- transfer prior learning to new situations
- generate and receive constructive feedback
- develop an ongoing habit of thoughtful, reflective practice.

In the **language development** course, students are required to reflect on their journey in language development and explore their goals and requirements in the language portfolio. Reflection is central to building a deep and rich experience in language development. Student learning is more effective when it is enhanced by reflection. Reflection enables students to explore skills, strengths, limitations and areas for further development.

IB Philosophy

In **ATL**, reflection is part of thinking skills, which is one out of five main categories. Reflection is a thinking skill that plays a particularly essential role in learning. The value of structured reflection activities in education is widely recognized, and elements are commonly incorporated into learning programmes in various forms. These activities may be written (eg, reflective essays, reading logs, case studies), oral (eg, presentations, video diaries, discussion) or artistic/creative (eg, photos or other images capturing scenes that can then be used to promote discussion).[150] They may also encompass elements of more than one form (eg, student portfolios). Online tools such as blogs (reflective journals), wikis (collaborative web pages), digital stories and podcasts, interactive micro-blogging and social networking also offer great opportunities for reflective activities in an IB education.

Another popular inquiry-based approach is that of problem-based learning (PBL). The main advantages of PBL are that it has been found to lead to improvements in information processing, skill proficiency and the development of a variety of skills, including problem-solving, reasoning, teamwork and metacognition.[151]

The **IB learner profile** aims to develop students who are 'inquirers'. Through the inquiry cycle of understanding and awareness, reflection and action, students engage in reflection and metacognition, which can lead them from academic knowledge to thoughtful action, helping to develop positive attitudes and a sense of personal and social responsibility.[152]

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[150] Approaches to teaching and learning in the International Baccalaureate (IB) Diploma Programme, International Baccalaureate Organization 2014
[151] Self-regulation and autonomy in problem and project-based learning environments, Prince,M. (2013)
[152] The IB Learner Profile, International Baccalaureate Organization 2013

Collaboration

IB programmes acknowledge that learning is a social activity. Students and teachers come together, each with unique life experiences, beliefs, ideas, strengths and weaknesses. Learning is the result of these complex interactions.

DP

During **CAS** students continue to develop individual and shared responsibility, and effective teamwork and collaboration. A CAS project involves collaboration between a group of students or with members of the wider community. Further, students undertake a CAS project of at least one month's duration that challenges students to show initiative, demonstrate perseverance, and develop skills such as collaboration, problem-solving, and decision-making. Service within CAS benefits all involved: students learn as they identify and address authentic community needs, and the community benefits through reciprocal collaboration.

CP

In **Service Learning**, students continue developing skills and knowledge applied to real-life situations, and the community through reciprocal collaboration. One of the aims in this course is to develop students into leaders who work collaboratively with others. The learning objective is for students to recognize the benefits of working collaboratively. At the end of this course, students should be able to identify and critically discuss the benefits and challenges of collaboration gained through service learning experiences. Issues of responsibility, commitment, communication, independence and interdependence, leadership, recognizing emotions and interpersonal relationships can all be explored.

In **Personal and Professional Skills course**, students are also encouraged to work collaboratively. Part of the course is relationship management which consists of collaboration, emotional intelligence, conflict strategies, interpersonal and social awareness.

IB Philosophy

In **ATL**, collaboration is part of the group 'social skills', one of the 5 main ATLs. A key focus of the teaching in the DP is on teamwork and collaboration and its one of the 6 main pedagogical principles. This principle applies to promoting teamwork and collaboration between students, but it also refers to the collaborative relationship between the teacher and students. Teachers should provide explicit opportunities in the classroom for students to practise and develop

their social and collaborative skills. Group formative assessment tasks can provide an excellent opportunity and incentive for students to improve their collaboration skills.

Creativity

Creativity is a main or sub target learning area in all reviewed documents within the DP programme and a sub target learning area in three out of six documents reviewed within the CP. Similarly, it is expressed as a sub target learning area in all reviewed documents within IB philosophy.

DP

CAS is organized around the three strands of creativity, activity and service defined as follows. Creativity is about exploring and extending ideas leading to an original or interpretive product or performance. If students are accomplished in a creative form, for example, music, painting or acting, they may choose to extend their involvement and deepen their skill level. Within their field, students can define new challenges and objectives to fulfil creativity in CAS. Some of the specific activities include photography, event management, tournament organization, website development, choir, speech and debate club, drama production, journalism, making a short documentary, music/band, learning an instrument, fashion show, art lessons. [153]

As a part of **the extended essay** students are expected to show evidence of intellectual growth, critical and personal development, intellectual initiative and creativity. Students need to choose a subject and then topic that interests them and allows them to develop and demonstrate their understanding, creativity and/or originality. [154]

In **TOK,** imagination which is a part of ways of knowing (WOK), is sometimes viewed in a broader way as being associated with creativity, problem-solving and originality. Integrated in arts there is artistic creation which is often a result of personal knowledge requiring imagination and creativity. [155]

CP

The **reflective project** is intended to promote creativity and develop the skills of creative thinking. This is also included in assessment which aims to gain an insight into the students' thinking, their intellectual initiative, and their creativity through reflections on the thought and research process. [156]

IB philosophy

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[153] Creativity, activity, service guide, International Baccalaureate Organization 2015
[154] Extended essay guide, International Baccalaureate Organization 2015
[155] Diploma Programme Core: Theory of Knowledge, International Baccalaureate Organization 2014
[156] Reflective Project Guide, International Baccalaureate Organization 2016

IB Learner Profile aims to develop thinkers who exercise initiative in applying thinking skills critically and creatively to recognize and approach complex problems, and make reasoned, ethical decisions.

Leadership and Growth Mindset are comparably represented across all reviewed documents. Leadership has large contribution to its development at least in one of the reviewed documents in both CP and DP while Growth Mindset has been spelled out as a main learning area only in one document within the DP. Within the IB philosophy related documents, Growth Mindset is only mentioned as a sub target in one out of three documents while Leadership does not appear as a target in any of them.

Leadership

DP

In **CAS**, it is recommended that schools develop student leadership within the programme so that students become leaders and role models for others. The principle that students should "own" their personal CAS programmes implies that they should be trusted to fulfil the commitments that they have made, unless they show themselves unworthy of that trust.[157]

One of the ways students can exercise their leadership is through "breaking the bubble" exercise which is an experience that takes students out into the community in smaller groups to investigate their needs. This builds upon on school's approach to service learning. Students can also take part in action at these sites; however, most often this is learning about real situations and circumstances and beginning to find a role of how they may respond in partnership with these organizations to make authentic contributions.
Especially senior students have witnessed and been involved in the basic steps required to successfully become involved in a wide range of important community social projects such as animal care, urban farming, low-cost housing project, local school language and music connections, disabled sports competitions, and on-campus documentation of successes.

There is no mention of Leadership in CP and IB philosophy related documents.

4.2.3 Low contribution – Bottom four competencies

Growth Mindset

DP

In DP's document **From principles into practice** there is a mention that IB World Schools support lifelong learning by emphasizing "learning how to learn" and helping students interact

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[157] Creativity, activity, service guide, International Baccalaureate Organization 2015

effectively with the learning environments they encounter in schools and beyond, thus promoting the autonomy of the learner.

CP

In the **service learning** course, personal development refers to the ability to tap into students' self-perception in relation to their abilities and potential. During the service learning process, students identify personal interests, skills, talents and areas for growth. Through awareness of their strengths, areas for growth, feelings and thoughts, students become more self-aware, self-confident and self-directed. [158]

IB Philosophy
Within the IB philosophy related documents, the only reference made to growth mindset is in the ATL. It mentioned that establishing that metacognitive awareness creates "growth mindset", characterized by the belief that learning improvement is a function of effort and strategy use, and that both of these things are within the student's control.

Curiosity, Courage and Resilience are the competencies with the lowest contribution across both DP and CP as well as IB philosophy. Curiosity is only mentioned once as a main target for development in the DP's Extended Essay and as sub-target across all three documents in IB philosophy. Both courage and resilience are represented in a similar number as a sub target across both DP and CP, while courage is represented in a stronger way as a sub-target within IB philosophy than resilience.

Curiosity

DP

One of the pedagogical principles that underpin all IB programmes is that of teaching based on inquiry. Being inquirers is one of the attributes of the **IB learner profile**, where the process is seen as involving the development of students' natural curiosity, together with the skills needed to enable students to become autonomous lifelong learners. It is expected that they will actively enjoy learning and this love of learning will be sustained throughout their lives.[159]

Part of learner profile is also being open-minded. Students develop understanding and appreciation of their own cultures and personal histories, and are open to the perspectives, values and traditions of other individuals and communities. They are accustomed to seeking and evaluating a range of points of view and are willing to grow from the experience.

The extended essay contributes to the development of curiosity. It is perhaps the most inquiry-based activity that students will undertake, especially given that it is a completely open-ended task, directed by student interest. This is not coincidental: the extended essay is

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[158] Service Learning Guide, International Baccalaureate Organization 2016
[159] The IB Learner Profile, International Baccalaureate Organization 2013

intended to encourage students to examine significant issues and areas of research that they personally care about in an in-depth and meaningful way. [160]

IB philosophy

In **ATL**, many categorizations of thinking skills also emphasize related behaviours such as curiosity, flexibility, posing problems, decision making, being reasonable, creativity, risk taking, and other behaviours that support critical and creative thought.[161]

<u>Courage</u>

DP

The **CAS TSM** document mentions that challenging oneself is one of the key aspects of the programme. Students are expected to choose to look for challenges because the IB understands that it is imperative to have a sense of personal accomplishment and success.

One of the learning outcomes outlined in the document is that students should demonstrate that challenges have been undertaken, developing new skills in the process. They are expected to participate in an experience that poses an appropriate personal challenge; this could be with new or familiar experiences.

CP

The **service learning** component refers to personal development as the ability to tap into students' self-perception in relation to their abilities and potential. During the service learning process, students identify personal interests, skills, talents and areas for growth. Through awareness of their strengths, areas for growth, feelings and thoughts, students become more able to take risks and are able to explore new and unfamiliar challenges. [162]

IB philosophy

Risk-taking is closely linked to the idea of failing well (King 2009), and it is important that teachers create an atmosphere where students do not feel that they have to get things right first time. Regarding learning as a process of gradual improvement through reflection on mistakes can encourage students to ask questions, take risks, be more adventurous in their thinking, and be more creative with their ideas.

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[160] Extended essay guide, International Baccalaureate Organization 2015
[161] Approaches to teaching and learning in the International Baccalaureate (IB) Diploma Programme, International Baccalaureate Organization 2014
[162] Service Learning Guide, International Baccalaureate Organization 2016

In the **ATL** framework, an important connection to highlight between ATL skills and the learner profile is the connection between resilience and the learner profile attribute of being "risk-takers" which is defined as an approach to unfamiliar situations and uncertainty with courage and forethought.[163] Resilience is a vitally important part of self-management and includes learning from mistakes. Some of the reviewed documents suggests that DP students might be under a great deal of pressure to succeed, particularly given the high stakes nature of DP assessment, which can make them reluctant to ever risk failure.

Resilience

DP

One of the learning outcomes mentioned in the teacher's support material for **CAS,** is an ability to show commitment and perseverance by demonstrating regular involvement and active engagement with CAS experiences and project.

In **the extended essay**, through their research, students can learn not only about their research topic, methodology, and critical thinking, but they can also learn important transferable skills. As the extended essay is an independent task, it requires students to self-manage by developing organization and affective skills, including mindfulness, perseverance, resilience and self-motivation.

CP

In **professional and personal skills** qualities that the course encourages are: responsibility, perseverance, resilience, self-esteem. The theme of personal development addresses the development of students' confidence, independence, interpersonal skills and resilience in a variety of personal and professional situations and contexts. Part of self-management is also an ability to manage change.

Through **service learning** students develop and apply academic knowledge, personal skills and social skills in real-life situations involving initiative, responsibility and accountability for their actions. Personal development refers to the ability to tap into students' self-perception in relation to their abilities and potential. During the service learning process, students identify personal interests, skills, talents and areas for growth. Through awareness of their strengths, areas for growth, feelings and thoughts, students become more resilient.[164]

IB philosophy

In **ATL,** the development of affective skills is a key part of the development of self-management skills. This can enable students to gain some control over their mood, their

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[163] Approaches to teaching and learning in the International Baccalaureate (IB) Diploma Programme, International Baccalaureate Organization 2014
[164] Service Learning Guide, International Baccalaureate Organization 2016

motivation and their ability to deal effectively with setbacks and difficulties. There is also an important link between this area of ATL and the crucial area of student health and well-being, which historically has tended to be "mostly separated from other aspects of school life".[165] Resilience appears to be the affective concept that is most inclusive of almost all other desirable affective elements of the successful DP student. The resilient learner is mindful, persevering, emotionally stable and self-motivated. Through focusing on developing resilience with respect to learning, teachers may find that many other important affective skills are practised and developed as well.

4.3 Important considerations and recommendations

There are several considerations one should keep in mind when reading the results of curriculum mapping and analysis.

Written, taught and assessed curriculum

The results reported here are based on analysis of what is captured in various IB curriculum documents which corresponds to 'intended' curriculum. The question remains whether it is aligned with the actual curriculum, the one that occurs in the classroom. In order to find out whether there is an alignment between intended and actual curricula, assessment and further research such as school visits and classroom observations would have to be done.
Modern Knowledge

While this report was focused on a review of competencies, it is also important to mention the knowledge part. Modern disciplines (such as Technology & Engineering, Media, Entrepreneurship & Business, Personal Finance, Wellness, Social Sciences, etc.) respond to present and future demands for knowledge. Also, they can be conducive to develop many of the important competencies and should be accommodated as a standard part of the curriculum, not as supplementary or optional activities (and whilst we recognize that jurisdictions have not reached this understanding yet). IB could be a thought-leader in this field and have a comparative advantage if it would include modern disciplines in its curricula.

Spaced repetition/habit forming

Spaced repetition is a learning technique[166] that incorporates increasing intervals of time between subsequent review of previously learned material. It is commonly used in contexts in which a learner must acquire a large number of items and retain them indefinitely in memory. Since most of the competencies are better acquired and developed as part of a sequence of learning (coherence of curriculum), it might be important to consider what is intended 'spaced repetition' of these competencies throughout various programmes.

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[165] Approaches to teaching and learning in the International Baccalaureate (IB) Diploma Programme, International Baccalaureate Organization 2014
[166] Sean H. K. Kang (2016), Spaced Repetition Promotes Efficient and Effective Learning: Policy Implications for Instruction, Policy Insights from the Behavioral and Brain Sciences 2016, Vol. 3(1) 12–19

Furthermore, there is a significant gap, when it comes to competencies, between mere understanding and behavior modification. It is the latter that matters most and by far, and the hardest one to effect in all of us, requiring doggedness and discipline.

Part V. Main Themes across Employability Skills Teaching and Learning Models

5.1 Teaching and Learning: Increasingly Student-Centered

Teaching

Studies across the world have demonstrated time and again that changes in teaching practice improve student learning more than any other school-based interventions. While some important employability skills—such as digital literacy—can be taught through teacher-directed instruction, many others cannot. To hone their ability to collaboratively solve problems, for example, children need teaching and learning experiences that give them space to lead, experiment, fail, and try again. Supporting teachers' capacity to guide children's learning is an important part of transforming the teaching and learning process. Indeed, leapfrogging in education requires being open to new ways of teaching and learning that may look quite different from what characterizes the average classroom. [167]

Therefore, effective teaching puts student inquiry at the center and actively engages students in doing things and thinking about the things they are doing.[168] A collection of diverse pedagogical approaches is motivated by this overarching principle. These teaching strategies frequently recognize that children are natural-born learners, often citing the important role active student inquiry has in developing a wide range of skills and capacities. One of the main aims of all IB programmes spelled out in the IB Learner Profile is to develop learners that are 'inquirers'. They are supported to develop their natural curiosity, acquire the skills necessary to conduct inquiry and research and show independence in learning. IB's extended essay is perhaps the most inquiry-based activity that students will undertake, especially given that it is a completely open-ended task, directed by student interest. Through their research, students can learn not only about the topic of their research, methodology but also develop critical thinking.

Some other pedagogical approaches entail harnessing children's innate ability to play as a way of helpings students "actively engage in meaningful discovery" and allowing them the freedom to experiment and explore problems. IB's Creativity, Activity, Service (CAS) enables students to enhance their personal and interpersonal development. A meaningful CAS programme is a journey of discovery of self and others. For many, CAS is profound and life-

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[167] Margaret Hilton and James Pellegrino, "Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st-century," National Research Council (Washington, D.C.: The National Academies Press, 2012), 175,
[168] Paniagua, A. and D. Istance (2018), *Teachers as Designers of Learning Environments: The Importance of Innovative Pedagogies*, Educational Research and Innovation, OECD Publishing, Paris

changing. Each individual student has a different starting point and different needs and goals.

Others focus on connecting classroom learning to the everyday lives of students, including pedagogies in which learners participate in real-life activities, such as internships and community projects, and learn through reflecting on those experiences. Educators use a range of terms to describe these various approaches—including active learning, experiential learning, and problem-based learning—and each emphasizes a slightly different piece of the teaching and learning process. At IB, students have a chance to experience this method through Service Learning which is the practical application of knowledge and skills towards meeting an identified community need. Through service, students at IB can develop and apply personal and social skills in real-life situations involving decision-making, problem-solving, initiative, responsibility and accountability for their actions

Learning

In 1956, Benjamin Bloom developed a framework for student learning behaviors to promote higher forms of thinking in education. As learners move from "lower-order" to "higher-order" skills, they are able to accomplish increasingly sophisticated learning objectives.[169] This movement requires students to demonstrate increasing levels of agency in the learning process. A range of studies justify this focus on both knowledge and application. Of course, higher-order cognitive skills not only build on lower-order ones but also help to strengthen them. In a recent review of dozens of studies on cognitive development and literacy, researchers underscore the fact that complex skills are deeply intertwined with lower-order skills. For readers and writers to thrive, they need to learn both the cognitive basics, such as decoding words, and higher-order skills, such as inference.[170] One study showed that training fourth graders in making inferences helped improve learning outcomes for poor readers; researchers posited that these readers likely struggled because they lacked the higher-order ability to draw connections between ideas, not because they lacked basic word-decoding abilities.[171]

This is relevant in the context of employability skills, which can be developed by allowing students the opportunity to utilize diverse skills while learning specific academic content.[172] For example, students could hone their ability to collaborate with others in science classes by working in teams to investigate the habitats of different animals. Integrating the development of employability skills into traditional classroom subjects—or, as we call it, teaching "skills

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[169] Benjamin Samuel Bloom, Taxonomy of Educational Objectives: the Classification of Educational Goals. Handbook 1: Cognitive Domain (New York: David McKay, 1974); Lorin W. Anderson, Benjamin Samuel Bloom, and David R. Krathwohl, A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives (New York: Longman, 2001).

[170] Peter Smagorinsky, and Richard E. Mayer, "Learning to be Literate," in The Cambridge Handbook of the Learning Sciences: Second Edition, ed. Keith Sawyer (New York, NY: Cambridge University Press, 2014)

[171] J. Hansen and P. D. Pearson, "An Instructional Study: Improving the Inferential Comprehension of Fourth Grade Good and Poor Readers," Journal of Educational Psychology, 75, (1983)

[172] Margaret Hilton and James Pellegrino, "Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st-century," National Research Council (Washington, D.C.: The National Academies Press, 2012), 175, https://doi.org/10.17226/13398.

through subjects"—is an important strategy for cultivating the breadth of skills and competencies. As we move along the leapfrog pathway, education increasingly requires learners to create and evaluate original work using a broad range of skills, character and meta-learning.

5.2 Recognition of Learning: Increasingly Individualized

In most learning environments, students are grouped into age grades, where they learn together and at the same pace. There is a linear progression from one grade to the next, and students move together through their classes and onto the next grade. Within this context, assessments are frequently used to determine whether a student can move to the next age grade—for example, students may be required to repeat a grade if they do not achieve passing marks in their courses. However, this system largely treats age as one of the most important determinants of student ability. By providing limited flexibility in how we recognize learners' abilities, we erase individual difference between learners—both struggles and strengths.

Research from learning sciences consistently shows that one of the most impactful teaching practices is continuously assessing student ability in order to appropriately tailor academic content.[173] Matching teaching with student needs is equally important for fostering social and emotional skills.[174] Proponents of ability-based progression often talk about "mastery-learning" or "competency- based" learning, which are pedagogical approaches widely examined in contemporary research.[175] Broadly defined, these efforts focus on providing differentiated supports to ensure that learners master needed skills, developing novel assessments that can capture this mastery across both academic and interpersonal and intrapersonal skills, and devising progression mechanisms that give students the time they each need to master a skill.[176] Useful assessment practices that can help more authentically reflect students' competencies across a broad range of skills include things such as self-assessments and peer assessments, computerized adaptive quizzes, and student portfolios. Preliminary evidence suggests that these approaches to assessment, which focus on what a learner can do with her knowledge, lead to improved learning outcomes.[177]

IB is using a range of formative assessment across various subjects. In the extended essay, one of the assessment criteria is critical thinking. Theory of knowledge (TOK) assessment asks students to communicate their understanding and perspective in both oral and written form.

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[173] John Hattie, Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement (New York: Routledge, 2009).

[174] Margaret Hilton and James Pellegrino, "Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st-century," National Research Council (Washington, D.C.: The National Academies Press, 2012), 180, https://doi.org/10.17226/13398.

[175] Keith Sawyer, "Conclusion: The Future of Learning: Grounding Educational Innovation in the Learning Sciences," in The Cambridge Cambridge Handbook of the Learning Sciences: Second Edition, ed. Keith Sawyer (New York, NY: Cambridge University Press, 2014), 726-746.

[176] Chris Sturgis, Reaching the Tipping Point: Insights on Advancing Competency Education in New England (Vienna, VA: Inacol, 2016).

[177] See Betty McDonald, "Self Assessment and Student-Centred Learning," ERIC - Education Resources Information Center, 2012, http://files.eric.ed.gov/fulltext/ED536980.pdf

As part of Approaches to Teaching and Learning (ATL), teachers should provide explicit opportunities in the classroom for students to practice and develop their social and collaborative skills. Group formative assessment tasks can provide an excellent opportunity and incentive for students to improve their collaboration skills.

5.3 Pedagogy

Pedagogy is at the core of teaching and learning. Many education policies will only lead to better learning outcomes if they lead to changes in teaching and learning practices. At the same time, as the aims of education systems have become more ambitious about what young people should achieve, pedagogy has become more complex. The shift towards learner-centred pedagogies is part of a larger change towards expecting higher levels of educational attainment. Countries now aim to prepare their young people to become lifelong learners with a deep understanding and a broad set of employability and social skills. The strong focus on learners acquiring a diverse set of skills, character and meta-learning requires a correspondingly strong focus on pedagogy. Acquiring competences such as collaboration, persistence, creativity, and critical thinking depends fundamentally on the modelling of the teaching and learning itself i.e. pedagogy. If these competences are to be systematically developed, rather than being left to emerge by accident, then pedagogy must be deliberately designed to foster these competences. Innovative pedagogies can play an important role in this. [178]

Learner-centred pedagogies, such as inquiry-based learning or collaborative learning, are particularly suitable in promoting the application of key skills, character and meta-learning. Importantly, it must be understood that emphasising these competences does not come at the expense of content knowledge and a deep grasp of substance. Instead, the demanding policy reality is that both 21st century competencies and a deep understanding of content knowledge are needed. Hence, effective pedagogy requires teachers to have professional expertise to support the simultaneous pursuit of the deep learning of content and of ambitious transversal competences that need to be practised to be acquired.

Professional expertise is both about the practical complex art of teaching and the design of learning environments to get the most from the teaching and pedagogy. Pedagogical expertise is exercised through:

- *Classroom management* (is how teachers keep students organized, attentive and focused)
- *Supportive climate* (refers to the student-teacher relationship and is high when teachers give positive and constructive feedback)
- *Cognitive activation* (means teaching that fosters student cognitive engagement with the subject matter) [179]

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[178] Paniagua, A. and D. Istance (2018), *Teachers as Designers of Learning Environments: The Importance of Innovative Pedagogies*, Educational Research and Innovation, OECD Publishing, Paris

[179] Paniagua, A. and D. Istance (2018), *Teachers as Designers of Learning Environments: The Importance of Innovative*

To implement these three components, teachers can draw on a combination of pedagogical approaches. Based on the literature review and consultations with diverse experts, the OECD's Innovative Pedagogies team has identified six broad clusters of pedagogical approaches[180]:

Blended learning rethinks established routines to get more from teaching. This pedagogical approach blends student work and teaching for understanding, adapts their sequencing and draws heavily on digital learning resources. The aim is to be both more engaging and coherent for learners and to free teachers from routine practice in favour of interactive and intensive classroom activities. There are three main forms within this cluster of pedagogies:

- *The inverted/flipped classroom*, in which students work on material first and only then access the teacher(s) to practice, clarify and deepen understanding.
- *The lab-based model* in which a group of students rotates between a school lab and the classroom with the application of content through face-to-face interactions with teachers.
- *'In-Class'* blending, in which individual students follow a customised schedule rotating between online and face-to-face instruction.

When it relies on digital resources, it assumes teachers have the skill to operate technologies and an understanding of content, technology, and pedagogy in interaction.

Gamification builds on how games can capture student interest and facilitate learning. Play occupies an important place in children's learning, and supports intellectual, emotional and social well-being. It opens potential learning experiences, driven by self-motivation and interest. Gaming in education takes different forms (e.g. gamification, game-based learning, serious games), but in this report "gamification" encompasses the pedagogical core of gaming and the benefits of playful environments for engagement and well-being. There are two main pedagogical components: mechanical elements (rapid feedback, badges and goals, participation, and progressive challenge) and emotional elements (narratives and identities, collaboration and competition). Gamification has been used successfully in a range of subjects, such as science, maths, languages, physical education, history, and art and design. Gamification can foster self- regulated learning, collaboration, exploration and creativity.

Computational thinking develops problem-solving through computer science. This looks at problems in ways that computers do and then uses them to solve those problems. Its basic elements are:

- *Logical reasoning*: analyse and deduce outcomes.
- *Decomposition*: break down a complex problem into smaller ones.

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[180] Paniagua, A. and D. Istance (2018), *Teachers as Designers of Learning Environments: The Importance of Innovative Pedagogies*, Educational Research and Innovation, OECD Publishing, Paris

- *Algorithms*: describe routines and create step-by-step instructions.
- *Abstraction*: capture the essence of a problem, removing unnecessary detail.
- *Patterns*: identify common solutions to common problems.

Computational thinking takes programming and coding as a new form of literacy and as a new approach to ICTs. It brings together a language (coding), process (problem-solving), tools (programs), and uses experimentation and learning-by-doing to produce discrete outputs. Inquiry skills are developed through logical reasoning, algorithm framing and decomposition, while programming and coding foster writing abilities.

Experiential learning takes place through active experience, inquiry and reflection. This approach mixes content and process; reduces guidance; promotes engagement; enables connections to be made between learning and the wider environment; and generates insights from experience. Its four main components are:

- *Concrete experience* of a task potentially disruptive of students' existing understanding.
- *Reflective observation,* moving between hypotheses and values, and addressing conflicting ideas.
- *Abstract conceptualisation,* making sense of experiences and reflections and building abstract ideas.
- *Active experimentation*, putting learning into action in a way relevant to the student.

Well-known innovative pedagogical approaches in this cluster include inquiry-based learning and service-learning. It also includes more recent approaches such as education for sustainable development and outdoor learning. Guidance and scaffolding play pivotal roles. Decisions need to be made about which areas can best use experiential learning and to identify potential activities that fit course objectives. Experiential learning thus needs to build platforms for active learning experiences and explicitly encourage reflection.

Embodied learning connects the physical, artistic, emotional and social. This entails a significant shift in many education systems that have traditionally favoured abstract thinking, the individual and passive content acquisition. Embodied pedagogies develop and exploit two natural dispositions in the young - creativity and expression – and consciously use creative experiences and active student involvement to promote knowledge acquisition. Three main approaches are:

- *School-based physical culture*: focusing on the role of physical education as an encompassing resource to enhance personal qualities and thinking skills.
- *Arts-integrated learning:* promoting student engagement through connecting arts with other subjects.
- *Maker culture:* tinkering and the construction of tools and artefacts.

Embodied learning is particularly suited to develop curiosity, sensitivity, multiple perspective-taking, risk-taking, as well as metaphorical thinking, and other metacognitive and executive skills fostering learner achievement. It develops socio-emotional skills and other fundamental interdisciplinary content eg, gender issues, diversity. It is therefore highly relevant to 21st century competences.

Multiliteracies and discussion-based teaching aims at developing cultural distance and critical capacities and refers to a range of practices and principles rather than a single pedagogical approach. Literacy lies at the heart of student learning and critical literacies situate knowledge in its political, cultural and authorial context, deconstructing narratives through interchange and collaboration. While class discussion is valuable no matter what the pedagogical approach, it becomes central in the questioning of received ideas. The four main principles of this pedagogical cluster are:

- *Situated practice* uses students' life experiences to create meaningful classroom activities within a community of learners.
- *Active teacher interventions* scaffolds learning through collaborations between teachers and learners in complex tasks.
- *Critical framing* encourages constructive critique and distance from what has been learnt, so that students can apply and extend it.
- *Transformed practice* encourages students to extend their learning to other situations and cultural contexts.[181]

Based on the reviewed documents, IB is currently using some of the above-mentioned innovative pedagogies. There is an integration of 'experiential learning' through service learning in the CP and inquiry-based learning through extended essay in the DP. Inquiry based learning is also emphasized in the TOK.

Another form of innovative pedagogies 'embodied learning' is expressed through CAS in the DP. Creativity, action, service (CAS) involves students in learning through a range of artistic, sporting, physical and service activities. Students are for example encouraged to engage in creative endeavours that move them beyond the familiar, broadening their scope from conventional to unconventional thinking. This may include visual and performing arts, digital design, writing, film, culinary arts, crafts and composition.

Lastly, 'discussion-based teaching' is also taken seriously at IB and is well integrated, especially through TOK. Students are asked to submit essays, analytical pieces of work, oral presentations and demonstrate active participation in class discussions. It is a core element which all Diploma Programme students undertake and to which all schools are required to devote at least 100 hours of class time. It is fundamentally about inquiry into the process of knowing rather than about learning a specific body of knowledge. At the moment, there seems

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[181] Paniagua, A. and D. Istance (2018), *Teachers as Designers of Learning Environments: The Importance of Innovative Pedagogies*, Educational Research and Innovation, OECD Publishing, Paris

to be a lack of 'blended learning', 'gamification' and 'computational thinking' pedagogies applied in the IB's CP and DP programmes based on the reviewed documents.

Certainly, it is not possible to adopt all the pedagogies but rather a combination of some that are most suitable for IB programmes. These pedagogies usually have an interdependent relationship as one skill such as for example collaboration can be achieved and retained through the employment of gamification and blended learning. During the next review process, the IB's DP and CP programmes could consider seeking an alignment among the most suitable pedagogies to effectively enhance further development of employability skills in its core subjects.

Conclusion

There is ample of evidence all around us of the many changes the 21st century has brought to our lives. We live in a more competitive, yet more interdependent world. The rapid increase in the rate at which technological change is occurring around the globe creates a world that is increasingly volatile, uncertain, complex, ambiguous (VUCA) and thus hard to predict. Such an unpredictable context requires an increased capability for humans to engage with complex challenges, agility to adapt to new situations, along with a diverse set of individual competencies.

An increased number of occupations in the future will involve complex problem solving and creative thinking and require complex social interactions. Facing the challenges of the 21st century requires deliberate effort to cultivate in students these competencies to respond to the needs of the labour market. The knowledge dimension matters, but the skills, character and meta-learning dimensions are just as important and therefore all of them need to be fostered for individuals and societies to prosper.

As the analysis of curriculum content mapping of CP and DP demonstrated, there are some competencies that are well integrated in the existing intended curricula and others that are not represented sufficiently. The top four competencies that seem to have a large contribution across both programmes are communication, ethics, mindfulness and critical thinking. The middle four competencies that have less contribution but are still sufficiently covered in both programmes are metacognition, collaboration, creativity and leadership. There seems to be low contribution in both CP and DP for following four competencies: growth mindset, curiosity, courage and resilience. These are important competencies related to positive academic and labour market outcomes and should be explicitly integrated into the curricula and intentionally taught in the Diploma and Career-related Programmes.

Innovative pedagogies and changes in teaching practice are an important component in developing above mention competencies in students. To hone their ability to collaboratively solve problems, for example, children need teaching and learning experiences that give them space to lead, experiment, fail, and try again. Innovative pedagogies such as gamification, blended learning or experiential learning among others are particularly effective in developing students' 21st century competencies. It is not possible to adopt all the pedagogies but a combination of some that are most suitable for IB programmes would be recommended.

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