10TH ANNIVERSARY GFCC

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The Global Federation of Competitiveness Councils (GFCC) is a network of leaders and organizations from around the world committed to the implementation of competitiveness strategies to drive innovation, productivity and prosperity for nations, regions and cities. The GFCC develops and implements ideas, concepts, initiatives and tools to understand and navigate the complex competitiveness landscape.

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Acknowledgments

The Board of Directors and members of the Global Federation of Competitiveness Councils (GFCC) extend their deepest gratitude to the Brazilian National Confederation of Industry (CNI) for its initial financial support of the research undertaken to develop the GFCC's new report *Future Skills: Lessons and Insights from a Review of Innovative Skills Development Initiatives*.

Future Skills is the culmination of one of the GFCC's most ambitious collaborative efforts, involving staff research, a survey of GFCC members and fellows, feedback from the GFCC network of partners, and interviews with education, training, and policy experts. This work, initially funded and made possible by CNI, complements its own skills research carried out in parallel with the hope it will have significant application in Brazil's workforce development efforts. In the spirit of knowledge sharing that inspired the founding of the GFCC, the larger GFCC community is eager to learn from the findings of CNI's research in Brazil.

The Board and members are also grateful for the strong support sustaining member CNI has given the GFCC over the years, particularly the commitment and active participation of CNI's Director of Innovation Gianna Sagazio — one of the brightest stars in the GFCC constellation — and the support of her outstanding team, Candida Oliveira, Zil Miranda, Marcos Arcuri, and colleagues. The expertise, insight, and experience of CNI's Innovation Team have enriched significantly the dialogue, knowledge base, and understanding of global trends on which GFCC members depend to shape and improve their domestic efforts to improve competitiveness, innovation, economic growth, and prosperity.

Special Thanks

The GFCC would like to give special thanks to everyone in the list below for contributing interviews; suggesting case studies; and sharing contacts, references, and information that helped to build this report. Thank you also to everyone in the GFCC Community who contributed information, references, and suggestions.

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From the GFCC Leadership

On behalf of the Board of Directors and members of the Global Federation of Competitiveness Councils (GFCC), we are pleased to present Future Skills: Lessons and Insights from a Review of Innovative Skills Development Initiatives. Nations around the world are confronted with rising global competition, rapid technology advancements, adoption of new organizational forms and business models, new market and social trends, and accelerating automation. These changes are transforming economies, industries, businesses, what people do on the job and the skills they need. As a result, it is more important than ever to ensure workers have the skills needed to compete globally and thrive in a changing labor market.

Future Skills is the culmination of one of the GFCC's most ambitious collaborative efforts, capturing insights and findings from GFCC staff research, a survey of GFCC members and fellows, feedback from a broader GFCC network of partners, and interviews with education, training, and policy experts. Based on this deep exploration, the report characterizes the evolving workforce education and training landscape, and how nations around the world are responding to the challenges and opportunities this landscape presents.

Future Skills highlights megatrends shaping the demand for skills — widespread digitalization, the experience economy, greater life expectancy, the COVID-19 pandemic, rapid technology advancement, and employers' desire for workers with both hard technical skills, and soft skills such as critical thinking and problem-solving. The report presents examples of education and training efforts in 20 countries — both advanced and emerging economies — across 5 continents. These include national skills initiatives that seek to lead countries in new directions in developing the workforce, and programs that train people. Training programs include youth programs, digital schools, degree institutions, professional schools, and training connected to economic development. Each of these training programs has an innovative feature, for example, curriculum, education method, how they engage industry, and the technology they use. Looking across these diverse initiatives and programs, the report offers a set of lessons learned. We hope this rich compilation of experiences and insights can help inform GFCC members and the larger community working to build 21st century skills.

On behalf of the GFCC, we wish to extend our deepest gratitude to GFCC sustaining member and long-time champion Brazil's National Confederation of Industry, which provided a grant that supported the research undertaken for Future Skills. We also wish to thank the GFCC members, GFCC fellows, and experts who contributed their intellect and insights to the development of this report.

The GFCC was founded on the belief that sharing knowledge and best practices among national competitiveness organizations and among nations would provide benefit to all. May our GFCC members and others around the world put the knowledge and insight we gained in the Future Skills project to good use in developing a skilled, competitive, and thriving workforce for the future.

The Hon. Deborah L. Wince-Smith
President, Global Federation of Competitiveness Councils

President & CEO, Council on Competitiveness

Mr. Charles O. Holliday, Jr.
Chairman, Global Federation of Competitiveness Councils

Boosting Future Skills Will Drive Inclusive Prosperity

Dr. Roberto Alvarez
Executive Director, Global Federation of Competitiveness Councils

What is needed to build a sustainable, resilient, inclusive and more prosperous future? There are many things that come to my mind when I think about it and I am sure the same happens to you. Despite any differences in thinking, I believe we can all agree that we need people, human capabilities and skills to build the future.

Skills must be at the center of any development and growth strategies. Not a single country, region or city can thrive if the skills needed for today's economy are not available in the workforce and, increasingly and specially, without being capable of developing and supplying the skills that will be needed in the future. The action must start now.

We live in a time of accelerated transformation which creates a challenging scenario for skills development. Three main aspects stand out in this context: space, speed and scale.

- **Space:** Still today, most of humanity does not take part in the knowledge and digital economy. Besides, many who are active in today's economy will see their jobs vanish. Societies will only thrive when most people participate in the future economy. Skills development is the only solution to create space to include vast contingents of citizens as active players in future industries.
- **Speed:** As technology accelerates, new business models emerge at an unprecedented pace, competition gets fiercer, business cycles shrink, the lifespan of companies and the shelf life of skills drop. Speed is critical to allow people in the workforce to acquire new skills as they become relevant, supplying market needs and enabling job and career transitions. Skills development needs to happen at speed.
- **Scale:** The transformations in the economy brought about by new technologies and business models will eliminate a massive number of jobs, while creating others. This is not a small shift, but a big one, in a scale that economies and societies never experienced before. Re-skilling, upskilling and skills development efforts in general have to be massive, at scale.

The challenges posed by a new technology era and the resulting transformations in the global economy are not trivial. They are particularly critical for developing nations, that have not fully transitioned their economies, display productivity levels below the standards of developed countries and, in many cases, lack capabilities that are vastly available in those more sophisticated economies. Advanced economies also face important challenges, as they need to re-skill the workforce to stay competitive and prosperous, and include various demographics in the knowledge and digital economy.

In general, we have signals, hints and insights about the skills needed for the future economy that quickly unfolds in front of us. They are outlined and explained in the report. However, I believe the key issue is how to develop skills, at scale and speed, creating spaces to include people in the future economy. What new models to develop skills should we know? How do they work? What can we learn from them? These questions are the core of the thinking behind the work we have done.

This report results from a research originally commissioned and supported by the Brazilian National Confederation of Industry (CNI). CNI has been an essential voice advocating for innovation and innovation policies in Brazil and, among other things, played a key role in the update of Engineering curricula in the country. It also owns and operates one the largest vocational training systems in the globe. The Brazilian National Service for Industrial Training (SENAI) includes hundreds of secondary and post-secondary level professional schools, offers a variety of short-term courses and, in recent years, has established a network of innovation centers throughout the country. It is hard to find an organization to which the topic of future skills could be more relevant.

Working with CNI colleagues in 2020 and 2021 was a true source of inspiration and learning for the GFCC team, and a fundamental part of the work we executed. Gianna Sagazio, Candida Oliveira, Zil Miranda and Jorge Boeira, the CNI consultant who reviewed the Brazilian context, were true partners and deserve credit for many ideas in this document. While the GFCC was focused in researching global experiences, the Brazilian team researched and systematized information on Brazilian cases — the results of that effort will be published shortly by CNI and we will surely share news about it on GFCC platforms.

I had the pleasure to initiate this project with Yasmin Hilpert and, later, count on the research and editorial work of Simone Melo and Carol Ann Meares — thank you for the partnership and the amazing work you have done. Above all, this report would not be possible without the support of people from around the globe, within and outside the GFCC community. The GFCC team worked with members, fellows and partners, collected their insights, built a list of cases to check based on their recommendations, received comments and suggestions from our network. We are thankful to all of those who contributed to this initiative and hope the content here can prove useful to them.

As economic transformations gain momentum, the issues raised in this report will become even more important. Building a sustainable, resilient, inclusive and more prosperous future will depend on the capacity of nations to develop skills and create opportunities for all. The time is ripe for us to decide if many of our fellow citizens should be placed in the assets or liabilities columns of our social accounting, the difference between the two will mostly arise from the scale and speed of our efforts to develop future skills.

Executive Summary

Globalization, hyper global competition, and rapid advancements in multiple revolutionary technologies are transforming economies, industrial sectors, businesses, and societies around the world. These changes are driving the emergence of new industries, types of work, organizational forms, and models of services and production. These technologies are also expanding and accelerating automation.

The changes brought about by disruptive technologies can affect the workforce at every level of the economy — from the desktop to the workplace, to the labor market, to the mix of industries in a community or country — creating new opportunities for jobs but also hardships for some workers.

Today, such impacts on the workforce come at rapid pace and are likely to accelerate in the years ahead. This means individuals, companies, communities, educators, and trainers have less time to adapt and prepare than they have had in the past when the life-cycles of technologies were longer. As a result, it is more important than ever to understand emerging skill needs to adjust education and training programs to ensure those needs in the economy are met and that workers have the skills they need to thrive in a changing labor market.

Among the skills employers increasingly seek are those related to using digital technologies to perform complex work, and "soft skills" such as critical thinking, creativity, problem solving, adaptability, working with information, complex communications, interpersonal skills, and teamwork. As "smart machines" imbued with artificial intelligence and autonomy are increasingly deployed across the economy, the need for higher level skills will spread beyond manufacturing to employment and occupations that, historically, have not been affected much by automation.

Recognizing the changing nature of skill needs and labor market demands, countries are reviewing their national frameworks for workforce development. Industry organizations, and education and training institutions are experimenting with new types of non-degree credentials, occupational certifications, and training programs. Workers are increasingly participating in career-advancing non-degree courses and engaging in continuous learning.

This report reviews some of these trends, and some of the innovative solutions being adopted to develop skills projected to be in demand in the future.

Megatrends Affecting the Global Skills Landscape

Several trends are reshaping the global skills landscape:

Increasing Demand for Digital and STEM Skills: As the Digital Revolution has scaled, demand for computer professionals has increased dramatically and, as economies based on knowledge, technology, and innovation have expanded, skills in science, technology, engineering, and mathematics have become more important. Many employers around the world report having difficulty finding the right skills or talent, or filling jobs. Areas of basic skill deficiencies include basic computer skills and mathematics, and applied skills such as critical thinking, problem-solving, professionalism, work ethic, leadership, and written communications.

Structural Transformation in Labor Markets: Some labor markets are undergoing structural transformation due to consumer trends, demographics, and new technologies.

Experience Economy. As e-commerce has gained market share and disrupted the retail sector, many goods have become commoditized, increasingly abundant, and differentiation and consumer preferences are increasingly geared towards experiences. As a result, experience-related industries are likely to grow in the long-term — hiring more personnel, and demanding industry-specific skills and experience. However, post COVID-19, they may have a larger digital content requiring employees with skills at the intersection of digital and traditional experiences.

Human Longevity. Increased access to housing, sanitation, and healthcare — combined with dramatic improvements in disease prevention, medical treatments, and health technologies — have extended life expectancy and improved human wellness. Longevity creates a chain effect in the provision of health services: the more health services are available to people, the longer they are likely to live which, in turn, means they will require more health treatment. As a result, countries and cities will need more health professionals. However, research suggests that global demand for healthcare professionals will significantly exceed the healthcare worker supply.

Rapid Technology Advancement: Rapid advancements in technologies are the chief factor driving the need for future skills. Great revolutions in science and technology are converging on the global economy and society simultaneously — biotechnology, big data, nanotechnology, autonomous systems, and a new phase of the digital revolution characterized by vast deployment of sensors, the Internet of Things, and artificial intelligence, the apex technology of the next 50 years.

As these new technologies scale and are deployed across the economy, they will bring about a need for new skills, reskilling, and upskilling, and at a pace that matches technological change. In addition, automation has already eliminated many middle-skill jobs that have supported a middle-class lifestyle. As automation of routine tasks increases, the ability to perform non-routine work and complex tasks becomes more important in securing employment.

Need for a New Blend of Hard and Soft Skills: The use of digital technologies for both blue and white collar workers is likely to increase in the years to come, although not everyone will be required to create software or control digital hardware. To some degree, all workers can be expected to use digital technologies to execute general businesses processes, likely to be function and job agnostic. However, other workers will need more sophisticated skills to execute specific technical functions; program, maintain, adjust, setup, train and/or analyze digital artifacts; or develop and create digital technologies and artifacts.

In addition, employers are embracing new organizational forms such as work in multidisciplinary teams, management approaches that increase worker autonomy, and serving a diverse global customer base. These developments have increased the need for advanced cognitive skills such as critical thinking and problem-solving; socio-behavioral skills such as engaging with clients, and collaboration in complex working environments.

The Need for Greater flexibility in Education and Training Systems: Rapid advancement of technologies poses a challenge to skills training programs, and to education systems that seek to provide some foundational level of occupational or workforce skills. The skills and training required for jobs are ever-changing and need to be met with new curricula, teaching methods, and industry engagement. In addition, individuals already in the workforce increasingly must update their skills, and some must acquire new occupational skills if they change jobs, change industries, or their skills become obsolete due to automation. Many adult learners work part time or full time, have dependents, and responsibilities that compete for their time, energy, and financial resources. These workers need education and training options that can accommodate their adult and working lives.

National Skills Development Initiatives

Meeting the challenge of rising skill requirements in knowledge and technology-based industries and economies is increasingly among the top priorities for governments, businesses, labor organizations, educators, and research institutions. Different countries have commissioned studies, created bodies, and/or launched national initiatives to address the changes in skills requirements. Most of these initiatives have aimed to understand the skills situation, and many are experimenting with innovative action-oriented models, for example:

- **Canada:** A government-funded Future Skills Centre includes test-beds for new skill development models. These impact workers and employers, and serve as sources of learning and insights.
- **Singapore:** Government is funding the Skillsfuture Program which provides solutions to professionals, other workers, employers, and the Singaporean society at large.
- **Malaysia:** Convened Cabinet-level leaders and is using findings of a study on the "Future of Work" to inform strategic conversations and the design of new policy initiatives, such us the National Industry 4.0 Policy, focused on equipping future talent with the necessary skills for the future of work, and retraining existing talent.
- **France:** Launched a national initiative that encourages re- and upskilling of the French labor force, and provides every worker the opportunity to spend up to 5,000 EUR on training and education over the course of their career, and 8,000 EUR for workers with no prior professional skills.

- **Austria:** Education Account provides workers with the opportunity to apply for co-funding for educational and training courses. Depending on the education and training level of the workers, between 30-60 percent, and a maximum of 2,400 EUR of training costs are covered by the government grant.
- **Germany:** Kurzarbeit policy enables companies to keep employees during a crisis, but reduce their working hours; workers' lost income is partially replaced, and they are encouraged to spend the extra time in training and education.
- **Japan:** Education and training initiatives have been mostly focused on older workers seeking to transition between industries. The Silver Human Resource Centers focus on workers in the 60+ age group who are either unemployed or want to make late-in-life career changes.
- **Korea:** To reduce the financial burden of continuous education and vocational training on households, the Korean government introduced several policies to limit the costs and tuition fees for students of all ages.

These approaches highlight a diverse set of program characteristics to consider in program design and implementation: combination of action and experimentation at the micro level with institutional learning at the macro policy-making level (Canada), empowering citizen by providing a solution to individuals (Singapore), using foresight to guide policy design for training and education (Malaysia), public-private cooperation and embedding skills development into labor regulation (Germany), and focus on re-skilling and up-skilling the incumbent workforce (Canada, Germany, and Singapore).

Innovative Skills Implementation Solutions

The report examines 31 skills implementation solutions — initiatives directly training people and developing skills — across 15 countries: Australia, Cambodia, Canada, Chile, Denmark, Finland, France, Germany, Israel, Mexico, New Zealand, Portugal, Sweden, the United Kingdom, and the United States. These solutions seek to primarily develop cross sector and cross industry skills — those needed in the economy as a whole — while several focus on meeting the need for sector and industry specific skills.

Several trends are apparent:

- The past decade experienced a proliferation of learning enterprises that aim to increase digital literacy, entrepreneurial skills, and professional upskilling.
- IT, data science, engineering, and technology are key areas of program focus. A significant number of solutions involve programs that teach coding and programming languages.
- Developing hard skills is at the core of 68 percent of cases presented.
- A blended learning method that improves technical expertise while also developing soft skills — such teamwork, creativity, resilience, and leadership — is also common in the cases examined.

The implementation solutions presented vary in audience, type of skill needs they address, scale of effort, and methodologies they adopt. All of the programs have innovative features. The following summarizes the programs reviewed:

Youth Education: These programs and schools focus on developing technology and soft skills before students reach higher education. Some feature industry collaborations, which provide students an opportunity to learn from industry specialists, engage early on in real-world projects, and test their ideas with an audience of real-world experts. Some of the initiatives allow students to start to build a professional portfolio while still in K-12. Some of the innovative features of these programs include:

- *Fire Tech* (U.K.) was one of the first companies in the world to offer programs to train children in technology. All programs follow the experiential learning method. Recently, the company started programs that allow students to engage in "real life" projects.
- *Líger Leadership Academy* (Cambodia) offers a curriculum that is experiential and project-based, and encourages individual initiative and entrepreneurship in one of the least developed countries in the world.
- *Ørestad Gymnasium* (Denmark) is entirely digital. The school's architectural design — an open-plan model with few closed-off spaces — is supposed to help facilitate learning.

- *The Singular School* (Israel) teaches students to work in teams using real-world problem-solving approaches. It partners with traditional schools, exposes students to cutting edge technology ideas, and develops entrepreneurship skills
- *Unistream* (Israel) has deep connections with industry and the Government of Israel, and helps teens establish their own start-up companies.

The solutions featured indicate that:

- Relevant cases exist in both advanced and emerging nations.
- Soft skills are critical for the future economy, and are at the core of youth programs.
- Industry engagement can start at an early age.
- Entrepreneurship training for youth is valued in innovation-oriented countries.
- Professionals outside of the education industry are driving change.

Digital Schools: These are non-degree programs and employ a bootcamp model in which participants are immersed in the subject for a limited and intense period of time, attaining a steep increase in their knowledge base and skills. The majority of these are coding schools. Some of the innovative features of these programs include:

- *Academia de Código* (Portugal) bootcamps allow workers and children to go from little knowledge to proficiency in a very short period of time. It also displays an innovative method to select participants.
- *Code Avengers* (New Zealand) programs are accessible online and can be completed at the student's own pace, while also having a focus on training teachers.
- *Coding Dojo* (USA) uses the bootcamp model for coding training, and has a strong approach to industry engagement. It offers programs in ten cities and online.
- *École 42* (France) 3-year model is unique to the industry; it has no teachers or professors, and leverages peer-to-peer and project-based learning. Students direct their own education, dictate their own pace of learning, and assess their classmates' work. It operates a franchise model.
- *General Assembly* (USA) was a pioneer school globally for focusing on the emerging set of digital skills — beyond coding — offering non-degree certificates in a variety of areas. It has strong ties with industry and on-the-ground needs for digital skills.
- *YouGrow Academy* (Germany) combines bootcamp-like software coding training with industry projects, and recruitment and placement in industry. Recruitment comes before training and participants are paid, a unique feature.

The solutions featured indicate that:

- The young age of the schools (all founded after 2010) reflects the continued widespread scaling of digital technologies.
- Getting to scale seems to be a challenge for coding bootcamp schools.
- Active learning methods for developing upper-level digital skills is important.
- Digital schools mirror the organizational models and practices of digital companies.
- Schools are enlarging their portfolios to cover other relevant areas and digital skills.
- They are increasingly connected to recruitment agencies, serving as talent brokers.
- Connections between schools, and labor market demands and trends are important.

Degree Institutions: These are innovative higher education institutions and/or programs, especially in engineering and technology fields. Some of the innovative features of these programs include:

- *Monterrey Institute of Technology and Higher Education* (Mexico) Tec21 education model blends several elements, such as challenged-based learning, and is innovative because of its scale involving 100,000 students.
- *Olin College of Engineering* (USA) curriculum teaches students to think critically about the social implications of their work and the entrepreneurial skills necessary to transform their ideas into real solutions.
- *Minerva Schools at KGI* (USA) experience is global in nature. Through four years of study, students travel with a cohort of classmates, spending time in up to seven different cities around the world.

- *Aalto University* (Finland) focuses research on key areas of innovation: ICT and digitalization, materials, art and design, business, energy solutions, living environments, and health and well-being. Research and learning emphasize identifying and solving societal challenges.
- *E3 Program* (USA) combines educational instruction with practical hands-on industry experience. It reconceptualized entrepreneurship as a set of technical, business, and social skills that can be taught and learned.

The solutions featured indicate that:

- Multidisciplinarity creates the opportunity for students to develop both hard and soft skills.
- Creating university organizational solutions to enable experiential learning is needed.
- Industry engagement is essential for experiential learning programs; developing social capital helps in building relationships with industry.
- Resources from outside university boundaries can be leveraged.
- Preparing students to work in global settings is important.

Professional Schools: These initiatives focus on people who are in the workforce and aim to upskill or reskill, and connecting them with demands in job markets. Some of the innovative features of these programs include:

- *AltMBA* (USA) leadership and management bootcamp, conducted over four weeks online, requires participants to work around the clock in teams to solve ill-structured problems and complete a flow of deliverables throughout the program.
- *Hyper Island* (Sweden) has a project-based curricula is designed by industry professionals. It works with high-profile companies to give students internships and training opportunities in their chosen fields.
- *Alberta Machine Intelligence Institute* (Canada) is one of the pioneer institutes in the world focused solely on AI and designed to combine research with translation through projects and training.
- *College for America* (USA) programs allow a maximum level of flexibility for students — the pace of learning is set by how long it takes to complete competency-based projects. Its flexible setup allows for people who work to engage in education, update their skills, and obtain degrees.
- *Davis Global Center* (USA) is a healthcare training and simulation facility with a heavy emphasis on advanced medical technologies and new techniques of patient care. It leverages emerging technologies such as VR/AR to train healthcare professionals and help students learn to work in teams the way they will in a real clinical environment.
- *Culinary Institute of America* (USA) is a vocational school offering undergraduate and graduate degrees, and adult learning programs. A pioneer school of its type in the Americas, it has evolved into a thought leader in the food world, convening conferences and creating industry-wide opportunities for culinary leaders and professionals to engage and drive industry innovation.
- *Disney Institute* (USA) is the training and development arm of the Walt Disney Company. It was a pioneer in implementing a curriculum focused on service excellence. It makes the expertise and resources of the Walt Disney Company available to clients and professionals around the globe.

The solutions featured indicate that:

- Industry engagement is essential to design, implement, and scale-up professional education.
- It is easier to digitalize training programs that do not require industry specific settings or equipment.
- "Train as you work" is a powerful concept.
- New technologies can boost in-person learning.
- Professional education can be coupled with cutting edge technology research.
- Economywide upskilling can be turbocharged.
- As schools grow, they tend to expand their portfolios.
- Distinctive industry assets and capabilities can be leveraged to build innovative programs.

Economic Development: Typically, these initiatives result from industry and government partnerships, and aim to foster economic development through workforce development and the creation of employment opportunities.

- *NYC Tech Talent Pipeline* (USA) is governed by a group that includes technology industry leaders, and was conceptualized to provide training solutions aligned with employer needs.
- *Chicago Codes* (USA) program is tuition free, making skills training accessible to larger portion of the population.
- *Talento Digital para Chile* (Chile) provides a common forum for companies, training institutions, and government, and combines the efforts of these entities to develop new capacities in people in tune with the demands of the digital economy.
- *Apprenticeship Carolina* (USA) targets only the industries that need workers the most, giving students the best chance of landing a job.
- *P-Tech* (USA) model has expanded to more than 20 countries and includes close partnerships with more than 200 universities that grant students access to opportunity in the labor market following successful program completion.
- *Skillful* (USA) works with industry at the city, region, and state levels to identify skills needs, and trains people in the workforce to meet industry needs. In some way, it is a broker and marketplace of skills, and training facility.
- *Industry 4.0 Higher Apprenticeship Program* (Australia) was co-designed by industry and academia, and combines the Germany-inspired vocational training method with a higher education framework.
- *National College for Advanced Transport & Infrastructure* (UK) is innovative in its degree of industry engagement. The college was founded for the express purpose of developing a workforce capable of performing high-quality work on specific rail projects.

The solutions featured indicate that:

- Industry partnerships are essential for effective skills development initiatives.
- Public-private partnerships can only exist in environments that have legal frameworks that allow for these partnerships in a practical and secure way.
- Learning from existing experience is valuable and adaptation is critical.
- New programs can harness the potential of existing solutions.
- Industry leadership is critical to build skills partnerships that provide participants with real-world experiences and equip them with relevant skills attuned to today's need.
- Skills development initiatives need practical solutions to scale up.

Lesson Learned

A number of lessons learned emerged across the cases examined by the GFCC:

1. Awareness and action related to future skills are on the rise.
2. It is easier to inspire than to actually develop skills.
3. Benchmark initiatives emphasize both soft and hard skills.
4. The most ambitious programs are problem-oriented and have strong linkages with industry.
5. Successful programs emphasize career services.
6. Significant social capital is needed to develop a program that resonates with industry.
7. Scaling up is challenging.
8. Innovative programs that target mid-career professionals are increasingly designed to accommodate participants' schedules.
9. Selection processes are very important for success.
10. Technology offers possibilities to expand access and enable new learning experiences.
11. There is growing interest in national and city-level public-private partnerships to develop digital skills.

INNOVATION AREAS			
Implementation Solution	**Curriculum**	**Education Method**	**Industry Engagement**
YOUTH EDUCATION			
Fire Tech	X	X	X
Liger Leadership Academy	X	X	
Orestad Gymnasium		X	X
Singular School	X	X	X
Unistream		X	X
DIGITAL SCHOOLS			
Academia de Codigo		X	X
Code Avengers		X	
Coding Dojo	X	X	X
Ecole 42	X	X	X
General Assembly	X		X
YouGrow Academy		X	X
DEGREE INSTITUTIONS			
Monterrey Tech	X	X	
Olin College of Engineering	X	X	
Minerva Schools at KGI	X	X	
Aalto University	X	X	
E3 Program	X		X
PROFESSIONAL SCHOOLS			
AltMBA		X	
Hyper Island	X		X
Alberta Machine Intelligence Institute	X		
College for America	X	X	X
Davis Global Center		X	
Culinary Institute of America	X		X
Disney Institute	X		
ECONOMIC DEVELOPMENT			
NYC Tech Pipeline		X	X
Chicago Codes			X
Talento Digital para Chile			X
Apprenticeship Carolina	X		X
P-Tech	X	X	
Skillful	X	X	X
Industry 4.0 Higher Apprenticeship Program	X	X	X
National College for Advanced Transport & Infrastructure	X		X

	Organization Set-up	Material	Online Platform	Physical Infrastructure	Skill Type
					X
					X
		X	X	X	
	X				X
	X				X
			X		
	X	X	X		
			X		
					X
	X				
			X	X	
	X				X
					X
		X	X		X
					X
					X
			X		
		X		X	X
				X	
	X				
	X				
	X				
					X
	X				
	X				
				X	

Trends

Analysis of the cases presented in this report and lessons learned point to continuing trends and new developments in the years ahead:

Trend No. 1: Technology education and leadership skills development will be increasingly highlighted in early education inside and outside of the traditional education system.

Trend No. 2: As the digital revolution continues to scale, more coding bootcamps, and digital and innovation schools coming to the market can be expected.

Trend No. 3: The importance of soft skills will be increasingly recognized. As technical content and training become widely available online, the differences in performance and productivity arising from the lack of soft skills that are commodities in advanced economies will be increasingly noticed in emerging nations.

Trend No. 4: Online education will continue to expand — across the board, at all education levels, for all trades and professions, and for hard and soft skills. Enriched and immersive platforms are likely to become more widely used.

Trend No. 5: Experiential learning will probably gain momentum. As the design of experiential learning programs is generally more demanding than traditional methods, scale may be limited.

Trend No. 6: Demands will grow on education and training institutions to offer flexible training and education options for people in the workforce.

Trend No. 7: New programs to develop hard and soft skills will continue to appear in the market. In some nations, governments will empower citizens to make their skills development choices using vouchers and/or skills tax credits.

Trend No. 8: Education systems will be challenged to change, become more flexible, and widen the tools they use to certify skills, or even accept certifications from outside the formal education realm. As institutional change is slow and the performance of work and work teams increasingly cross national boundaries, there could be intense debates on the matter worldwide in the coming years.

1. Introduction

Globalization, hyper global competition, and rapid advancements in multiple revolutionary technologies are transforming economies, industrial sectors, businesses, and societies around the world. These changes are driving the emergence of new industries, types of work, organizational forms, and models of services and production. These technologies are also expanding and accelerating automation.

The changes brought about by new technologies can affect the workforce at every level of the economy — from the desktop to the workplace, to the labor market, to the mix of industries in a community or country — creating new opportunities for jobs but also hardships for some workers.

Today, such impacts on the workforce come at rapid pace and are likely to accelerate in the years ahead. This means individuals, companies, communities, educators, and trainers have less time to adapt and prepare than they have had in the past when technology life-cycles were longer. As a result, it is more important than ever to understand emerging skill needs to adjust education and training programs to ensure those needs in the economy are met and that workers have the skills they need to thrive in a changing labor market.

Structural changes in the labor market are already underway. Automation — robots, machines, devices, sensors, and software — is increasingly capable of doing routine tasks that have made up jobs for millions of workers. The price of automation has fallen significantly in the past few decades, both in absolute terms and relative to the cost of labor.[1] As the cost of labor rises, and the cost of automation declines, it becomes more attractive to automate work and eliminate some jobs.

Many lower skill workers perform tasks that are easier to automate, or tend to use technology that reduces the skills needed on the job.[2] In contrast, the labor market is rewarding

How Technology Can Affect Jobs and Workers

Task/Job Level

- Change skills needed on the job
- Change the way work is organized
- Change tasks performed

Organizational Level

- Make workers more productive so fewer workers are needed or jobs eliminated
- Change mix of human capital and skills needed in the organization

Industry Level

- Drive expansion in an existing industry's employment
- Create new industries with growing employment; drive declines and employment losses in other industries

Occupational Level

- Create new or eliminate existing occupations

Labor Market Level

- Change what skills/occupations in demand
- Change supply of skills/occupations in the labor market
- Change labor market value of skills

1 Job Polarization Leaves Middle-Skill Workers Out in the Cold, Maria E. Canon and Elise Manifan, The Regional Economist, Federal Reserve Bank of St. Louis, January 2013.

2 How Computerized Work and Globalization Shape Human Skill Demands, Frank Levy, MIT and Richard Murnane, Harvard University, 2006.

well-educated workers who can perform non-routine work and complex tasks. Higher-skilled workers are not only at a premium when new technologies are introduced, because they are better able to use them, they are also better prepared to move to new industries, new jobs, new occupations, or new skills when displaced by technological, labor market, or market disruptions. This phenomenon has been a driver in labor market polarization — into high-skill/high-paying jobs on one end and low-skill/low-paying jobs on the other, and fewer middle skill jobs — a trend seen across the advanced nations.[3]

Although there is not a full consensus on the specific changes that will happen in jobs, the labor market, and the world of work, there is agreement among experts, educators, and employers that education, training, and life-long learning are becoming ever more important to a nation's competitiveness, the functioning of a rapidly changing technology-driven economy, and the ability of workers to maintain employment and prosper.

Among the skills employers increasingly seek are those related to using digital technologies to perform complex work, and "soft skills" such as critical thinking, creativity, problem-solving, adaptability, working with information, complex communications, interpersonal skills, and teamwork.[4] As "smart machines" imbued with artificial intelligence and autonomy are increasingly deployed across the economy, the need for higher level skills will spread beyond manufacturing to employment and occupations that, historically, have not been affected much by automation.

Recognizing the changing nature of skill needs and labor market demands, countries are reviewing their national frameworks for job qualifications and putting competencies at their core. Industry organizations, and education and training institutions are experimenting with new types of non-degree credentials,

occupational certifications, and training programs. Workers are increasingly participating in career-advancing non-degree courses and engaging in continuous learning.

This report reviews some of these trends, and some of the innovative solutions being adopted to develop skills. These solutions include new types of programs, degrees or certificates, training organizations, curricula, education methods, and online platforms and physical environments for training and education.

The goal of this report is to inform the development of strategies, future research, and the design of new initiatives by GFCC members and the external community. This report is not intended to be a conclusive guide on how future skills should be developed, nor is it inclusive of all the innovative workforce education and training programming taking place around the world. Rather, it is a source of insights and examples, and readers are encouraged to look for cases in this report and elsewhere aligned with their own national, regional, and local conditions and realities.

Finally, the COVID-19 pandemic is having an unexpected and significant effect on the labor market, and the skills employers and workers need. The pandemic has accelerated and expanded trends that were already underway, for example, the digitalization of work and the need for digital skills. It has also increased the demand for workers in certain industries and particular occupations, such as health care workers and workers in industries that deliver products to the home. Conversely, the pandemic has constrained or reduced employment in the experience economy (see discussion in section 2.2). We still are in the early days of pandemic-driven employment shifts, and there is great uncertainty about the long-term impact on jobs and skills.

About This Report

In developing this report, GFCC staff carried out a range of research and other activities to collect the knowledge, insights, and examples needed to characterize the evolving workforce education and training landscape, derive lessons learned, and present case materials representing a diversity of initiatives and experiences:

- *Information Research*: Current information on how countries adapt to changing workforce needs, and on skills expected to be in demand in the future were reviewed. This included reports from international organizations, information on different training programs and institutes, as well as company materials, websites, and other documents.
- *Consultation and Survey*: To tap the rich source of knowledge and experiences within the GFCC member community, a group of GFCC members and fellows were surveyed about innovative training and education solutions around the world. The survey results were shared with all GFCC members, a broader GFCC network of partners, and national experts around the globe, encouraging additional input, comments, and insights.

3 How Technology and Globalisation are Transforming the Labour Market, OCED Employment Outlook 2017.

4 Work. Thriving in a Turbulent, Technological and Transformed Global Economy, Council on Competitiveness, 2016.

- *Training and Education Expert Interviews*: Leaders from some of the key education and training programs and institutes identified during the earlier research were interviewed to find out more about their innovative approaches and how they can be scaled up and applied in other national, industry, or economic environments.
- *Policy Expert Interviews*: Discovering a diversity of approaches during research for this report, a select group of policy leaders were interviewed to probe why and how their countries reacted differently to the need for change. Their insights are captured in the report.

Report Organization

The report is organized in 5 sections. In addition to this introduction, Section 2 reviews trends affecting the skills workers need, and insights gained during the research, interviews, and consultation with leaders in the GFCC network. Section 3 presents a selected set of national initiatives for skills development. Section 4 includes a review of innovative solutions for skills development, and Section 5 presents the main trends in skills development and lessons learned.

Characterization of Solutions

There are different levels of skills development intervention, for example, levels of sponsoring government, and different types of solutions such as policies and implementation solutions:

- Policy solutions include government programs, legislation, and strategies at the national and subnational levels that create the frameworks for investments in skills development, and set guidelines for the design and deployment of skills development initiatives.
- Implementation solutions are tools related to the direct provision of skills to people such as training and education programs.

While this report covers both, greater attention is given to implementation solutions. Section 3 offers information, examples, and insights on policy solutions, while Section 4 is devoted to the review of implementation solutions.

Thirty-one innovative implementation solutions across 15 countries were analyzed. For each solution, the following information was captured: type of program or initiative, main characteristics, when and how it was started, and where each is active (e.g., number of locations, education level covered, etc.). Any novel elements were identified, as well as strong alignment with trends in skills development.

In the review of implementation solutions in Section 4, a common framework is applied (and expressed in a table included in the Executive Summary) to enable comparisons of the education and training innovations that were identified. Examples include elements such as curriculum or the use of online platforms, the education method, and type of skills being developed.

The lessons learned and insights presented in Section 5 emerged from GFCC staff analysis, and were informed by the knowledge and experience of a group of experts and GFCC fellows.

2. Megatrends Affecting the Global Skills Landscape

The global skills landscape is changing. Transformations in the global economy, demographic shifts, accelerating technology advancement, and the COVID-19 pandemic are reshaping the skills needed in economies across the globe. In this section, some of these trends and their implications are reviewed.

2.1. Changes in the Demands for Skills — and the Challenges of Meeting Those Demands — Will Grow in the Transition to the Jobs of the Future

As the Digital Revolution has scaled, demand for computer professionals has increased dramatically and, as economies based on knowledge, technology, and innovation have expanded, skills in science, technology, engineering, and mathematics have become more important. For example, the U.S. Bureau of Labor Statistics projects that employment in computer occupations will increase by about 530,000 in the United States over 2019-2029, growing 11.5 percent. However, annual job openings will be higher — averaging about 362,000 — due to a combination of employment growth, and workers separating from jobs to find employment in other occupations or to leave the labor force entirely.

For many jobs, higher education will be needed. By 2025, around 48 percent of all job opportunities in Europe will require a higher education degree.[5] In the United States, by 2029, it is projected that 30 percent of jobs will be in occupations that require an associate's degree or higher.[6]

In the United States, over the past few years, there have been frequent reports of employers having difficulty in recruiting and hiring employees with the skills and experience they need. Areas of basic skill deficiencies include basic computer skills and mathematics, and applied skills such as critical thinking, problem-solving, professionalism, work ethic, leadership, and written communications.[7] Some four out of ten EU employers report having difficulty finding the right skills or talent, or filling jobs.[8] Emerging nations also report difficulties in filling skilled jobs, for example, Brazil,[9] Vietnam,[10] South Africa,[11] and Romania.[12]

The degree to which employers have difficulty in recruiting and hiring workers with the skills they need varies from industry to industry, city to city, country to country, and case to case. For example, in Europe, genuine skill shortages — where employers cannot fill a job vacancy because job applicants do not possess the required skills even though a competitive job offer is made — arise more in high-innovation and globally competitive sectors and occupations.[13] However, such imbalances do benefit some workers by raising the value of the skills in high demand and in short supply.

5 Cedefop 2018. Online available at: https://www.cedefop.europa.eu/files/3075_en.pdf.

6 Occupational Employment Projections 2019-2029 data set, Bureau of Labor Statistics, U.S. Department of Labor.

7 The New Talent Landscape, Recruiting Difficulty and Skills Shortages, Society for Human Resource Management, 2016.

8 Cedefop 2018. Online available at: https://www.cedefop.europa.eu/files/3075_en.pdf.

9 Estadão Conteúdo, 2019: Em um país com desemprego de 13%, sobram vagas na área de tecnologia. Revista Pequenas Empresas e Grandes Negócios. Online available at: https://revistapegn.globo.com/Startups/noticia/2019/05/pegn-em-um-pais-com-desemprego-de-13-sobram-vagas-na-area-de-tecnologia.html.

10 Montague, Alan, 2013: Vocational and skill shortages in Vietnamese manufacturing and service sectors, and some plausible solutions. Asia Pacific Journal of Human Resources vol. 51, 208-227.

11 Mateus, Antonio; Allen-ILE, Charles; Iwu, Chux, 2014: Skills Shortage in South Africa: Interrogating the Repertoire of Discussions. Mediterranean Journal of Social Sciences vol. 5. 63-77.

12 PwC 2019: The skills shortage generates total losses of over EUR 7 billion to Romanian private businesses. Online available at: https://www.pwc.ro/en/press-room/press-releases-2019/pwc-report--the-skills-shortage-generates-total-losses-of-over-e.html.

13 Cedefop 2018. Online available at: https://www.cedefop.europa.eu/files/3075_en.pdf

Labor markets work like other markets do, subject to price and requirement adjustments during fluctuations in supply and demand. And, just as in other markets, changes in supply and demand change the behavior of market actors. For example, recent research suggests that, in the United States, employers take advantage of high unemployment levels and elevate skill requirements for jobs for which they are recruiting — scaling up skill requirements in periods of higher unemployment, and scaling them down when labor markets are tighter.[14] In another example, in the United States, as the digital revolution has scaled and the demand for highly paid computer professionals increased, market signals have driven an increase in the number of students acquiring higher education degrees in computer science — from 5,228 in 1997 to 43,086 in 2018.[15] At the same time, IT-related education and training programming expanded dramatically in a wide variety of formats. Similarly, as Big Data has scaled over the past several years, degree attainment in fields of mathematics and statistics has steadily increased.[16]

2.2. Labor Markets Are Undergoing a Structural Transformation

Labor markets are constantly evolving, shaped by new technologies, new markets, the emergence of and growth of new industries and the decline of others, global competition, transformations in society, automation, and government policies and regulations that affect the economy. For example, new jobs have emerged that did not even exist a few years or a few decades ago — data scientist, social media influencer, drone pilot, customer experience manager, app developer, cloud engineer, YouTube editor, podcast producer, and others.

In addition to the long-term employment decline in manufacturing and rise of employment in services in many nations, three other long-term trends are driving transformations in the jobs and skills landscape: the rise of the experience economy, increased human longevity and, chief among all, rapid advances in technology. The first two are related to the mix of industries within economies and the types of jobs they require, while the latter trend cuts across all industries, sectors, and types of human activities.

The COVID-19 pandemic has affected some labor markets in the short-term. For example, it has driven scaling of the workforce in the home delivery sector, and devastated labor markets in the restaurant and hospitality industry. It remains unclear what the pandemic's long-term implications will be, but this event has deeply affected economies and job markets around the world.

The Experience Economy

As e-commerce has gained market share and disrupted the retail sector, many goods have become commoditized, increasingly abundant, and differentiation and consumer preferences are increasingly geared towards experiences. For example, since 2004, Americans have spent more on food purchases at restaurants and bars than at grocery stores.[17] Grocery stores have stepped up their game with wine bars, coffee shops, and in-store restaurants. In its values statement, one grocery chain described the customer experience it seeks to provide: "We continually experiment and innovate to offer a better customer experience. We create store environments that are inviting, fun, unique, comfortable, attractive, nurturing, and educational. Our stores are community meeting places where people can join

14 Modestino, Alicia Sasser; Shoag, Daniel; Ballance, Joshua, 2019: Upskilling: Do Employers Demand Greater Skill When Workers Are Plentiful? Proceedings of the American Economic Association Annual Meeting. Online available at: https://www.aeaweb.org/conference/2019/preliminary/1021.

15 Integrated Postsecondary Education Data System (IPEDS), U.S. Department of Education.

16 ibid.

17 Food Expenditure Series, Economic Research Service, U.S. Department of Agriculture, June 2020.

their friends and make new ones,"[18] while another states they have been "transforming grocery shopping into a welcoming journey full of discovery and fun..."[19]

In the United States, millennials have surpassed baby boomers as the largest living adult generation.[20] A recent Harris/EventBrite poll found that more than three in four U.S. millennials would choose to spend money on a desirable experience or event over buying something desirable. Nearly as many say they would like to increase their spending on experiences rather than physical things in the next year.[21] Growth in many "experience industries" has been significant. For example, in the United States, during 2009-2019, average annual growth in output[22] in arts, entertainment, and recreation, as well as accommodation and food services industries was higher than the annual average for all industries, and employment grew significantly, more than half a million for the former, and nearly three million for the latter. Prior to the COVID-19 pandemic, the U.S. Bureau of Labor Statistics projected that, between 2019-2029, these same industries would experience annual growth in output significantly higher than output growth in all industries, and increase employment significantly over the period (234,200 for the former and 881,400 for the latter).[23]

However, the COVID-19 pandemic delivered a serious blow to the experience economy — for example, curtailing dining in restaurants, closing theaters, cancelling sporting events and concerts, and slashing travel and hotel occupancy. In response, many of the experiences individuals consume are either being digitalized and decoupled from the physical world, or simply ceasing to exist. And it is unclear when or the degree to which these operations and activities will resume in full measure.

These experience-related industries are likely to recover and grow in the long-term — hiring more personnel, and demanding industry-specific skills and experience. But, the pandemic catalyzed the digitalization of experiences — from education to sports — with effects that may persist in the long-run.[24] A blended reality may emerge, with strong focus on skills at the intersection of digital and traditional experiences.

Human Longevity

Increased access to housing, sanitation, and healthcare — combined with dramatic improvements in disease prevention, medical treatments, and health technologies — have extended life expectancy and improved human wellness. Longevity creates a chain effect in health services: the more health services are available to people, the longer they are likely to live which, in turn, means they will require more health treatment and support of health professionals. As a result, countries and cities will need more health professionals.[25]

For example, as a consequence of Europe's aging population, employment in the EU's human health and social care sector is expected to increase by ten percent between 2020-2030, with rapid growth in Romania (47.4 percent), Greece (40.2 percent), Ireland (33.2 percent), and Cyprus (30.3); and more than 20 percent in several EU countries including Belgium, Slovakia, and Slovenia.[26] In the United States, the U.S. Bureau of Labor Statistics projects that, over 2019-2029, six of the top ten fastest growing occupations, and four of the top ten occupations that will have the largest job growth are healthcare occupations. A pre-pandemic modeling study showed global demand for health workers will increase to 80 million by 2030, but a 65 million healthcare worker supply. Almost all regions of the world would face inadequate pools of healthcare labor, with East Asia and Pacific, South Asia, and Latin American regions facing the greatest challenge. Countries in the upper-middle and lower-middle income groups would face significant challenges, as would countries with higher rates of economic growth and an aging population.[27]

2.3. Rapid Technology Advancement is the Chief Factor Driving the Need for Future Skills

Today, great revolutions in science and technology are converging on the global economy and society simultaneously — biotechnology, big data, nanotechnology, autonomous systems, and a new phase of the digital revolution characterized by vast deployment of sensors, the Internet of Things, and artificial intelligence, the apex technology of the next 50 years.

18 Whole Foods Mission and Values Statement.

19 About Us, Trader Joe's.

20 National Population by Characteristics: 2010-2019, U.S. Census Bureau.

21 Millennials: Fueling the Experience Economy, Harris Research on behalf of EventBrite, 2015. https://f.hubspotusercontent00.net/hubfs/8020908/DS01_Millenials%20Fueling%20the%20Experience%20Economy.pdf?__hstc=195498867.1cdb69fd52360d3464819074ea827a63.1614817902398.1614817902398.1614817902398.1&__hssc=195498867.1.1614817902398&__hsfp=1812308554.

22 Billions of chained 2012 dollars.

23 Employment and Output By Industry, Employment Projections 2019-2029, Bureau of Labor Statistics, U.S. Department of Labor, September 2020.

24 The Tour de France Goes Virtual, as E-cycling Takes Off During Quarantine, FastCompany, June 29,2020.

25 The Future of Work in America: People and Places, Today and Tomorrow. McKinsey Global Institute, 2019. Online available at: https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Future%20of%20Organizations/The%20future%20of%20work%20in%20America%20People%20and%20places%20today%20and%20tomorrow/The-Future-of-Work-in-America-Full-Report.ashx.

26 Skills Panorama, Health and Social Care, Future Employment Growth, Cedefop.

27 Liu, J.X., Goryakin, Y., Maeda, A. et al. Global Health Workforce Labor Market Projections for 2030, Human Resources for Health 15, 11 (2017). https://doi.org/10.1186/s12960-017-0187-2.

These technologies will have significant impact on industry, labor markets, occupations, and skills. For example, autonomous systems such as robots are already teaming with workers on the job. Artificial intelligence is likely to affect portions of almost all jobs, change the tasks performed, the way work is organized, and the way decisions are made and problems solved. As these new technologies scale and are deployed across the economy, they will bring about a need for new skills, reskilling, and upskilling, and at a pace that matches technological change. A recent European Union survey found that 43 percent of employees in Europe have already experienced changes in the technologies they use at work, and about one in five considers it very likely that several of their skills will become outdated in the next five years.

Digital Technologies

Digital technologies are now fundamentally integrated into every aspect of human existence — defense, the economy, every industry, heathcare, education, all aspects of communications, critical infrastructure, transportation, personal living, and more. This vast digitalization is having massive impact on the skills required in all sectors, and changing the occupational mix in many manufacturing and service industries. For example, a skills forecast by the European Center for the Development of Vocational Training reports that, by 2025, 85 percent of all EU jobs will need at least a basic digital skills level.

Manufacturing Transformation

Manufacturing is the engine of economic growth for many economies around the world, and a main vehicle for economic development in emerging economies. Now, a rapid transformation is underway in the way we conceive, design, make, and distribute things. This transformation of manufacturing is not simply from advancements in a single technology, but rather from the convergence of different technologies:

- Biomanufacturing is on the rise. A recent study suggests as much as 60 percent of the physical inputs to the global economy could be produced biologically — one-third biological materials, and two thirds produced using biological processes, for example bioplastics.[28]
- Nanotechnology is being applied to create materials and coatings with novel properties, and for development of advanced microelectronics, while 3-D printing is enabling the production of objects and shapes that were previously physically impossible.
- Collaborative teaming of humans and smart robots will reduce manufacturing costs, increase quality, and provide quick response to changing customer demands. Advanced robotic systems that are flexible and perform multiple tasks will reduce capital investment by eliminating the need for several special-purpose tools. Robot-based production systems can also enable efficient batch-of-one production for mass customization.
- Manufacturing operations are becoming inextricably linked to data, information, and digital networks. Digital design and manufacturing distributes the information needed to transform designs and raw materials into products, creating a highly connected industrial enterprise that can span multiple companies within a supply chain. Smart manufacturing senses and corrects anomalies to ensure product uniformity and quality. The Internet of Things is weaving a complex web of controllers, machines, facilities, fleets, and people to sensors, networks and controls, enabling an integrated, information-intensive system, and production and supply chain systems optimization.

Automation

Automation has already eliminated many middle-skill jobs that have supported a middle-class lifestyle. For example, in manufacturing, automation has eliminated many routine assembly jobs; in the United States, fewer than 40 percent of workers in U.S. manufacturing establishments are now directly engaged in production.[29] And many of the jobs that remain in manufacturing require greater education and skills.

There is little consensus on how many jobs could be automated in the years ahead. One review showed dramatically different predictions about jobs that automation could create and destroy, for example, with estimates for job losses in the United States ranging from 3.4 million by 2025 to 80 million by 2035.[30] But the studies also indicated that millions of new jobs would be created. As some jobs are eliminated, new ones created, and other jobs transformed by technology, old skills will become obsolete, and many workers will be required to acquire new skills.

28 The Bio Revolution: Innovations Transforming Economies, Societies, and Our Lives, McKinsey Global Institute, May 2020.

29 U.S. Manufacturing in International Perspective, Congressional Research Service, March 17, 2015.

30 Every Study We Could Find on What Automation Will Do to Jobs, in One Chart, MIT Technology Review, January 25, 2018.

2.4. A New Blend of Hard and Soft Skills Will be Needed

Hard Skills

Most workers already use digital technologies to some degree to implement or support business processes, from billing, group communications, and project management to community engagement, basic office routines, and engineering tasks. The use of digital technologies for both blue and white collar workers is likely to increase in the years to come, although not everyone will be required to create software or control digital hardware.

For example, a survey of manufacturing executives identified five types of skills needed to succeed in the so-called Fourth Industrial Revolution: (1) digital skills, (2) technology and computer skills, (3) working with tools and techniques, (4) programming skills for robots and automation, and (5) critical thinking.[31] In skill sets 1-4, there are different levels of expertise that may be needed, for example, using software vs. writing code to create it. The digital and technology-related skills required for operators using machines on the shop floor are different from those necessary for engineers who design such machines.[32]

A four level framework is useful for understanding different levels of digital skills needed in the evolving workplace:

1. Ability to use digital technologies to execute general business processes
2. Ability to use digital technologies to execute specific technical functions
3. Ability to program, maintain, adjust, setup, train and/or analyze digital artifacts
4. Ability to develop and create digital technologies and artifacts

All workers can be expected to be able to use digital technologies to execute general business processes; that is, to cover level one, which is likely to be function (manufacturing, sales, finance, etc.) and job agnostic. The sophistication of skills and their STEM requirements grow from level 1 to 4. Unlike level 1, the content of skills in levels 2-4 depends on the particular function and job — the tools used are specific. For example, operators on the shop floor will increasingly be required to use digital technologies to execute specific technical functions and program, maintain, and adjust digital artifacts — either software

BOX 1

The Global COVID-19 Pandemic is Speeding Things Up and Requiring New Skills for Many

In one of the COVID-19 pandemic's most dramatic effects, governments issued resident lockdown orders, offices around the world were shuttered, and hundreds of millions of workers transitioned to telework, an organizational shift without precedent. This kind of transformation in the economy would normally take decades, but occurred in just a few weeks. This shift to remote work, made possible by digital technologies, allowed many companies to remain active and in business. But with the lockdowns and shift to telework came new skill challenges.

First, the importance of digital skills increased across the economy and society, and became indispensable in life — from acquiring household supplies and communicating with family to getting an education and seeing a doctor. Many people got an entry-level digital skills crash course when required to use online platforms and other tools — the "hard skills" part of the equation.

The second part of the skills equation is how we use those tools during work — "soft skills." With workers disbursed, patterns of communication began to change to maintain performance in the disrupted environment. In a study of more than three million users of digital communications in 16 metropolitan areas around the world, compared to pre-COVID lockdown levels, workers are having more meetings, virtually, and bigger meetings. They are sending their co-workers more emails, and individual emails have more addressees. More frequent meetings and more people in the loop are likely to have been needed to coordinate and rapidly reconstruct work processes for a virtual operation. Managing a team from afar is a different skill than managing in a physical location, and staying in touch with project teammates is more of a task in a virtual work space than a physical one.

31 Deloitte Insights / Manufacturing Institute 2018. Online available at: https://www2.deloitte.com/us/en/pages/manufacturing/articles/future-of-manufacturing-skills-gap-study.html.

32 Wellener, Paul; Dollar, Ben; Ashton Manolian, Heather; Monck, Luke; Hussain, Aijaz, 2020: The future of work in manufacturing: What will jobs look like in the digital era? Online available at: https://www2.deloitte.com/us/en/insights/industry/manufacturing/future-of-work-manufacturing-jobs-in-digital-era.html#personas.

or hardware — while only people in engineering and development functions are likely to be called on to create new technologies using sophisticated digital design tools.

Soft Skills

As automation of routine tasks increases, the ability to perform non-routine work and complex tasks becomes more important in securing employment.[33] Also, employers are embracing new organizational forms such as work in multidisciplinary teams, management approaches that increase worker autonomy, and serving a diverse global customer base. These developments have increased the need for advanced cognitive skills such as critical thinking and problem-solving; socio-behavioral skills such as engaging with clients, and collaboration in complex working environments; and skill combinations associated with the adaptability needed in careers characterized by non-routine work and technical change, such as creating new solutions and continuous learning.[34] The need for soft skills is even more pronounced in emerging economies, where business protocols and practices — and the soft skills that enable those — that are widely adopted in advanced economies are not fully disseminated, constraining the workforce readiness to engage in global business and work for global corporations.

Employers Need Both Hard and Soft Skills

In the GFCC survey of members and fellows, 30 respondents from South America, North America, Europe, the Middle East and North Africa, and Asia rated a variety of soft and hard skills according to their importance. There was consensus that a combination of soft and digital hard skills is required. The main skills priorities were: (1) creative and innovative mindset, (2) emotional and social intelligence, (3) flexibility, (4) ability to work in a group and team spirit, (5) digital literacy, (6) big data analysis, and (6) coding.

For example, advanced manufacturing requires a mix of soft and hard skills. Workers who can use specific digital tools such as robots, software, data interfaces, and networks are needed. But also needed are workers who can integrate different tools into work processes; apply data and knowledge from different sources; collaborate with colleagues in complex processes such as planning; solve problems; engage with customers; conduct performance evaluations; perform failure analyses; lead continuous improvement processes; and participate in new product development and introduction.

2.5. Rapid Technology Advancement and Turbulent Labor Markets Require Greater Flexibility in Education and Training Systems

The rapid advancement of technologies poses a challenge to skills training programs, and to formal education systems that seek to provide some foundational level of occupational or workforce skills, for example in high school industrial arts and computer science classes, or in higher education programs that seek to make their graduates more workforce ready. For instance, the demand for skills in artificial intelligence and machine learning is now expanding beyond the realm of research specialists; the demand for skills in sustainable production has grown along with corporate social responsibility initiatives and commitments to address climate change; and the demand for skills in data science and data analytics has soared with the exponential growth of ecommerce and digital consumption, and the widespread deployment of sensors and "smart" technologies. None of these skills were in significant demand a decade or so ago.

The skills and training required for jobs are ever-changing and need to be met with new curricula, teaching methods, and industry engagement. In addition, individuals already in the workforce increasingly must update their skill portfolios, and some must acquire new occupational skills if they change jobs, change industries, or their skills become obsolete due to automation. Many adult learners work part time or full time, have dependents, and many responsibilities that compete for their time, energy, and financial resources. These workers need education and training options that can accommodate their adult and working lives.

Static education and training systems face more challenges in keeping pace with advances in technology, changing labor markets, and the demand for new skills. When national education systems are slow in reacting to changes in the demand for expertise and skills, new opportunities for individual training and education providers arise. This report features cases found around the globe that provide good examples of how a demand that was not filled by existing formal education institutions is being filled (see Coding Dojo, Ecole 42, etc.).

33 Work: Thriving in a Turbulent, Technological and Transformed Global Economy, Council on Competitiveness, 2016; How Computerized Work and Globalization Shape Human Skill Demands, Frank Levy, MIT and Richard Murnane, Harvard University, 2006.

34 World Bank Group, 2019: World Development Report; Deloitte Insights / Manufacturing Institute 2018. Online available at: https://www2.deloitte.com/us/en/pages/manufacturing/articles/future-of-manufacturing-skills-gap-study.html.

The cases described in this report still rely on a certain basic level of education — a foundation that is laid in K-12 education. An inflexible K-12 education system provides graduates that are taught in a way that may not match the teaching and training methods used in the innovative training initiatives described in this report, while a more flexible education system may be able to provide a better prepared group of graduates, even before the vocational and/or academic training and industry engagement begins. Also, the education systems in some countries allow students to switch their learning paths from a more academic track to a vocational path and vice versa to varying degrees. For example, Argentina, Austria, Australia, Brazil, Canada, Germany, the Netherlands, New Zealand, and the U.K. provide opportunities for students to switch between different schools and career tracks.

In addition, despite the increasing number of workers that must keep their knowledge and skills up-to-date, the practice and policies of many institutions in the higher education system continue to favor traditional, financially dependent 18 to 21 year old high school graduates who enroll full time. Some of the cases presented in the report describe programs that target mid-career professionals and accommodate participants' schedules.

3. National Skills Development Initiatives

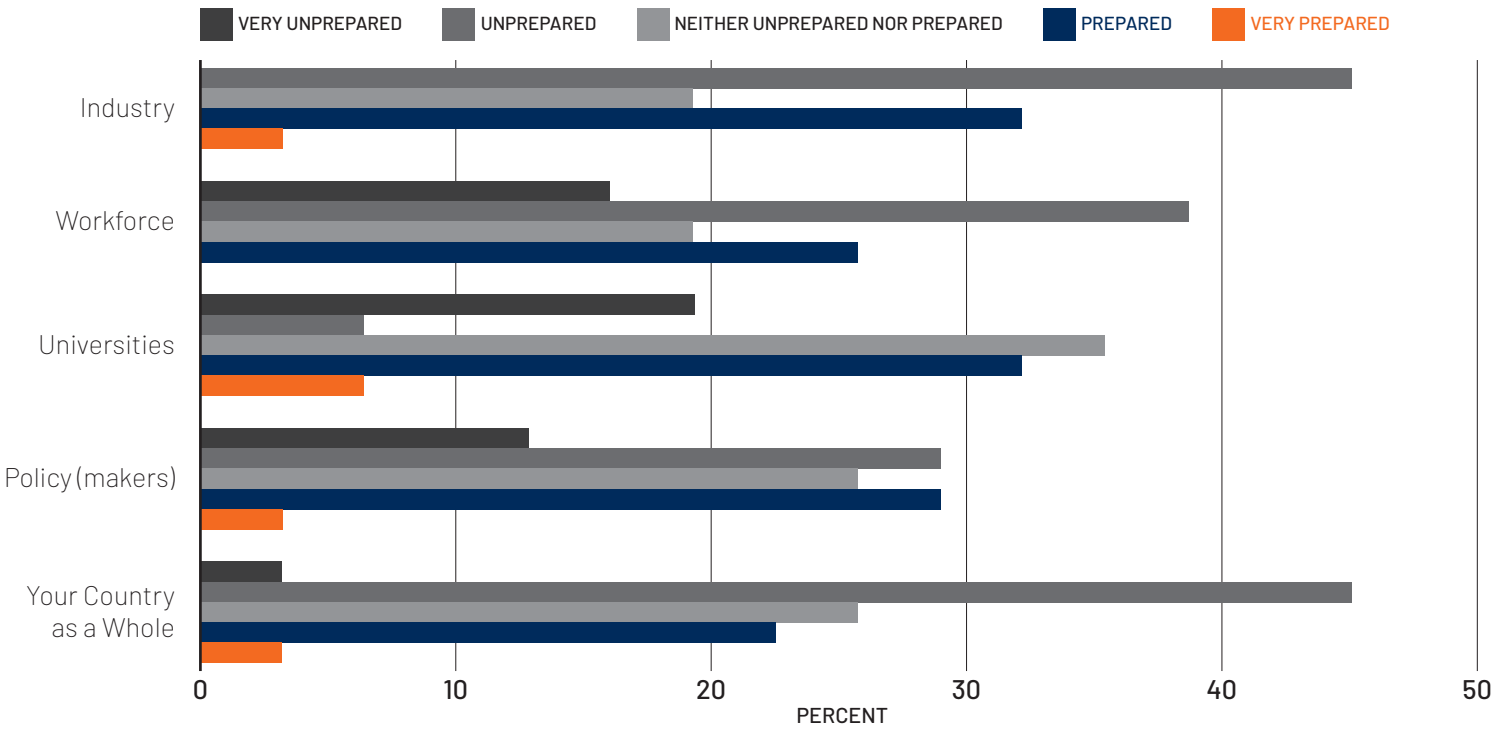
3.1. National Skill Preparedness

The challenge of meeting rising skill requirements in knowledge and technology-based industries and economies is increasingly among the top priorities for governments, businesses, labor organizations, educators, and research institutions at the city, regional, and national levels, as well as international organizations.

In the GFCC survey of its members and fellows, many respondents believe that their countries are not adequately prepared to incorporate digital and other advanced technologies in production systems, services, and work processes. Almost 50 percent of respondents stated that their countries are unprepared or very unprepared to adopt advanced technologies, and none of them believe that the workforce is fully prepared.

Figure 1. Preparedness to Adopt Advanced Technologies

Source: GFCC Future Skills Survey



It is interesting to note that, despite an earned reputation in many countries for their resistance to change, the university sector is relatively reputed as the most prepared to adopt advanced technologies. However, respondents to the GFCC survey of members and fellows frequently indicated that universities were "very unprepared" or "unprepared." This suggests how hard it is to navigate a period of transition in technology and education models. Finally, according to the survey, policy makers rank toward the low end of the preparedness scale, even though government's capabilities are critical in a period of major economic and technological change.

3.2. National Skills Initiatives

Governments, businesses, and other national organizations are concerned about skills because human capital is fundamental to the economy and national competitiveness. For example, organizations such as the Council on Competitiveness call for the design and implementation of a "National Skills Agenda" and a "National Skills Investment Plan,"[35] while the World Bank articulates why a government role in skills development is needed:[36]

> "Individuals and families often cannot afford the costs of acquiring human capital. Even when human capital investments are affordable, individual decisions may be shaped by lack of information, or restricted because of the prevalent social norms. Individuals also do not necessarily consider the wider social benefits for others. For these reasons, governments have an important role to play in fostering human capital acquisition."

Different countries have commissioned studies, created bodies, and/or launched national initiatives to address the changes in skills requirements. For example, France created a national research network to foresee skills needs;[37] in Australia, the Council of Australian Governments implemented the Australian Industry and Skills Council,[38] and an Industry and Skills Committee;[39] the German Government expanded the existing adult education and vocational training offered, and started a National Skills Strategy, developed jointly by the Federal Ministry of Labour and Social Affairs, and Federal Ministry of Education and Research; and, in 2008, the United Kingdom established a Commission for Employment and Skills, a non-departmental public body that provided advice on skills and employment policy to the U.K. Government until 2017 and published a foresight study on jobs and skills needs.[40]

Canada and Singapore are very different countries. One has continental dimensions, a diverse economy — strong in natural resources, food production, and manufacturing — and almost 40 million inhabitants, while the other is a city-state, with less than 6 million inhabitants and a sophisticated post-industrial economy that is globally competitive in advanced microelectronics. Despite their differences, both have an advanced, knowledge-oriented economy and have pioneered national-level initiatives focused on the supply of future skills.

In 2019, Canada launched a government-funded Future Skills Centre (Box 2), which organized test-beds for new models of skills development. These impact workers and employers, and serve as sources of learning and insights. To date, the Centre has funded 24 projects. Singapore's government-funded Skillsfuture Program (Box 3) is governed by the public-private Future Economy Council, which provides solutions to professionals, other workers, employers, and the Singaporean society at large.

Malaysia adopted a different approach. Building on the foresight capabilities of GFCC member Malaysian Industry-Government Group for Hight-Technology (MIGHT), the country has been convening Cabinet-level leaders and using the findings of a study on the "Future of Work" to inform strategic conversations and the design of new policy initiatives, such as the National Industry 4.0 Policy (Box 4).

In the GFCC survey of its members and fellows, respondents identified European countries, especially Northern European countries, as benchmarks and models in the state of skills development around the globe. Northern European countries invest significant amounts in adult training in relation to their GDP — 1.4 percent in the Netherlands, 2 percent in Germany, and 3 percent in Sweden.[41] In addition to this investment, two characteristics of the Northern European approach stand out: the joint government-industry-labor governance scheme for adult training, and the prevalence of dual education systems.[42]

35 Work: Thriving in a Turbulent, Technological and Transformed Global Economy, Council on Competitiveness, 2016 Online available at: https://www.compete.org/storage/WORK_Full_Report.pdf.

36 World Development Report, World Bank Group, 2019.

37 France Strategie — Réseau Emplois Compétences — https://www.strategie.gouv.fr/projets/reseau-emplois-competences.

38 Council of Australian Governments (COAG) Industry and Skills Council (CISC) — https://www.industry.gov.au/about-us/what-we-do/council-of-australian-governments-industry-and-skills-council.

39 Australian Committee — https://www.aisc.net.au/.

40 UK Commission for Employment and Skills; The Centre for Research in Futures and Innovation; Z_punkt, 2017:The Future of Work Jobs and Skills in 2030. Online available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/303334/er84-the-future-of-work-evidence-report.pdf.

41 Jacobs, Antoine T. J. M., 2020: Labour Law in the Netherlands, 3rd Edition. Wolters Kluver.

42 Niranjan, Ajit, 2018: What is Germany's dual education system — and why do other countries want it? Deutsche Welle. Online available at: https://p.dw.com/p/2u0ts.

BOX 2

National Initiative Spotlight: Canada's Future Skills Center

Launched in 2019, Canada's Future Skills Centre is based in Toronto and operated as a partnership between Blueprint, Ryerson University, and The Conference Board of Canada. It is overseen by an Advisory Board, composed of Canadian business, non-profit, union, and education leaders. The Centre is expected to receive 155 million USD in funding from the Government of Canada over four years (2019-2022) and 51 million USD thereafter to fulfill its mission.

The Centre's model combines innovative projects, research, and engagement. It seeks to help Canadians make informed training decisions and gain skills they need to succeed in the changing labor market and workplace. It developed evidence-based recommendations emerging from analysis of the innovative skills development projects, and shares those recommendations, results, and best practices with citizens, companies, educators, policymakers, and other stakeholders.

The Centre launched a first call for projects in 2019. Each project selected receives an average annual budget of 430,000 USD for two years to serve about 500 people. It currently has 16 projects testing innovative approaches to skill acquisition operating in all Canadian provinces. Each projects is, simultaneously, an initiative aligned with the needs of third party partners, an experiment, and a source of insights and lessoned learned that will be shared with others. The Centre's also analyzes trends in skills and skills development.

To learn more:
Future Skills Center

Government of Canada Future Skills Centre

Future Skills Center Innovation Projects

Future Skills Center "Evaluation is at the Heart of the Future Skills Center Innovation Projects"

Betakit "Future Skills Centre Investing $7.65 Million in 10 Skills Development Projects"

BOX 3

National Initiative Spotlight: Singapore's Skills Future Singapore

Launched in 2014, SkillsFuture Singapore strives to develop a highly-skilled workforce across all ages of Singaporeans. The program is funded by the Government of Singapore, pooling funds from the Ministries of Education, Manpower, and Trade and Industry. SkillsFuture is overseen by a Future Economy Council, chaired by the Deputy Prime Minister and Minister for Finance Heng Swee Keat, and composed of 33 members including government ministers, leaders of labor and business organizations, university presidents, and private firms.

SkillsFuture has four goals: inform individuals' choices about their education, training, and careers; develop training that responds to constantly evolving needs; promote employer recognition of skills and mastery; and foster a culture that celebrates lifelong learning.

SkillsFuture estimates that 500,000 individuals and 14,000 entities benefitted from their programs and linkages in 2019 alone, with the top three areas of training in information and communications technology, food and beverage, and productivity and innovation. Interest has also been high in skill areas such as urban solutions, data analytics, and advanced manufacturing, SkillsFuture does not prescribe any path for workers to take. Instead, it provides information and opportunities to those who want them, leaving it up to workers to execute their skill and career development goals in their own way. This unique approach requires a myriad programs, including work-study programs, internships, connections with mentors, and links to corporate leadership programs. To maximize access to this broad base of programs, SkillsFuture maintains a cloud-based portal providing access for anyone seeking to take advantage of their programming.

To learn more:
Singapore Government Skills Future

Singapore Government Ministry of Manpower Skills Future

Singapore Government Skills Future FEC Members

The Business Times "Skills Future Council Members Announced"

Singapore Government About Skills Future

"500,000 Individuals and 14,000 Enterprises Benefitted From SkillsFuture Programmes in 2019"

Singapore Government My Skills Future

Germany and its companies are at the forefront of the drive toward Industry 4.0 — the concept crafted in collaboration among the German government and industry. In addition, Germany's training system is considered by many as a global benchmark.

Germany's recently launched National Skills Strategy is taking steps to supply its economy with the skills that will be needed in the future.[43]

There is no one-size-fits-all model for skills development; continuous learning and adaptation are key for the evolution of any program. The diverse approaches featured in this section of the report highlight a diverse set of program characteristics to consider in program design and implementation:

- Canada's Future Skills Center combines **action and experimentation** at the micro level with **institutional learning** at the macro policy-making level. Its addresses and draws lessons from a variety of local realities.
- Singapore's Skills Future was established and is governed as national program, focusing on the provision of solutions to individual citizens. **Citizen are empowered for the future economy**.
- Malaysia's use of **foresight to guide policy design for training and education** is a distinctive characteristic. It underscores the notion that government and industry should collaborate to build the capabilities that will be needed in the economy, rather than simply reacting to the needs for skills as they emerge.

BOX 4

The Future of Work and the Fourth Industrial Revolution in Malaysia

By Rushdi Abdul Rahim, Senior Vice President, MIGHT

In 2017, a report on the Future of Work — Work, Workplace, Workforce — was presented to selected cabinet ministers during Malaysia's National Science Council meeting chaired by the Prime Minister. The overarching theme of the Future of Work report was the need to ensure national preparedness for the changing economic landscape by addressing the implications of rapid technological development, diffusion, and digitalization. This includes benefits and opportunities such as mastering new skills and technologies, creating new industries and new sources of economic growth, building knowledgeable communities, increasing productivity and efficiency, maintaining social cohesion, and ensuring equitable and sustainable development. Focus was also paid to mitigating risks and threats of major job displacement and industrial downturn, societal collapse, compromised national sovereignty and security, and the nation being left behind.

According to the *2016 Global Manufacturing Competitiveness Index* — published by Deloitte Touche Tohmatsu Limited and the Council on Competitiveness, USA — Malaysia is ranked 17th and projected to climb four places to 13th by the end of 2020. In the readiness for the Future of Production Report, Malaysia ranks among the top 20 nations. However, in today's globally competitive environment and era of rapid advances in technology, strategies and initiatives to ensure future competitiveness, economic growth, productivity, and higher skilled employment opportunities are needed, prompting Malaysia's Ministry of International Trade & Industry to craft a strategic framework for Industry 4.0. The framework's focus areas include attracting stakeholders, and creating an ecosystem for Industry 4.0 to drive adoption of smart manufacturing across industry. The framework has three guiding principles:

- First, communicate the government's intent and purpose — an initiative to create a national platform and consolidate industry's efforts under a flagship program backed by the government.
- Second, motivate participation from various stakeholders — an initiative that demonstrates the government's commitment to providing a wide range of support for Malaysian companies.
- Third, be inclusive and do not appeal only to specific or select industries.

The initiative's economic and competitiveness goals can only be attained if the necessary skill set is in place. Industry4WRD — National Industry 4.0 Policy — was launched in 2018 as a direct result of the MIGHT's Future of Work report. This program is focused on training and development to equip future talent with the necessary skills for the future of work, and retraining existing talent. There continues to be many other skills development initiatives under this policy that are being carried out by leveraging existing organizations, vocational institutes, and skills development centers.

To learn more:
MIGHT, 2017: Future of Work. MyForesight — Malaysia's National Foresight Magazine, 02/2017.

Malaysia Ministry of International Trade and Industry Industry4WRD: National Policy on Industry 4.0

43 German Federal Ministry of Labor and Social Affairs and the Federal Ministry of Education and Research, 2018: National Skills Strategy — continuing education and training as a response to digital transformation. https://www.bmas.de/SharedDocs/Downloads/EN/Topics/Initial-and-Continuing-Training/national-skills-strategy.pdf?__blob=publicationFile&v=6.

BOX 5

Highlights of Other National Initiatives: France, Austria, Japan, Korea

France: Under the cabinet of President Emmanuel Macron, the Ministry of Labor has put in place a national initiative that encourages re- and upskilling of the French labor force. Research suggests 10-20 percent of French jobs are at risk for automation, while more than 200,000 job vacancies went unfilled in 2018. To close the skills gap, since January 2020, the French government provides every worker the opportunity to spend up to 5,000 EUR on training and education over the course of their career, and 8,000 EUR for workers with no prior professional skills. Employers are required to provide paid leave for these courses. These measures come on top of an annual 32 billion EUR spending program to train one million jobless and one million school dropouts over the next five years.

Austria: The Education Account provides workers with the opportunity to apply for co-funding for educational and training courses. Depending on the education and training level of the workers, between 30-60 percent, and a maximum of 2,400 EUR of training costs are covered by the government grant.

Japan: Education and training initiatives have been mostly focused on older workers seeking to transition between industries. Silver Human Resource Centers focus on workers in the 60+ age group who are either unemployed or want to make late-in-life career changes. In recent years and in light of an increased skills gap, similar education and training initiatives have been expanded to more workers of various age groups.

Korea: To reduce the financial burden of continuous education and vocational training on households, the Korean government introduced several policies to limit the costs and tuition fees for students of all ages.

To learn more:

Pour l'école de la confiance

Bildungskonto: Geld für Weiterbildung

Addressing the Challenges of Population Ageing in Asia and the Pacific (pdf)

Education Policy Outlook: Korea (pdf)

- Germany's focus has been on **cross sector and public-private cooperation**. Innovative policies, such as the *Kurzarbeit* (Box 6), embed skills development into labor regulation, and provide incentives for the counter-cyclical adjustment of the stocks of skills in the economy.
- In Canada, Germany, and Singapore, initiatives have an explicit focus on re-skilling and up-skilling the **incumbent workforce**.

BOX 6

Employment and Skills in COVID-19 Times: Germany

Unemployment rates have risen across the globe, however, the degree to which economies have been affected varies greatly. While unemployment in the United States jumped from 4.4 percent in March 2020 to 14.8 percent in April 2020, Germany experienced an unemployment increase from 5.1 percent to 5.8 percent over the same period.

Germany uses a policy instrument called "Kurzarbeit" — translated as "short work" — which allows companies to keep the majority of their employees during a crisis, but reduce their work hours. Workers' lost income is replaced by as much as 60 percent or more depending on the duration of the crisis, enabling employees to retain 80 percent of their salaries. The income replacement is paid by funds collected from corporate tax payments. Employees are encouraged to spend the extra time in training and education — a win-win for employers and workers: companies do not have to invest time and money to train new workers after a crisis and have a more skilled workforce, and workers can continue to support their families and do not fall into unemployment, saving taxpayer money.

4. Innovative Skills Implementation Solutions

In the survey of GFCC members and fellows, two broad categories of skills in demand emerged: (1) skills required across sectors and industries, and (2) skills needed for specific sectors or industries, or have specific content related to those sectors and industries.

This section of the report is focused primarily on cross sector and cross industry skills — those needed in the economy as a whole. However, it is important to recognize the need for sector and industry specific skills. The GFCC members and fellows surveyed ranked information technology, logistics, and manufacturing as key industries facing skill challenges. For example, technology life cycles in the information technology industry are short, requiring workers to frequently learn new programming languages. And a host of technologies — from robots, the Internet of Things, and high performance computing to biotechnology, nanotechnology, and artificial intelligence — is transforming manufacturing and the sector's skill requirements. As such, this section also includes several initiatives focused on sector- and industry-specific skills.

Different countries, regions, cities, industries, and businesses are responding to the need for skills and qualifications in different ways. This reports examines case examples that span a variety program aims, education levels, and nations — from advanced to developing countries. These initiatives are all directly training people and developing skills, and are referred to in this report as "implementation solutions," distinguishing them from policy frameworks or strategies.

More than 30 implementation solutions were analyzed across 15 countries: Australia, Cambodia, Canada, Chile, Denmark, Finland, France, Germany, Israel, Mexico, New Zealand, Portugal, Sweden, the United Kingdom, and the United States. Several trends were apparent:

Demand for Skills

Cross Sector and Industry Skills

- Basic digital skills
- Soft skills

Sector- and Industry-Specific Skills

- Skills for industries that grow
- Specific digital skills

- The past decade experienced a proliferation of learning enterprises that aim to increase digital literacy, entrepreneurial skills, and professional upskilling. Most of the cases presented in the report describe programs that are relatively recent — about 70 percent of the programs analyzed by the GFCC were founded after 2010.
- Information technology, data science, engineering, and technology are key areas of program focus. A significant number of solutions involve programs that teach coding and programming languages (see the "digital and innovation schools" category below).
- Developing hard skills is at the core of 68 percent of cases presented.
- A blended learning method that improves technical expertise while also developing soft skills — such teamwork, creativity, resilience, and leadership — is also common in the cases presented.

The cases presented were selected based on GFCC research and inputs coming from the GFCC network. However, the cases presented do not cover the entire spectrum of solutions in the skills development arena, but rather provide a snapshot of important emerging developments and trends.

Fire Tech residential camp.

The implementation solutions presented vary in audience, type of skill needs they address, scale of effort, and methodologies they adopt. They focus on the development of soft and hard skills, and aim to develop both cross-sector and cross-industry skills, as well as sector- and industry-specific skills.

The cases present in this report are grouped into five categories:

1. **Youth education:** Programs and schools focused on developing technology and soft skills before students reach higher education.
2. **Digital schools:** Schools dedicated to training people in digital technologies and their use in business.
3. **Degree institutions:** Innovative higher education institutions and/or programs, especially in engineering and technology fields.
4. **Professional schools:** Initiatives focused on people who are in the workforce and aim to upskill or reskill, and connecting them with real demands in job markets.
5. **Economic development:** Initiatives that typically resulted from industry and government partnerships, and aim to foster economic development through workforce upskilling and the creation of employment opportunities.

4.1. Youth Education

The six cases presented in this section describe youth education programs in four countries: the U.K., Cambodia, Denmark, and Israel. They provide students with important skills early on in their lives — whether they be soft skills such as leadership, teamwork, and entrepreneurial spirit or hard skills such as design, marketing, finance, budgeting or coding. Some schools and programs in this category feature industry collaborations, which provide students a unique opportunity to learn from industry specialists, engage early on in real-world projects, and test their ideas with an audience of real-world experts. Some of the initiatives allow students to start to build a professional portfolio while still in K-12.

4.1.1. Fire Tech

www.firetechcamp.com
London, UK

Fire Tech offers experiential technology training to children aged nine to seventeen in the United Kingdom, Australia, and Oman, using in-person and online delivery methods.

Innovation
Fire Tech was one of the first companies in the world to offer programs to train children in technology. All programs follow the experiential learning method and, more recently, the company started to implement programs that allow students to engage in "real life" projects.

Innovation Areas	
✓ Curriculum	Material
✓ Education method	Online platform
✓ Industry engagement	Physical infrastructure
Organizational setup	✓ Skill type

In 2013, entrepreneur Jill Hodges could not find any courses to satisfy her two tech-enthused kids. Facing a widening skills gap in an increasing technology-based world, she founded Fire Tech to inspire children in a creative and supportive environment, and lay the groundwork for more advanced training later in life.

Líger Leadership Academy.

Fire Tech offers tech camps to children aged 9-17 in the United Kingdom, including day camps, weekend clubs, and full-time residential camps. Its model focuses on project-based learning, problem solving, and creative skills.[44] Fire Tech camps offer hands-on learning year-round, and include more than 30 different courses in a wide variety of areas including robotics, coding, electronics, and creativity. The camps maintain a large staff to work directly with students, with an 8:1 student-to-tutor ratio.[45] All tutors are trained and background checked by Fire Tech.

While Fire Tech is a for-profit company, they do offer scholarships to cover course fees, as well as courses sponsored by government organizations, charities, and corporations. For example, the Amazon Future Engineers Partnership has made Fire Tech courses available to more than 5,000 primary school students across the United Kingdom.[46]

As of 2020, Fire Tech reports that its courses have reached more than 70,000 students during camps held in London, Surrey, Reading, and Manchester, and more than 20 other locations. A limited number of courses are available through online instruction. Now, Fire Tech has begun to expand its learning opportunities to other states in Europe, Australia, the Caribbean, and the Middle East.

4.1.2. Líger Leadership Academy

www.ligeracademy.org
Phnom Penh, Cambodia

Líger Leadership Academy is a non-profit boarding school that offers an experiential, entrepreneurship-focused curriculum to a highly selected group of students in Cambodia.

Innovation

Líger's curriculum is heavily experiential and project-based, and encourages individual initiative and entrepreneurship in one of the least developed countries in the world. It provides a tailored education to students, based on projects.

Innovation Areas	
✓ Curriculum	Material
✓ Education method	Online platform
Industry engagement	Physical infrastructure
Organizational setup	✓ Skill type

44 https://www.firetechcamp.com/.

45 https://www.firetechcamp.com/about/.

46 https://amazon.firetechcamp.com/.

Ørestad Gymnasium.

Líger Leadership Academy is a not-for-profit school in Phnom Penh, Cambodia, founded in 2012 by two entrepreneurs, Trevor Gile and Agnieszka Tynkiewicz-Gile. It provides entrepreneurial education for economically disadvantaged children aged 11-18 years old. The Academy's educational model aims to develop leaders who are game-changers and lead social and economic development in the country. From an early age, kids engage in project-based learning connected with real problems that affect the Cambodian population. Students receive incentives to find solutions and act for the benefit of local people.

The Academy enrolls 110 students, selected from a recruiting process that screens 12,000 Cambodians in the country's 25 provinces. It takes up to two years to find between 50-60 candidates. Recruitment involves seven rounds, testing different abilities and skills beyond academic knowledge, such as leadership, enthusiasm, ingenuity, and determination. The school operates as a residential campus, and all pupils receive a full scholarship that covers tuition, housing, health care, school supplies, and transportation.

The teaching program takes six to eight years, and is tailored to accommodate individual interests. Senior students can engage in expertise learning in their area of interest or sign up for a long-term enterprise that takes up to two years. The school also teaches English and Khmer literacy, math, and science. Líger adopts a design-thinking approach that encourages students to research and analyze problems in depth, brainstorm ideas, and plan and implement solutions to real-life challenges.

Students have participated in a business model competition, published a book about the country's geography, and taught local communities about dengue fever prevention and the importance of garbage composting. All students have participated in real or simulated start-ups. And 95 percent of female pupils have competed in global coding competitions. There is an ongoing study on scaling up the program and exporting the model to other countries.

4.1.3. Ørestad Gymnasium

www.oerestadgym.dk
Copenhagen, Denmark

Ørestad Gymnasium is a Danish high school located in Copenhagen. It enrolls more than 1,000 students ages 16-19. It specializes in educating students interested in careers in media, communications, and culture, and emphasizes digital learning.

Innovation

The school is entirely digital — all learning materials and assignments are online. In addition, the school's architectural design — an open-plan model with few closed-off spaces — is supposed to help facilitate learning.

Innovation Areas	
Curriculum	✓ Material
✓ Education method	✓ Online platform
✓ Industry engagement	✓ Physical infrastructure
Organizational setup	Skill type

Ørestad Gymnasium is a Danish high school founded in 2005 in Copenhagen. It offers specialized study programs focused on media, communications, and culture. Ørestad enrolls 1,100 students, age 16-19 years old, for a three-year curriculum within natural sciences, social sciences, and humanities. The school's innovative approach to teaching emphasizes technology, interdisciplinarity, project-based learning, networking with firms, and architectural design. Ørestad was a global pioneer in adopting an entirely digital approach to teaching. All learning materials are available online, and students can access them at any time.

The first three months of the curriculum includes a standard introductory course. Then, students must choose a specialized area that combines two to three subjects to pursue for two and a half years. They also undertake compulsory courses depending on the program selected.

The school focuses on interdisciplinarity and collaboration. Students from different areas of specialization work together in a project and address a problem from their study's perspective. For example, climate change is discussed from both a social science and natural science point of view. The goal is to enable different disciplines to operate together, emulating the nature of real-life problems.

Located in the same district as Danish radio and TV companies, the IT University, and many media businesses, the school organizes networking visits. Ørestad also nurtures connections with tertiary institutions. In addition to visiting firms and universities, students participate in real-life cases taught in cooperation with these external partners.

Finally, Ørestad's design follows an open-plan model with large open spaces, flexible structures in a circular shape, moveable walls, and few closed-off areas. The architecture is supposed to improve learning and incentivize collaboration among students. On a typical day, half of the lessons occur in a traditional classroom and the other half in open learning areas.

4.1.4. The Singular School

singularity-school.com
Tel Aviv, Israel

The Singular School is an educational program that operates in schools across Israel. It emphasizes entrepreneurship, and encourages students to turn their creativity and initiative towards solving large-scale problems in their communities and across the globe.

Innovation

The Singular School aims to reinvent traditional education by teaching students to work in teams to think and work using real-world problem-solving approaches. It partners with traditional schools, exposes students to cutting edge technology ideas, and develops entrepreneurship skills.

Innovation Areas	
✓ Curriculum	Material
✓ Education method	Online platform
✓ Industry engagement	Physical infrastructure
✓ Organizational setup	✓ Skill type

The Singular School is focused on entrepreneurship for children and operates in six regular schools in Israel. Students aged 10-18 work to set up their first start-up by the end of a project. Future researcher and scientist, Erez Livneh, develop the Singular School experiential method when representing Israel in a global competition at Singularity University in the United States. The American institution invited global leaders to propose strategies that would encourage positive change in the world.

The Singular School program runs in two stages. First, in a three-week educational marathon, students face a new learning experiment each week. Second, in a project-based learning experience, students learn foundational concepts on entrepreneurship and begin their start-ups. They develop a prototype for a product, a business plan, and a presentation for stakeholders, and think about branding their enterprise.

Two other learning options include a multidisciplinary lecture marathon and entrepreneurship workshops. The first is an intensive series of seminars on different topic areas run by volunteers from the school community. The goal is to broaden children's horizons by exploring new perspectives and different angles. The second is a series of workshops on various business aspects, and children work in groups. Finally, parents, school staff, and others gather in the Singular Entrepreneurs Conference where children present work products and have the opportunity to discuss what they have learned.

4.1.5. Unistream

unistream.co.il/home
Israel

Unistream is a non-profit with 13 entrepreneurship centers and active in 50 communities across Israel, with an emphasis on providing entrepreneurship training to underprivileged students.

Innovation

Unistream has deep connections with industry and the Government of Israel — via the Innovation Authority — and helps teens establish their own start-up companies, going beyond simply inspiring them and sparking innovation thinking.

Unistream.

Innovation Areas	
Curriculum	Material
✓ Education method	Online platform
✓ Industry engagement	Physical infrastructure
✓ Organizational setup	✓ Skill type

Unistream was founded in 2001 by Israeli entrepreneur and businessman Rony Zarom to overcome socioeconomic disparities in entrepreneurship. The program is run in 13 entrepreneurship centers, is active 50 communities, and provides services to 2,000 teens and 2,000 young adults from all religious and ethnic communities, with a particular focus on children of foreign workers and the black Hebrew community. Unistream aims to develop their entrepreneurial skills early on so they can grow to be successful in their business endeavors and, thereby, improve business and society in Israel.

Unistream participants found start-up companies in parallel to their high school education, and have access to mentors from more than 3,000 businesspeople from all over Israel, who help them acquire hard skills (such as basic business and financial planning skills), and soft skills (leadership and team spirit) to make them successful entrepreneurs. Graduates have access to an alumni group that also offers preparation for university studies, career placements, and workforce integration mentoring.

Funding for Unistream comes from donations and is supplemented by partners for different programs: the three-year Tomorrow's Leaders Program is supported by USAID, and the one-year Start-up Now Program is co-funded with the Israeli Innovation Authority. In addition, Unistream is supported through their network of volunteers — business professionals who provide their knowledge as mentors free of charge.

4.1.6. Reflecting on Innovative Youth Education Initiatives

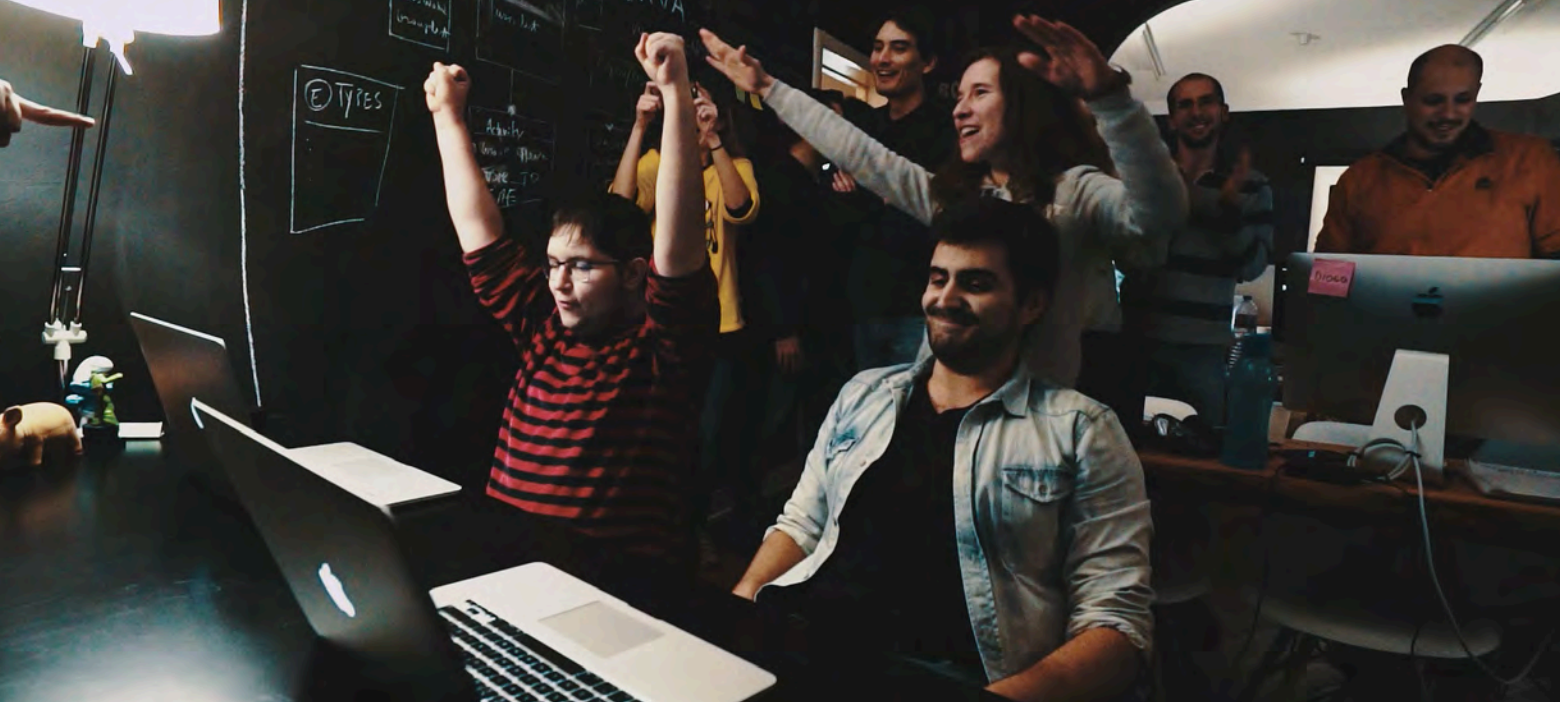
The five youth program cases presented share some important common characteristics:

- Education is an active process, not passive
- A technology component is present
- Soft skills are emphasized
- Team working is essential

The Ørestadt Gymnasium, launched in 2005, currently has about 1,100 students and, over the years, has graduated nearly 4,000. Fire Tech has trained more than 15,000 participants in-person and 55,000 online since 2012. Liger, started in 2009, has less than 200 students. Unistream has trained about 3,000 students since 2001. These examples show scale is a challenge, even for extracurricular programs. Youth training programs can scale-up with the use of online platforms, but questions arise on the about developing soft skills online, with limited human contact.

The youth program solutions featured indicate that:

- Relevant cases exist in both advanced and emerging nations.
- Soft skills are critical for the future economy, and are at the core of youth programs.
- Industry engagement can start at an early age.
- Entrepreneurship training for youth is valued in innovation-oriented countries.
- Professionals outside of the education industry are driving change.



Academia de Código.

4.2. Digital Schools

As digital technologies sweep the globe, the demand for IT professionals and skills is increasing significantly across all industries. In response, there is a growing number of schools around the world that provide specialized training in digital technologies. The majority of these are coding schools.

The six cases presented in this section describe digital schools in five countries: France, Germany, New Zealand, Portugal, and the United States. All offer non-degree programs and employ a bootcamp model, in which participants are immersed in the subject for a limited and intense period of time, attaining a steep increase in their knowledge base and skills. This approach is gaining momentum, as some major companies are accepting candidates without college degrees for IT jobs, and the shelf life of skills in IT is limited.[47]

4.2.1. Academia de Código

www.academiadecodigo.org
Portugal

Academia de Código bootcamps teach coding to adults unfamiliar with coding. It offers bootcamps in five locations across Portugal, recently expanded to Africa, and started to offer training to children.

Innovation
Participation in its bootcamps allows workers — and now children — to go from little knowledge to proficiency in a very short period of time. It also displays an innovative method to select participants.

Innovation Areas	
Curriculum	Material
✓ Education method	✓ Online platform
✓ Industry engagement	Physical infrastructure
Organizational setup	Skill type

Academia de Código was founded in 2015 to reduce unemployment rates in Portugal's economy by teaching digital skills in high demand in the IT sector. Courses on coding are offered in four cities — Lisbon, Aveiro, Porto, and Praia da Vitória — to adults who do not have prior knowledge in computer programming. According to the website, 90 percent of alumni find a job within one month of course completion.

Academia de Código uses a bootcamp model — a 14-week full-time immersive experience focused on teaching software development skills. Students learn front-end and back-end development, and best practices in programming. In the end, they have acquired the skills to be a professional Junior Full Stack software developer.

Bootcamps admit 30 people at a time in each city. To participate, candidates must be 18 years of age or older, and have proficiency in English (able to read, write, and speak). They also need to complete a selection process that involves different tasks, such as completing a basic online computer science course from Stanford, workshops, and an interview.

Workshops in Lisbon and Porto cost between 6,500 and 7,000 EUR. But scholarship options are available to Portuguese citizens with a clean credit record. In other cities, partnerships with municipal governments and companies permit paying the tuition after getting a job. In Aveiro, the course is subsidized by the regional government and local firms. It is free to participants, as long they commit to working in local businesses for 14 weeks after finishing the boot camp.

In 2020, the Academia de Código expanded to Cape Verde in Africa. There, a similar full-stack bootcamp program is offered for free. Candidates must be nationals of Cape Verde between 18-35 years old and complete the selection process. However, due to the COVID-19 pandemic, the first class has been suspended.

In 2018, the Academia de Código began teaching coding to children in the Lisbon region. The program first ran in primary schools with kids aged six years old, with the University of Aveiro helping prepare the educational content. They recently expanded to an online learning platform called Ubbu, which offers ready-to-use lesson plans, solutions, topics for discussions, and class reports to teachers.[48]

4.2.2. Code Avengers

www.codeavengers.com
New Zealand

Code Avengers brings together school teachers, software developers, marketing experts, and designers to provide an online space for learning to code. They have online programs available for learners of all ages (as well as teachers), and cover many common code languages.

Innovation

Programs are accessible online and can be completed at the student's own pace. An important characteristic of Code Avengers is its focus on educators — it provides solutions for educators in the formal education system and does not compete with them.

Innovation Areas	
Curriculum	✓ Material
✓ Education method	✓ Online platform
Industry engagement	Physical infrastructure
✓ Organizational setup	Skill type

Code Avengers is an online learning platform developed in New Zealand that offers computer science courses for children and teenagers ages 5-18. The service is available by a monthly subscription that costs 29 USD, through which clients have access to 500 lessons, guided projects, and quizzes. There is an option for schools to complement classroom instruction with lesson plans for teachers and project-based learning across subject areas such as sciences, mathematics, and humanities. Code Avengers also organizes 1-3 day in-person code camps for kids and teenagers without prior knowledge of coding. The platform also offers professional online courses for adults.

The platform for children has three levels: foundational, intermediate, and advanced. Kids have contact with block-based language, logic exercises, diagrams, and algorithms. The intermediate level is for children over ten years old. They learn how to create games, the basics of computer language, and conceptual ideas such as the Internet of Things. The advanced course, for ages 13-16, touches on artificial intelligence and computer graphics. Advanced learners can transition to mainstream programming languages, such as JavaScript and Python, and web languages such as HTML5 and CSS3. All courses follow three tracks: algorithms, programming, and data representation. In addition to teaching coding, the platform aims to develop creativity, logic, confidence, and resilience in children by engaging with real-world problems. Through the platform, parents can follow their kids' progress to support the learning process.

The school option is aligned with the Digital Technologies curriculum in New Zealand. It follows a similar three-track educational model as the at-home learning. Teachers do not need prior knowledge in coding or specific training to start using the method and adapt it to students. Educators have access to all courses to undertake themselves, along with supporting materials (lesson plans and outlines) and a specific platform for learning and development.

Code Avengers also runs 1-3 day code camps. Children can participate without any prior knowledge in coding. They learn to build websites, games, and apps, and also spend time planning, designing, and discussing activities in groups to learn soft skills, such as teamwork, leadership, and problem-solving.

Finally, there is an online platform with a version for adults who want to learn a programming language or fast track a career in software development, web developer, or web designer.

48 https://www.ubbu.io/.

Coding Dojo.

4.2.3. Coding Dojo

www.codingdojo.com
USA

Coding Dojo is a coding bootcamp that teaches software development to people from all walks of life over the course of an intensive 14-week program. Headquartered in Seattle and San Jose, it offers programs in ten U.S. cities as well as an online program.

Innovation

Coding Dojo uses a bootcamp model for coding training. Its industry engagement approach and focus are worth noting.

Innovation Areas	
✓ Curriculum	Material
✓ Education method	✓ Online platform
✓ Industry engagement	Physical infrastructure
Organizational setup	Skill type

Coding Dojo was founded in 2012 to expand access to coding education and prepare participants for software development. It offers in-person and online short duration bootcamps with intense learning at a rapid pace. Full-time and part-time bootcamp options are offered for maximum flexibility. It operates ten brick-and-mortar campuses across the United States, with flagship campuses in San Jose and Seattle. While its programs have covered programming languages — Python, Java, C#, and Ruby — Coding Dojo hopes to expand to data science and AI. A typical bootcamp lasts about three months and costs $15,000. It offers limited scholarships to students from specific groups, such as women and veterans.

Coding Dojo has developed an online training platform used for both in-person and online bootcamps, and follows a problem-oriented, hands-on education method. It provides content organized in learning chunks (i.e., participants have to "crack problems" to progress through modules), and emphasizes project-like activities. In-person bootcamps have local facilitators who help participants navigate content and mentor them in learning. It has partnered with UCLA, UCSD, Microsoft, the Idaho Department of Labor, the Chicago Cook Workforce Partnership, MIT, and others to provide the content and method for coding education programs. [49]

In addition to the platform and training method, Coding Dojo has innovated in its approach to place students in the workforce, combining a focus on soft skills and industry engagement. Coding Dojo operations include activities such as career mentoring, mock interviews, LinkedIn review, GitHub, and leadership training, as well as structured initiatives to build and nurture relationships and partnerships with industry.

Over its eight-year history, Coding Dojo has trained more than 6,000 students. It reports an 89 percent job placement rate within six months of graduation, and an average starting salary of $76,500.[50]

49 https://www.codingdojo.com/corporate-training.

50 https://www.codingdojo.com/career-services.

4.2.4. École 42

www.42.fr
France

École 42 is a coding school that offers a 100 percent free, three-year coding training program at its headquarters in Paris, Silicon Valley, and facilities in 20 countries. It operates globally via a franchise model.

Innovation

The three-year model is unique in the industry and the method is innovative: it has no teachers or professors, and leverages peer-to-peer and project-based learning. Students direct their own education, dictate their own pace of learning, and assess their classmates' work.

Innovation Areas	
✓ Curriculum	Material
✓ Education method	Online platform
✓ Industry engagement	Physical infrastructure
Organizational setup	Skill type

Founded by the self-taught French entrepreneur Xavier Niel in 2013, Ecole 42 is a digital training center that provides free education and training in digital skills to 18-year-old students. Its name stems from the number of students accepted into the program. The original center, based in Paris, has since opened a branch in Silicon Valley, and 42 succeeded in developing a global network of 20+ franchised campuses by 2020.

42 is unique in its training and education method, as well as its physical infrastructure: there are no classrooms, no teachers, no curricula. Instead, students learn from each other in a peer-to-peer approach and develop their skills in group settings. The building was erected with this innovative approach to training and education in mind, and was built to make students enjoy their time while learning. In addition to typical training and education infrastructure such as computer rooms, the building has a large video gaming room, an amphitheater to watch movies, a cafeteria and bar, a food truck, and a game room. The building is accessible to students around the clock.

Groups of students solve real-world problems, and they then become evaluators to their peers. While the program was designed to be completed in three years (including internships and part-time work), 42 follows the general idea that everyone learns and succeeds at a different pace. Syllabus-free, students can remain on a subject longer if needed without pressure, and those who have previous experience and finish a task faster can study subjects in greater depth and keep learning.

Generally, the program is divided into two parts: a first phase during which students are equipped with compulsory skills needed to get a job as a developer (such as basic programming, algorithms, etc.), and a second phase in which students learn about different applications of the skills developed in phase 1 (e.g., AI, deep learning, security, etc.).

4.2.5. General Assembly

generalassemb.ly
USA

General Assembly focuses on developing skills for the digital age, from coding and data science to marketing and design. It offers courses online and in-person on 20 campuses across the world.

Innovation

It was a pioneer school globally for focusing on the emerging set of digital skills — beyond coding — offering non-degree certificates in a variety of areas. It grew out of a co-working space in New York City and, from the outset, has had strong ties with industry and on-the-ground needs for digital skills. It is the most successful non-degree school of the category.

Innovation Areas	
✓ Curriculum	Material
Education method	Online platform
✓ Industry engagement	Physical infrastructure
Organizational setup	✓ Skill type

General Assembly.

General Assembly provides training and education for the most in-demand skills in software coding, UX design, marketing, and data science. What started as a co-working space in New York City in 2011 has since raised investment, was taken over by a corporation, and grown to more than 20 campuses across the globe, more than 20,000 instructors, and more than 70,000 alumni.

General Assembly has a strong focus on partnerships with industry. While students participate in courses to build their skills, they connect with more than 10,000 hiring partners. The dynamic curriculum adjusts to the needs of industry, especially in data science and web development where both hardware and software change frequently, and skills need to remain up-to-date. General Assembly pilots, updates and sunsets courses in accordance with the needs of their corporate partners.

Their courses are available as either full-time on campus, full-time remote or part-time remote options, and they generally take 3-4 months. Funding for the program comes from student tuitions; however, General Assembly provides financing options and scholarships, and free courses are available to overlooked talent. More than half of their students are sponsored by their employers. Graduates develop a portfolio that will help them find hiring companies, as the syllabus and student projects include real-world problems and challenges faced by General Assembly's corporate clients. General Assembly is currently owned by the Switzerland-based Adecco Group, a Fortune 500 company and second largest human resources provider and temporary staffing firm.[51]

4.2.6. YouGrow Academy

yougrow-group.de/start.html
Germany

YouGrow Academy offers coding training for free and has a unique engagement with industry, positioning itself as a bridge between companies and IT talent. Programs include preparation, eight weeks of coding bootcamp, and 18 months of industry projects.

Innovation

It combines bootcamp-like software coding training with industry projects, and recruitment and placement in industry. Recruitment comes before training and participants are paid, a unique feature.

Innovation Areas	
Curriculum	Material
✓ Education method	Online platform
✓ Industry engagement	Physical infrastructure
✓ Organizational setup	Skill type

Founded in 2018, YouGrow Academy in Frankfurt, Germany operates a coding school and recruitment agency. It trains people with little IT expertise to become software developers through a combined program of four weeks of online learning and eight weeks of full-time boot camp.

The tuition is free, and students are paid a salary during training. In exchange, they commit to working as IT consultants in an 18-month project assignment with YouGrow clients after concluding the training. The school offers financing options for those who do not want to tie themselves to an employment contract. Students can get a loan through a cooperative agreement with Chance eG, a German social enterprise, and repay course fees after finding a job. YouGrow is linked to recruitment agencies in Europe; it is a brand of Tempo team and part of Randstad.[52] The agencies connect prospective clients in the private sector to software developers trained by YouGrow.

YouGrow training starts with a four-week (four hours per day) e-learning curriculum that covers a basic understanding of IT and programming. After completing the first module, all students undertake intensive training in a bootcamp format to become a software developer. The program includes 350 hours of coding practice. In a typical bootcamp week, students spend three days learning and improving on coding language, and programming their applications. Two days a week are reserved for small group assignments. The aim is to work close to the code while also developing soft skills.

After successfully passing the bootcamp and a final exam, students typically engage in an 18-month project assignment with a YouGrow client. During this period, employees still have access to the e-learning platform and online training. At the end of 21 months, students have a technical background in IT and relevant professional experience with increased chances of succeeding in the job market.

51 https://www.adeccogroup.com/.

52 https://www.randstad.com/.

4.2.7. Reflecting on innovative digital schools

The six digital school cases presented share some important common characteristics:

- Place emphasis on the participant selection processes
- Work to develop ties with industry and provide career services to students
- Offer non-degree, bootcamp-like immersive programs
- Have programs that are very hands-on, with participants developing projects

All of the schools were founded after 2010, reflecting the continued widespread scaling of digital technologies, although they differ significantly in terms of scale. Among the schools featured, General Assembly has the largest number of alumni–80,000. Pure coding schools display more limited numbers, for example, Coding Dojo has trained about 7,000 students since it was established. Getting to scale seems to be a challenge for coding bootcamp schools.

The digital school solutions featured indicate that:

- The young age of the schools (all founded after 2010) reflects the continued widespread scaling of digital technologies.
- Getting to scale seems to be a challenge for coding bootcamp schools.
- Active learning methods for developing upper-level digital skills is important.
- Digital schools mirror the organizational models and practices of digital companies.
- Schools are enlarging their portfolios to cover other relevant areas and digital skills.
- They are increasingly connected to recruitment agencies, serving as talent brokers.
- Connections between schools, and labor market demands and trends are important.

Finally, it is interesting to note that the cutting edge of digital and coding schools is occupied by software solutions such as Grasshopper (see Box 7). We are in the early stages of automated training and adaptive learning, and more examples can be expected to emerge in the years to come.

4.3. Degree Institutions

The five cases presented in this section describe innovative implementation solutions deployed by higher education institutions in three countries: Mexico, the United States, and Finland. These include new higher education institutions, new university programs, and university-wide transformation initiatives in education models.

BOX 7

Software Solution Spotlight: Grasshopper

grasshopper.app
Mountain View, USA

Grasshopper is an interactive coding app for adults at a beginner's level. A team of Google coders created it during a workshop for innovative products. Users have access to free courses on their smart phone or desktop. They can learn the fundamentals of programming, writing JavaScript, web development, and other skills. The app is continuously updated with new content. It is online available in English.

4.3.1. Monterrey Institute of Technology and Higher Education

tec.mx/en/model-tec21
Mexico

Monterrey Institute of Technology and Higher Education, or Monterrey Tech, is a Mexican technical institute offering a wide variety of degree programs from the high-school level to the doctoral level. It has 26 campuses across Mexico.

Innovation

Monterrey Tech's Tec21 education model blends several elements and is particularly innovative because of its scale. Its challenge-based component deserves to be highlighted, as it is being deployed across the board for a university with almost 100,000 students.

Innovation Areas	
✓ Curriculum	Material
✓ Education method	Online platform
Industry engagement	Physical infrastructure
Organizational setup	Skill type

Monterrey Tech is a private university founded in 1943 by a group of businesspeople in Mexico. It has 26 campuses across the country, and offers 44 undergraduate degrees and a few options for postgraduate education. The university uses a challenged-based learning model called Tec21, which involves an experiential learning approach that actively engages students in solving real-world problems across disciplines. Monterrey Tech develops close relationships with the business community and non-governmental organizations, which provide insights into the pedagogical process.

Monterrey Institute of Technology and Higher Education library.

In Tec21 at the undergraduate level, students undertake a three-phase journey that lasts four years. In the first phase, which lasts three semesters, they choose from one of six topic areas: built environment, health, creative studies, business, engineering, or social sciences. The period is an exploration, providing a broad view of a professional area. In the second phase, students deepen their understanding of the subject and commit to a degree option. During the last phase — the specialization level — they select a topic to concentrate their learning. The program is flexible and encourages students to follow a professional path that suits their interests and passions.

All freshmen participate in challenged-based learning during their first semester. Connecting theory and practice, they apply academic knowledge to solve real industry and business problems. Large companies, such as Siemens, Amazon, Heineken, IBM, etc. participate in the design and assessment of the challenges, and provide feedback. In the model, teachers from different disciplines first introduce a challenge and lecture students on the technical knowledge necessary to address the issue. Students then analyze the challenge, evaluate the application of theories, test hypotheses, and brainstorm possible solutions. They hear and explore different perspectives from other groups working on the problem. Throughout the process, teachers act as advisers, mentoring students to ensure they achieve their learning objectives. At the end, they present their solutions to an external partner, either companies or NGOs.

Project evaluation is weighted — 75 percent on technical expertise, and 25 percent on the soft skills students demonstrate. Also, teachers evaluate how the student integrated into and participated with members of the project team. The Tec21 educational model fosters development of cross-cutting competencies, which include self-awareness and management, innovative entrepreneurial attitude, social intelligence, ethics, communication, complex reasoning, and use of digital technologies.

In August 2019, the School of Business launched a challenge involving 4,000 students divided into 750 groups across the 26 campuses. Students had five weeks to adapt the business plan of a low-income Mexican retail brand to include better corporate social responsibility through the millennial consumer's lens. Students interviewed customers and managers working in the business and redesigned the business model to fit new commitments. The best solutions were presented to the board members at the company's headquarters.

4.3.2. Olin College of Engineering

www.olin.edu
USA

Olin College of Engineering is an undergraduate institution dedicated to rethinking engineering education and teaching students the skills to contribute to innovative solutions to global challenges.

Innovation

Olin's innovative curriculum teaches students to think critically about the social implications of their work and the entrepreneurial skills necessary to transform their ideas into real solutions.

Olin College of Engineering.

Innovation Areas	
✓ Curriculum	Material
✓ Education method	Online platform
Industry engagement	Physical infrastructure
Organizational setup	Skill type

Olin College of Engineering is an undergraduate institution dedicated to rethinking engineering education. Founded in 1997, the College has a campus in Boston and an enrollment of about 400 students. With a 300+ million-dollar endowment, the College is funded primarily by the F.W. Olin Foundation as well as by donations and other grant programs. Upon admission, students have access to the Olin Tuition Scholarship, which is awarded to all students, and covers half of their total tuition fees.

Olin embraces the traditional model of university education, but expands it to include opportunities for students to design their own path of creation and learning. Students have the option of independent studies and co-curricula where they can collaborate directly with faculty around common interests. Every semester, the College hosts the "Olin Expo" where students and faculty share information on their projects with the College community. The school also encourages all students to join clubs and organizations to further their learning and discover their passions outside of the classroom.

Olin's innovative curriculum teaches students to think critically about the social implications of their work and the entrepreneurial skills necessary to transform their ideas into real solutions. Olin also focuses on preparing students for and providing a pathway to the professional world through internships, fellowships, and scholarship opportunities. The *Princeton Review* ranks Olin the fifth best school in the United States for internship opportunities.[53] Should they chose to do so, Olin also supports students seeking further education with an on-campus Office of Post-Graduate Planning, which maintains relationships with graduate schools.

The College has partnered with others in the region to form relationships between institutions, such as the International Development Design Summits in collaboration with MIT.[54] This effort includes summits and community-based training that bring a diverse group of student and faculty together to focus on developing solutions to poverty, technology, and other global problems.

4.3.3. Minerva Schools at KGI

www.minerva.kgi.edu
USA

Minerva Schools at KGI offer undergraduate and graduate degrees based on innovative curricula. Minerva students can earn an undergraduate degree in five accredited colleges: Arts & Humanities, Business, Computational Sciences, Natural Sciences, and Social Sciences.

53 https://www.princetonreview.com/college-rankings?rankings=best-schools-for-internships.

54 http://www.olin.edu/research-impact/social-environmental-impact/.

Minerva Schools at KGI.

Innovation

The most innovative element of the Minerva experience is its global nature. Through four years of study, Minerva students travel with a cohort of classmates, spending time in up to seven different cities around the world.

Innovation Areas

✓ Curriculum	Material
✓ Education method	✓ Online platform
Industry engagement	✓ Physical infrastructure
Organizational setup	Skill type

Minerva Schools at KGI is an online undergraduate and graduate program headquartered in San Francisco, California. The program is a joint venture between the Minerva Project, a for-profit educational services and technology group, and Keck Graduate Institute (KGI), a college in the Claremont Colleges Consortium.

Minerva Schools began with support from U.S. venture capital firms in 2012, and worked to build a faculty in the years following. As the school's leadership laid the groundwork for full-scale operation, the school received accreditation and admitted its first undergraduate-only class in 2014. Since then, the school has expanded to include a master's program in decision analysis in addition to its Bachelor of Science programs in natural sciences, computational sciences, social sciences, and business. Minerva also offers a Bachelor of Arts in arts and humanities.

While Minerva Schools operate online, the school maintains housing for students in major cities around the world. Students begin their learning in San Francisco, but then have the option to spend semesters in six other cities including London, Berlin, Buenos Aires, Seoul, Hyderabad, and Taipei.[55] At these locations, students are immersed in local culture, while continuing the same education online as they move from one city to the next. The education focuses heavily on fostering students' personal growth as they focus on their long-term goals, supported by personal coaching and talent development. Minerva reports that 87 percent of students secured internships after their first year, and 90 percent of managers said that these students' performance was above average.[56]

The Minerva Schools at KGI's innovative approach to education has attracted attention, first, for its ambitious goal of becoming an elite, global university and, second, for its scalable and systematic approach to liberal arts curricula.[57]

55 https://www.minerva.kgi.edu/global-experience/.

56 https://www.minerva.kgi.edu/career-development/.

57 https://www.insidehighered.com/digital-learning/article/2018/12/05/minerva-project-draws-notice-its-practical-rigorous-curriculum.

Aalto University.

4.3.4. Aalto University

www.aalto.fi/en
Finland

Aalto University is a private university in Finland, emphasizing a multidisciplinary approach to learning. Their community blends science and art to meet the modern needs of technology and business.

Innovation

Research focuses on key areas of innovation: ICT and digitalization, materials, art and design, business, energy solutions, living environments, and health and well-being. Research and learning in these areas emphasize identifying and solving societal challenges, and building an innovative future.

Innovation Areas	
✓ Curriculum	Material
✓ Education method	Online platform
Industry engagement	Physical infrastructure
✓ Organizational setup	✓ Skill type

Aalto University is a private university in Finland, emphasizing a multidisciplinary approach to learning. It was established in 2010 with the merging of the Helsinki School of Economics, the Helsinki University of Technology, and the University of Art and Design Helsinki.[58] Their approach to education blends science and art to meet the modern needs of technology and business. Aalto University has two campuses in the greater Helsinki region, with its main campus in Otaniemi and another in Töölö.

The University operates six Schools: Engineering; Business; Chemical Engineering; Science; Electrical Engineering; and Arts, Design and Architecture. Although each school operates its own departments and units, the University has a strong multidisciplinary focus, encouraging collaboration across schools in high-quality research projects. The University places research and art at the center of its focus, emphasizing projects that help create the conditions for innovation, economic growth, employment, and well-being. To this end, Aalto's research focuses on seven key areas of innovation: ICT and digitalization, materials, art and design, business, energy solutions, living environments, and health and well-being. Research and learning in all of these areas emphasize identifying and solving societal challenges and building an innovative future.

The most unique element of Aalto programs is the goal of renewing society by art, creativity, and design. These fundamentals are present in programs across all disciplines. Most programs also combine these fundamentals with the digital environment, bringing art-focused research into the 21st century. Aalto "Platforms" are a critical element of research. They bring together research expertise from many departments, and

58 https://www.aalto.fi/en/aalto-university.

collaborations with the University's external support network. Platforms can include opportunities for networking, events, training, practice, and long-term support such as seed funding for emerging research lines. Platforms serve to encourage the spin-out of university research and collaboration with community partners working at the cutting edge of innovation in areas such as energy, materials, artificial intelligence, and healthcare.

4.3.5. E3 Program

cdme.osu.edu/e3-program
USA

E3 Program at Ohio State University combines educational instruction in product design, manufacturing, and business modeling.

Innovation

The E3 Program combines educational instruction with opportunities for practical hands-on industry experience. Its main innovative feature is its reconceptualization of entrepreneurship not simply as the result of individual genius, but as a set of technical, business, and social skills that can be taught and learned.

Innovation Areas	
✓ Curriculum	Material
Education method	Online platform
✓ Industry engagement	Physical infrastructure
Organizational setup	✓ Skill type

The Ohio State University's Experiential Entrepreneurship and Engineering Program, or "E3 Program," offers students an innovative approach to educational instruction in product design, manufacturing, and business modeling.[59] Its approach to instruction includes opportunities for practical, hands-on industry experience to fulfill two goals: talent attraction and recruitment. [60]The program was launched at the beginning of the 2017 school year, and is overseen by the Center for Design and Manufacturing Excellence in the University's College of Engineering.[61]

The E3 Program aids three groups of industry players in the ever-increasing competition for college graduates: advanced manufacturing firms, engineering service firms, and high-technology ventures. Firms from each of these groups leverage their existing relationships with the University by opening the door to industry-ready, STEM-focused talent who have sound technical skills. In addition, E3's students learn to become more comfortable in a dynamic workplace, by working either as the member of a team or its leader.

Students that participate in the E3 program do so alongside their traditional coursework, using hands-on experiences to build work readiness while still enrolled in school. The program centers around the University's partnerships with industry, particularly with small and medium-sized regional manufacturing companies. Students are hired as employees, working up to 16 hours per week. Students can gain experience bringing inventions to market through these partnerships, as well as the practical experience of the University's faculty. These many sources of knowledge provide students with a broad-base of experience before entering the workforce full-time and, if students choose, they can also enroll in industry-recognized certification programs that grant them even more experiential learning opportunities.

Immediately following E3's announcement, a pathbreaking partnership with FANUC, a global leader in manufacturing automation and robotics, ignited a wave of new interest in the program. FANUC's partnership with E3 was closely followed by partnerships with other firms including Honda, Lincoln Electric, and Rockwell. As of 2018, about 150 students participate in the E3 program, but the model of education is scalable and will likely expand in the coming years. The E3 Program is funded by Ohio State and a gift from the estate of Ed Claugus, an Ohio State College of Engineering alumnus.[62]

4.3.6. Reflecting on Degree Institutions

The five degree institution cases presented share some important common characteristics:

- Project-based learning
- Industry engagement
- Multidisciplinarity

GFCC member Monterrey Tech's model stands out for its scale. While other universities such as Waterloo[63] have pioneered co-op education and experiential learning, Monterrey Tech adopted those at a larger scale, making challenge-based learning the standard education method for all its courses. The barriers to achieving scale are many for a university with almost

59 https://58718284-cf1e-4e31-b747-11d767345900.filesusr.com/ugd/f344ed_d0a5f71224994d1280b17544c1c3d528.pdf.

60 https://cdme.osu.edu/sites/default/files/uploads/6005c_e3_program_-_industry_flyer.pdf

61 http://www.nationalnetwork.org/wp-content/uploads/2018/01/OhioStateE3Program-2.pdf.

62 https://cdme.osu.edu/e3-program.

63 https://uwaterloo.ca/future-students/co-op.

100,000 students. Monterrey Tech created an office to develop partnerships with industry and engage outside stakeholders in their educational programs.

The degree institution solutions featured indicate that:

- Multidisciplinarity creates the opportunity for students to develop both hard and soft skills.
- Creating university organizational solutions to enable experiential learning is needed.
- Industry engagement is essential for experiential learning programs; developing social capital helps in building relationships with industry.
- Resources from outside university boundaries can be leveraged.
- Preparing students to work in global settings is important.

4.4. Professional Schools

Professional training is a broad domain — ranging from vocational training to executive training. As such, this category includes different types of implementation solutions serving people in the workforce. The seven cases presented in this section describe professional schools in three countries: Canada, Sweden, and the United States.

4.4.1. AltMBA

altmba.com
USA

AltMBA is a month-long bootcamp on leadership and management. Conducted exclusively online, it mostly aims to develop participants' soft skills and drive changes in mindsets, unlocking the individual potential of participants and their companies.

Innovation
AltMBA's fast-paced and action-oriented method requires participants to work around the clock in teams to solve ill-structured problems and keep a flow of deliverables throughout the program.

Innovation Areas	
Curriculum	✓ Material
✓ Education method	✓ Online platform
Industry engagement	Physical infrastructure
Organizational setup	✓ Skill type

The AltMBA is an intensive four-week leadership and management workshop in a bootcamp format. The program was founded in 2015 by Seth Godin — entrepreneur and author of best-sellers on business, marketing, and work — and has grown to include students from 70 countries. The program is completely digital and students can participate from anywhere.

Group sessions take place in a digital format over the Internet, using platforms such as Discourse, Zoom, and Slack that are in wide use in the professional world.[64] Each workshop includes about 120 students who are granted admission based on a simple, online application. The program accepts students of all backgrounds. Some are managers and leaders at large corporations, NGOs, and non-profits, and others are entrepreneurs and freelancers. Participants have represented household names including Nike, Microsoft, Lululemon, Google, Amazon, and the Red Cross.

Students join a cohort of about 20 who live in the same or close by time zone, have the same coach, and work more closely together. The program is synchronous for all participants (i.e., they do not complete a session at their own pace), with regular deadlines, group discussions, and face to face video calls. Each students publishes results of 13 assigned hands-on projects on the community AltMBA site.

The program is funded through student tuition, currently $4,450 USD. Along with admission to the online workshop, a packet of physical materials is sent to participants to supplement digital resources. In addition to networking with those in their cohort and workshop, students are encouraged to network with AltMBA Changemakers and alumni based in their areas. These resources expand the value of the AltMBA program beyond the four-week workshop.

64 https://altmba.com/about.

4.4.2. Hyper Island

www.hyperisland.com/contact
Stockholm, Sweden

Hyper Island provides training and education on innovation methods and techniques, and also offers consultancy to business clients. Hyper Island's training ranges from workshops to a master's program accredited by the U.K.-based Teesside University.

Innovation

There are no teachers or instructors at Hyper Island, and its project-based curricula is designed by industry professionals. It works with a number of high-profile companies to give students internships and training opportunities in their chosen fields.

Innovation Areas	
✓ Curriculum	Material
Education method	Online platform
✓ Industry engagement	Physical infrastructure
Organizational setup	✓ Skill type

Hyper Island is a learning institute that operates as a school and business consultancy, developing programs in direct connection with industry experts. It was founded in 1996 by two entrepreneurs, Jonathan Briggs and David Erixon.

The institute teaches digital media, innovation, leadership, and entrepreneurship through a learning-by-doing method called "try-and-test." Recently, Hyper expanded schools to five countries — Singapore, United Kingdom, United States, Finland, and Brazil — while still offering online courses and training.

Hyper provides a variety of programs on-site and online such as a master's degree in digital management, three-day courses about online process design, vocational diplomas on artificial intelligence and business, and other innovative programming. Curricula reflect industry partners' insights on digital trends shaping the global market. Teachers do not follow conventional classroom approaches. Instead, the school incentivizes a collaborative environment involving hands-on experience finding solutions to real problems from real clients. Hyper's methodology also focuses on developing students' soft skills, such as adaptability, continuous learning, critical thinking, creativity, decision making, leadership, and emotional intelligence. For businesses, the institute offers programs to help companies navigate the digital transformation, such as consulting services and workshops. More than 5,000 students have graduated from full-time and part-time courses over 20 years of Hyper's learning experiment.

Alberta Machine Intelligence Institute (Amii).

4.4.3. Alberta Machine Intelligence Institute

www.amii.ca
Edmonton, Canada

Alberta Machine Intelligence Institute is an independent institute that spun-out of the University of Alberta. In addition to performing and sponsoring research on machine intelligence, it trains workers in machine intelligence literacy to help prepare them for a modern workplace in which AI and machine learning have abundant applications.

Innovation

Amii is one of the pioneer institutes in the world focused solely on AI and designed to combine research with translation through projects and training.

Innovation Areas	
✓ Curriculum	Material
Education method	Online platform
Industry engagement	Physical infrastructure
Organizational setup	✓ Skill type

Alberta Machine Intelligence Institute (Amii) is a research center located in Edmonton, Alberta that develops solutions for businesses and industries that leverage machine learning (ML) and artificial intelligence (AI) technologies. Founded in 2002 at the University of Alberta, it later expanded to an independent

College for America.

organization with support and funding from the local and federal governments. Amii also engages in educational and community initiatives, offering training sessions and online courses.

Amii has played a vital role in Alberta's economic diversification strategy by developing a close relationship with local industries and businesses. The center offers a service to start-ups, and small and medium-sized enterprises to guide them through developing in-house AI capabilities. They have engaged in 49 formal industry partnerships with companies such as Climate Corporation and Imperial Oil, amounting to $2 million in industrial service contracts.

Business engagement starts with a meeting to understand and evaluate business needs. Amii offers advice in planning and managing AI/ML projects. In addition, company employees get foundational training in ML and are encouraged to apply the technology to their workflows. Further counseling can include support in experimental projects, sessions with experts, and advanced research guidance.

Amii has an educational branch with reskilling and upskilling training for corporations and individuals. Academic learning is available at the University of Alberta, which shares part of the staff with Amii. In 2019, Amii provided two online training courses in partnership with Coursera: *Machine Learning: Algorithms in the Real World*, and *Reinforcement Learning Specialization*. In less than one year, the platform has reached more than 23,000 students. Amii also holds community events and panel discussions to spread ML literacy.

Amii's 140 researchers have developed 200 new technology solutions, including algorithms, applications, and theories. Amii has been recognized for creating innovative solutions such as the UCT algorithm (at the heart of many improvements in game research), Chinook (checkers-playing AI), Arcade Learning Environment (ALE) (software platform for evaluating the general competence of AI algorithms, fundamental in Deep Reinforcement Learning), and an improvement to tuberculosis analysis through AI.

4.4.4. College for America

www.snhu.edu/about-us/college-for-america
Manchester, USA

College for America is a program of the Southern New Hampshire University that offers a variety of competency-based education programs through a workplace partnership geared towards working adults. These programs aim to provide job-specific skills through employer-sponsored projects.

Innovation

College for America programs allow a maximum level of flexibility for students — the pace of learning is set by how long it takes to complete competency-based projects rather than by imposed deadlines. Its flexible setup allows for people already in the workforce to engage in education, update their skills, and obtain degrees.

Innovation Areas	
✓ Curriculum	Material
✓ Education method	✓ Online platform
✓ Industry engagement	Physical infrastructure
Organizational setup	Skill type

The College for America Personal Path is a collection of programs within Southern New Hampshire University (SNHU). The College for America is a suite of digital, competency-based programs that educate students through workplace partnerships. SNHU began the College in 2013 with the goal of exploring what a reinvented and improved higher-education environment would look like. The College gained a foothold quickly, gaining the attention of employers with support from the Bill & Melinda Gates Foundation, and the Lumina Foundation.[65]

Rather than taking scheduled online classes, the College embraces a "Competency-Based Education" (CBE) format. This approach allows students to complete projects and demonstrate competencies via direct assessments, rather than traditional testing or coursework. Students work to master job-related 'competencies' one at a time until they demonstrate proficiency. Because of the College's high proportion of adult learners, many of these skills may incorporate knowledge that learners have already gained through the workforce, making it possible to accelerate through their work at their own pace. Recognizing the program's innovative approach, the U.S. Department of Education approved the College for America to receive financial aid under direct assessment provisions, the first to receive approval outside of the traditional credit hour model. The U.S. Department of Education hopes to use the success of the CBE format at College for America to expand nationwide access to adult-learning programs that are easily accessible to workers in full-time positions.

Programs are all designed to meet the needs of working adults. They allow a high level of flexibility for students — for example, the pace of learning is set by how long it takes to complete competency-based projects rather than by imposed deadlines. The College also developed a unique model of pricing classes, charging for the duration of a term and allowing student to "master" as many of the CBE programs they can in that amount of time. Some programming provides job-specific instruction, and select employer-sponsored projects often come at low or no cost to the student after employer-provided subsidies are applied.

4.4.5. Davis Global Center

www.unmc.edu/iexcel/global-center/index.html
USA

Davis Global Center is a healthcare training and simulation facility overseen by the University of Nebraska Medical Center. Davis seeks to provide students with an environment where they can experiment safely and build knowledge of their work with confidence.

Innovation

The Center emphasizes advanced medical technologies and new techniques of patient care. It also leverages emerging technologies such as VR/AR to train healthcare professionals and help students learn to work in teams as they will in a real clinical environment.

Innovation Areas	
Curriculum	✓ Material
✓ Education method	Online platform
Industry engagement	✓ Physical infrastructure
Organizational setup	✓ Skill type

The Dr. Edwin G. & Dorothy Balbach Davis Global Center is a healthcare training facility at the University of Nebraska Medical Center. At the 192,000 square-foot facility in Omaha, Nebraska, the center seeks to provide medical students with unique hands-on experiences to better prepare them for the medical field. The Center received funding from the City of Omaha, the State of Nebraska, and other public and private grants.[66]

Students use the Center's 3-D and virtual/augmented reality systems to train safely in a realistic replicated health care setting. To provide the best experiential learning environment possible, the Center uses cutting-edge technology with an emphasis on patient care. Students use human-patient simulators, touch screen learning walls, and visualization technology such as head mounted displays. Companies such as Eon Reality (Box 8) provide AR/VR solutions for training and education, a trend that should grow in the years to come. In addition to its technology component, the Center focuses on developing the leadership and decision-making skills of its students. Unlike traditional lectures, students learn to focus on teamwork in a fast-paced environment.

65 https://www.snhu.edu/about-us/college-for-america.

66 https://www.unmc.edu/publicrelations/_documents/iEXCEL-Groundbreaking-Release.pdf.

Davis Global Center.

Each level of the Center's building has a distinct purpose, and skyways connect the Center to other buildings in the University of Nebraska Medical Center, integrating the building seamlessly and encouraging collaboration among students and staff.[67]

BOX 8

Software Solution Spotlight: Eon Reality

eonreality.com/
Irvine, USA

Eon Reality provides interactive digital platforms that allow users to follow and create educational content with augmented and virtual reality (AR, VR). The application is available for free download, and it runs on any device with the addition of a VR cardboard. Teachers can tap an open library with immersive educational materials in different subject areas. They can also create lessons using the app, adding features such as quizzes, challenges, videos, and voice recordings. The solution allows students to engage with the topic through an immersive learning experience. The company also supports corporative training across industries, offering experiential instruction to employees. Eon's solutions have already reached 40 million users worldwide.

4.4.6. Culinary Institute of America

www.ciachef.edu
USA

Culinary Institute of America (CIA) is a U.S.-based vocational school, offering undergraduate and graduate degrees as well as adult-learning programs, specializing in advanced culinary education.

Innovation
CIA was a pioneer school of its type in the Americas and has evolved into a thought-leader in the food world, convening conferences and creating industry-wide opportunities for culinary leaders and professionals to engage and drive industry innovation.

Innovation Areas	
✓ Curriculum	Material
Education method	Online platform
✓ Industry engagement	✓ Physical infrastructure
Organizational setup	Skill type

The Culinary Institute of America (CIA) is a vocational school headquartered in Hyde Park, New York offering undergraduate and graduate degrees, adult-learning programs, and online

67 https://www.unmc.edu/publicrelations/media/press-kits/iEXCEL-building-highlights.pdf.

Culinary Institute of America.

programs. It recently opened additional campuses in California, Texas, and Singapore. Founded in 1946, CIA operates as an independent, non-profit university with about 3,000 students.

All coursework at CIA specializes in advanced culinary education. The CIA approach places a heavy emphasis on experiential learning in real-world environments. CIA's undergraduate degree programs — including Bachelor's degrees in culinary science, applied food studies, hospitality management, and food business — make use of more than 2,000 internships around the world.[68] These internships provide students with expert mentors in the fields of food and hospitality. The CIA also offers associate degree programs in culinary arts or baking and pastry arts, as well as graduate education in food business, and wine and hospitality management. The Institute places a major emphasis on its alumni network, which includes more than 50,000 alumni across the food world.[69] Students have the opportunity to participate in innovative culinary immersion programs, either in a two week intensive trip or over the course of a fifteen week semester. In Napa Valley, France, Peru, and more, students can explore food at a hands-on level that the classroom could not provide.

The four campuses host career fairs that attract dozens of employers seeking to recruit students to the professional world after their completion of a CIA degree. These career fairs make use of the partnerships the CIA has built with employers, as well as faculty connections with the food and hospitality industries. The CIA also seeks to serve as a thought-leader in the food world, convening conferences and creating industry-wide opportunities for culinary leaders and professionals to reflect on potential future innovations.

4.4.7. Disney Institute

www.disneyinstitute.com
Lake Buena Vista, USA

Disney Institute is the training and professional development arm of the Walt Disney Company. It uses business solutions and best practices of Walt Disney Parks and Resorts to advise other organizations on how to enhance the customer experience.

Innovation

The Disney Institute was a pioneer in implementing a curriculum focused on service excellence. It harnesses the expertise and resources of the Walt Disney Company and makes them available to clients and professionals around the globe.

Innovation Areas	
✓ Curriculum	Material
Education method	Online platform
Industry engagement	Physical infrastructure
✓ Organizational setup	Skill type

Disney Institute is the training and professional development arm of the Walt Disney Company. It uses the business solutions and best practices of Walt Disney Parks and Resorts to advise other organizations on how to enhance the customer experience, functioning as an out-of-house training and consulting group.

68 https://www.ciachef.edu/why-study-at-the-cia/.

69 https://www.ciaalumninetwork.com/s/898/17/home.aspx.

The Walt Disney Company has a suite of well-developed and scalable resources for human resources and employee development. Through the Institute, it makes these resources available to partners of all sizes who would otherwise have to invest significantly to build a similar catalog. This approach is particularly innovative because of the savings it offers small and medium-sized companies that take advantage of the training.

Occurring regularly throughout the year, the Institute's Professional Development Course is available in Florida and California, and spans three days of engagement work. The Institute also holds specialized summits at its resort in Florida, each focusing on a unique professional development topic, such as customer experience or data and analytics. Other organizations — such as companies, chambers of commerce, and colleges and universities — can bring Disney courses to their locations. Most of these sessions consist of a one-day seminar on business excellence, including development of teams and a sense of community within an organization.

The Disney Institute offers solutions across many industries, such as automotive manufacturing, sports and venues, insurance, healthcare, finance, and real estate.[70] The core expertise of the Institute comes in developing individuals through programs on leadership, engagement, and service excellence. This allows an organization's employees to gain experience in a part of their job in which a traditional approach to management might undermanage or ignore.

4.4.8. Reflecting on Professional Schools

The professional school cases presented share some important common characteristics:

- Industry engagement is of paramount importance
- Development of both soft and hard skills
- Experiential learning approaches

The cases indicate that outreach efforts are needed to develop relationships with industry, require dedicated resources, and can only succeed over time. They also suggest that there are different potential paths to be followed in connecting industry with professional education institutions.

The professional school solutions are a mix of in-person and online training. However, the Davis Center does not offer online training, and the CIA's online offerings are limited to food business courses. This points to the fact that is easier to digitalize training programs that do not require industry specific settings or equipment — such as food processing or healthcare.

These cases once again underscore the difficulties associated with scaling-up training operations targeting soft skills. Hyper Island, for example, which operates a globally-known innovation and entrepreneurship school, has trained only 5,000 participants since it was established in 1996.

The professional school solutions featured indicate that:

- Industry engagement is essential to design, implement, and scale-up professional education.
- It is easier to digitalize training programs that do not require industry specific settings or equipment.
- "Train as you work" is a powerful concept.
- New technologies can boost in-person learning.
- Professional education can be coupled with cutting edge technology research.
- Economywide upskilling can be turbocharged.
- As schools grow, they tend to expand their portfolios.

New technologies such as algorithms are starting to perform content creation and delivery. It is possible that technology solutions such as those provided by Obrizum (see Box 9), originally developed for the corporate market, will reach the larger training and education market, becoming available to individuals who want or need to expand their knowledge and improve their skills. Organizations interested in skills development should follow emerging technology closely.

BOX 9

Software Solution Spotlight: Obrizium

www.obrizum.com
Cambridge, UK

Obrizum is a learning platform for large corporations that uses artificial intelligence (AI) to automatically create, deliver, and monitor online training in high-skill areas. Users upload content files of any format, and the technology uses analytical techniques such as natural language processing to define subjects related to each piece of content, establishes relationships and dependencies between content elements, and creates adaptive information sequences (e.g., short courses). The AI also observes each user's interaction with the platform and quickly learns user preferences to optimize the educational experience. Obrizum runs on the cloud, and can operate on a global scale. It also combines AI and data science to read and examine complex information, helping clients quickly understand figures with analytics dashboards.

70 https://www.disneyinstitute.com/.

4.5. Economic Development

A skilled workforce is a critical enabler for industry and economic growth across countries. To build this crucial asset, government agencies, industry bodies, and companies form partnerships to create and implement skills development programs and institutions. The eight cases presented in this section describe economic development-related training programs in four countries: Australia, Chile, the United Kingdom, and United States.

4.5.1. NYC Tech Talent Pipeline

www.techtalentpipeline.nyc
New York, USA

NYC Tech Talent Pipeline is a public-private initiative that works to define the skills needed by firms, and launches different programs to develop those skills in people and enhance their employment opportunities. NYC Tech Talent Pipeline offers more than ten different programs to teach 21st century skills.

Innovation

NYC Tech Talent Pipeline is governed by a group that includes some of the most prominent technology industry leaders, and was conceptualized to provide at scale training solutions aligned with the real-world needs of employers.

Innovation Areas	
Curriculum	Material
✓ Education method	Online platform
✓ Industry engagement	Physical infrastructure
Organizational setup	Skill type

The NYC Tech Talent Pipeline is a public-private initiative that works to define the skills needed by firms, and to launch programs to develop those skills in individuals, eventually filling jobs where skilled workers are needed most.[71] The program is funded by New York City Small Business Services and the City of New York.

The Tech Talent Pipeline strategy has three elements: engaging industry, which involves working with top employers in the City of New York to track which jobs will be most important in the future economy; developing solutions, which focuses on training and education to equip New Yorkers with skills to succeed; and worker outreach.

The NYC Tech Talent Pipeline is overseen by an advisory board including 28 CEOs, CTOs, CIOs, and senior executives from the city's top technology employers. Firms represented include LinkedIn, Verizon Wireless, Goldman Sachs, and Viacom. The Tech Talent Pipeline also seeks input from its Academic Council, comprised of 16 post-secondary education institutions working to develop pathways for New Yorkers to begin careers in technology-based fields. These institutions include the City College of New York, Columbia University, Pace University, and Cornell Tech.

Leaders from more than 60 companies have evaluated and shaped the training curricula to support rapid development of qualified job candidates. Training takes place at partner institutions such as City University of New York and Hunter College, and is available to a range of individuals including well-qualified undergraduates or adults. Upon completion of training, participants have access to many opportunities such as internships and connections with full-time jobs.

4.5.2. Chicago Codes

www.chi.codes
Chicago, USA

Chicago Codes is a tuition free software coding training program launched by the Chicago Cook Workforce Partnership and powered by coding schools such as Coding Dojo and Coding Temple.

Innovation

By expanding access and making the program tuition-free, the skills that Chicago Codes teaches are accessible to larger portion of the population.

Innovation Areas	
Curriculum	Material
Education method	Online platform
✓ Industry engagement	Physical infrastructure
✓ Organizational setup	Skill type

Chicago Codes is an 11-week learning program designed to address the need for software developers in Chicago's job market. The initiative was launched by the local government and Chicago Workforce Partnership — the largest non-profit workforce development system in the United States, which combines federal and philanthropic resources.[72] It is open to all residents of the city who are at least 18 years of age and proficient in English.

71 https://www.techtalentpipeline.nyc/building-the-pipeline/joinus.

72 https://chicookworks.org/about-us/.

Talento Digital para Chile.

Different from other coding bootcamps, Chicago Codes is tuition-free. The curriculum is industry-approved and teaches the skills necessary for pursuing a career in software development, such as programming in Python. Students also participate in internships with local firms. The program has the support of Microsoft, Facebook, and The Rockefeller Foundation

4.5.3. Talento Digital para Chile

talentodigitalparachile.cl
Chile

Talento Digital para Chile is a public-private initiative executed by Fundación Chile and Kodea Foundation. Its goal is to identify emerging skills that firms need and then launch programs to impart the skills to workers, expanding their employment opportunities.

Innovation

While similar to other programs in Chile — providing a common forum for companies, training institutions, and government — this initiative is innovative because it combines the efforts of these entities to develop new capacities in people in tune with the demands of the digital economy.

Innovation Areas	
Curriculum	Material
Education method	Online platform
✓ Industry engagement	Physical infrastructure
✓ Organizational setup	Skill type

Talento Digital para Chile is a public-private initiative executed by Fundación Chile and Kodea Foundation that integrates the efforts of companies, learning institutes, and the Chilean government to develop skills for the digital economy. The aim is to accelerate the transition to a new market, by improving people's abilities that are in high demand within companies and industries.

The collaboration launched in 2019 has three elements: identifying employer needs in partnership with companies, training, and job placement. It aims to instruct 16,000 people by the end of its first phase in 2022.[73]

Talento Digital adapted the American bootcamp format to Chile's context, where this type of training was previously scarce. They offer intensive courses of short duration (less than six months), focusing on developing skills on day one. Other abilities taught

73 https://fch.cl/iniciativa/talento-digital-para-chile/.

include job search strategies and networking. Usually, training is delivered in a live format. But due to the COVID-19 pandemic, all lessons have been moved online. Courses cover programming languages, and range from beginner level to specialized training. Enrollment options include: UX design, front-end developer, full-stack JavaScript, Python, and full-stack Java. All curricula are validated by specialists in the private sector, and aligned with labor market needs.

The inspiration for the Chilean model came from the New York Tech Talent Pipeline, which follows a similar strategy and supports local communities.[74] As in New York, in Chile, the goal is to empower a diversity of people interested in careers related to digital technology, and providing them with the possibility of accessing quality jobs. In 2020 alone, the initiative offered 4,450 scholarships, while also making available free programming and design courses.[75]

4.5.4. Apprenticeship Carolina

www.apprenticeshipcarolina.com
USA

Carolina Apprenticeship program works with employers in South Carolina, providing access to information and resources to create apprenticeship programs at their businesses. They provide their services at no cost to the companies involved.

Innovation

Apprenticeship Carolina targets only the industries that need workers the most, giving students the best chance of landing a job.

Innovation Areas	
✓ Curriculum	Material
Education method	Online platform
✓ Industry engagement	Physical infrastructure
Organizational setup	✓ Skill type

Founded as a division of the South Carolina Technical College System, this program works with employers in South Carolina, providing access to information and resources to create apprenticeship programs at their businesses. They provide their services at no cost to the companies involved.[76] Rather than focusing exclusively on outreach and recruitment of apprentices, Apprenticeship Carolina reaches out to businesses to ensure they have the resources they need to sponsor formal apprenticeship programs. Apprenticeship Carolina targets only the industries that need workers the most, giving their students the best chance of landing a job.

The program provides consultants with expert knowledge to guide companies through the registered apprenticeship development process, specifically the process of collecting information and registering in a national database — called the Registered Apprenticeship Program — maintained by the U.S. Department of Labor.[77] Apprentices have a wide variety of options to choose from, with more than a thousand registered programs in the state through colleges, and 232 youth apprenticeship programs.[78] Apprenticeship Carolina has worked to expand the number of occupations for apprenticeships, realizing that an innovative economy involves hundreds of diverse professions. They have also worked to expand access to as many workers as possible, allowing anyone over the age of sixteen in South Carolina to get involved in an official internship.

Apprenticeship Carolina reports that it efforts have reached more than 35,000 apprentices through the participation of 16 colleges and representation in all 46 counties in the state. Apprenticeship Carolina also focuses on building the South Carolina economy. It works with other business groups in the state, such as the readySC technical college program, to provide assistance in South Carolina's overall effort to build a competitive workforce and meet the needs of a changing economy.

4.5.5. P-Tech

www.ptech.org
New York, USA (headquarters)

P-Tech provides students with programs for earning a high school diploma, an industry-recognized associate degree, and hands-on work experience in a field of increasing importance to the workforce.

Innovation

The P-Tech model has expanded to more than 20 countries and includes close partnerships with more than 200 universities that grant students tremendous access to opportunity in the labor market following graduation.

74 https://www.techtalentpipeline.nyc/.
75 ibid.
76 https://www.apprenticeshipcarolina.com/about.html.
77 https://www.apprenticeship.gov/registered-apprenticeship-program.
78 https://www.apprenticeshipcarolina.com/by-the-numbers.html.

Innovation Areas	
✓ Curriculum	Material
✓ Education method	Online platform
Industry engagement	Physical infrastructure
✓ Organizational setup	Skill type

P-Tech is an education program that provides an opportunity for students to earn a high school diploma, an industry recognized associate degree, and work experience upon graduation. Developed by IBM, P-Tech is a new model of school to prepare youth with the academic, technical, and professional skills required for success in the 21st century job market. This approach addresses the current gap between the ambitions of students for a college degree and a subsequent career, and the needs of employers in high growth industries.[79]

The primary goal of P-Tech is to expand access to education. The model emphasizes college attainment and career readiness, meeting the desires of its students and the needs of its industry partners. P-Tech schools include students as young as ninth grade, and typically last for six years: four years of work towards a high school diploma and another two years towards the associates degree or other attainment in a STEM field. Along the way, P-Tech provides students with work experience through mentorship, worksite visits and, eventually, paid internships. These programs include public-private partnerships that focus on areas such as IT, healthcare, and advanced manufacturing. Upon graduation, students choose to either proceed to a four-year degree program or seek an entry level career. In some cases, students who move at a quicker pace will complete the six-year model in as little as four years, allowing them to take advantage of these options even sooner.

The P-Tech model has expanded to more than 20 countries and includes close partnerships with more than 200 universities that grant their students tremendous access to opportunity in the labor market following successful P-Tech completion.[80] In the United States alone, P-Tech has 120 school partners and 78 college partners, giving them a strong foothold for future growth.

4.5.6. Skillful

www.skillful.com
USA

Skillful works to create opportunities for Americans, particularly those without college degrees. It connects employers, educators, career coaches, policy makers, and people in the workforce, works with these stakeholders to create labor markets that value skills, while also providing training to workers.

Innovation

Skillful works with industry at the local level (city, region, state) to identify skills needs (not backgrounds or degrees), and trains people in the workforce to meet those industry needs. In some way, it is a broker and marketplace of skills, and training facility.

Innovation Areas	
✓ Curriculum	Material
✓ Education method	Online platform
✓ Industry engagement	Physical infrastructure
Organizational setup	Skill type

Skillful is a non-profit initiative of the Markle Foundation working to help Americans build professional skills and find high paying jobs.[81] Skillful works to expand the number of employment opportunities for individuals without four year college degrees, as well as to pool resources from employers, educators, and policymakers to find new channels for skill development.

Skillful has formed a close partnership with Microsoft and many local organizations to expand access to resources at the grassroots level.[82] These include career coaches, educators focused on lifelong learning, and employers. Collaboration among these groups makes Skillful's approach unique, and expands access to training, tools, and innovative methods on a national level.

As they began to scale up their initiative, Skillful targeted two U.S. states as the focus of their local approach: Colorado and Indiana. The Colorado operation got underway in 2015 and worked closely with the Governor's office to redirect efforts of the state government to foster a skills-based labor market. In 2018, the program expanded to Indiana and began coordinating with key organizations across that state. Skillful has an Executive Director on the ground in both Colorado and Indiana, each coordinating with the Executive Director of Skillful as a whole.

79 https://www.ptech.org/about/.

80 https://www.ptech.org/p-tech-network/our-schools/usa/.

81 https://www.markle.org/.

82 https://www.skillful.com/about.

In addition to the local emphasis on Colorado and Indiana, Skillful has built a network with a 29-state membership. With both a state and local approach, Skillful can refine its local approach in Colorado and Indiana, while building relationships in other states where it could one day expand. As its regional partnerships grow in number, its collaborative network grows in size and effectiveness.

4.5.7. Industry 4.0 Higher Apprenticeship Program

www.swinburne.edu.au/industry-4-0
Australia

Industry 4.0 Higher Apprenticeship Program trains participants to work in the advanced manufacturing environment, teaching them digital technologies and engineering. Students engage in a two-year apprenticeship-centered program developed with industry partners and receive an Associate Degree in Applied Technologies.

Innovation

The Industry 4.0 Apprenticeship program was co-designed between industry and academia, and combines the Germany-inspired vocational training method within a higher education framework. It also displays an innovative institutional setup and scale-up approach.

Innovation Areas	
✓ Curriculum	Material
✓ Education method	Online platform
✓ Industry engagement	Physical infrastructure
✓ Organizational setup	Skill type

The Industry 4.0 Higher Apprenticeship Program prepares students in Australia, both those with degrees and those seeking them, for jobs in high-technology manufacturing. It was established in 2018 as a public-private partnership with resources provided by the Government of Australia, Siemens, the Australian Industry Group, and a consortium of higher education organizations led by Swinburne University of Technology. The initiative is an outcome of the work done by the Australian Prime Minister's Industry 4.0 Taskforce,[83] which has Swinburne's former Vice President of Research and Enterprise (now at RMI University) as one of its members, and is chaired by the CEO of Siemens Australia-Pacific.

The program adapted the German vocational training approach to the Australian context, and was piloted by Swinburne University of Technology in Melbourne. Siemens played a key role in the program design — donating software tools to university partners, connecting Australian higher education institutions with industry and academia in Germany, providing a template for the curriculum based on its apprenticeship program in Berlin, advising on program design, hosting training activities, etc. — and Swinburne led a coalition of higher education institutions that includes the universities of South Australia, Tasmania, and Western Australia, as well as the University of Technology Sidney and Queensland University of Technology. Participants of the Industry 4.0 Higher Apprenticeship Program receive an Associate Degree in Applied Technologies.

Its academic curriculum runs concurrently with on-the-job training of students who work in apprenticeships for nearby companies. This approach focuses on eliminating redundancy between university and industry training, and enhances workforce readiness — graduates are ready to work in industry when they finish the program.

The first cohort of 20 students was trained by Swinburne in 2018 and 2019. The program now has the previously mentioned universities involved in delivery and is scaling-up internships across the country. One hundred twenty students are currently enrolled and the program's leadership team envisions that 1,000 students could be participating in the program in 3 years, and a total of 10,000 graduates in the next 5 years.

The Industry 4.0 Higher Apprenticeship Program relies on partnerships to scale-up. It is developing a partnership with the Australia's Advanced Manufacturing Growth Centre, which maintains more than 1,000 connections with small and medium sized enterprises that could provide connections for apprenticeships, and has presence in major manufacturing clusters in the country.

Going forward, the Industry 4.0 leadership identifies their challenge as finding strategies for sustainable growth of their model as they expand to more subject areas such as artificial intelligence and machine learning. They hope that, when Industry 4.0 becomes the standard, they can continue providing skill development both in partnerships with universities and by sharing their resources directly with those seeking to succeed in the new economy.

83 https://www.aigroup.com.au/policy-and-research/mediacentre/releases/0db37b24-ab1c-e611-80ce-0050568007a5/.

National College for Advanced Transport & Infrastructure, Doncaster.

4.5.8. National College for Advanced Transport & Infrastructure

www.nchsr.ac.uk
Birmingham, UK

National College for Advanced Transport & Infrastructure is a pioneer joint venture of the United Kingdom government and private partners in the rail transport industry.

Innovation

NCATI is innovative in its degree of industry engagement. The college was founded for the express purpose of developing a workforce capable of performing high-quality work on specific rail projects.

Innovation Areas	
✓ Curriculum	Material
Education method	Online platform
✓ Industry engagement	✓ Physical infrastructure
Organizational setup	Skill type

The National College for Advanced Transport & Infrastructure, originally known as National College for High Speed Rail, is a pioneering joint venture of the U.K. government and private partners in the rail transport industry. Founded in 2017, the NCATI is a "new kind of college" with a highly specialized faculty who seek to provide students with the skills to build the rail industry of the future. The College has two campuses — its main campus in Birmingham and another in Doncaster — both with access to a variety of resources for training students for industry work in high speed rail.[84]

Students choose to either participate in apprenticeships or full time-courses. The College offers both a Certificate of Higher Education and an Access to Higher Education Diploma, which still allow students to learn-by-doing by exposing them to new technologies and facilitating mentorships with industry leaders. Apprenticeships combine the College's instruction with companies developing the next generation of trains, carriages, and track and digital systems. The different levels of coursework available in the classroom complement a wide variety of apprenticeships for students with different skill levels. Some of these apprenticeships focus more on basic skill building, while others work to provide complex skills to lay the foundation for a career.

4.5.9. Reflecting on Economic Development Skills Initiatives

The eight economic development skills initiative cases share some important common characteristics:

- Have economic development as their primary goals
- Were established and/or operate as public-private partnerships
- Leverage resources from a network of partners.

84 https://www.nchsr.ac.uk/about-us/.

The economic development skills solutions featured indicate that:

- Industry partnerships are essential for effective skills development initiatives.
- Public-private partnerships can only exist in environments that have legal frameworks that allow for these partnerships in a practical and secure way.
- Learning from existing experience is valuable and adaptation is critical.
- New programs can harness the potential of existing solutions.
- Industry leadership is critical to build skills partnerships that provide participants with real-world experiences and equip them with relevant skills attuned to today's need.
- Skills development initiatives need practical solutions to scale up.

5. Trends and Lessons Learned

The 31 cases examined, and other policies and programs described in this report represent a rich set of experiences from which insights can be drawn. This closing section reviews the main findings and lessons learned, and identifies key trends that will shape skills development initiatives in the years to come.

5.1. Lesson Learned

1. Awareness and action related to future skills are on the rise. Interest in developing skills for the future is growing in both advanced and emerging economies, and igniting new initiatives. Policy leaders are including future skills development in their agendas, and updating and/or piloting policy solutions to address the challenge, while entrepreneurs are taking advantage of growing demand and launching new schools, programs, and software solutions. The emerging skills development landscape is diverse, with responses that in some way combine: (i) new policies that mobilize traditional tools, (ii) new types of tool, (iii) citizen empowerment, (iv) a revigorated emphasis on public-private partnerships, and (v) experimentation.

2. It is easier to inspire than to actually develop skills. There is an abundance of technology, courses, workshops, and programs focused on future skills, particularly digital and soft skills. Those provide value as they raise awareness about rapid technology advancement, new business models, and organizational forms, and they energize participants. However, this research suggests there is a gap between that activity and the existence of solutions that actually deliver the skills needed to perform digitally-enabled and innovation-related work in a real business environment.

3. Benchmark initiatives emphasize both soft and hard skills. Most of the solutions featured in this report address the development of both hard and soft skills. This is especially true with respect to incorporating advanced technologies in business; it is important for professionals to know how to use certain technology and how to work with other people to integrate new technologies with the legacy systems that currently support business operations. Working with teams and knowing how to use a toolset in practice is the overarching challenge.

4. The most ambitious programs are problem-oriented and have strong linkages with industry. They combine the development of hard and soft skills with an industry context, such as an industry internship or apprenticeship, mentorship, work on real industry projects, engagement with industry personnel, participation on industry problem solving teams, etc. The design and deployment of this type of program requires deep engagement with industry.

5. Successful programs emphasize career services. In addition to developing hard skills, a fundamental part of the services successful programs provide to their participants is related to career development. Activities include workshops, mock interviews, coaching sessions, CV and LinkedIn review and bootcamps, self-assessment, portfolio preparation, networking sessions, etc.

6. Significant social capital is needed to develop a program that resonates with industry. Technical content alone is not enough. To create successful programs, organizers need deep relationships with industry and be able to mobilize industry resources (mentors, facilities, equipment, knowledge, etc.) in program deployment. Developing relationships with industry and tapping industry assets is an important part of any successful program, beyond academic capacity or credentialling.

7. Scaling up is challenging. In response to a growing demand for coding and, more recently, data analysis skills, a number of independent schools were launched around the globe in recent years. These bootcamp-like programs last for a few months and claim to develop the skills that are needed for software development jobs. In spite of their success and the quality of the professionals they train, they remain limited in scale.

8. Innovative programs that target mid-career professionals are increasingly designed to accommodate participants' schedules. Instead of forcing participants who are in the workforce to adapt to the schedules that schools and programs offer, successful programs allow participants to study while they continue their professional activities. This type of approach is increasingly critical, as skills requirements continue to evolve and an expanding number of white- and blue-collar professionals are required to become life-long learners.

9. Selection processes are very important for success. Some of the most innovative and successful solutions featured in this report emphasize selection processes, which resemble more the selection for a professional job than for a course. On the one hand, this allows for a better fit in terms of participants' profiles; on the other, and above all, the selection process requires applicants to polish their skills.

10. Technology offers possibilities to expand access and enable new learning experiences. Classic in-person training and education remain an effective way for students to become more proficient in new skills. But an increasing number of schools also provide virtual classrooms and online education, which increases access to education for students living in more remote and underdeveloped areas around the world, and lowers the financial thresholds for participation. Technologies such as VR/AR, social networks, simulation, and others offer new opportunities to develop skills and can be deployed to power in-person and online programs.

11. There is growing interest in national and city-level public-private partnerships (PPPs) to develop digital skills. City and national governments are increasingly assembling programs governed by leaders from the technology industry (e.g., software, IT, etc.) and implemented as PPPs. Such programs normally have a content partner that provides expertise, the education method, and training platform, and leverage the relationships of the leaders who take part in the governance body to create opportunities to connect participants with industry and train them in practical, soft skills. Programs can be government and/or industry funded.

BOX 10

Successful Skills Development Strategies

- Academic content combined with practice in an industry context
- Flexible schemes that enable working students to participate in programs
- Mentoring, support, and coaching provided by people with industry experience
- Challenged-based learning to develop soft skills
- Industry leadership in the design of skills development program/school
- Career services to connect participants with job markets
- Highly curated, structured, and applicant-focused selection processes
- Online, globally distributed teamworking for management and leadership training
- Bootcamp models for software coding and development of soft skills
- Adaptive learning combined with peer-to-peer support and mentoring
- Technology to support and augment learning experiences
- Data analytics to monitor and respond to individual student performance

5.2. Trends

The analysis of the cases presented in this report and the lessons learned from them point to continuing trends and new developments in the years ahead.

Trend 1. Technology education and leadership skills development will be increasingly highlighted in early education inside and outside of the traditional education system. Artificial intelligence education programs for children can be expected to become popular.

Trend 2. As the digital revolution continues to scale, more coding bootcamps, and digital and innovation schools coming to the market can be expected. Independent providers of that type of training will partner with formal education institutions, from kindergarten to higher education, and even provide branded training programs.

Trend 3. The importance of soft skills will be increasingly recognized. As technical content and training become widely available online, the differences in performance and productivity arising from the lack of soft skills that are commodities in advanced economies will be increasingly noticed in emerging nations.

Trend 4. Online education will continue to expand — across the board, at all education levels, for all trades and professions, and for hard and soft skills. Enriched and immersive platforms are likely to become more widely used, from Google Expedition to new EdTech solutions.[85]

Trend 5. Experiential learning will probably gain momentum. As educators, students, industry leaders, and other stakeholders increasingly recognize the positive results of the method, it is likely to become more popular. As the design of experiential learning programs is different and generally more demanding than traditional methods, scale may be limited, but there is an opportunity for businesses and schools that focus on training the trainers.

Trend 6. Demands will grow on education and training institutions to offer flexible training and education options for people in the workforce. They will likely respond with a variety of part-time, competency-based, adaptive, flexible skills development programs to serve a growing cadre of lifelong learners.

Trend 7. New programs to develop hard and soft skills will continue to appear in the market as the economy changes and becomes more complex. The future skills development landscape can be expected to be characterized by diversity, with a plethora of programs, schools, and courses being launched across the globe. This can make choices more difficult for people in the workforce, and new tools such as marketplaces can be implemented by government and/or industry to inform the choices of those exploring training and education program options. In some nations, governments will empower citizens to make their skills development choices using vouchers and/or skills tax credits.

Trend 8. Education systems will be challenged to change, become more flexible, and widen the tools they use to certify skills, or even accept certifications from outside the formal education realm, such as those provided by companies, independent schools, and even individuals and the crowd (e.g., reputation, badges, starts in social platforms, or others). As institutional change is slow and the performance of work and work teams increasingly cross national boundaries, there could be intense debates on the matter worldwide in the coming years.

85 https://edu.google.com/products/vr-ar/expeditions/?modal_active=none.

Appendix: Interviews

Interview with Sven Rahner, Head of Secretariat of the German National Skills Strategy

GFCC: Mr. Rahner, Germany is one of the countries that addressed Industry 4.0 and digitalization very early on. In relation to skills and education, what are the key challenges that Germany is facing and how are you addressing them with the National Skills Strategy?

Sven Rahner
Head of Secretariat, German National Skills Strategy

Dr. Sven Rahner: Germany has a very skilled workforce and a strong manufacturing base. For us, ensuring the steady supply of skilled workers and addressing the increasing skills mismatch is the main priority. Our goal at the National Skills Strategy is to develop concrete solutions with our social partners, with industry and labor unions, to make the transition as smooth as possible. The issue of skills development is prioritized because of digitalization and also because of demographic challenges: our society is aging. There is the issue of threatening unemployment of skilled, middle-aged workers. Digitalization makes this issue even more pressing. Within the Ministry, monitoring of the need for skilled workers has shown that by 2025 we will have a total job loss of around 1.3 million while a total of 2.1 million jobs will be created. By 2035 the picture is very different: 4 million jobs will be lost while 3.3 million jobs will be created. Our predictions have shown that if we do not meet the demand for training and education, we may face a loss of production of 100 billion € per year.

GFCC: In your experience with the German industry, what do you think will be needed with regard to skills development and training?

Rahner: It's clear that we will need a combination of very specialized skills and general skills. In light of the increase of digital technology in everyone's work and life, we obviously have to make it a priority that every worker is equipped with basic knowledge of digital technology, especially for low-skilled and older workers. We need to bring more people to completion of their professional degrees, and we need to allow for flexible solutions that allow workers to adapt to changes in the industry. We need more employment options and possibilities for change over the course of a worker's working lifespan. We are examining individualized instruments to develop these existing skills or facilitate a switch into industries that are likely to experience employment growth.

GFCC: Between research and your engagement with social partners, what is the main purpose of the National Skills Strategy?

Rahner: Originally, the National Skills Strategy developed from a number of existing committees on skilled workers and industry specialists. In 2018 we needed to streamline these efforts and developed a strategy across different ministries. The National Skills Strategy is a joint project of the Federal Ministry of Labor and Social Affairs as well as the Federal Ministry of Education and Research. And because of the federal system in Germany, we are also involving the Bundesländer and their respective Labor, Education, and Economic Affairs Ministers. Additionally, we have industry groups and members of our confederation of labor unions involved. Within our economic and social system, we see this inclusivity in finding a solution as a key to success and a broadly carried decision and policy-making process. At the same time, we also see our role as an intersection between policymaking and civil society. The transition costs from digitalization are worrying for some and we want to ensure that workers

can rely on guidance about their individual professional developments. Providing and expanding on our advisory services is therefore also a priority for us.

GFCC: What policies and legislation have come out of this initiative?

Rahner: Since our inception, we have drafted and developed concrete policies. For a long time, re-skilling and expanded training were predominantly available for the unemployed to facilitate re-entry into the labor market. The approach that we are aiming at is an "Employment Insurance" rather than what we already have in place, only the unemployment insurance. In other words, prevention and anticipation are important. The Skills Development Opportunities Act is an example of the first step of such preventative measures, which already contains a binding right to counseling on continuing education and training by the Federal Employment Agency and extends support for continuing education and training to workers who are affected by structural changes regardless of their qualifications or the size of their company. Right now we are working on another legislation the Work for Tomorrow Act, which specifically addresses education and training for short-timed workers, which not only allows for added training but also encourages and supports workers to catch up on vocational qualifications.

GFCC: What is your main audience for these policies? Do you have a focus on specific worker groups that are more or less vulnerable in this transition?

Rahner: Given that the National Skills Strategy is under the guidance of the Ministry of Labor and Social Affairs as well as the Ministry of Education and Research, we are certainly addressing more the issues of blue-collar workers and low-skilled workers. The big challenge for blue-collar workers is automation and direct competition with advanced manufacturing technology, so there is a strong need to upskill.

GFCC: You mentioned the National Skills Strategy is a very cooperative initiative. Given the challenges faced, how do you capture what falls into the financial and organizational responsibility of industry, companies, policymakers, educational institutions, and labor unions?

Rahner: We definitely see a shared responsibility here. It's reflected in how we distribute the costs of such innovative solutions. We know for sure the market alone cannot regulate this. Skills development has largely been a patchwork of different actors finding different solutions over the years and it's largely worked out well. But these are unprecedented times and so we see our responsibility in bringing these actors together and finding a coherent solution in line with an inclusive industrial policy. In terms of the financial responsibility, this is a joint effort–but equity and equality for the individual is a big priority. We are very fortunate that we have very well-established industrial relations and that our industry partners have a strong interest in upskilling locally, at the plant. This makes our initiatives accessible to workers.

GFCC: Earlier you mentioned that there are different international initiatives and discussions on a supranational level. What can you tell me about the National Skills Strategy's engagement with other national partners?

Rahner: Within the European Union there are also supranational discussions about such instruments. France and Austria, for example, have already developed similar ideas. The OECD is currently also working on a report on different national training and skills initiatives and their work is covering our work here at the National Skills Strategy as well, along with some case studies about other government initiatives. Korea, for example, is doing something similar. The ILO is also addressing the issue of skills and retraining at their congress in June this year. We have bilateral exchange with Japan as well — so we really want to exchange best practices with other countries around the globe who are faced with similar challenges.

Interview with Jeff Connolly, Chairman and CEO of Siemens Australia and Pacific; and Aleksandar Subic, Deputy Vice-Chancellor (STEM College) & Vice President of Digital Innovation at RMIT, about the Industry 4.0 Higher Apprenticeship Program in Australia

GFCC: How did you get to the concept and implementation of the Industry 4.0 Apprentice Program? What was the problem that you were trying to solve?

Jeff Connolly
Chairman and CEO, Siemens Australia and Pacific

Aleksandar Subic
Deputy Vice-Chancellor (STEM College) & Vice President of Digital Innovation, RMIT

Jeff Connolly: There was discourse in Australia about the lack of job-ready education outcomes. A person would do an undergraduate degree, go to a large organization and that organization would say: "I need to invest another two to three years to make this person job ready." I think the success achieved in this program is because it's an integrated model that breaks down those barriers.

Aleksandar Subic: We also saw for ourselves the dynamics of transformation in industry due to digitalization with whole sectors of manufacturing and other sectors entering. We basically conceptualized an advanced apprenticeship program which is also a new form of apprenticeship.

Connolly: There's a bit of background we should consider too. There was a Prime Minister's Taskforce put together via agreement between the Australian Government and the German Government, to look at how Australia could leverage the work of the Germans on Industry 4.0. It covered several aspects, including future of work and education. After twelve months of work, we focused on getting that component kicked off in a meaningful way.

GFCC: And what was your conclusion? What are the levers that you pulled? What did you and your colleagues decide to do in practice to build an impactful initiative?

Connolly: Siemens is the largest automation company in the world and also the largest industrial software company - including areas such as design, engineering collaboration, simulation and integration of cyber physical systems. We granted software licenses to each of the six universities participating in the network, and the institutions built curricula around those future-oriented, state-of-the-art, industry standard tools. We also provided access to key curriculum from the Siemens Professional Education Centre in Berlin.

GFCC: When you said in the beginning that you felt the need in Australia to address the industry readiness gap was that more linked to soft skills or hard skills?

Subic: In terms of hard skills, we realized that there's a need for far more advanced, comprehensive digitalization skills dealing with digital systems, integrating digital systems, developing digital twins, understanding how you can create autonomy intelligence within an industrial Internet of Things environment. We also realized that there was a level of soft skills needed to deal with complexity and work with far more diverse and geographically dispersed teams of technical and non-technical people.

Connolly: It would be fair to say in many countries we need more STEM skills. The realization in this particular program is we need more people that can operate in a real-world environment, use the tools, and work with different types of people by integrating hard and soft skills. They don't necessarily need to write the source code for an algorithm. The bulk of the jobs that are going to be needed are the ones that are actually down the stream from there but they do need to know what's possible and how to get it done.

Subic: In Australia, 95 percent of our manufacturing companies are small to medium enterprises. The future workforce has a key role to play in working within those companies, contributing at different levels, integrating different types of knowledge and helping transformation. In many cases it will be about knowing what's possible and then applying the skills with the right tools to make that a reality.

Connolly: In Australia we didn't have the benefit of the advanced apprenticeship approach in the German dual-education model. The model of moving students back and forth between a formal classroom in an education institution and a real company, putting knowledge into practice through an accredited higher education program did not exist here in this way previously.

GFCC: Have you worked in building the industry partnerships for the program to be delivered right when you talk about workplace learning? What were the dynamics of building the alliances and partnerships needed for that? That was certainly a critical factor.

Aleksander: This initial pilot was a partnership with Swinburne University of Technology, The Australian Industry Group and Siemens. From the outset, when we were developing the pilot and implementing the first phase of the program, Siemens focused on ensuring the participation of their supply-chain partners and arranging placement opportunities that were aligned with a common standard. In fact, Siemens even had their own staff member appointed to work with the university to ensure that was achieved. So, we've had co-management roles and co-coordination roles between the university and Siemens, and working with various industry partners. This work is ongoing and complex. We have now expended the pilot across a national network of universities including RMIT, University of Western Australia, University of Tasmania and University of Technology Sydney and have moved beyond the Diploma programs to degree programs as part of our scale up strategy. The network of universities engaging with industry more broadly beyond the initial pilot is a major milestone to see this program deliver real national benefits at scale.

Connolly: The decision to have grants for universities was key. Because of our scale, when Siemens said we would provide significant grants of our hi-tech industrial software, the Federal Government said if the university committed to develop the curriculum and implement the program, it would help fund universities to build physical environments, the test labs, for new technologies and skills development. These Industry 4.0 TestLabs led by Aleks are environments designed to engage with both students and industry so that Australian companies could continue to build Industry 4.0 capability by seeing what good looks like; by seeing what is possible in an Industry 4.0 environment with many different applications. This was all possible because of trusted long-established relationships.

GFCC: Let's talk a bit about the participants. What are their profiles? How did you select them?

Connolly: Siemens helped recruit students in the pilot stage, people with different backgrounds, coming from industry, coming from university and coming directly out of secondary school. For example, we had students who had two or three years of practical experience and had undergraduate degrees in engineering, but also participants who didn't have access to higher education and even some who were working in industry in areas such as geology but didn't see their future in that direction. We even had a beautician.

Subic: The interview process was designed to uncover their motivation, their thinking, their maturity, their ideas. It's a different approach than what a traditional education system would have. having an income whilst learning was critical for many of them who had to support their independence or their families and traditional university just wasn't an option.

GFCC: Could you share some figures on the scale of the program? How do you scale the two sides of your platform: industry and university? What are you doing to expand?

Subic: We initially implemented the Industry 4.0 Apprenticeship Program through a Diploma program and then expended this model across the network via an associate degree program. We're now running the associate degree program with a few hundred students trained and we launched a master's degree, which has another 500-600 students. We are expanding the whole initiative and deploying various programs across a national network of partner universities. Within a few years, our vision across the nation would be to reach a cohort of thousands of students going through a related grad and undergrad continuum which incorporates Industry 4.0 curriculum and skills.

Connolly: A critical aspect of the future success is to have partners to scale up. Outside of the Siemens business chain, in Australia there's the Advanced Manufacturing Growth Centre. They have over 1000 contact points with SMEs in this space. You also have The Australian Industry Group with over 60,000 members for example. These groups are all part of looking at how we expand the nation's capability when it comes to advanced manufacturing and Industry 4.0. Many companies need these types of skills in their workforce urgently. If you take a company like BAE, British Aerospace, for example, they're building frigates in Australia and need people who have skills in the latest technologies. Or even smaller engineering companies like DEACAM who provide technology and digital solutions to the craft brewing industry - they also need people with the right skills and expertise to help their customers digitalize and grow. Our pharmaceutical and chemical industries need people who have knowledge about advanced manufacturing so they can build greater sovereign capability for instance. There have also been additional funding announcements by the Federal Education Minister to support expanding the programs in the national network of participating universities. Success will come through collaboration.

GFCC: When you scale the program up and place students in different companies, they will have different experiences. How do you do quality assurance?

Connolly: We're working to build a national network and no doubt the programs will continue to evolve as we continue to learn and as the world continues to change. I mentioned the Advanced Manufacturing Growth Centre before... that and other organizations are critical nodes located in manufacturing clusters across the country. There is an actual natural magnetism for people working and interested in the manufacturing space. For example the Dulux Group in Australia have one of the most advanced paint manufacturing facilities in the world and this requires a completely different type of workforce. One which is more comfortable with a computer tablet and operating a paperless manufacturing facility than people who can lift heavy bags of

raw ingredients. We are weaving the network, connecting as many hubs as possible, leveraging demand and expertise. For example, HeliMods, an advanced helicopter aerospace company in Queensland who use digital twin technology to innovate and supply critical solutions around the world, is now working with the University of Queensland - one of our national network of universities. We need this holistic and interconnected view to really bring this topic of the Fourth Industrial Revolution (Industry 4.0) to life for Australian business.

Aleksander: And we've been sharing the learnings, sharing the information, sharing the model actively through the network because we work very closely together. So basically, all those industry partners or potential industry partners are via those clusters, those hubs inducted into the model, inducted into that philosophy, inducted into the practice that we've been developing, and in a way that practice is becoming standard practice. We've now brought the whole work stream model under the umbrella of the Australian Industry Group, which involves, more than 60,000 companies and businesses.

GFCC: This is amazing. But I imagine you faced many challenges along the way. Could you comment a bit about that and maybe the challenge that you foresee going forward to scale the program up?

Subic: From my perspective, the biggest challenge was to work across the artificial boundaries of universities, business and other institutions: to really connect all the stakeholders in a kind of a seamless ecosystem approach. This had to be done in a strategic and non-competitive way with the goal of creating a national capability. Going forward, the biggest challenge is to scale up and expand beyond the initial network of universities. We have over 40 universities in Australia and New Zealand. True impact and scale will only be achieved if we bring more partners on board and I'm please to say that this is underway.

Connolly: It is important that this is not seen as a technology specific approach. The worst thing that could happen is to have somebody saying: "Well, Industry 4.0 is yesterday's news. We're going to Industry 5.0." I think that actually would be an indicator of a complete misunderstanding of what we're talking about. As an overarching issue, postsecondary institutions will need to continuously focus on the provision of a series of accreditations through a lifelong journey of accreditation, and it's not just limited to the delivery of a standard undergraduate degrees. The minute you stand still with your knowledge is the minute you go backwards. A growth mindset requires a continuous focus and interest in learning, and people who have this mindset will ensure our region remains competitive and prosperous.

Interview with Ed Halliday, Chief Operating Officer at FireTech

Ed Halliday
Chief Operating Officer, FireTech

GFCC: Could you please introduce Fire Tech and tell us when and why was it created?

Ed Halliday: Fire Tech today is the U.K.'s leading provider of tech education experiences for 9 to 17-year-old and, in fact, probably Europe's leading provider at this point. We started in 2013, when our founder Jill Hodges, wanted her own children to learn about tech skills. Back then the only providers who would do it were only offering Web 1.0 content, so she decided to quit her job and do it herself. She recruited some tutors from local universities and ran a pilot at Imperial College London. And since then, we've grown and built all sorts of different curricula.

GFCC: This is super inspiring. And.. where do you stand today?

Halliday: As of 2021, we have reached more than 80,000 students during camps held online, and in classrooms in 20 locations across the UK as well as locations in Europe, Australia, the Caribbean, and the Middle East. Since 2020, Fire Tech has reached over 65,000 young people through their online courses, including in partnership with major tech companies, organizations, and governments, including Amazon, Google, Nesta, and the Saudi Space Agency. The way that work is broken down is that our core business in the U.K. is camps and tech clubs. The majority of those, at least until recently, were in-person holiday camps in school holidays structured around our 40 pieces of tech education curriculum in coding, robotics, AI, cybersecurity, creative design, how to set up your own YouTube channel, all sorts of different content with tech at its core. We have pivoted in 2020 to become an online education business, with live and blended, self-guided tech courses available to students across the world, and now aim to become the leading education platform for STEM education across the world.

GFCC: Who actually delivers the camps, your team or the schools?

Ed: Our camps and programs are delivered by our expert tutors who are recruited and trained from some of the U.K.'s leading universities The idea is that this is education that is relevant and cutting edge in a way that schools don't have the means, the resources to deliver.

GFCC: What do you mean when you say it is cutting edge? What is distinctive in your approach to the school IT or robotics class?

Halliday: We want our students to discover the latest technologies and learn in a way that is completely different from school. Our courses are structured in small classes, maximum of eight students per class, and centered around challenge-based learning. Challenge-based learning is very rigorous, true to real-life applications of these technologies. Students learn from expert young innovators — design engineers, AI engineers, and PhD researchers from the UK's leading universities — who are just a few years ahead of them, so are very relatable and inspiring.

GFCC: Your model looks super cool, but it seems to be hard to scale it up. How are you addressing that?

Halliday: Now we're at a point where we're really looking to scale it up. Our goal is to build a global subscription platform for STEM education, combining on-demand learning content with access to live tuition from expert instructors, that provides K12 students with the inspiration, skills, and experience to become tech innovators of the future. There's a huge pressing demand across the world and we are forming partnerships with corporations such as Amazon in the U.K. We're working with Arm which is a big hardware and tech company, WPP, Barclays, a few others, and governments like the Sultanate of Oman where we are running an online program for 15,000 young students.

GFCC: What innovations you see coming up in children's tech education and training? Anything that you are doing?

Halliday: Yes, definitely. This possibly the most exciting thing we are doing. What we are working on is a kind of three-sided marketplace that Fire Tech — and our curriculum and tutors –the students and then employers themselves to create virtual work experiences. This is something that's actually very hard to access particularly, you know, dependent on socioeconomic background. We deliver [work experiences] virtually to help students build a portfolio which would then make them relevant to future employers... and they can do this at age 15.

GFCC: Could you explain a bit more about the virtual job experience?

Halliday: First thing: this is a very early stage. We are just prototyping how this is going to look and opening that up to partners. This is about contextualized learning. For instance, a student can choose to work for a video game studio — we're in early discussions with Epic Games who's the creator of Fortnite and Unreal — and they could, for example, sponsor that whole experience.

GFCC: How does that work in practice?

Halliday: It is very oriented toward doing things, real projects. Over the course of a week, participants would meet up with a boss, a person from the industry sector, and then be commissioned to work on different projects. What we've been talking to Epic Games about are projects in 3D visualization or engineering, animation, operations. You could pick a series of projects or challenges and build your own work experience, plan, or project-based on those. And then, over the course of a week or two weeks, or however long your work placement would last, you set challenges and complete them virtually.

GFCC: That is ambitious. What's the age range for participants?

Halliday: We haven't really nailed down exactly who this is for, but provisionally it would be for 14 to 17. And then we could look to expand beyond that.

GFCC: So you are building in order really to deploy this full-fledged, do you need a roaster or a consortium of the industry partners?

Halliday: Potentially, we could do it ourselves, but actually it really comes to life in partnership because we want it to be real, we want it to be tangible, and we want it to be relevant to employers. Ideally, a whole consortium of employers will get behind this.

GFCC: Do you imagine participants working alone or in teams or both in this new model?

Halliday: The idea is to basically structure each day like a stand-up meeting as if you are working in a dev team. Then you actually feel like you're part of a group because work is not like this. Usually working remotely means independently. This is working with others. We want to build that in as a core component of the experience.

Interview with Gianna Sagazio, Innovation Director of the Brazilian National Confederation of Industry

Gianna Sagazio
Innovation Director, Brazilian National Confederation of Industry

GFCC: Why was CNI interested in creating a report on future skills? What incited the start of the project?

Gianna Sagazio: As the official representative of the industrial sector in Brazil, CNI is aware of the obstacles and demands from industrial companies in Brazil. Adding to this representative role, CNI also coordinates the Entrepreneurial Mobilization for Innovation (MEI), a movement of more than 300 innovative companies in the country that work together to promote the Science, Technology, and Innovation (STI) agenda. Therefore, CNI-MEI work to promote and foster modernization, productivity, innovation, and, consequently, competitiveness in the Brazilian industry. Being a country of more than 200 million citizens and the 12th largest economy in the world, Brazil has the resources to be a more competitive and innovative economy. But structural obstacles create gaps in the path of social and economic development. One of the main areas in the CNI-MEI agenda is focused on Human Resources for Innovation. Manufacturing is one of the productive sectors that is more exposed to the technological development applied to the production models and the evolution of work. Companies are always pressed to adapt their production processes to the new technologies to remain competitive, as Industry 4.0 is a consolidated reality, and their workers face the challenge to keep up with these changes. In this sense, knowing the main trends in professional skills for the industry in the future is essential for any company to create medium and long strategies and maintain or regain their competitiveness.

GFCC: How would you describe the current situation in Brazil concerning the development and preparedness of future skills? In which ways is that comparable to other emerging nations in Latin America, Africa, and Asia?

Sagazio: Brazil faces serious challenges in basic and professional education, which is also an obstacle for companies to be more competitive. If we observe Brazil's position in different international rankings, they are not reasonable considering the country's potential. In the Program for International Student Assessment (PISA) from the OECD, Brazil occupies one of the lowest positions amongst the 79 countries accessed by the survey. This weakness in education reflects directly on the productive sector. With deficiencies in basic education, especially in sciences and mathematics, Brazil also lost positions in international competitiveness rankings. Between 2011 and 2019, Brazil lost 18 positions in the World Economic Forum's Global Competitiveness Report, ranking 71 amongst 141 countries in 2019. For the skills section of the Report, Brazil placed 96th. In a new study from CNI in partnership with the Portulans Institute, addressing the Future Readiness Index, which analyses Innovation, Talent, and Technology aspects in different countries, Brazil is also at one of the last positions of the rank. To summarizing, we are aware of where our weaknesses are and where to act, but there is a long and challenging path ahead. Comparing to the BRICS countries, Brazil does not lead in basic education aspects but is competitive in scientific production. According to the Future Readiness Index, China is ahead, and Brazil and South Africa have comparable positions ahead of India. The fast pace of Asian countries' development in technology and innovation is a result of years of focused education and industrial policies and private investments and should be a reference for developing countries such as Brazil. Nevertheless, in the Latin American context, Brazil has significant advantages in terms of human resources for STI and the manufacturing sector. With the right goals, the entrepreneurial sector and the government can work together to promote major changes in our competitiveness.

GFCC: What are the critical areas to advance in Brazil? Could you identify the main available initiatives to address these areas?

Sagazio: Considering the industry point of view, professional training is one of the most strategic areas to prepare companies for the future. With the rapid changes imposed by technological development and disruptive innovations, companies and professionals have to keep up with new tools and processes applied to production. The rise of digital technologies, that lead to the now well-known Industry 4.0 context, impose new challenges to the traditional models of production. To respond to those challenges, companies need to invest not only in the modernization of their equipment and machines but also in the training of their workers to operate in this new context. So Brazilian companies, in an effort to reach out for a place in the global market, are searching for fast and effective ways to adapt to new product solutions and the new skills required to operate them. One of CNI's branches, the National Service for Industrial Training (SENAI), has made important and notorious progress in professional training for the industry in Brazil. SENAI offers industrial companies the opportunity not only to qualify their workers in the latest technological and managing trends of the various areas of industrial production but also offers a country-wide network of research and development centers focused on Technological development and Innovation projects.

GFCC: What are the skills that you see as the most relevant and urgent to develop at scale?

Sagazio: The Covid-19 pandemic exposed many weaknesses and tendencies with the intense changes imposed by the public health crisis, social distancing, and economic crisis. Not only in our personal lives, but also in the way we work. And Digital Transformation is one of these tendencies. Considering the rapid expansion of applications of digital technologies in industrial production and in telecommunications, some skills are more demanded now and should be even more in the future. Digital abilities and flexibility should be trends in professional skills in the near future, in various areas of the market. Also, with more intense use of automation and artificial intelligence by companies, more skilled and qualified professionals should be required. Science, engineering, and mathematics are already highly demanded qualifications in the market, but soft skills, such as communication abilities and critical and creative thinking, are essential to future professionals.

GFCC: How has CNI contributed to advance this agenda and reduce the skills shortage in Brazil?

Sagazio: Since 2016, CNI and MEI have acted, through a working group composed of companies, public and private institutions of higher education, representative entities in the field of engineering and government agencies, in favor of strengthening engineering education and promoting the STEAM (Science, Technology, Engineering, Arts and Mathematics) disciplines. The Engineering/STEAM WG has been dedicated to contributing to the modernization of the engineering National Curricular Guidelines of Brazil. The WG collaborated on a proposal for a new engineering curricular guideline to the government in the name of all its members. In 2019 it was approved by the Ministry of Education, and it has been disseminated all over Brazil since then. The WG has helped in this process, producing materials and organizing meetings to get together universities and companies to debate and share their experiences in implementing the new regulation. The WG is still active, and its members debate new alternatives and actions for the diffusion and adoption of STEAM disciplines by education and professional training institutions. Also, as a result of the Engineering/STEAM WG and to attend priorities of the Human Resources for Innovation agenda, MEI will create, in 2021, a platform to connect companies and universities, and in 2022, we plan to realize the National Forum for the University-Industry Articulation. The objective is to identify gaps in the relationship between universities and industry in the pursuit of innovation, as well as to promote the Interaction between them. Because professional training is such a high priority for the Brazilian industry, CNI and MEI have, once again, mobilized their companies to create a new initiative: the Professional and Technological Training Working Group. The new WG's main objective is to promote professional training in Brazil focusing on intermediary (High-School) education by interacting with federal and state governments and presenting its strategic value for the social and economic development of the country. The Professional and Technological Training WG had its first meeting this year and has already engaged large Brazilian and international companies and government and academia representatives in its agenda.

GFCC: Could you compare new models coming out of Brazil to other initiatives worldwide?

Sagazio: As mentioned above, the National Service for Industrial Training (SENAI), one of CNI's branches, is an example of success in the professional training area. Although its foundation dates to the beginning of the 1940s, the institution could keep up with the evolution of industry in Brazil and with the latest technological trends worldwide. SENAI has, today, 58 technological institutes and 26 innovation institutes distributed in the 27 Brazilian states. SENAI's model was inspired by European initiatives of industrial R&D and training centers. One of the inspirations was the Fraunhofer Institute in Germany. Recently, in 2018, SENAI and Fraunhofer established a partnership to modernize SENAI's institutes for innovation and guide their strategy in the Industry 4.0 context. This is an important initiative for the Brazilian industry not only because it proves that traditional institutions can evolve and provide companies what they need to be more competitive, but also because it makes clear the importance of partnership and connecting to evolve and innovate.

GFCC: What would you highlight as the main findings collected in the research that covered mainly the Brazilian landscape?

Sagazio: Some of the findings are undeniably more appealing to Brazil. One of these pressing trends in the digitization of education. As part of the larger process of digitization of the economy, education must be more digital to overcome the obstacles created by the Covid-19 pandemic. Particularly in Brazil, digital infrastructure and access to digital technologies (smartphones and computers) were a big issue when schools had to shut down, and students needed internet connection and devices to attend the online classes. To be more competitive, Brazil needs to

improve its digital infrastructure and online education models. Along with digital and online education, flexibility is already an important subject to develop skills in Brazil. Professional education is one of CNI-MEI priority agendas. The digital technologies applied to the industrial process are causing a great impact on productivity, but also an impact on work structures. Industry 4.0 or Advanced manufacture demands the reskilling of professionals in factories and offices all around the productive sector. In Brazil, where we already have obstacles in professional training, flexibility is a central question. Industry and education institutions in Brazil are discussing new ways to solve the gap between the market's demand for qualified professionals and the actual models of professional training and STEAM education. And flexibility should also be important not only in creating new models of reskilling the professional but also in including soft skills in the education of future professionals.

GFCC: What are the most interesting initiatives about skills that you have seen around the globe?

Sagazio: A major event that mobilizes young professionals from around the world and promotes the best practices in professional education is the World Skills. A competition in various areas of professional skills is held between students from different countries to stimulate exchange and inspire the new generations. In 2019, represented by SENAI students, Brazil ranked 3º amongst the 63 participant countries. Another dimension of skills that should be at the top of our priorities is gender equality in education. In this matter, the United Nations has been active and is promoting awareness about the persistent inequality between genders in STEAM education and professions. According to UN's International Telecommunication Union (ITU), while girls tend to outperform boys in reading and writing skills, they continue to be under-represented amongst top performers in STEAM. To reinforce the message that "careers have no gender," the International Girls in ICT Day initiative has for ten years now encouraged girls and young women to pursue STEAM education and help to reduce gender inequality in science, technology, and innovation areas.

Interview with Sebastian Espinosa, Managing Director of Coding Dojo

Sebastian Espinosa
Managing Director, Coding Dojo

GFCC: What do you think are the main challenges in skills and training?

Sebastian Espinosa: The main challenges are the speed of change and the amount of re-skilling and retraining needed in a short period of time.

GFCC: How is Coding Dojo approaching this challenge?

Sebastian: We do intense short programs that prepare people to get jobs. Basically, our boot camps teach people the skills and the abilities that are required to get a job in the tech world. Our main program teaches full stack development for different segments of the population.

GFCC: What skills do you believe will prove to be most important in the labor market in the next 5 or 10 years?

Espinosa: We teach languages like Python, JavaScript, and others, but most importantly we teach programming. Programming is an area where things are changing very fast. More than static knowledge, you need to be a continuous learner. We do that with programming, but we also do it with data science and cyber security.

GFCC: Okay, where are you planning to settle after the US?

Espinosa: We've been in different parts of the world, in Saudi Arabi, Latin America (Chile, Perú, Ecuador, and Costa Rica); in eastern Europe (Albania) and in the Middle East (West Bank).

GFCC: What do your students study? What are they attracted by?

Espinosa: Students come from different backgrounds. Some are just finishing school high school and want something to take into the marketplace and workplace. Others are university graduates: some have a technical background and others studied something else—others are working in something completely different. You could lose your job and come here for new skills to look for a job again.

GFCC: What makes your approach to skill training unique?

Espinosa: I would say it's having a very good curriculum that has been perfected over 8 to 10 years. Having our own instructors that create and handle the curriculum. Being very market oriented: we check, take what's required in the market and create a new curriculum. Also, this combination of training on site and online. It's the content, having our own structures and technically we're the only boot camp in the world that teaches three full stacks in 14 weeks. Because you learn different languages, you also see the patterns between the different languages.

GFCC: Do you think this skills training methodology is scalable to a national or global level?

Espinosa: Trying to replicate this in other places and it's totally possible. The need is everywhere. Companies cannot find the talent that they're looking for in this area. It's a good opportunity and what we do is totally transferable. We can teach others how to do it.

Appendix: Acronyms list

4IR	4th Industrial Revolution
AAAC	American Association for the Advancement of Science
AI	Artificial Intelligence
AIG	Australian Industry Group
CNI	Brazilian National Confederation of Industry
COAG	Council of Australian Governments
COVID-19	Coronavirus disease 2019
EU	European Union
EUR	Euro
GFCC	Global Federation of competitiveness Councils
IFTF	Institute for the Future
ILO	International Labor Organization
MENA	Middle East and North of Africa
MIGHT	Malaysia Industry-Government Group for High-Technology
NYC	New York City
OECD	Organization for Economic Cooperation and Development
STEM	Science, Technology, Engineering and Math
UK	United Kingdom
UCLA	University of California Los Angeles
UNESCO	United Nations Educational, Scientific and Cultural Organisation
US	United States of America
USAID	United States Agency for International Development
USD	U.S. Dollars
UX	User experience
VET	Vocational education and training
WEF	World Economic Forum

Global Federation of Competitiveness Councils

SUSTAINING AND GENERAL MEMBERS

Australia
Advisory Board on Technology and Healthcare Competitiveness

Government of Australia

Brazil
National Confederation of Industry — CNI/SENAI/SESI/IEL

Canada
Western Economic Diversification Canada

Greece
Council on Competitiveness of Greece — CompeteGR

Delphi Economic Forum

Japan
Japan Innovation Network

Japan Science and Technology Agency — JST

Kazakhstan
Kazakhstan Competitiveness Council

Malaysia
Malaysian Industry-Government Group for High Technology — MIGHT

Qatar
Qatar Research, Development and Innovation Council — QRDI

Russia
Eurasia Competitiveness Institute

UNIVERSITY AND RESEARCH MEMBERS

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RMIT University

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Qatar
Qatar University

Saudi Arabia
King Abdullah University of Science and Technology

Ukraine
Kyiv National Economic University

United Kingdom
Queen Mary University of London

University of Southampton

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