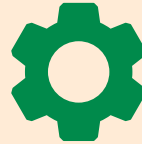# Education Policies and Programmes in G20 Countries

One Earth, One Family, One Future through Education

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ONE EARTH • ONE FAMILY • ONE FUTURE

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Report

Education Policies and Programmes in G20 Countries

One Earth, One Family, One Future through Education

Acknowledgements

Main acronyms and abbreviations

AI	Artificial Intelligence
CEDEFOP	European Centre for the Development of Vocational Training
COL	Commonwealth of Learning
Collab-CNCI	Collaboration CNCI Indicator
CSO	Civil Society Organization
DEWG	Digital Economy Working Group
ECEC	Early Childhood Education and Care
EEA	European Education Area
EMIS	Education Management Information System
ESCO	European Skills, Competences, Qualifications and Occupations
EU	European Union
FNL	Foundational Literacy and Numeracy
FOSSEE	Free Open-Source Software for Education
GDP	Gross Domestic Product
GPDPR	Global Public Digital Platforms Repository
G20	Group of Twenty
G20 EdWG	G20 Education Working Group
HEI	Higher Education Institutions
ICT	Information and Communication Technology
IEA	International Association for the Evaluation of Educational Achievement
ILO	International Labour Organization
IMF	International Monetary Fund
ISCED	International Standard Classification of Education
LLECE	Latin American Laboratory for Evaluation of the Quality of Education
LMS	Learning Management System
MOE	Ministry of Education
MOOC	Massive open online course
MPL	Minimum proficiency level

MSME	Micro, small and medium-sized enterprises
NCF	National Curriculum Framework
NQF	National Qualifications Framework
NLAs	National Learning Assessments
NSF	National Skills Framework
OA	Open Access
OECD	Organisation for Economic Co-operation and Development
OER	Open Education Resources
PDPs	Public Digital Platforms
PIACC	Programme for the International Assessment of Adult Competencies
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Student Assessment
PISA-VET	International Vocational Education and Training Assessment
RDI	Research, development and innovation
RQF	Regional Qualifications Framework
RPL	Recognition of Prior Learning
SDG	Sustainable Development Goal
SME	Small and medium sized enterprise
STEM	Science, technology, engineering and mathematics
STI	Science, technology and innovation
TEIs	Teacher Education Institutes
TES	Transforming Education Summit
TIMSS	Trends in Mathematics and Science Study
TVET	Technical and Vocational Education and Training
UIS	UNESCO Institute for Statistics
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
WB	The World Bank

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Executive summary

In taking up the Group of Twenty (G20) Presidency, the Government of India has proposed four priority areas under the G20 Education Working Group (EdWG). These include:

↘ ensuring that all children are set up for life with foundational literacy and numeracy (FLN) and can enjoy opportunities for lifelong learning, by improving teaching and learning practices, including through blended learning;

↘ leveraging digital resources and technologies to accelerate progress in education;

↘ understanding how education systems will be impacted by the future of work, and strengthening their relevance and linkages;

↘ promoting closer collaboration between higher education, the research and development sector and societies, both within and across national boundaries.

To this end, the G20 EdWG has underscored the interconnectedness of the challenges and opportunities in member states, and the importance of collaboration to achieve the G20 Indian Presidency's goal of 'Vasudhaiva Kutumbakam' (One Earth, One Family, One Future). The Presidency has shed light on the role of the G20 mechanism in providing strong leadership and inspiration to address challenges, including the role of education-driven economic and social development in the transition toward greener and digital economies.

Furthermore, it has identified three cross-sectoral and transversal levers – digital transformation, sustainable transition to a green economy and women-led development – as accelerators for achieving the Sustainable Development Goals (SDGs), including in education. These are considered boosters for equitably expanding access to education, transforming teaching and learning practices for an increasingly technological, interconnected and knowledge-driven world, and enabling evidence-based decision-making and monitoring in education.

Across the board, bold and scalable responses are still needed to address the global learning crisis. The G20 countries have expertise, experiences, key lessons learned and promising practices to share among themselves and with other countries, to drive transformation and change at the global, regional and national levels. In this

light, G20 members and invited countries were requested to provide information on their education policies and practices as part of the EdWG meetings, responding to questionnaires and participating in seminars and exhibitions organized prior to each working group meeting. Such sharing of information supports peer learning and discussions around successful programming. Policies and programmes selected from among the information gathered from the countries are highlighted below, as well as in the report's thematic chapters.

Ensuring foundational literacy and numeracy, especially in the context of blended learning:
This theme looks at initiatives to expand access to, and improve the quality of, programmes supporting FLN. Acquisition of these skills is considered crucial to developing other forms of high-order knowledge and skills, as well as to achieving individual self-empowerment and well-being through lifelong learning. Without solid foundational learning skills, children may struggle to progress through the education system and thrive in various aspects of life, work and society. Thus, foundational learning is considered a fundamental cornerstone for the full realization of SDG 4 on education, as well as many other SDGs.

The report assesses various factors influencing the acquisition of FLN, such as access to early learning and childcare, students' readiness to learn, teachers' capacities, curriculum enhancement, content creation, digital resources and assessments. It emphasizes the need for high-level leadership and political will to drive systemic change and sustain progress, particularly in quality pre-primary education, as well as engage parents and communities. The report particularly highlights progress made in:

↘ **Readiness to learn:** Securing and enacting concrete financial commitments to affordable and inclusive access to quality early childhood and preschool education will promote readiness to learn. Country highlights include programming to reach First Nations children in Australia, stipends and midday meals for learners in Bangladesh, expanding access to areas and age ranges (0-2 year-olds) under-served by pre-school education in Spain, free and compulsory education from the age of 3 in France, and early learning support for infants and toddlers with disabilities in the United States and Türkiye. In India, the National Education Policy 2020 emphasizes universal participation in schooling, tracking student progress and providing alternative re-entry options for dropouts.

↘ **Curriculum enhancement and content creation:** Adjusting or rebalancing curricula to prioritize the fundamental skills, knowledge and competencies needed in today's world, and creating relevant and impactful curriculum contents, will improve learning outcomes. Methodologies include innovative pedagogic approaches, as well as remedial and play-based learning. China's Compulsory Education Curriculum Plan and Curriculum Standards reflect economic and social shifts. India's National Curriculum Framework for the Foundational Stage focuses on the continuum of learning for children aged 3–8. Germany promotes language and reading skills through joint initiatives between the federal government and the states (Länder). Likewise, Italy's National Guidelines give pride of place to the development of language, scientific and mathematical competencies, as well as cultural tools, as preconditions for personal growth and the full exercise of citizenship.

↘ **Digital resources:** Improving the learning experience, accelerating learning, and closing gaps in access to quality foundational learning through digital resources such as online learning platforms, educational apps and digital education games is particularly beneficial for learners in rural areas and those displaced by natural disasters. Examples include the Early Digital Learning Programme in Mauritius, the online platform for foundational learning in Türkiye and the augmented reality-based literacy experience in the United Arab Emirates.

↘ **Building teachers' capacities:** Countries such as Indonesia and South Africa have enhanced pedagogical knowledge, while India and Brazil have adopted hybrid/blended approaches. Other countries, such as Saudi Arabia, have addressed teacher-workforce deployment disparities by motivating outstanding teachers to work in schools with low educational performance, and Germany has implemented programmes to increase the number of men in early childhood education.

↘ **Assessments:** Countries are conducting assessments to help decision-makers understand children's foundational learning levels and the capacities of the education system to deliver quality education. India, for example, has conducted the first-ever Foundational Learning Study and benchmarked children's learning levels in literacy and numeracy. Indonesia has eliminated high-stakes testing and now focuses on problem-solving, critical thinking and building the civic character. The Netherlands and the United States have used assessments to monitor learner proficiency in various subjects.

Making tech-enabled learning more inclusive, qualitative and collaborative at every level: Under this second theme, the report reviews strategies employed by G20 members and invited countries to make tech-enabled learning more inclusive, equitable, qualitative and collaborative across all levels of education. It highlights the role of technologies in ensuring learning continuity during the COVID-19 pandemic, the growing trend towards blended and hybrid learning, and the need for countries to identify entry points and levels of investment for their digital transformation while considering their level of readiness, particularly for emerging technologies such as Artificial Intelligence (AI), and the potential risks.

The report proposes five critical components for advancing tech-enabled learning, as follows: coordination and leadership, content and curriculum, connectivity and infrastructure, capacity and culture, and cost and sustainability. Across these components, the report underlines the roles of data ecosystems and data analytics in improving education management, system efficiency and learning outcomes. Against this backdrop, the following progress is highlighted:

↘ **Coordination and leadership:** Several countries, including Brazil, Germany, Mauritius, the Netherlands and Spain, have made significant investments in the digital transformation of their education systems, including infrastructure, institutional training, and digital content and competence development. Countries such as India, Japan and the United States are also implementing specific initiatives to reduce inequities in digital education. Japan, for example, leverages digital learning to support personalized, self-regulated and collaborative learning across the education spectrum. In the United States, the National Educational Technology Plan guides the use of technology to improve equity and opportunity for all students.

↘ **Content and curriculum:** Digital platforms and learning management systems in China, Germany, Indonesia, Singapore, the United Arab Emirates and South Africa (among many other G20 member and invited countries) now provide a wide range of multimodal contents, including in national languages, and support varied pedagogical approaches and flexible learning pathways. In countries such as Bangladesh, Germany, India, Mexico and South Africa, many of the contents are open source and interoperable. Bangladesh, France, India, the Republic of Korea and Saudi Arabia focus on integrating digital skills into the classroom and promoting flexible learning through blended and hybrid approaches. Australia and India are developing quality standards for e-learning contents and pedagogies.

↘ **Connectivity and infrastructure:** Governments play a central role in creating and maintaining digital learning infrastructures and powering the digital transformation of education systems. Countries such as China have transformed their digital infrastructure for education by upgrading platforms and resources, improving digital literacy among teachers and students, and providing internet access, multimedia classrooms and computer terminals to schools. Indonesia and Mauritius prioritize digital equity for underdeveloped areas and disadvantaged learners by expanding infrastructure and connectivity, implementing tech-enabled interventions, ensuring learning continuity during crises and emphasizing emergency preparedness.

↘ **Capacities and culture:** Investing in the capacities and digital competencies of all education stakeholders is crucial to creating a culture of digital learning, innovation and growth. Efforts to enhance digital and data skills for teachers, education leaders and decision-makers are underway in G20 member and invited countries. Spain and the United Arab Emirates use digital frameworks and tools to support schools in improving technology use in teaching and learning. The Republic of Korea focuses on creating intelligent educational environments through comprehensive plans for Information and Communication Technology (ICT) in education.

↘ **Cost and sustainability.** Digital learning must be underpinned by financial investments in infrastructure, connectivity, devices and data storage, requiring strategic planning and allocation of resources in national budgets. The range of country experiences shows that funding sources for digital learning include government budgets, external funding from international organizations and innovative financing models. As a pathway to sustainability, several countries are pursuing infrastructure, connectivity and data investments through cross-sectoral cooperation. Belgium, Brazil, France, the Netherlands, South Africa and the United Arab Emirates have formed partnerships with different stakeholders to support digital transformation, including the interoperability of digital services and solutions. The European Union, France, Spain and Türkiye also engage in cross-border cooperation to advance tech-enabled learning.

Governments recognize that mainstreaming a gender lens, and empowering women and girls in digital education, are important steps for the realisation of a digital culture built around equity and inclusion. In that respect, the report highlights initiatives to bridge the gender gap in digital adoption and workforce opportunities. The safe and purposeful use of education data is critical to advancing all five components of tech-enabled learning. Here, governments have introduced a range of measures promoting regulation and data privacy in digital learning, data-collection tools and data centres. Countries such as Nigeria, Oman and Saudi Arabia are reconciling issues related to digital ethics, personal data rights and privacy, while also promoting interoperability. The Russian Federation and the European Economic Area are addressing safety issues in the use of digital technology by updating educational standards, building digital literacy and ensuring individual access to electronic resources.

Building capacities, promoting lifelong learning in the context of the future of work: The report provides an overview of the challenges and opportunities for lifelong learning and the future of work posed by megatrends, significant technological advancements and automation, including AI. It emphasizes the need for all school leavers, young people and working adults to acquire skills and be ready to continuously reskill to find their place in future job markets. The information gathering highlights progress made across the G20 member and invited countries in three key areas.

↘ **Postsecondary education and training:** Postsecondary education is identified as a prerequisite for many jobs, and the demand for advanced skills in knowledge-intensive sectors is quickly evolving. Countries have made significant investments in expanding their postsecondary education to increase enrolment capacity and support students. National policies focus on two main approaches: supply-side policies that support postsecondary education providers in developing programmes for upskilling and reskilling, and demand-side policies that expand financial support for adult learners. Canada, for example, introduced the Sectoral Workforce Solutions Programme In response to the COVID-19 pandemic. Other countries on the supply side include South Africa, which has established 'articulation hubs' to facilitate student mobility between different sites for learning, upskilling and reskilling. Oman and the United Arab Emirates, for their part, have created internship programmes to bridge the gap between postsecondary education and the workforce. Policies to support ongoing learning include providing targeted grants and need-based loans to eligible students, such as the Canada Student Financial Assistance (CFSA) Programme and England's proposed lifelong loan entitlement. These policies aim to reduce the costs associated with participation in education and training, and to make it easier for adults to access support for upskilling and reskilling. Micro-credentials are also gaining in popularity, with the European Union encouraging the development of national micro-credential systems.

↘ **Technical and vocational education and training (TVET):** G20 countries recognize TVET as a crucial tool for improving equity in learning, enhancing employability and addressing evolving skill demands within the labour market. Several countries have implemented initiatives to diversify and expand TVET opportunities for upskilling and reskilling. Brazil has introduced the 'Professionals of the Future' and 'Qualify More' programmes, and France has created vocational education and training excellence hubs. Italy is introducing reforms to enhance student guidance on educational pathways and employment opportunities, and to strengthen the connection between the first and second cycles of education and training. Germany's digital platform, 'Innovationswettbewerb', also helps people find professional training and AI-supported learning processes. Countries like Indonesia and Spain are emphasizing work-based learning components, such as apprenticeships and internships.

↘ **Adult education and learning:** Finally, G20 countries have implemented various initiatives to enhance adult education and learning. Countries such as France, Canada and Japan are prioritizing relevant skills in emerging sectors. France is implementing national funding schemes, learner-targeted financial incentives and individual learning accounts to ensure access to adult education, while its 'One Young Person, One Solution' platform facilitates professional training for young adults. India's 'NASSCOM FUTURESKILLS' platform focuses on upskilling in emerging technologies. Targeted interventions also support underrepresented groups; these include the 'Integrated Education and Training Programme' for low-income adults and migrants in the United States and Nigeria's National Commission for Mass Literacy, which offers second-chance education.

The chapter closes by examining the governance implications of lifelong learning beyond schooling and how this relates to the future of work. The country practices suggest that certain countries have moved to establish national skill strategies and coordination bodies spanning multiple government levels and departments, as well as non-governmental stakeholders. Examples include France and Germany's collaboration between national and subnational governments, agencies and stakeholders, Saudi Arabia's strategy for future skill foresight and

innovation, and the United Kingdom's reforms for further education. Countries such as Canada, Singapore and the Republic of Korea have implemented initiatives to support youth employment and lifelong learning.

High-quality data and evidence are crucial for informed decision-making around lifelong learning, and countries such as Saudi Arabia, the United Arab Emirates and Singapore have invested in data-gathering programmes. Engaging with the private sector is essential, as seen in France's collaboration with social partners and the tripartite collaboration in Japan. Finally, financing plays a significant role, with governments needing to align and coordinate funding arrangements to support inclusion and address skill imbalances.

Strengthening research and promoting innovation through richer collaborations: The fourth priority area concerns the increasingly important role of higher education at the intersection of education, research and innovation. It suggests the need to rethink strategies for supporting higher education research, given its important contribution to the scientific and technological breakthroughs needed to address today's and future challenges, particularly in subjects of global relevance such as energy, health and climate change. The current context of uncertainty, disruption and rapid technological change also requires a comprehensive examination of universities' potential to contribute to global common goods through cross-border cooperation. Examples highlighted in the report include:

↘ **Modalities to support collaboration between higher education, academia, industry, the research and development sector and public policy institutes at the national level:**
A variety of modalities are being deployed to bridge gaps between applied research and the commercialization and take-up of innovative ideas and technologies. The Australian Government has announced six Trailblazer Universities that collaborate with industry partners to create innovation ecosystems that support the translation and commercialization of university research, promoting research commercialization capabilities in priority areas. The IMPacting Research INnovation and Technology programme in India promotes the practical application of scientific research for societal improvement. The Russian Federation's Single Digital Platform for Scientific and Scientific-Technical Interaction automates processes to foster collaboration and create scientific products.

Canada, Indonesia, Japan and Singapore offer non-financial incentives such as innovation boards, laboratory equipment, information exchanges and support for institutional collaboration across universities. The Ministry of Education in Saudi Arabia has launched various initiatives to support technology transfer and commercialization, including the Institutional Funding Programme, Sustainable Partnerships, Entrepreneurship University and Entrepreneur Professor. With a specific focus on enhancing inclusion in research, development and innovation (RDI) and academia, Canada has undertaken consultations to examine barriers to accessing research opportunities for women in science and underrepresented groups (e.g. Indigenous Peoples, minorities and people with disabilities). The Natural Sciences and Engineering Research Council's Equity, Diversity and Inclusion (EDI) Action Plan lays out programmes and initiatives such as the Chair for Women in Science and Engineering (STEM), which supports women in science, technology, engineering and mathematics, and the Dimensions programme, which encourages universities and colleges to address systemic barriers to EDI.

↘ **Horizontal collaboration across G20 countries:** Cross-country research and collaboration in higher education are also essential to produce global common goods and foster international talent supply chains. India runs the Scheme for Promotion of Research and Academic Collaboration with higher education institutions (HEIs) in 28 countries. In Japan, the Virtual Campus is an online platform

that enables universities inside and outside Japan to share educational resources. The Campus for Research Excellence and Technological enterprise (CREATE) in Singapore is an international research campus established by the National Research Foundation (NRF) which fosters institutional partnerships between leading academic institutions worldwide, bringing together international research talent to work on interdisciplinary research programmes.

Indonesia and the United Kingdom have focused on research mentoring, peer skill training and reducing barriers to cross-institutional research within higher education. The European Union's (EU) European Universities Initiative includes flagship initiatives such as European Universities alliances; the European Network for Teaching Excellence in higher education, which promotes cross-national cooperation, joint degree programmes and innovative teaching practices; and the Erasmus+ Programme, which supports mobility and cooperation between universities across Europe through student and staff exchanges, joint degree programmes and capacity-building projects. Canada, France and Indonesia offer joint degree programmes which allow students to study at multiple institutions, promoting cross-disciplinary collaboration and exposure to different academic cultures.

The global response to the COVID-19 pandemic highlighted the importance of open science and knowledge-sharing, and countries are therefore diversifying supply chains and channels for research dissemination to provide open access to peer-reviewed research. For instance, India's e-ShodhSindhu platform offers access to a wide range of core journals, databases and publications to member institutions. Open-access research publication is increasing globally, with funders and governments advocating increased accessibility.

Lessons learned, promising practices and the way forward: The magnitude of the foundational learning crisis across the globe and the frequent disconnect between basic education, professional training and the future of work within a lifelong learning agenda demand bold responses from countries, deployed at a large scale and at a fast pace. Based on the country practices and analysis in this report, a number of lessons and examples of good practice are emerging across the G2O community that could help all governments and their partners move more quickly, by prioritizing investments in 'what works' across different types of programming. With further development, the examples could eventually enable G20 countries to work even more closely together and arrive at initiatives which scale up each other's best practices across the four priority areas addressed in this report.

Overview of the G20

The Group of Twenty (G20) is a leading forum of major economies that seeks to develop global policies addressing the world's most pressing challenges. Collectively, the G20 members account for two-thirds of the world's population, 80 percent of its economic output, and 75 percent of its trade. The G20 members are Argentina, Australia, Brazil, Canada, the Peoples' Republic of China, the European Union, France, Germany, India, Indonesia, Italy, Japan, Mexico, the Republic of Korea, the Russian Federation, Saudi Arabia, South Africa, Türkiye, the United Kingdom and the United States. Each year, the Presidency invites guest countries to fully participate in the G20 exercise. Under the Indian G20 Presidency in 2023, the invited countries are: Bangladesh, Egypt, Mauritius, the Netherlands, Nigeria, Oman, Singapore, Spain and the United Arab Emirates.

Introduction

The G20 Education Working Group (G20 EdWG) has reached an important five-year milestone and has much to celebrate. Since its establishment during the Argentina Presidency in 2018, the EdWG has drawn the attention of policy-makers across the G20 member countries to a range of pressing education issues, generating a respected platform for dialogue and peer learning. This year, the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Children's Fund (UNICEF), and the Organisation for Economic Co-operation and Development (OECD) are invited to participate in the knowledge-sharing and peer-learning process of the G20 EdWG.

Under past G20 presidencies, Education Working Groups have focused on strengthening educational systems by making them more inclusive, accessible and innovative at all levels, and discussed the need to strengthen linkages between the world of education and the changing world of work. Focus areas have included educational poverty, universal quality education, the continuity of learning during crises, inclusive higher education and supporting teachers. Working Groups have considered the role of technology in expanding education access, quality and continuity, and examined challenges pertaining to the digital divide, providing access to all learners, data privacy, cyber safety and responsible use.

During the Indonesian Presidency, the G20 EdWG supported revisions to the 2015 G20 Skills Strategy, which was updated under the Employment Working Group and presents policy principles aimed at addressing challenges that have emerged on account of the evolving impacts of megatrends and the COVID-19 pandemic on skills. The EdWG further acknowledged the courage, resilience and creativity of G20 countries in tackling learning disruption during the pandemic, which spanned the presidencies of Saudi Arabia, Italy and Indonesia.

During the pandemic, Ministries of Education partnered with other government institutions, the private sector and service providers to ensure immediate access to remote learning. They adjusted curricula at all education levels, supported teacher upskilling (including structured pedagogies) for remote classrooms, and made greater efforts to monitor children's learning and identify those at risk of dropping out. Reports from international organizations also suggest that a wide range of policies were put in place to redress learning losses and kick-start recovery, including through catch-up and accelerated learning, socio-emotional support initiatives and conditional cash transfers to disadvantaged families.

The focus of India's G20 Presidency centres on striving for just and equitable growth for all in the world, in a sustainable, holistic, responsible and inclusive manner. This spirit is embodied in the theme 'One Earth, One Family, One Future', which resonates with India's ancient belief that the world is one family. Thus, the efforts made in all areas, including education, have focused on working together to find solutions to the common challenges facing the planet and support each other in achieving the desired goals. Guided by this objective, seminars before EdWG meetings, exhibitions and panel discussions were held to garner the perspectives, experiences and concerns of all G20 and invited countries, for purposes of both peer learning and informing deliberations during Working Group meetings.

Under India's G20 Presidency, the EdWG has built on the work done by past presidencies. It has identified and discussed new priority areas, such as bolstering FLN as the building block for future learning; fostering open educational resources, strengthening the interoperability of digital resources and encouraging standardized frameworks for educational content, technology and pedagogy; and enhancing research collaboration among educational institutions in G20 countries, through mechanisms such as student mobility and joint or dual degrees.

To ensure in-depth deliberations on the identified priority areas, each of the four meetings of the Working Group at Chennai, Amritsar, Bhubaneswar and Pune was preceded by a full-day seminar and a three-day exhibition on a single priority area. G20 member and invited countries participated in the panel discussions held during these seminars. Some member countries also set up stalls at the exhibitions, providing an excellent opportunity for countries to learn from each other. The lessons learned and exchanges during these seminars and exhibitions proved useful in informing the main deliberations of the G20 EdWG.

In this spirit, the EdWG under India's Presidency has worked to:

1. Identify and understand barriers encountered by learners that reduce the impact of education as a tool for improving lives.

2. Help build on the strengths acquired over the years, especially the use of technology in education.

3. Enable critical reflection on teaching and learning methods, contents, curricula, pedagogies and assessment to ensure better learning outcomes and render education more relevant to the skills, competencies, values and attitudes required in the 21st century.

4. Encourage collaboration between people, industries and societies in the quest to widen the horizons of knowledge for the good of humankind.

Priority Issues and report chapters

Against this backdrop, the G20 Indian Presidency identified the following four priority issues for deliberation:

1. Ensuring **foundational literacy and numeracy**, especially in the context of blended learning.

2. Making **tech-enabled** learning more inclusive, qualitative and collaborative.

3. Building capacities and promoting **lifelong learning** in the context of the future of work.

4. Strengthening **research** and promoting **innovation** through richer collaboration and partnerships.

FLN is the essential building block for further learning and development. Although access to school has expanded over the last few decades, a large number of children across the world still do not have FLN competencies. There is therefore a compelling need for countries to accelerate reforms to learning system at scale and redesign approaches for achieving universal FLN.

Technology-enabled learning is now recognized as an immense force multiplier for expanding educational access and enhancing student learning, but leveraging it depends on several interconnected factors, including access to infrastructure, affordable devices, trained teachers and facilitators and relevant educational content. Appropriate policies and practices are needed to ensure the safe and purposeful use of technology to support effective teaching and learning.

The world is witnessing transformative changes in the nature of jobs and the way they are performed. Against this backdrop, it is critical to ensure that learners acquire knowledge and skills that are relevant to the emerging work ecosystem, and that every individual is empowered to derive the benefits of skilling, reskilling and upskilling at different stages of life.

Many of the challenges facing the world today require countries to collaborate on research and knowledge creation. This entails enhanced cooperation among higher educational institutions in G20 and invited countries.

Taken together, the four priority areas are expected to lead to the desired outcomes of inclusive, equitable and quality education and lifelong learning opportunities for all, as visualized in Figure 1 below.

Figure 1: Framework for G20 Indian Presidency EdWG
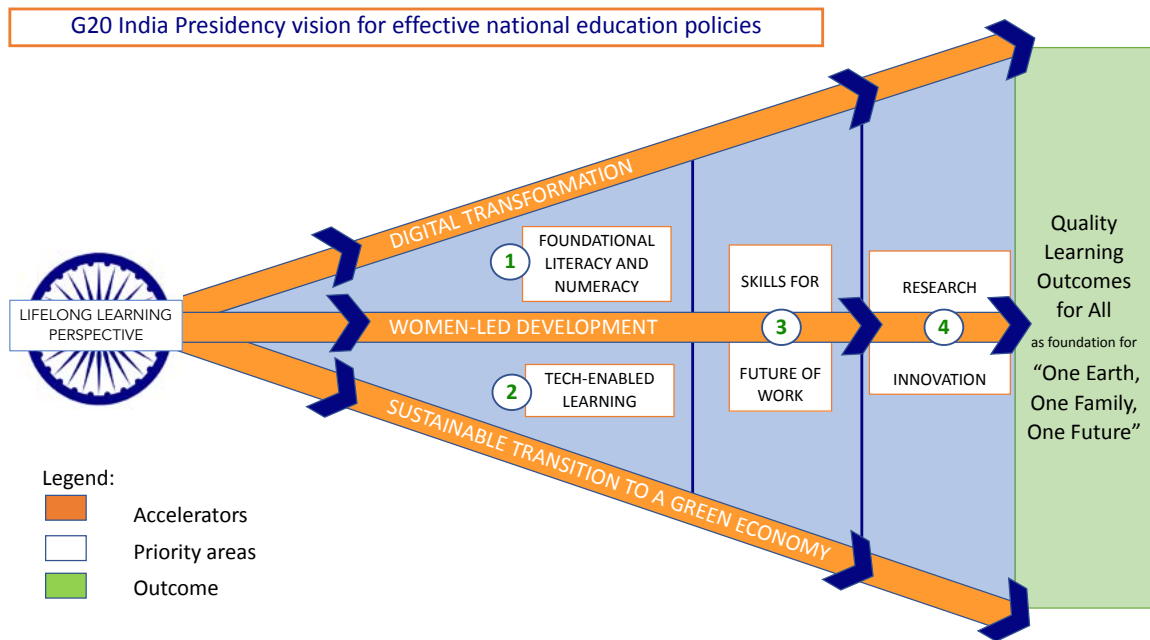
Source: G20 Education Working Group (2023).

The figure depicts a lifelong learning perspective on the role of education and training systems in pursuit of the G20 Indian Presidency's goal of achieving 'Vasudhaiva Kutumbakam' ('One Earth, One Family, One Future'). It places FLN and tech-enabled learning as the first of the four building blocks to achieve inclusive quality education and lifelong learning opportunities for all. These then feed into capacity-strengthening and promotion of lifelong learning for the future of work, followed by supporting the SDGs and the green transition through collaboration and partnerships between higher education systems and countries' research, development and innovation capacities (RDI).

The four areas are interconnected and mutually influential, acting as a valuable frame of reference that threads across interconnected education policies from a lifelong learning perspective. Progress across all priority areas – and more broadly across all the SDGs – is advanced by accelerators, including digital transformation, women-led development and the sustainable transition to a green economy.

The first G20 Sherpa meeting also identified these three accelerators to help advance the SDGs. The next section explores the potential contribution of these accelerators in more detail.

Report structure and information gathering

In this report, each building block or priority area is given its own distinct chapter: **Chapter 1** discusses foundational learning; **Chapter 2** explores tech-enabled learning; **Chapter 3** considers the future of work; and **Chapter 4** looks at research and innovation, including the role of higher education. **Chapter 5** concludes with lessons learned and policy recommendations across the four priority areas. The role of accelerators is also filtered into the analysis of the four priority areas as they appear in the chapters.

In January 2023, India requested that all G20 members and invited guest countries complete a questionnaire to provide information on their education policies and practices, with the objective of sharing knowledge, reinforcing peer learning, and setting a common education agenda for discussion and action. At the time of writing, 28 countries had submitted responses to the questionnaire. A compendium of each country's submitted policies and initiatives accompanies this report.

Synergy with other G20 Working Groups

Under the G20 Indian Presidency, the G20 Digital Economy Working Group (DEWG) and G20 Employment Working Group (EWG) are also exploring key topics related to education and skill development. A comparative analysis of each group's issue notes and presentations at EdWG meetings shows synergies between these groups' aims and those of the EdWG (see Box 1).

Scope of the report

This report is based on the questionnaire filled by the G20 and invited countries, as well as their inputs during EdWG deliberations. Its objective is to present education policy-makers with fresh perspectives and alternate approaches to solving common problems. The report flags challenges and critical issues pertaining to each priority area, sharing examples from G20 and invited countries on the various ways in which these have been addressed in order to learn from each other's experiences. The way forward and recommendations at the end of the report are only suggestive. Countries can choose to build on these learnings in accordance with their priorities and extant policies.

Box 1: Synergies between the Education, Digital Economy and Employment Working Groups

Synergies between the Education, Digital Economy and Employment Working Group

The Digital Economy Working Group has identified three priority areas: public digital platforms, cybersecurity and cyber safety in digital economy, and digital skilling. These find s synergy with Priory Area 2 of the EdWG, which deals with tech-enabled learning. The DEWG aims to produce a Global Public Digital Platforms Repository (GPDPR) that stores an open-source platform the details of all public digital platforms (PDPs) developed by G20 members. The EdWG also recognizes the need to take collective action to develop technology ecosystems among the G20 member and invited countries, foster open educational resources and strengthen the interoperability of digital resources, while also encouraging ethical practices in use of technology and protecting privacy and security. The DEWG further proposes introducing a 'universal digital skill toolkit' that can be used to develop strategies for digital skilling programmes. This is a clear alignment with two priority areas of the EdWG, namely tech-enabled learning and the future of work.

The Employment Working Group (EWG) is exploring ways to address skills gaps across G20 countries. The EWG and EdWG can explore the goal of developing a unified harmonized skills and qualifications framework to assist in the formulation of respective skilling and lifelong learning strategies to address these gaps and mismatches. The G20 Skills Strategy and its continuing evolution, as well as the priority area of lifelong learning for the future of work, find synergy with the priorities of the EdWG and EWG

Accelerators towards all SDGs in an era of cascading crises and new opportunities

The *Sustainable Development Goals Report 2022* of the United Nations highlights that the 'confluence of crises, dominated by COVID-19, climate change, and conflicts, are creating spin-off impacts on food and nutrition, health, education, the environment, and peace and security, and affecting all the Sustainable Development Goals.'1 While nations have adopted the SDGs and taken various steps to meet these goals and their targets, the global community is still collectively off track towards declaring success by 2030. The COVID-19 pandemic has further slowed progress. Meanwhile, the SDG financing gap is widening, owing to unfavourable macroeconomic conditions, record inflation and increasing debt burdens.

At a time when the world is looking for solutions, pathways and accelerators for progress, the G20 is in a unique position to provide the leadership and strong political momentum required to reshape the world's sustainable development trajectory, respond to global and regional crises, and bring the world back on track. Such leadership is a key priority under the Indian Presidency. The section below unpacks the potential of the three accelerators proposed by the Indian Presidency for addressing crises, advancing towards the SDGs and enabling a sustainable transition to a green economy.

Accelerator 1: Digital transformation

All education working groups under G20 Presidencies have underscored that the development and deployment of digital technologies could result in transformations that power inclusive and sustainable growth. Digital transformation has a profound impact on achieving the SDGs, by revolutionizing the connectivity, accessibility, affordability, governance, security and regulation of technology and services.

Digital platforms and content have played a crucial role in expanding access to education during the pandemic. Digital tools offer personalized instruction and support, catering to learners' specific needs and preferences, emphasizing the need for content in local languages and considering the needs of individuals with disabilities. They also foster cooperative avenues for knowledge production, research and innovation in higher education institutions. Collaboration between higher education systems, research clusters and clients can drive progress in SDG areas like health, energy, food security and technology. AI has transformative potential, automating tasks like content creation and grading. A close monitoring of these developments is necessary: ensuring the ethical use of digital tools and generative AI requires addressing risks, and implementing safeguards and regulations.

Digital transformation also facilitates upskilling and reskilling for adult learners in emerging job markets, benefiting various industries, including the gig economy and informal sectors. Access to information on job opportunities and industry insights empowers individuals to make informed career decisions. Ensuring that everyone can participate in the digital economy is crucial, and requires promoting equal and affordable access to digital skills, especially for disadvantaged and vulnerable individuals. Furthering digital literacy and skills in education and lifelong learning is essential to bridge the digital divide, including the gender gap. In 2023, the G20 EdWG has emphasized in three of its four priority areas the cross-cutting role of digital transformation in preparing learners to build foundational skills; facilitating learning that is qualitative, collaborative and inclusive; and enabling lifelong learning.

Accelerator 2: Sustainable transition to a green economy

As the world today strives to transition to low-carbon economic models, education and skill training provide the backbone for achieving a fair and inclusive transition in G20 countries. To ensure a green transition that benefits everyone, schools should integrate sustainability and green-economy skills in their curricula. They play a key role in equipping learners with the foundational and 'green skills' needed to develop resilience, promote community involvement and ensure contributions to renewable energy, sustainable agriculture, waste management and resource efficiency (among others).

The continuous nature of the transition means our education and skill-training systems must support the sustainable transition toward green economies through lifelong learning approaches. Individuals entering the workforce, those in transitioning industries and vulnerable communities in particular should be able to benefit from a fair distribution of green-transition benefits. Higher education institutions play a major role in bringing about this transition by undertaking interdisciplinary research in areas in need of advancement, such as overcoming energy and resource limitations, addressing climate-change impacts, exploring greener business models and studying the role of advanced technologies. Through collaboration and problem-solving networks, these institutions can actively participate in designing greener and fairer economies.

While the G20 has shown remarkable commitment and action to spearhead the sustainable transition to a green economy, all member countries face serious challenges. Financing the transition is a concern, especially for low-resource nations. India's leadership of the G20 EdWG aims to foster dialogue and action on aligning

education and skill training, with the desired trajectory of an equitable and efficient green transition. India's Lifestyles for the Environment (LiFE) initiative particularly aims to encourage the adoption of sustainable lifestyles and bring individual behaviours to the forefront of the global climate-action narrative. LiFE envisions replacing the prevalent 'use-and-dispose' economy with a circular economy and plans to leverage the strength of social networks to influence social norms. Through the G20 EdWG, India aims to catalyse international action on sustainability, with particular emphasis on the role of foundational learning, lifelong skill acquisition and higher education in the context of the future of work and society.

Accelerator 3: Women-led development

Women are well placed to define young girls' education needs in terms of foundational learning, skill preparation and upgrading opportunities. Involving women and girls more closely in thought leadership, governance and management positions within green transition models and research is therefore paramount to accelerate progress towards the SDGs

To ensure women's meaningful participation in the digital era, it is important that women partake in policy-making pertaining to emerging technologies like AI, the future of work and cyber safety. There is not only a need to reduce barriers, but also to increase women's employment and entrepreneurship in the digital space. Consistent investments in mentoring and programmes for upskilling and reskilling can spur women's employment and increase entrepreneurship opportunities.

We need to find definitive solutions for addressing the gender digital divide and enhancing the representation of women and girls in science, technology, engineering and mathematics. Hearing women's voices more clearly at the centre of education (and development) debates requires formal mechanisms for expanding women's inclusion and authority within community decision-making and civic spaces; in high-level agenda-setting, review and monitoring roles; and within private-sector management positions. Harnessing the power, responsibility and commitment of the G20 EdWG platform, India will highlight women's participation, leadership and contributions to educational progress, and enhance women's decision-making role. The India Presidency considers that such an approach would accelerate the redistribution of skewed opportunities, resources and choices towards women.

Chapter 1

Ensuring foundational literacy and numeracy especially in context of blended learning

This chapter analyses how G20 member and guest countries support children in developing foundational skills in literacy, numeracy and socio-emotional well-being. It uses an evidence-based framework for improving foundational learning to review evidence from G20 countries, including political will and leadership; children's readiness to learn, and the teaching and assessment practices used; the health and socio-emotional support provided to learners; and the engagement of parents and communities in improving education. The chapter also suggests policy pathways forward, which are further discussed in chapter 5.

What do we mean by foundational learning?

Foundational learning skills include literacy, numeracy and socio-emotional skills that are vital for leading an empowered, self-determined life. The acquisition of these skills begins in the early years and continues throughout children's lives. Literacy and numeracy are *foundational* because they form critical building blocks in the process of acquiring other types of knowledge, experiences and opportunities, and thus empower children for life, work and participation in society.

Foundational learning as the basis for acquiring knowledge and skills, and for all other learning

Foundational skills are not only an end in themselves, they are a starting point for preparing children to progress through various stages of the education system and continue learning throughout their lives. Just as a house cannot be built without solid foundations, children cannot thrive without solid foundational learning skills.

During the school years, the inability to acquire foundational skills can hinder children from mastering more complex knowledge and skills. Thus, weak foundational skills not only affect academic learning, but children's prospects in adult life and work.[1] Students may fail to acquire the necessary knowledge and competencies to power their careers once they leave school, or the skills that will help them become engaged citizens and nurture healthy, prosperous families.[1]

In short, in today's world, a failure to facilitate children's mastery of foundational skills is likely to severely hamper their opportunities for future learning and success. Such failure could set in motion a lifetime of missed opportunities, including an inability to develop the higher-order and job-specific skills needed to thrive in increasingly demanding labour markets. For countries, it could lead to difficulties in optimising the human capital needed to ensure sustained, inclusive economic growth and break cycles of intergenerational poverty.

Foundational learning as an essential building block for achieving all other SDGs

Foundational learning is essential to SDG 4, 'ensure inclusive and equitable quality education and promote lifelong learning opportunities for all'. It is also a fundamental cornerstone for achieving all other SDGs, including SDG 1 ('no poverty'), SDG 2 ('zero hunger') and SDG 3 ('good health and well-being').

Without adequate foundational learning, individuals are less likely to achieve higher levels of education, which can limit their employment opportunities, reduce their earning potential, and perpetuate cycles of poverty and inequality. Moreover, inadequate education and foundational learning can lead to poor health, as individuals may lack the knowledge and skills needed to make informed decisions about their health and well-being, and may struggle to access and understand critical information related to nutrition, health and disease prevention.

Where do G20 education systems stand on foundational learning?

At this juncture of the post-pandemic recovery, G20 countries have a unique opportunity to ensure that children have the foundational skills they need to succeed by reimagining the purpose and content of education and ensuring that all learners are ready to learn. Above all,

> quality education must support the development of the individual learner throughout his or her life. It must help people learn how to learn, with a focus on problem-solving and collaboration. It must provide the foundations for learning, from reading, writing and mathematics to scientific, digital, social and emotional skills. It must also develop students' capacity to adapt to the rapidly changing world of work. It must be accessible to all from the earliest stages and throughout their lives. And it must help us learn to live and work together, and to understand ourselves and our responsibilities to each other and to our planet.[2]

As measured against international and regional benchmarks, the majority of G20 economies perform reasonably well in ensuring foundational learning for their children. At the same time, G20 countries recognize that children from vulnerable groups face additional challenges acquiring foundational learning skills and could benefit from additional support to overcome barriers to learning.

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[1] UNICEF, Global Framework on Transferable Skills, New York, UNICEF, November 2019.

[2] UN Secretary-General press release: Secretary-General, at Transforming Education Summit, Urges Greater Commitment to Make Schools Safe, Support Lifelong Learning, Increase Resources for Students | UN Press

Figure 2 below shows the proportion of pupils meeting the minimum proficiency level by country/territory in G20 member countries and guest economies. The proportion of those achieving the minimum proficiency level by grade 4 is above 94 per cent in most countries/territories participating in the Progress in International Reading Literacy Study (PIRLS). However, a sizeable number of children are unable to read simple written and informational texts.[3]

Figure 2: Proportion of pupils meeting the minimum proficiency level (MPL) by country/territory

G20	Assessment	Proportion of pupils achieving MPL (%)	Proportion of pupils not achieving MPL (%)
Argentina	ERCE (2019)	54.00	46.00
Australia	PIRLS (2021)	94.00	6.00
Brazil	PIRLS (2021)	61.00	39.00
Canada	PIRLS (2016)	96.00	4.00
China, Hong Kong SAR	PIRLS (2021)	98.00	2.00
England (IEA member)	PIRLS (2021)	97.00	3.00
France	PIRLS (2021)	94.00	6.00
Germany	PIRLS (2021)	94.00	6.00
India*	NLA (2021)	39.00	61.00
Indonesia	TIMSS (2015)	50.00	50.00
Italy	PIRLS (2021)	97.00	3.00
Japan	TIMSS (2019)	99.00	1.00
Mexico	ERCE (2019)	62.60	37.40
Northern Ireland (IEA member)	PIRLS (2021)	97.00	3.00
Republic of Korea	TIMSS (2019)	99.00	1.00
Russian Federation	PIRLS (2021)	98.00	2.00
Saudi Arabia	PIRLS (2021)	71.00	29.00
South Africa	PIRLS (2021)	19.00	81.00
Türkiye	PIRLS (2021)	86.00	14.00
United States	PIRLS (2021)	95.00	5.00

Invited countries/territories	Assessment	Proportion of pupils achieving MPL (%)	Proportion of pupils not achieving MPL (%)
Bangladesh**	NLA (2017)	47.00	53.00
Egypt	PIRLS (2021)	45.00	55.00
Mauritius	SACMEQ (2017)	88.20	11.80
Netherlands	PIRLS (2021)	96.00	4.00
Nigeria***	NLA (2021)	23.00	77.00
Oman	PIRLS (2021)	62.00	38.00
Singapore	PIRLS (2021)	97.00	3.00
Spain	PIRLS (2021)	95.00	5.00
United Arab Emirates	PIRLS (2021)	75.00	25.00

Sources: International Association for the Evaluation of Educational Achievement (IEA) for PIRLS and TIMSS; Latin American Laboratory for Evaluation of the Quality of Education (LLECE) for ERCE; The Southern and Eastern Africa Consortium for Monitoring Educational Quality (SEACMEQ) for SACMEQ Mauritius; and national learning assessments (NLAs).

Notes on NLAs (National Learning Assessments):

* India, National Achievement Survey (NAS) 2021

** Bangladesh, National Student Assessment, Ministry of Primary and Mass Education, Bangladesh Bureau of Statistics

*** Nigeria, UNICEF Country Office Annual Report 2022

Quality pre-primary learning and education are the foundation of a child's lifelong learning journey and are critical to ensuring readiness for schooling and foundational learning. High-level and visible leadership are critical to initiating and sustaining systemic change and many G20 economies have made appreciable progress in this regard, investing in and providing early learning and education opportunities for young children.

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[3] This report uses the PIRLS designed to measure reading achievement at the fourth-grade level to benchmark the minimum proficiency level in reading. In case there was no PIRLS participation, the results of the Trends in International Mathematics and Science Study (TIMSS), the Regional Comparative and Explanatory Study (ERCE) or national large-scale assessments were used as a benchmark or proxy.

Figure 3 provides and compares gross enrolment rates (GER) of the G20 members and invited countries, which are used as proxy indicators to measure the level of readiness of young children for primary education and foundational learning. The data used are those collected from and validated by relevant statistical authorities through UNESCO and/or OECD. However, it is recognized that the definition of pre-primary education may differ across countries in relation to age ranges, curriculum focus and expected outcomes, as well as in terms of governance, management, financing and service delivery, which makes measurement of this level of education difficult and challenging.

Figure 3: Pre-primary gross enrolment ratios in G20 member and invited countries (%), 2022
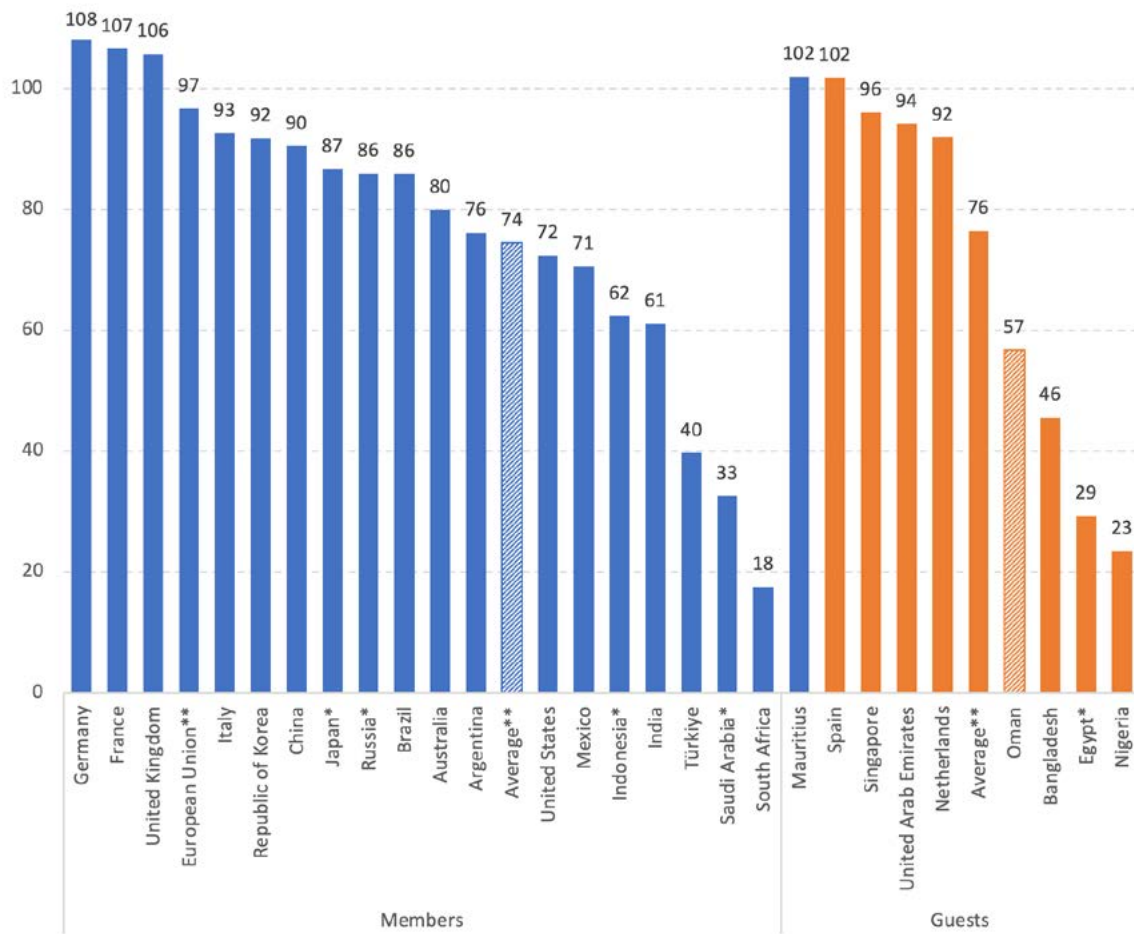
Source: UNESCO Institute for Statistics (UIS) SDG dataset, February 2023

Notes:

* Different years of value: Japan (2015), Russia (2019), Indonesia (2018), Egypt (2019), Saudi Arabia (2022, data directly from the country, not from UIS)

** Simple (non-weighted) average

Progress is still not sufficient, though, if governments are to meet their 2015 commitment to SDG target 4.2, 'ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education' by 2030. There are also noticeable disparities between G20 education systems, with enrolment rates ranging from below 20 per cent to over 100 per cent.

1.1 Ready to learn

Although research has long shown the remarkable benefits of early childhood and preschool learning, quality early education is often out of reach for children from low-income backgrounds, remote communities, and families facing other vulnerability factors, such as migration, forced displacement and climate change.

The following examples demonstrate how G20 member, and invited countries, have sought to ensure more equitable access to quality early childhood and preschool education and resources across all population segments, with a particular focus on groups at risk of being left out such as girls, children with disabilities and individuals from minority groups.

In **Australia**, all children are entitled to 15 hours of preschool a week (i.e. 600 hours a year) in the year before they start school. Australia is also investing in targeted measures to improve the lives of First Nations children through better access to quality early childhood education and care. For example, the Connected Beginnings programme helps First Nations children meet the learning and development milestones needed for a smooth start to school by ensuring families have access to culturally appropriate early education and support services.

In **Brazil**, the national effort to consolidate the pedagogical identity of early childhood education, regulated by the National Curricular Guidelines for Early Childhood Education and the National Common Curricular Base, stands out. Early childhood education encompasses daycare for children aged 0 to 3 years old and preschool for children aged 4 and 5 years old. It is a crucial stage of basic education and is required to be provided in non-domestic institutional spaces, whether public or private, under the supervision of social control bodies. Funding for early childhood education is guaranteed by the Fund for Maintenance and Development of Basic Education and Valorisation of Education Professionals (Fundeb).

Children in **France** have access to free and compulsory education from age 3, with France's priority education policy mitigating the impact of social and economic inequalities on student performance, including by 'capping' class sizes to 12 pupils (at ages 5, 6 and 7) in priority education areas to ensure better literacy and numeracy acquisition and combat inequality.

In **India**, the National Education Policy 2020 prescribes that all students must attain foundational literacy and numeracy skills by Class 3. Currently, due to the lack of universal access to ECEC, a substantial proportion of children join Class 1 with no previous preschool experience. To ensure that all students are school-ready, an interim three-month play-based 'school preparation module' ('Vidya Pravesh') for all Grade 1 students has been introduced in schools.

Italy's strategy to ensure universal FLN starts with the strengthening of educational services for children and kindergartens, followed by a series of interconnected interventions at primary and secondary school level, including teachers' training. In **Mauritius**, a policy decision has been taken to make the pre-primary sector free beginning in 2024. Children in low-performing schools in socially vulnerable regions are supported through various measures, including the provision of daily meals, sponsorships, strengthened community linkages and a special pedagogy to encourage student learning and progression. The National Education Counselling Service also closely monitors students' emotional well-being and supports them through consultations with educational psychologists.

In **Saudi Arabia**, the Ministry of Education focuses on Early Childhood Education by increasing access to education at an early age, promoting parental engagement, enhancing educators' training at the pre-primary by leveraging e-training and expanding the network of kindergarten in remote areas. The expansion in pre-primary education involves developing the network of pre-primary classrooms across the country to ensure

that wherever there is a family, there is access to appropriate pre-primary facilities. Access to pre-primary education has increased from 21 per cent in 2019 to 32.6 per cent in 2022 with the aim of reaching 40 per cent in 2025 and 90 per cent in 2030.

Singapore has brought childcare centres and kindergartens under the same regulatory framework by implementing the Early Childhood Development Centres Act and is ensuring quality teaching and learning in preschools through the Nurturing Early Learners Curriculum Framework for Preschool Education. Singapore is also expanding government-supported preschools to ensure accessibility and affordability of preschool for all families. By 2025, 8 in 10 preschoolers will be enrolled in a government-supported preschool.

In **Spain**, both recent changes in law and the setting up of a specific Territorial Cooperation Programme foster the promotion of the first cycle of Early Childhood Education and Care (ECEC) for the entire population, especially the most vulnerable, addressing regional disparities in participation. The country's 'PROA+ Programme' further aims to strengthen the 3,000 schools with a higher percentage of students in vulnerable situations. Throughout the programme's duration (3 school years), participating schools must develop a Strategic Improvement Plan to identify the challenges to be addressed in order to improve inclusiveness.

Türkiye continues to invest in expanding its preschool education services, aiming to make one year of preschool education free of charge before the 1st grade of primary school. In 2022, capacity of the preschool education was increased by adding more than 16,100 new kindergarten classrooms. To reach this target, new schools are being constructed and some classrooms are being re-allocated for preschool education services.

The **United Kingdom** (England) has spent £20bn over the past 5 years to support families with childcare costs. The current entitlement and childcare offers include a universal 15-hour offer for all 3- and 4-year-olds, a 15-hour offer for the most disadvantaged 2-year-olds, and a 30-hour offer for 3- and 4-year-olds of working parents. By 2027-28, the Government expects to provide over £4.1 billion to fund 30 hours of free childcare per week for working parents with children aged nine months to three years in England.

In the **United States**, the Individuals with Disabilities Education Act aims to enhance families' capacity to meet the developmental and learning needs of their infants and toddlers with disabilities. The goal is to minimize developmental delays and reduce the need for later special education, maximizing the potential of individuals with disabilities. The intervention is family-centred, supporting caregivers in implementing the interventions in the context of the families' daily routines.

Table 1: Programmes focussing on ready to learn

Bangladesh: Stipend and Midday Meal
In Bangladesh, a monthly stipend has been provided to mothers of primary education students meeting certain performance and need-based conditions since 2002. In mid-2017, the government began transferring the stipends directly to mobile banking accounts of nearly 10 million mothers of 13 million enrolled children. Additionally, the Prime Minister's Education Assistance Trust was established in 2012 to provide stipends and tuition fees to students from poor families ranging from the 6th to graduate levels. In FY 2021-22, nearly 231 million USD was distributed directly among 5,860,738 students through mobile and online banking systems. Over three million students in 15,700 primary schools receive midday meals under the National School Meal Policy, with the goal of universal midday meal coverage for all government primary schools by 2023.

Brazil: Fund for Maintenance and Development of Basic Education and Valorization of Education Professionals (Fundeb)

Pre-primary education has a constitutionally guaranteed financing system through the Fundeb. In parallel, the Secretariat for Basic Education (SEB), through the General Coordination of Early Childhood Education (COGEI) of the Directorate of Policies and Guidelines for Integral Basic Education (DPDI), works to promote the expansion of daycare and preschool services. This programme consists of the transfer of financial resources in order to ensure the expansion of supply and the regular operation of new enrolments, either in new establishments or in new classes of early childhood education, until they are counted for receiving resources from the Fund for Maintenance and Development of Basic Education. Finally, the full-time Education Programme also aims to foster the creation of full-time basic education enrolments, and the Union is authorized to transfer financial resources to the states, Federal District and municipalities for the implementation of the programme's actions, aiming, among other objectives, to reach at least 25 per cent of students in basic education, as provided in Target 6 of the National Education Plan (Plano Nacional de Educação- PNE) in force (BRASIL, 2014).

Canada: Supporting Early Learning and Child Care (ELCC) Systems

The Government of Canada has made a significant investment to bolster provincial and territorial early learning and childcare systems across Canada. The Canada-wide Early Learning and Child Care (ELCC) agreements aim to ensure that families across the country have access to affordable, high-quality, flexible, and inclusive ELCC no matter where they live in Canada. In partnership with provincial, territorial, and Indigenous partners, the Government of Canada has made a transformative investment to build a Canada-wide ELCC system. The Canada-wide ELCC agreement will help children and families who are more vulnerable – including children with disabilities and children needing enhanced or individual supports, Indigenous children, Black and other racialized children, children of newcomers, and official language minorities. The goal is to bring fees for regulated childcare down to CAD $10 per day on average by March 2026. These targets apply everywhere outside of the province of Quebec, which already has an affordable, well-established system.

By December 2022, all of Canada's provinces and territories had either announced fee reductions to regulated childcare spaces or were already providing childcare services for $10 a day or less, with the majority of them having achieved – or exceeded – an average 50 per cent fee reduction. The Canada-wide ELCC Agreements between the federal government and provinces and territories have also ensured commitments to create more than 250,000 new childcare spaces by March 2026. As of February 3, 2023, provinces and territories have announced the creation of more than 50,000 new childcare spaces under the Canada-wide ELCC agreement, and several provinces and territories have used federal funding to increase supports for early childhood educators and staff.

India: NIPUN (National Initiative for Proficiency in Reading with Understanding and Numeracy) Bharat Mission

NIPUN (National Initiative for Proficiency in Reading with Understanding and Numeracy) Bharat Mission focuses on the 3-9 age group, including three-years of preschool to grade 3, with the objective of universal acquisition of foundational literacy and numeracy skills to be achieved by 2026-27. As recommended in the National Education Policy 2020, the Mission focuses on bringing children's home languages into the formal teaching and learning process in primary grades as this ensures inclusive and equitable student learning.

India has developed 'Jaadui Pitara' a play-based learning-teaching material for children in the age group of 3-8 years at the foundational stage of education. It is available in 13 Indian languages and is a giant leap towards enriching the learning-teaching environment, making it more child-centred, lively and joyful as envisioned in the National Education Policy 2020. It has been developed diverse teaching and learning materials such as toys, games, puzzles, puppets, posters, flashcards, story cards, play books and handbooks for teachers.

Complimentarily, POSHAN Abhiyaan (National Nutrition Mission), a flagship initiative of the Government of India to combat the issue of malnutrition in the country focuses on quality preschool education for children under 6 years through its campaign *Bachcha aur Shiksha– Poshan Bhi, Padhai Bhi*. Community outreach events include activities focussing on early childhood care and education. Additionally, there has been promotion and sensitization for early learning, through use and development of indigenous and locally available toys for learning, at anganwadi (early childhood development) centres

PM POSHAN (Poshan Shakti Nirman) Scheme provides one hot cooked meal to students enrolled in Grade 1 to 8 in government schools. From the year 2020 the scheme has been extended to cover children enrolled in preschools or Balavtikas in government schools.

Indonesia: Provision of quality reading books

The Ministry of Education, Culture, Research, and Technology has launched a programme aimed at improving the access and availability of literacy and numeracy modules for early childhood education units and primary schools. The programme involves printing and delivering quality books equipped with attractive illustrations and adapted to a child's reading level. Development partners are engaged in providing books and conducting training on fun reading techniques. In addition to printing and delivering the books, the government organizes training for principals, teachers, and librarians, and provides supplementary quality books to ensure the improvement of students' literacy skills from early childhood education up to primary level. The programme is an effort to enhance the quality of education in the country, particularly for young children. By providing high-quality reading materials and trainings, the government aims to improve the literacy and numeracy skills of students and promote a love for learning.

Italy: National Guidelines for the curriculum for Early Childhood and Primary Education

The National Guidelines give wide space to the development of language competences, scientific-mathematical competences and cultural tools for the exercise of citizenship. The development of broad language competences is seen as a precondition for personal growth, for the full exercise of citizenship, for critical access to all cultural fields and for achieving academic success in every pathway. The development of mathematical competences is also considered fundamental, not only as it provides tools to investigate and explain many phenomena of the world, but also as it fosters a rational approach to problems and thus offers an important contribution to the construction of a conscientious citizenship.

Mauritius: Early Support Programme (ESP)

The ESP is designed to support foundational learning in all grades in primary schooling. Its primary aim is to identify learning gaps as early as possible and provide remedial measures to prevent the accumulation of learning deficits that become more challenging to address in later years. The Mauritius Institute of Education is responsible for developing the curriculum and providing teacher training. The programme selects individual children for participation based on two assessments: the Learner Development Profile completed by pre-primary teachers, and the Primary School Readiness assessment done at the beginning of Grade 1.

The ESP provides a range of services, including early identification and screening, assessment, therapy, and education services. These services are provided through a network of trained professionals, including paediatricians, therapists, psychologists and special education teachers. The programme also provides support to families, including counselling, training, and advocacy services.

These instruments assess various aspects of a child's development and are used by the teacher during class time. They are diagnostic and not gateway examinations. Individual learning plans have been created for every pupil in the Early Support Programme, and the headmaster or deputy oversees the overall implementation, holding meetings with the ESP teacher and class teacher to monitor progress. Support Teachers work with groups of up to seven children who require ESP support. These teachers are responsible for organizing the best way to support these children, in consultation with the regular class teachers.

Spain: Programme for the opening of new public places in the first cycle of Early Childhood Education and Care (ECEC) and PROA+ Programme

The programme aims to increase participation in the first cycle of ECEC, especially among children who have lower attendance rates, including those girls from low socio-economic backgrounds, populations in rural and urban areas, minority groups (e.g., linguistic, and others), migrant populations, and children with disabilities. To achieve this, 60,000 new public places for ECEC are being created, with a preference for rural areas and urban areas with the highest vulnerability index, incidence of poverty or social exclusion. The municipalities are responsible for making contracts to create ECEC schools in their jurisdiction, hiring staff to work in the ECEC schools in operation, and reporting to the regional government on the agreed-upon objective for their municipality. In parallel, the PROA+ programme aims to strengthen schools with a higher percentage of students in vulnerable situations. The programme involves over 3,000 educational centres and aims to reduce early school leaving rates to 9 per cent and improve inclusiveness throughout the educational system.

United Kingdom (England): Phonics Screening Check (PSC)

By ensuring high quality systematic synthetic phonics teaching, the Government wants to improve literacy levels to give all children a solid base upon which to build as they progress through school and help children to develop the habit of reading widely and often, for both pleasure and information. Since 2010, the Government has driven the effective teaching of phonics and to help schools measure progress, it introduced a statutory phonics screening check (PSC) in 2012 for pupils at the end of Year 1. In 2019, 82 per cent of pupils in Year 1 met the expected standard in the phonics screening check, compared to just 58 per cent when the check was introduced in 2012. For disadvantaged pupils, this has gone from 45 per cent in 2012 to 71 per cent in 2019. 2019 results also showed that by the end of Year 2, 91 per cent of pupils met the expected standard in the phonics screening check.

United States: Individuals with Disabilities Education Act (IDEA), Part C: Programme for Infants and Toddlers with Disabilities

The Office of Special Education Programmes within the U.S. Department of Education is responsible for administering the IDEA Part C programme. At the state level, a governor-appointed lead agency oversees the administration and implementation of the grant. The IDEA Part C programme provides grants to states to establish a state-wide, comprehensive, coordinated, and interagency system that offers early intervention services to infants and toddlers with disabilities and their families.

The early intervention services provided aim to: ① Enhance the ability of families to meet the developmental and learning needs of their infants and toddlers with disabilities; ② Enhance the development of infants and toddlers with disabilities to minimize developmental delays and reduce the need for later special education services; and ③ Maximize the potential of individuals with disabilities. There are several national professional organizations that support Part C programmes, as well as technical assistance centres funded by the federal government. The primary national professional organizations are the Division of Exceptional Children and the IDEA Infant & Toddler Coordinators Association.

1.2 Building teachers' capacities

While most countries have policies and programmes in place for teacher preparation and continuing professional development, systemic problems contribute to the significant shortage of qualified and trained teachers at all levels of basic education. This represents a global challenge worldwide, and therefore impacts the teaching of foundational skills. The causes of teacher shortages are many, from unattractive status (including remuneration and working conditions) to poor career prospects, professional support and motivation/morale. But the result is nearly always the same: a large number of learners, often the most vulnerable, are not getting the learning and support they need.[4]

Many G20 countries have prioritized investments to enhance the attractiveness of teaching careers and strengthen the teacher workforce, including through strategies to redress gender assumptions and biases in education, as well as increase both the number of women and men in the teaching force at the lower education levels, especially in ECEC. **Germany**, for example, implemented the 'Mehr Männer in Kitas' ('More Men in Daycare Centres') programme in 2011–2013 and the 'Quereinstieg — Männer und Frauen in Kitas' ('Lateral Entry – Men and Women in Daycare Centres') programme from 2015-2020 to reorient men and women seeking a career change. While far from ensuring gender parity, the programmes have helped increase the share of men employed in ECEC in Germany from 3 per cent in 2006 to 7 per cent in 2019.[5]

Recognizing that teachers need to continuously acquire new knowledge, skills and resources to improve their teaching abilities and meet their students' evolving needs (especially in reading and mathematics), G20 and invited countries have also made investments in enhancing teachers' pedagogical knowledge, subject-matter expertise and leadership skills.

In **Indonesia**, the objective is to increase teachers' literacy and numeracy competence, as underlined in Directorate General of Teacher and Teacher Personnel Regulation Number 0340/2022 Regarding the Elementary School Teachers' Competence Framework of Literacy and Numeracy. In Mauritius, all primary school teachers in Mauritius receive compulsory pre-service education for 21 months and also engage in shared learning and capacity-building with the Mauritius Institute of Education through workshops. **South Africa's** Primary School Reading Improvement Programme strengthens the capacity of foundation and intermediate-phase instructors to teach learners how to read more effectively. The programme instils international best practices in relation to routines and methodologies, and provides a structured pedagogical approach to the teaching of reading.

Countries such as **Saudi Arabia** are reviewing current regulation and incentives to design and implement programmes encouraging the deployment of outstanding teachers to areas with low learning outcomes. The development of this initiative includes regulations, standards and procedures that help in selecting distinguished teachers and providing them with incentives. Technology is utilized to classify schools through the criteria adopted in the initiative and providing reports on teachers' and students' performance. The country has also introduced a mentorship programme between experienced and junior teachers to transfer knowledge and provide guidance and best practices to build their educational capabilities.

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[4] Source: UNESCO (2022a) Transforming education from within: current trends in the status and development of teachers; World Teachers' Day 2022 - UNESCO Digital Library

[5] UNESCO (2022b) Leave no child behind: global report on boys' disengagement from education

Again in **Indonesia**, and given that teachers reside in diverse geographical areas with different cultural characteristics and needs, easy-to-use videos, teaching modules and mini articles featuring literacy and numeracy contents have been provided via an online portal. Local government and institutions are also encouraged to provide teachers and learning communities with the downloaded versions of learning resources for use in face-to-face meetings.

The Turkish Presidency Investment Programme is designed to enhance the quality of language education in **Türkiye**, including the teaching, learning and assessment of Turkish, English, German, and other languages. Language teachers from different parts of the country are currently receiving intensive training on how to use the Common European Framework of Reference Companion Volume (CEFR CV) in their teaching and assessment practices.

One of the pandemic's most important lessons is the need for teachers to adapt to new ways of preparing their students for a technology-driven world. The rapid pace of digital transformation requires them to have the ability to both upskill online and integrate digital tools into their teaching practices. To this end, countries' investments in digital teacher training resources are providing opportunities for professional development and training for early childhood educators and to connect education practitioners nationally and from around the world, enabling them to share best practices and collaborate on innovative solutions to common challenges.

Hybrid and blended approaches to professional development tend to be more suitable for teachers living in rural, remote and crisis-affected areas, or those who face competing demands on their time and attention. Training has also been extended to those teachers who may not have access to traditional training programmes, such as those looking after children in refugee camps and very remote areas.

India's National Initiative for School Heads' Teachers' Holistic Advancement (NISHTHA) provides a platform where teachers can improve their knowledge and skills in foundational literacy and numeracy through 12 online courses using various digital resources and participating in online assessments. **Brazil's** 'Improvement Course in Education and Technology' complements and improves the technological training of basic education teachers; 2.2 million teachers can now follow the training, and over 103,000 professionals have already registered.

Finally, teachers in some countries receive training to raise their awareness of gender stereotypes and support equal educational pathways for girls and boys from pre-primary through higher education. **France** has formally recognized gender equality (SDG target 4.5) in Article L121-1 of the Education Code. An inter-ministerial agreement for equality between girls and boys, women and men in the education system (2019–2024) between the French Minister of National Education and Youth, and the Secretary of State for Equality between Women and Men and the Fight against Discrimination, outlines a comprehensive approach to education for equality.[7] The country has also reinforced its continuous teacher training scheme, with peer observation of classes in collectively-planned sessions to help teachers learn from each other.

Table 2: Building teacher capacities

Brazil: Improvement Course in Education and Technology

The main goal of this course is to enhance the technological skills of basic education teachers. The specific objectives are to introduce teachers to innovative teaching and learning methods using available technologies, to provide theoretical knowledge in this area, and to enable teachers to use the activities and exercises proposed in the course in their classrooms. The Education and Technology Improvement Course comprises five self-instructional modules. The modules are designed to be completed independently, without the need for a tutor to guide or monitor the studies or answer questions through chat rooms or discussion forums. The participant can study the modules in any order they choose. The course is overseen by the Director of Teacher Training and Professional Education Development (DIFOR).

European Union: Blended learning - Recommendation of the Council of the EU based on consultations and workshops among EU Member States

The aim of the Recommendation is to make school education more inclusive, improve the development of competences, and support teachers and school leaders. The Commission facilitates peer learning, resources, and professional development opportunities to assist member states with implementation. The European Education Area (EEA) Strategic Framework Working Group on Schools chose blended learning for inclusion as one of the first topics for exchange in 2022. Several resources on blended learning for teachers and the wider education stakeholder community, as well as courses for teachers, have been made available on the School Education Gateway throughout 2021-2022. This includes more general information on the framework for blended learning.

The EU agrees on common areas and objectives for its member states' policy and practice in education, which remains a national competence. Based on the Recommendation's broad definition of blended learning, the group focused on policy conditions and opportunities to support schools and teachers in implementing blended learning in teaching and learning practices in an inclusive way. A plenary discussion and a seminar brought together ministry and stakeholder representatives to discuss the pedagogical value of blended learning for inclusion and the related crucial and evolving role of teachers. Enabling factors such as policies, initial teacher education, and continuing professional development were also discussed to support teachers' readiness, willingness, and competences to take full advantage of blended learning as a pedagogical approach for inclusion.

India: National Initiative for School Heads' Teachers' Holistic Advancement (NISHTHA)

NISHTHA is a capacity-building programme for „Improving Quality of School Education through Integrated Teacher Training". It aims to build competencies among all the teachers and school principals at the elementary stage. NISHTHA is the world's largest teachers' training programme of its kind. The National Council of Educational Research and Training developed a 12-module course on foundational learning, including language, literacy, and numeracy. Programmes cover themes ranging from teacher's own literacy, numeracy and competencies in reading and other subject-specific areas, as well as structured pedagogical approaches.

The programme has so far benefitted 1.2 million teachers and 500,000 school leaders and has been offered nationwide in 11 Indian languages through the national Digital Infrastructure for Knowledge Sharing (DIKSHA) learning portal, a national platform for school education, an initiative of the Computer Emergency Response Team (CERT) under the Ministry of Education which enables a wide variety of services spanning learning, assessments, tracking learning outcomes to interactions and credentialing.

Each state and union territory utilized the DIKSHA platform, with a separate window, 'DIKSHA FLN,' created to provide free e-learning resources. The resources include over 2,000 learning outcome-wise videos, infographics, worksheets, and other FLN-related documents.

Indonesia: Elementary School Teachers' Competence Framework of Literacy and Numeracy (Directorate General of Teacher and Teacher Personnel Regulation Number 0340/2022)

Teachers in Indonesia reside in diverse areas throughout Indonesia with different geographical characteristics and needs. To make learning materials available to all teachers, a technology-based platform is the best means of increasing teachers' knowledge of the conception of literacy and numeracy as well as teaching strategies that strengthen students' literacy and numeracy skills. This is conducted through providing friendly-to-use videos, teaching modules and mini articles featuring literacy and numeracy content.

The Regulation is a competencies guide for teachers to enhance their literacy and numeracy skills through a progression of competences. It covers several aspects, including: ① the formulation of the regulation and the conceptual framework; ② literacy and numeracy learning resources for teachers, such as self-assessment instruments, modules, and learning media/decodable books created by teachers; and ③ partnerships with foreign universities to enhance teachers' literacy and numeracy competencies, involving teachers in elementary schools. The Indonesian Ministry of Finance provides financial support for teachers participating in the online literacy and numeracy training.

Teachers' learning journey is guided through the learning resources that provide strategies to improve students' literacy and numeracy skills. These resources demonstrate ways for teachers to implement literacy and numeracy learning using the Independent Curriculum. Moreover, teachers are encouraged to learn from their counterparts in different countries to broaden their horizons in literacy and numeracy. The Ministry of Education, Culture, Research and Technology collaborates with the Ministry of Finance to support selected teachers' participation in online courses conducted by Columbia University New York and Monash University Australia.

Saudi Arabia: 1) Incentivizing high-quality teachers to work at schools with low student outcomes; 2) Teacher Mentorship Programme Initiative

Deployment of outstanding teachers to low learning outcome areas: The Ministry of Education is working on an initiative that motivates outstanding teachers to work in low performing schools for the purpose of improving students' learning outcomes. This initiative aims to provide equal access to quality education regardless of social and geographical differences. The programme is monitored through teams that evaluate the level of students and teachers on monthly basis, and at the end of each semester (the academic year is three semesters), the program is also evaluated through an external party (Education and Training Evaluation Commission) to measure the average performance of students in national tests.

Teacher Mentorship Programme Initiative: The objective of the initiative is to ensure continuous professional development for teachers through in-person mentorship approach. The programme provides mentorship for newly recruited teachers through experienced teachers. The objective of the programme is to improve teachers' self-awareness by focusing on their areas of strengths and weaknesses. The focus of the programme is to develop teachers' skills in different areas such as research skills, planning, and classroom management skills. Improving the teaching practices in the classroom can improve students' learning outcomes and develop vibrant professional learning communities.

Teacher development and training on new curriculum, modern teaching methods and dealing with all student categories: This programme for teachers is tailored to specific requirements: target segments (e.g., gifted students, students with disabilities, etc.); New curriculum (e.g., digital literacy, entrepreneurship...), using modern teaching methods (e.g. project-based learning, challenge based; ii) learning, problem-based learning etc.; Updated curriculum (e.g. social studies, Arabic language, Islamic education...), and directing teachers towards focus areas such as reading books; training programs for teachers transforming them into role models of target values, helping to promote and instil values in students.

South Africa: Primary School Reading Improvement (PSRIP)

The Primary School Reading Improvement Programme was developed to strengthen foundational reading and literacy skills in grade 1-7 classrooms. To achieve this, it incorporates international best practices in routines and methodologies, and provides a structured pedagogical approach to teaching reading. The programme upskills and supports department officials (subject advisers), school management team officials, and teachers. Its goal is to improve subject advisers' and teachers' understanding of approaches, policies, and associated assessments. It is funded by the Education, Training, Development Practices Sector Education and Training Authority (ETDP SETA) and implemented by the National Education Collaboration Trust (NECT) on behalf of the Department of Basic Education (DBE). The DBE and NECT, as the implementing partner, conduct internal monitoring and quality assurance of the programme.

Türkiye: 'I am Special. I am in Education.'

As part of the 'I am Special. I am in Education' initiative, which is a teacher training programme launched in 2019 that aims to promoting the professional development of teachers and improving the quality of education in the country, many applications were developed for students during the pandemic. One of them is for students with disabilities, called "I am Special. I am in Education". This application includes 55 games for students to play at home with their parents. There is an application for preparing "Public Personnel Selection Examination for People with disabilities" for students with disabilities, which offers useful digital activities for students with disabilities which would help students educate themselves, follow the curriculum and prepare for the exam.

United Kingdom (England): The Early Career Framework (ECF)

The Early Career Framework (ECF) reforms were rolled out nationally in September 2021 entitling all early career teachers (ECTs) in England to access high quality professional development at the start of their career. The ECF sets out what all ECTs should learn about and learn how to do during the first two years of their careers and is designed to help teachers feel more confident and in control at the start of their new career. In September 2021, England extended the statutory induction period to two years with funded time away from the classroom and the support of a dedicated mentor for new teachers across those two years.

The content of the ECF and its underpinning evidence was independently assessed and endorsed by the Education Endowment Foundation (EEF). The EEF has also independently assessed the training materials for the provider-led programmes to ensure their fidelity to the ECF. In the first year of national roll-out of the reforms, over 25,000 ECTs benefitted from government-funded ECF-based programmes (93 per cent of new teachers), a trend which continues at present.

1.3 Curriculum enhancement and content creation

During the early phases of the COVID-19 pandemic, many G20 countries adjusted their curricula to prioritize fundamental skills and knowledge as a response strategy. The success of these adjustments is seen as an opportunity to make more permanent adjustments that home in on the key competencies needed by learners in today's world and provide a more comprehensive and effective learning experience.

Many G20 countries have since rebalanced the curriculum towards teaching foundational skills; and adopt more inter- and transdisciplinary approaches that connect more closely with issues related to sustainable development and greening the economy. The idea is to instil in learners the values, attitudes and behaviours that support individual well-being, responsible local development and global citizenship.

Teachers are also being encouraged to implement remediation and catch-up programmes, as well as addressing learning gaps through additional instructional time on core skills and supplementing learning with additional teaching-learning materials, especially for those most in need. Countries have also looked more

closely at the continuity of the educational process with the objective of a positive transition between ECEC and primary education reflected in curriculum development, close coordination between teaching staff at both levels.

Creating more relevant and impactful curriculum contents begins with prioritizing learning objectives and identifying learning gaps, selecting relevant materials and resources, and developing instructional activities and assessments that align with those objectives. **Argentina** implements a universal programme to support the availability of contents needed for basic literacy and numeracy for all learners at all levels of the educational system. This is called *Libros para Aprender* (Books for Learning). As a complementary way to achieve the same goal, the *Hacia la Universalización de la jornada completa o extendida* (Towards universal all-day schooling) is implemented for state schools at the primary level.

In **Brazil**, the principles and assumptions of the Common National Curriculum Base (BNCC), approved by the National Education Council, for the stages of Kindergarten and Elementary School and for the High School Stage, regulate the development of school curricula and pedagogical proposals for the education network, and constitute a mandatory reference for the definition of the set of essential learning that all students must develop throughout the stages and modalities of Basic Education. From the perspective of a more relevant and impactful curriculum, as expressed in the BNCC, this should include knowledge, skills, attitudes and values, competencies that enable learners in a transversal and integrating way to deal with „contemporary issues that affect human life on a local, regional and global scale."

The People's Republic of China's Compulsory Education Curriculum Plan and Curriculum Standards illustrates how countries are advancing with the times, combining new changes in economic and social development and new achievements in scientific and technological progress to update curriculum contents. The Curriculum Plan and Standards were revised in 2022, with updated course contents, providing strong support for the high-quality and balanced development of compulsory education in China.

In **India**, the 'National Curriculum Framework for the Foundational Stage' was developed to support the vision of the National Education Policy (NEP) 2020. The framework is based on cutting-edge research from across the world and a better understanding of how young minds develop, based on neuroscience and cognitive science. A new pedagogical and curricular restructuring, starting with five years of foundational learning, has been introduced which recognizes the continuum of learning for children in the 3-8 age group (including) three years of preschool education. This aligns with the National Initiative for Proficiency in Reading with Understanding and Numeracy (NIPUN)'s 'Bharat Mission', which focuses on the 3-9 age group (including preschool to grade 3) with the objective of achieving universal acquisition of foundational literacy and numeracy skills by 2026–2027.

In **Indonesia**, early childhood education units and primary schools are provided with high quality, curated, age-appropriate books to improve the ease of access and availability of literacy and numeracy modules. In parallel, principals, teachers, and librarians also receive training to improve students' engagement in reading. There has also been a recent change of policy in the early childhood and primary education to ensure that children are able to develop not only their cognitive, but also their social, emotional, mental, and physical skills. This includes, among others, the abolishment of entry tests (reading-writing-counting) to primary schools, the requirement for schools to organize parents-students orientation during the first two weeks of schooling, and the implementation of holistic approach to learning.

In **Italy**, reform measures are being introduced to enhance student guidance on educational pathways and employment opportunities and strengthen the connection between the first and second cycles of education and training. This will enable students to make well-informed choices that leverage their potential and talents. It also seeks to reduce early school dropout rates and facilitate access to tertiary education.

Germany has conducted joint initiatives between the Federal Government and the Länder (federal states) on 'Transfer of language education, reading and writing support' ('BiSS-Transfer'), a follow-up to 'Education through Language and Writing' ('Bildung durch Sprache und Schrift' [BiSS], 2013-2020). Primary and lower secondary schools, along with daycare centres, work together to promote language and reading skills. In general, the 16 Länder oversee curricula, contents and quality in around 40,000 schools to promote language and reading skills. In BiSS-Transfer, evidence-based tools for language learning and diagnosis are identified, and the effects of language programmes on outcomes are monitored nationwide within groups of schools. About 2,700 schools across Germany will implement the language education measures in a coordinated approach.

Table 3: Curriculum enhancement and content creation

European Union: Pathway Initiative – Council Recommendation on blended learning approaches for high-quality and inclusive education

The Pathways initiative proposes a renewed framework for action, for Member States to develop their own integrated strategies for school success, supported by effective data collection and monitoring. It outlines a set of policy measures on monitoring, prevention, intervention, and compensation, with a stronger focus on prevention and early intervention, which Member States can apply and combine according to their specific circumstances and needs.

The Recommendation provides a framework for further action, including peer learning, cooperation, and exchange of information and experiences among Member States, stakeholders, and partner countries through a dedicated EU Working Group on Schools (Pathways to School Success sub-group). The School Education Gateway has made available several resources on blended learning for teachers and the wider education stakeholder community, including information on the framework for blended learning. Additionally, courses for teachers will be offered throughout 2021-2022. EU funding, including from Erasmus+, will be used to support the Recommendation and its goals for inclusive education. Follow-up activities will aim to reduce underachievement, particularly among groups at risk, and decouple educational attainment from socio-economic background.

The People's Republic of China: Compulsory Education Curriculum Plan and Curriculum Standards

The Compulsory Education Curriculum Plan is a comprehensive blueprint that outlines educational goals, objectives, and content for primary and middle school education in China. It consists of two parts: the general plan and the subject plan. The general plan includes the overall goals and objectives of education, while the subject plan covers specific requirements for each subject area, including Chinese language and literature, mathematics, science, social studies, physical education, and arts education.

The Curriculum Standards provide detailed guidelines for implementing the Compulsory Education Curriculum Plan, defining specific knowledge, skills, and competencies that students are expected to achieve at each grade level and in each subject area. They ensure that students receive a well-rounded education and are prepared for further studies or employment after graduation. Besides subject-specific standards, the Curriculum Standards also include requirements for teaching methods, assessment, and technology use in the classroom. They stress the significance of developing students' critical thinking, creativity, and problem-solving skills.

The Compulsory Education Curriculum Plan and Curriculum Standards are regularly revised to remain relevant and effective in meeting the changing needs of China's society and economy. The latest revision in 2022 introduced changes such as more emphasis on environmental education, health education, and digital literacy.

India: National Curriculum Framework for Foundational Stage and Samagra Shiksha

The National Curriculum Framework for Foundational Stage (NCF-FS) has been developed to enhance the foundational learning of children across the country. It aims to ensure every child achieves the desired level of reading and numeracy skills as well as socio-emotional well-being by the end of the foundational stage of education. The framework focuses on providing age-appropriate and activity-based learning experiences to children.

Samagra Shiksha is a flagship programme of the Government of India aimed at achieving universal school education and is the vehicle for rolling out the NCF-FS. It is one of the largest education initiatives in the world. It is an overarching programme for the school education sector extending from preschool to class 12, and therefore prepared with the broader goal of improving school effectiveness measured in terms of equitable access to schooling and quality learning outcomes for all children in India.

Italy: Reforms to enhance educational pathways

Starting from the 2023/2024 school year, reforms to technical and vocational education will enable the inclusion of a 30-hour guidance module in lower secondary schools and the first two years of upper secondary schools. In the final three years of upper secondary schools, 30 curricular hours will be allocated to this purpose. To optimize the effectiveness of the guidance pathways, the curricular modules in the last three years of upper secondary schools will be developed in collaboration with institutions at the subsequent education and training level. These collaborations will involve ITS Academies, universities, higher education institutions specializing in arts, music, and dance, businesses, regional guidance services, employment centres, and other relevant services in the area, all working together to facilitate the transition from school to work.

The Netherlands: 'Masterplan Basisvaardigheden' (Masterplan Basic Competence)

The Masterplan aims to enhance foundational learning in areas such as literacy, numeracy, digital competences, and citizenship. The plan focuses on key aspects such as providing teachers with more time and resources to develop their skills and curricula, access to evidence-based teaching methods, strengthening the connection between schools and the environment, acknowledging that foundational learning occurs outside of the classroom, implementing a regulated monitoring and oversight system to track student progress, and providing clearer expectations for schools regarding what students should be capable of doing.

Saudi Arabia: Review and update primary to secondary curriculum framework to give more focus to basic skills and build skills for the future

The curriculum framework is being reviewed and modified to prioritize the development and promotion of skills and values and allocating more hours and emphasis to specific subjects, such as literacy and numeracy skills, utilizing high-quality and engaging educational content, including educational technology for enhanced learning experiences. The Kingdom of Saudi Arabia considers it essential to introduce mandatory digital and computer science education, including coding, beginning from grade 1. This should encompass lessons on digital safety, protection against threats, and personal data management. English classes should also be made mandatory from grade 1, with additional options for learning other relevant languages, such as Chinese. Both genders should have access to physical education, including sports and self-defence. Cultural topics, including drama, poetry, and music, should be incorporated into the curriculum. Intermediate and secondary levels should focus on developing skills such as design thinking, decision making, information management, project management, entrepreneurship, and financial literacy. Additionally, there should be a restructuring of subjects like Islamic education, ensuring that it promotes Islamic values, and social studies, which should concentrate on highlighting the nation's civilizational achievements and fostering a sense of national belonging.

Singapore: Learning Support for Mathematics (LSM) and the Learning Support Programme for English (LSP)

The LSM programme aims to provide early intervention support for students who need help in acquiring basic numeracy skills, such as counting from 1 to 10, number recognition and simple pattern recognition, when they enter primary school. Students are taught in smaller groups during their regular mathematics periods or have supplementary lessons by specially trained teachers. On a yearly basis, students who make sufficient progress can graduate from the programme early and re-join their class. The programme is monitored and evaluated through classroom observations, focus group discussions with teachers and measures of student performance.

The LSP provides targeted literacy support for primary one and two students who lack basic literacy skills, such as the ability to read and spell words, and to read grade-level texts with fluency and understanding. The teaching pedagogies used in the LSP are informed by evidence-based best practices in beginning reading instruction and aim to address the five key components of effective reading instruction: phonemic awareness, phonics, fluency, vocabulary, and comprehension. In the LSP the Gradual Release of Responsibility model is used to introduce basic literacy skills to students, leading to students' independent use of the strategies. To foster alignment between the LSP and the regular English Language (EL) curriculum, the texts used in the LSP are the same texts used in regular EL lessons. MOE monitors student outcomes on a yearly basis and conducts regular reviews of the LSP to ensure it continues to fulfil its objectives of helping students narrow their literacy gaps.

South Africa: Strengthening of the National Curriculum Statement

South Africa recognizes that while there have been significant improvements in learning outcomes over the past 10-15 years, much work remains to achieve quality education across the sector. Research suggests that poor learning outcomes in early years contribute to the large number of learners who exit the basic education system without adequate knowledge and skills to succeed in life after school. Deep systemic challenges have been further compounded by the ongoing impact of the COVID-19 pandemic on teaching and learning.

In order to respond holistically and sustainably to these multifaceted challenges, the Ministry of Education is embarking on deliberate action in five broad areas: updating and strengthening the existing national curriculum statement; updating and strengthening current assessment practices; effective classroom teaching and pedagogical practices; Enhancing the space (physical and non-physical/virtual) in which learning takes place, to enable effective teaching and learning; strengthening the basic compulsory learning resources.

The Ministry of Education will review current subjects and potentially add new subjects and themes like environmental literacy; update content in existing subjects; systematically incorporate social, emotional, and cognitive competencies into teaching and learning. The outcome is to ensure that learners leave school with a holistic combination of knowledge, skills, character, attitudes, and values to succeed in a changing world.

Türkiye: Remedial Programme in Primary Schools (IYEP)

The Remedial Programme in Primary Schools (IYEP) is a supportive program that addresses students who cannot attain standard learning outcomes in reading comprehension, writing skills, natural numbers, and four operations until the end of grade 3. Students who benefited from IYEP do not have any diagnosed learning disabilities or any special education needs. The six key components of IYEP include; curriculum, assessment and evaluation tools, e-school system, learning materials, teacher training and legislation. All resources developed for the programme are available both digitally and in print. In IYEP, the process of identifying, evaluating students, forming student groups, and assigning teachers is carried out through the central e-School System.

Student responses to the questions are entered into the system by the teachers, and the system determines which students need IYEP. The system also determines which module the students will start. The student peer groups are formed based on their learning level, and teachers are assigned to these groups through the system. The level of each student at the beginning of the programme, the level of progress at the end of the programme, how many students are included in the programme, the impact level of the programme, participation of teachers and students at provincial and country levels are monitored. Approximately 1.3 million students at grade 3 have benefited from this programme.

United Arab Emirates: Arab Reading Challenge (ARC)

The ARC is the largest-ever Arab knowledge initiative. It seeks to instil the habit of reading Arabic literature among young students. The annual Challenge was launched in the 2015–2016 academic year, initially inviting students from grades 1 to 12 across the Arab region to participate, before expanding in scope to include Arab students from all over the world. The Challenge runs throughout the school year in staged qualifiers, beginning at class level, to school, country, and regional levels, leading up to crowning the ARC Champion at the final ceremony in Dubai. The number of participants in a single edition of the Arab Reading Challenge continues to increase year-on-year. Approximately 3.5 million students participated in the first edition, with the number doubling in the second edition to more than seven million students. As the third edition allowed entries from outside the Arab world, the number of participants came close to 10.5 million. The number of participants in the fourth edition of the challenge exceeded 13.5 million students from 49 countries, while the number of participants in the fifth edition reached more than 20 million students. This sixth edition saw 22.27 million participants. The growth rate of the number of participating students in the sixth edition, compared to the first edition, reached 536 per cent – a significant increase that reflects the growing impact of the challenge in encouraging reading in Arabic.

1.4 Digital resources for better teaching and learning

Under the right conditions, digital resources, such as online learning platforms, educational apps and digital education games, are closing gaps in access to quality foundational learning resources and support mechanisms for children, families and communities. This is particularly true for those living in rural and remote areas, or individuals displaced by natural disasters and other climate-related crises, who may not have the financial resources to access traditional onsite education programmes.

Some countries have focused on the digitization of learning resources and support mechanisms that can foster, accelerate or scaffold foundational learning. At the early education level, **Mauritius** has begun to embed digital technologies at scale in primary schools (grades 1–6) through the Early Digital Learning Programme. Education from primary to higher secondary level will see a major transformation. In 2023, the country is completing the Early Digital Learning Programme for the digitization of learning resources for the primary school sectors with the digitization of textbooks and contents for tablets.

The Rawdati platform (My Kindergarten Platform) in **Saudi Arabia** is an interactive model for distance education at the kindergarten stage. Rawdati offers alternative ways of learning for kindergarten children under the supervision of parents and the direction of teachers within a child-friendly virtual environment. It provides weekly digital content programme and featured functions to monitor attendance, make announcements and document students' records. Rawdati engages young learners in developing their foundational, social, and digital skills while ensuring creativity, connectivity, and sustainability. The Remote area schools development initiative also aims to improve access to education in remote areas through a review of the schools network and the introduction of distance learning tools to ensure access to high-quality education for all students.

Türkiye has developed an online platform and guidance materials for foundational learning. One such resource is the Education Information Network platform, an online portal featuring interactive games, videos and exercises aligned with the national curriculum and designed to help children develop literacy and numeracy skills. Another resource is the 'Reading Aloud' campaign, which encourages parents and caregivers to read to children from an early age.

In the **United Arab Emirates**, 'UAE Storytime' is an online programme that uses augmented reality (AR) to create an interactive literacy experience for young learners (ages 4–11). It was designed to enhance well-being during the COVID-19 distance-learning phase and uses an AR camera to capture reality and attach virtual objects. Other G20 countries have developed online initiatives mobilizing resources and psychosocial support to help children, adolescents and their parents in a comprehensive and multimodal manner.

Countries such as **Italy** have introduced digital portfolios as part of their reforms to guidance around education and training pathways. The E-Portfolio for secondary school learners will serve as a comprehensive framework, integrating the student's educational journey and supporting students and families in reflecting on and identifying the student's major strengths. It will also highlight their digital competencies and acquired experiences.

Table 4: Better resources for digital teaching and learning

Japan: Global and Innovation Gateway for All (GIGA) School Programme

The Global and Innovation Gateway for All (GIGA) School Programme is a collaborative effort between the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the Digital Agency, the Ministry of Economy, Trade and Industry, and the Ministry of Internal Affairs and Communications in Japan. It aims to enhance the quality of education and promote the effective use of Information and Communication Technology (ICT) in schools by integrating personalized and collaborative learning approaches, including the provision of one computer device per student. Originally planned to be implemented over several years, the programme was accelerated, and through national government subsidies to local governments, the goal of providing one device per student was achieved within one year.

Türkiye: Various programmes

Digitalization of Mathematics Materials: The Ministry of Education of Türkiye has launched a project aimed at transforming the perception of mathematics from a dry, abstract subject to one that emphasizes practical, real-life skills. The „Digitalization of Mathematics Materials" project plans to equip students with hands-on materials, such as tangrams, play money, blocks, scales, and weights, to facilitate their engagement with the subject. The aim of this project is to provide equal educational opportunities and make the learning of mathematics accessible to all students, including those in schools with limited access to these materials. To achieve this, the project will digitize the material sets and make them available on an open educational resource platform called Mathematics Platform. National education specialists, primary school teachers, and academics were invited to contribute to the development of the platform's content, which includes instructional videos and educational games that use the materials. The videos demonstrate how to use the materials in the classroom, while the games incorporate the materials to create an interactive and engaging learning experience.

Online Guidance Activities: Türkiye has developed several online guidance materials for foundational learning. One such resource is the EBA (Education Information Network) platform, an online portal that provides access to a range of digital resources for students, teachers, and parents. EBA includes materials for foundational learning, including interactive games, videos, and exercises that are aligned with the national curriculum and designed to help children develop their literacy and numeracy skills. Another resource is the „Reading Aloud" campaign, an initiative that encourages parents and caregivers to read to children from an early age. The campaign provides guidance on how to select appropriate books for different age groups, how to read aloud effectively, and how to create a reading-friendly environment at home. The campaign also provides online resources, such as e-books and audiobooks that can be accessed through the EBA platform.

Creation of Instructional Videos for Students with Disabilities: With this project, 1500 instructional videos applying different research-based teaching strategies were created for students with disabilities to help them with their education. The instructional videos were created specifically for students with disabilities to support their mental health and social-emotional learning.

United Arab Emirates: The Digital School – Basic Literacy and Numeracy (BLN) Programme and Storytime

The digital school developed the BLN programme aims to help students in underserved communities to acquire fundamental literacy and numeracy skills. This programme is delivered in English and Arabic and now is also developed in French and Spanish. The objective of the programme is to provide the students with foundational literacy and numeracy skills by enrolling them in the 2-3 months BLN programme provided by The Digital School.

After passing the basic literacy and numeracy exam, these students will be enrolled in an accelerated learning programme to help them recover from missing several academic years. This will allow them to be enrolled back in formal education in their respective group age and/or school grades.

UAE Storytime is an online programme that uses augmented reality to create an interactive literacy experience for young learners (aged 4-11) across the UAE and globally. Hosted on the Ministry of Education's YouTube channel, the Programme was introduced in June 2020 during the COVID-19 pandemic with the aim to engage young learners in literacy and technology. The programme was designed to enhance well-being during the distance learning programme and engage communities globally. Cambridge Partnership for Education supported by providing storytellers including authors of texts which had been published in Cambridge adapted MOE Bridge to Success books. They also read out their own series of Cambridge Reading Adventures (which are not featured in Ministry of Education Cambridge books). The Ministry of Education and Cambridge Team worked closely together to plan the project, schedule and disseminate roles in a short space of time.

1.5 Assessment

Large-scale learning assessments assist decision-makers in understanding children's foundational learning levels and the education system's capacity to deliver quality education. In addition to system-level data, quality classroom-level data are critical for monitoring learners' progress and correcting course where necessary. Across the G20 countries, high- and low-tech diagnostic and formative assessments are helping teachers and policy-makers understand progress against curricular standards and provide children with responsive and ongoing learning support.

In 2022, **India** conducted the first-ever Foundational Learning Study to benchmark children's learning levels in literacy and numeracy at the end of class 3 (end of kindergarten). The study covered 86,000 students from 10,000 schools and was conducted in 20 languages. India also conducts standardized large-scale learning assessment of students in grades 3, 5, 8 and 10 every three years.

The Government of **Indonesia** believes that problem-solving, critical thinking and civic character must take centre stage in students' learning outcomes and has therefore eliminated high-stake, subject-based testing. The new National Assessment now includes a survey on schools' learning environments and students' characters. All the data are available on the Education Report Card platform, a digital dashboard accessible to teachers and principals, as well as local governments, research institutes and ministries, so that they may observe students' foundational skill performance and plan strategies to jointly improve the quality of education.

With a view to ensuring adopted learning assessments in the primary sector, **Mauritius** has adopted a modular assessment model, with students sitting for end of cycle assessments in a staggered format over Grade 5 and 6, along with the inclusion of the evaluation of non-core subjects on a competency-based scale. In the **Netherlands**, two types of assessments are used to evaluate foundational learning. Schools are required to use a student monitoring system called LeerlingVolgSysteem and can use various types of tests in years 1 to 8 to monitor student proficiency in subjects such as mathematics and language for the individual student, class, and school. In the middle of grade 8, students also undertake an assessment called the 'doorstroomtoets'. In **Saudi Arabia**, the student assessment system measures learning outcomes related to skills, leveraging data driven diagnostic tools to provide regular feedback (including detecting at-risk students) through design students digital profiling and categorization. In the **United States**, the National Assessment of Educational Progress assesses student performance in reading and mathematics, providing a critical data point for understanding their level of mastery and their abilities nationwide. The **United Kingdom**'s (England) reform programme since 2010 is designed to bring higher standards to primary assessment, including introducing new assessments, such as the phonics screening check and multiplication tables check, and reforms to existing assessments, most notably the end of key stage 2 tests and teacher assessments taken as children finish primary school.

Table 5: Assessments

Australia: NAPLAN Reform
Assessments Australia: NAPLAN Reform Australia's National Assessment Programme - Literacy and Numeracy (NAPLAN) has been an annual assessment for all students in Grades 3, 5, 7, and 9 since 2008. The test measures skills that are essential for children to progress through school and life, including reading, writing, spelling, grammar and punctuation, and numeracy. From March 2023, the Australian Government introduced new proficiency standards and streamlined reporting, which provides improved transparency and precision in assessing students' literacy and numeracy abilities. The updated NAPLAN now has four clear levels of achievement that are better linked with the Australian Curriculum. These standards enable students to demonstrate skills beyond the minimum level for their year and support higher expectations of student achievement. Parents and caregivers also receive earlier, simpler, and clearer information about their child's achievement.

Bangladesh: National Assessment of Secondary Students (NASS)
The Ministry of Education in Bangladesh measures students' achievement towards learning outcomes through a nationally representative sample-based assessment called the National Assessment of Secondary Students (NASS). This assessment covers students in grades VI, VIII, and X. In 2019, NASS-19 was conducted, and NASS-21 could not be implemented due to the COVID-19 pandemic. Currently, preparations are being made for NASS-2023. Previously, this assessment was known as Learning Assessment of Secondary Institutions (LASI), which was conducted four times (2013, 2015, 2017, and 2019). The data from these studies were analysed, and public reports were disseminated through national-level workshops. Among these studies, 2015, 2017, and 2019 were conducted on a nationally representative sample. The consecutive three studies indicate a trend of improvement in students' achievement in learning outcomes.

France: National assessments

In France, since 2018, national assessments (carried out at the start of year 2, mid-year 2, at the start of year 3 and at the start of year 7) have been a key tool in fostering academic success. The national assessments of year 7 pupils provide teachers with a point of reference in order to adapt their teaching methods to the needs of each pupil. In year 7 classes, new organisational methods are being trialled in order to boost pupils' progress and raise their academic level. Besides, an experimental national assessment of pupils at the outset of year 5 aims at giving teachers the tools they need to monitor pupils' progress throughout their primary education.

The Netherlands: Doorstroomtoets

The test in grade 8 (Doorstroomtoets) serves two purposes. It measures the student's proficiency in both the Dutch language and mathematics and determines the appropriate level for further secondary education. The test complements the school's advice regarding the student's future education, with the school's advice being the primary guiding factor. The Inspectorate uses the results of schools and separate groups for supervision of the education system. In addition, the Netherlands participates in the Programme for International Student Assessment (PISA), which is a worldwide study conducted by the OECD that assesses the reading, mathematics, and science skills of 15-year-old students. The Results of PISA are used to compare educational systems across countries and inform policy decisions.

India: Foundational Learning Study (FLS)

The FLS is a large-scale research study conducted in India, by the National Council of Educational Research and Training which was conducted in March 2022. The study aims to understand what students in Grade 3 know and can do in foundational literacy and numeracy. The data derived from this study established reading proficiency benchmarks for fluency and comprehension for each of the languages (20 in number) assessed and proficiency benchmarks for numeracy.

The FLS study involves the administration of a standardized test for assessing literacy and numeracy skills to a representative sample of students in grades 3, enrolled in state government schools, government aided schools, private recognized and central government schools, across all states in India. The study assesses the extent to which students have acquired basic literacy and numeracy skills. The FLS study is unique in that it uses a diagnostic assessment approach, which provides detailed information on the specific skills that students have mastered and those they have not. This approach has helped establish a baseline for the NIPUN Bharat mission which aims to develop targeted interventions for improving learning outcomes. The FLS study is planned to be conducted periodically, and the results used by policy-makers and educators to inform education policies and improve the quality of education in India.

United States: National Assessment of Educational Progress (NAEP)

The NAEP measures foundational learning by assessing students' knowledge and skills in reading, mathematics, and science at various grade levels. The assessments are designed to measure what students know and can do in these subject areas, with a focus on assessing foundational knowledge and skills that are essential for success in later grades and in life.

For example, the reading assessment measures students' ability to understand and analyse written texts, including their ability to identify main ideas, make inferences, and draw conclusions. The mathematics assessment measures students' understanding of key mathematical concepts and their ability to apply those concepts to solve problems. The science assessment measures students' understanding of scientific concepts and their ability to apply scientific reasoning to real-world problems.

In addition to assessing student achievement, the NAEP also collects information on student background and experiences, such as their socio-economic status and their access to educational resources. This information is used to help policy-makers and educators understand the factors that contribute to student success and to identify areas where additional support may be needed. The assessments are administered at various grade levels, including 4th, 8th, and 12th grades, and are designed to provide a national snapshot of student achievement in these subject areas. The results are used to inform policy decisions and to identify areas where additional support and resources may be needed to improve student outcomes.

1.6 Conclusions

Given their complexity, foundational learning policies and programmes are difficult to implement. Appropriate solutions are embedded in the individual contexts and the nature of the challenges facing different population segments. Countries must act urgently on developing remediation solutions, applying government structures to ensure sustainability. They should seek alignment between challenges and opportunities in the design of learning policies and programmes, and ensure the necessary inter-sectoral and intergovernmental convergence to address highly complex problems. Implementation without government engagement and leadership, and cross-sectoral coordination, will fail. A review of country practices evidences several main lines of action, including:

System-level investments

Initiatives to strengthen system capacities: Many G2O countries have invested in expanding access to quality early childhood education for vulnerable population segments in underserved area. Countries such as France and Germany suggest that measures that can be taken to diversify the early childhood education and care (ECEC) workforce, with greater attention paid to gender parity and equality in training approaches.

Successful teaching of foundational learning requires a high level of training and complex interaction between many elements. While countries pursue initiatives to enhance foundational learning outcomes, they are often still struggling with persistent challenges related to, for example, improving the quantity and quality of available teachers and the technical expertise to support effective pedagogies throughout the system; ensuring

consistency in bridging early learning and primary education, collecting and using assessment data to support teachers in their practice and decision-making; and strengthening alignment among various system components (curriculum, teacher training, assessment, etc.) to have a successful impact on learning at scale.

Curriculum and pedagogy to meet learners where they are on their learning pathway: As the evidence shows, meeting children where they are, and tailoring curricula and instruction to their level of knowledge, is an effective way of improving foundational learning outcomes. Education systems must also ensure high-quality, engaging tech-enabled learning opportunities to help students in a rapidly changing digital age develop the digital skills they need for literacy and numeracy, active citizenship and the world of work.

Investments in early childhood learning and education still need to focus on improving the curriculum in areas such as language, play-based learning and the creation of teaching materials, as these areas can help provide a strong foundation for children's learning and development during their formative years. Focusing on language skills can improve children's communication and literacy abilities, which are critical to succeed in school and later in life. Play-based learning can enhance children's creativity, problem-solving skills and social development. Teaching materials that are culturally relevant and engaging can increase children's motivation and interest in learning, making the learning process more enjoyable and effective.

When the curriculum is enhanced with developmentally appropriate activities that support children's cognitive, social and emotional growth, it can have a positive impact on their overall development. In the end, effective teaching is holistic in nature: it requires teachers to use multiple instructional practices to successfully deliver contents. It teaches students how to learn by helping them think for themselves and apply various learning strategies. It connects with students emotionally by providing social and emotional support. Pedagogical programme design needs to ensure that remediation solutions are practical and sustainable, and not overly burdensome for teachers. Countries should build upon existing designs to maximize the impact on learning, without however alienating or overwhelming teachers.

Language policies: Language of instruction should ideally be brought to the forefront of discussions on education policy, as classroom instruction in a language that learners understand and use at home can provide a rich basis for the development of foundational skills. Poor language-of-instruction policies harm learning, access, equity, cost-effectiveness and inclusion, and yet almost 37 per cent of students are taught in a language they do not understand. SDG indicator 4.5.2 on 'the percentage of students in primary education who have their home (or first language) as a language of instruction' recognizes this. Yet even with evidence and support codified in an SDG indicator, implementation is still complex. To this extent, education programming that focuses on foundational learning should be founded on a clear understanding of language issues (including country positions within national education policies, and extending to household education choices) and an appreciation of 'what works' in specific contexts in terms of the language of instruction.

Use of technologies for supporting foundational learning: Technologies can provide new opportunities for learners to engage with (and become more interested in) FLN, enabling them to learn in more interactive and personalized ways. Such investments, where they are context-appropriate and meet capacity and affordability considerations, should be considered by G20 countries as a means of closing gaps in foundational learning among all learners. They might be diversified across online learning management systems and platforms, adaptive learning technologies, educational apps and games, and interactive whiteboards and tablets. Interactive whiteboards and tablets can also be used to display and manipulate maths problems, allowing students to work collaboratively and engage with mathematical concepts more interactively.

Scalability of solutions: Given the magnitude of the learning crisis, a shift in perspective from 'perfecting small pilots' to 'piloting at scale' is needed. Project-based approaches that are not linked to related interventions and function as an end in themselves, combined with weak integration into the education system and initial designs that are not sufficiently aligned with the system's structures and processes, can cause the system to drain essential resources.

In short, a well-designed, government-led, evidenced-based and integrated remedial programme provides countries with an ideal opportunity to respond to the learning crisis. Rather than starting from scratch or duplicating efforts, interventions should strengthen existing programmes and government systems, providing different forms of needs-based support to scale up remedial programmes. To this end, working closely with the education system will be important to introduce the critical principles of an evidence-based approach as a systemic strategy, allowing for periodic/incremental changes as it takes hold. The process should continuously test the theory of change to determine the impact on teaching and learning, including pedagogical robustness and partners' knowledge of the political and operational landscape. It will also be important to scrutinize the data and evidence from the field, particularly at the classroom teaching and learning levels. Equally important will be understanding the implementation challenges, and working together with teachers to address them.

Investments in learners, teachers and communities

Recognizing the diversity of learners and learning needs in programming for foundational learning: When it comes to foundational learning, students at any grade/level are often perceived as a homogenous group with similar learning needs and difficulties. And yet they are highly heterogeneous; they come from a wide range of socio-economic backgrounds, geographical locations (rural/urban areas), ethnicities (linguistic, religious, etc.) and groups (migrants/refugees/displaced populations), and have differences of ability (i.e. with or without learning difficulties or other disabilities and special needs) and gender. The intersectionality of disadvantage among students can exacerbate the likelihood of learning poverty.

Foundational learning programming requires an understanding of each students' contexts, backgrounds, learning needs and interests. Programmes can build on such an understanding, giving children well-structured opportunities to engage with instructions and learning processes independently and meaningfully, with adequate and targeted support. Emerging remediation models suggest grouping children based on their current competency levels and regrouping them according to their progress.

Investing in teachers: During the Transforming Education Summit held in September 2022, the international community agreed on the need for bold action to address persistent teacher shortages and the lack of diversity in ECEC in the teaching profession. In addition to other actions to fill the teacher gap (such as improving teachers' status, working conditions and remuneration), education systems need to improve gender equality in the teaching profession, and address gender biases at different education levels and specializations. Developing more flexible qualification and accreditation processes should allow multiple entry points for additional candidates to enter the profession while still maintaining quality standards. Female teachers need to be encouraged and provided with equal opportunities to take on leadership roles. Helping teachers to master the skills required to mitigate the risks of technology-enabled learning is another priority, as are measures to ensure cyber safety and cybersecurity for both teachers and students. This includes investments in digital coaching, mentoring and communities of practice.

Active engagement of parents and communities: Ensuring the active engagement of parents in their children's education is important, as empowered parents/caregivers demand quality education and actively support children's foundational learning at home and in schools. Parents need to be partners in children's education, and schools should require them to understand what children should be learning in the classroom. As interventions are scaled up, countries should be supported in integrating interventions into their mainstream foundational learning programmes and the broader education system. To ensure a long-lasting impact, all the programmes should be combined with country-led policies and adopt a 'test, adapt and scale' approach to support locally led innovation.

Chapter 2

Making tech-enabled learning more inclusive, qualitative and collaborative at every level

This chapter discusses how G20 members and invited countries are making tech-enabled learning more inclusive, equitable, relevant, effective, qualitative and collaborative at all levels. It reports on and analyses programmes and policies targeting digital transformation in education and is conceptually divided into five categories: coordination and leadership, content and curriculum, connectivity and infrastructure, capacity and culture, and cost and sustainability. Within each category, the data submitted by participating countries lead to emerging themes, supported by examples in narrative or table form.

In April 2022, the Special Rapporteur on the right to education, appointed by the United Nations Human Rights Council, urged the global community to frame digital technology around every person's human right to public, free, quality education (UNHCR, 2022). As the previous chapter suggests, technologies have enormous potential to improve access, inclusivity, equity and quality in education across all levels, from early childhood to adult learning. To this extent, they play an increasingly important role in delivering on G20 countries' commitments under both international human rights law and SDG 4.

During the COVID-19 pandemic, and as reported during the 2020 Saudi Arabian, 2021 Italian and 2022 Indonesian G20 presidencies, technologies enabled G20 countries to craft targeted COVID-19 responses. They did so through a wide range of flexible learning pathways and innovative pedagogical models to ensure learning continuity. Into the recovery period – and as the digital divide narrows with every passing year – digital and broadcast technologies are now permeating the lives of students and teachers at all levels of education across G20 countries.

Digital transformation in education is highly context-dependent and each G20 country is at a different stage in its development of sustainable, inclusive and equitable access to tech-enabled learning. As countries look to the future, they are striving to identify the entry points and levels of investment needed to leapfrog over continuing challenges to their education systems, including 'readiness' for more advanced technological capabilities. The goal is to mitigate potential risks and maximize the promise of digital technologies for accelerating the transformation of education systems.

Learning from the pandemic

As part of the coordinated global education response to the COVID-19 pandemic, UNESCO, UNICEF and the World Bank collaborated with the OECD to identify country measures and the lessons learned, particularly regarding the digitalization of education, with the goal of supporting educational planning and programming and the deployment of effective learning strategies. Four surveys were designed and disseminated to ministries of education to collect up-to-date information on education policy interventions and global responses to the pandemic between 2020 and 2022. Education ministries in 93 countries responded to the surveys over April–July 2022, once nearly all schools had reopened. The surveys, therefore, provide insights into policy-makers' ideas on how tech-enabled learning could continue in the post-pandemic period.

Figure 4: Countries taking digitalization measures to support education during the pandemic, with a direct impact on the public budget
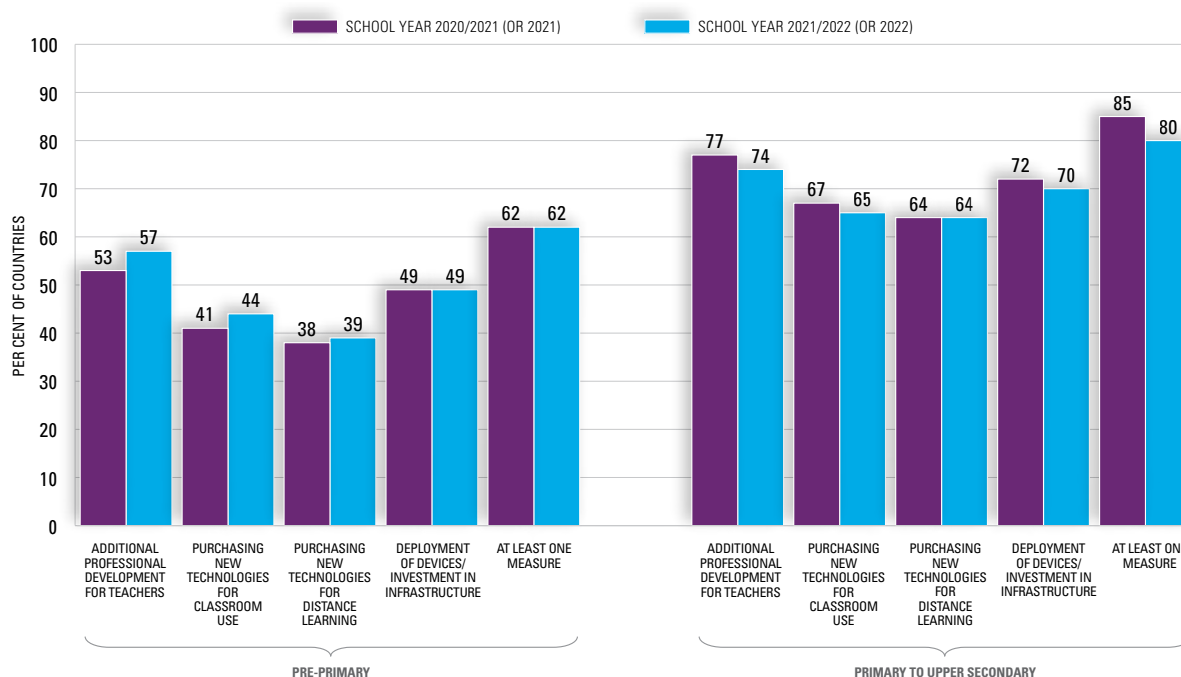
Source: UNESCO-UIS, UNICEF, the World Bank and OECD (2022).

Note: For each level of education, only countries with valid responses are included. 'At least one measure' includes countries who responded 'Other'. Caution is advised in generalizing the results represented in the figure, as the countries with valid responses may cover less than 50 per cent of the total 4-17-year-old population.

Figure 4 above shows that governments continue to support digital learning through a number of investments with a direct impact on the public budget. However, the percentage of countries taking at least one digitalization measure for primary to upper-secondary levels declined from 85 per cent in 2020/2021 to 80 per cent in 2021/2022. This could indicate that governments believed such investment to be less urgent, while still illustrating a widespread belief in the continued need to address the digital divide in access to and use of tech-enabled educational opportunities (particularly gender disparities and disparities among rural or underserved communities).

Moreover, the EdTech industry has grown dramatically, with its value expanding tenfold over the past decade to reach USD 300 billion (Jacobs Foundation, 2022).[1] As a result, countries are faced with countless technological solutions and evidence-based methodologies grounded in learning science, with varying degrees of usability and purpose. This hyper-saturated and competitive environment creates complicated choices regarding the types of educational technologies that countries should support, develop, procure or deploy. Such decisions require whole-of-government approaches and synchronicity with countries' IT policies in order to assess the benefits and risks of integrating frontier technologies and newly powerful tools into national educational systems.

Maintaining safe, affordable, equitable, ethical and inclusive tech-enabled learning environments requires linkages with wider national/sub-national efforts aimed at digital transformation. However, unlocking strategic digital transformation in education requires a comprehensive framework.

Evolving from an analysis of the discussions from the Transforming Education Summit convened by the Secretary-General of the United Nations in September 2022, this chapter proposes five critical components to advancing rights-based, human-centred, tech-enabled learning, aiming to leverage technology to increase and diversify access to and improve the quality of education and learning, while addressing the learning needs of all, especially the most disadvantaged learners: 1) coordination and leadership; 2) content and curriculum; 3) capacity and culture; 4) connectivity and infrastructure; and 5) cost and sustainability (Figure 5).

Figure 5: The five components for unlocking tech-enabled learning in education
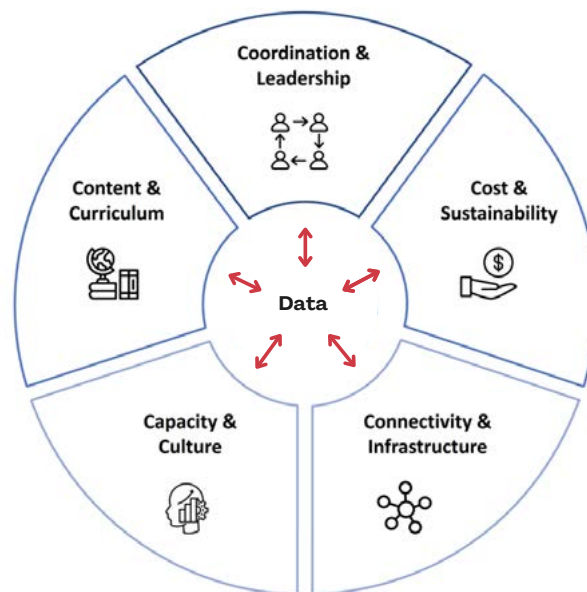
Source: UNESCO. (2023). Transforming education together: the Global Education Coalition in action.[2]

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[1] Jacobs Foundation. (2022). https://jacobsfoundation.org/wp-content/uploads/2022/04/2022-04-06_Call_GLOBAL-Unlocking-the-impact-of-edtech.pdf

[2] This framework for digital transformation in education was collaboratively created by members of the Digital Transformation Collaborative (DTC), a sub-group of UNESCO's Global Education Coalition (GEC).

Taken together, these five components could be seen as the elements required to provide all learners with the necessary skills to benefit from digital learning, while protecting them in digital environments. They are defined below:

↘ **Coordination and leadership** refer to a country's vision and goals, governance, data-informed decision-making, monitoring and evaluation, and data privacy and regulation measures.

↘ **Content and curriculum** are the platforms, digital content, learning pathways, pedagogical models, and curricular alignment and assessment supported by an education system.

↘ **Capacity and culture** indicate the future-ready skills of all education stakeholders, including teachers, leaders, parents and guardians, leveraging relationships with local communities.

↘ **Connectivity and infrastructure** are the hardware, software, electricity, internet access, learning spaces and data systems of the education system.

↘ **Cost and sustainability** concern the funding, development, maintenance and cost-effectiveness of the financing models for tech-enabled learning in the education ecosystem.

Cutting across all of these areas, and key to their success, are data ecosystems serving different pedagogic, administration and management purposes. The collection and analysis of data from education technologies and learning management systems on students learning behaviours, preferences, and progress can be used by teachers to adapt learning contents, methods, and pace to the individual needs of each student. Learning analytics tools and platforms can also be leveraged to automate the large scale collection, processing, and analysis of data and provide deeper insights into students learning. This can enable decision makers to identify patterns and trends in learning behaviours across demographic groups, diagnose learning challenges, and point toward targeted interventions.

From an administrative and management perspective, investments in system-wide data literacy and upskilling can optimise system functionality and create a supportive institutional culture for digital learning. Not only does this strengthen teacher's capacities to use evidence, but lays the groundwork for overall system functionality by helping education managers to monitor and evaluate the effectiveness of tech-enabled learning interventions.

Frontier technologies and recent technological advances in data processing and interoperability also suggest massive possibilities for expanding the analysis of usable education data from multiple sources (including education actors, humanitarian and development partners across the multilateral agencies, NGO, non-State and private sectors). This, in turn, opens up enormous opportunities for education analytics based on big data, i.e. identifying patterns across all types of data to "unveil nuances about educational inequities and inform actions in faster feedback cycles" (Fischer et al., 2020, p. 132).

In short, data eco-system approaches can support the overall institutional and organizational culture around digital learning. Insights and increased investments are needed in how to optimise them and generate more transparent governance (UNESCO, 2021). To assess where a given country is in its digital transformation journey, there is a need for accessible, complete data on all 5 Cs. Data is therefore a fundamental factor feeding into each component and a data eco-system approach can help to bring it all together, as depicted in the centre of Figure 5 above.

2.1 Coordination and leadership

Tech-enabled learning requires a clear vision, policies and strategies to make digital transformation inclusive and affordable, and engage all education community stakeholders in the process. Transforming this vision into actionable plans, programmes and projects calls for evidence-informed governance, monitoring and evaluation mechanisms, as well as data-privacy and regulatory frameworks. These combined elements enable countries to increase the interoperability of their digital solutions in ways that reconcile ethics and personal rights with the value of big data and analytics.

This section explores how G20 countries are articulating their goals for tech-enabled learning in their recent strategy and policy documents, and how this vision translates into monitoring and evaluation initiatives, data-informed governance, data privacy and regulatory action, and cross-sectoral and cross-country collaboration.

Vision, policies and strategies

Many G20 member countries and guest economies have placed digital equity at the forefront of their vision and goals, gearing recent policies and decisions towards tech-enabled teaching and learning across all education levels to blend online and in-person methods and tools more fluidly, and to ensure inclusive and equitable lifelong learning that reaches the most marginalized, including out-of-school children. The majority of G20 visions and strategies are permeated by recurring themes of personalized educational experiences, preparedness for an increasingly digital future, and continuity through crises and emergencies.

In **Argentina**, Conectar Igualdad (or the National Plan for Educational Digital Inclusion - PNIDE) is a federal level digital inclusion policy that aims to ensure the equitable distribution of educational and technological materials. Most notably, it oversees efforts to extend telecoms connectivity across the country and provides the framework for the pedagogical strategy of 'Conectar Igualdad.' As such, it is linked to the country's priority development goals and strategies 2022-2027.

In **Brazil**, the Innovation Network for Hybrid Education (RIEH) aims to promote the implementation of hybrid education strategies in all federal entities of the country, including investments in the infrastructure and technical capacities of the Education Departments for the equitable implementation of the New High School and hybrid education strategies.

The **People's Republic of China** has a vision for complete digital infrastructure across all levels of education. In recent years, this has been achieved by upgrading digital infrastructure and online learning platforms and applications and constantly enriching digital education resources. Investments have also been made in improving the digital literacy of teachers and students, all of which will provide strong support for future education reform and development. Internet access for all types of schools at all levels is now 100 per cent, and over 210,000 schools have access to a wireless network. Moreover, 99.5 per cent of schools have multimedia classrooms (totalling over 4 million), and there are now over 28 million computer terminals in schools throughout the country.

India is another leading example of an equity-oriented vision for narrowing the digital learning divide. India's growth story stands on an expansive digital public infrastructure, designed to ensure that *no one is left behind*. India envisions to transform the entire nation into a digitally empowered society and knowledge economy. Educational technology will play a critical role in bringing this vision to reality. India's approach to building Digital Public Infrastructure in education is to keep the learners at the centre and ensure equitable access and

opportunities For this the government is providing enabling policy framework, building infrastructure, developing the digital content ecosystem that ensures access and equity for all learners.

Indonesia's strategy is also rooted in a vision of equity, which steers ICT infrastructure and content development towards the overall goal of ensuring quality education access to frontier, outermost and underdeveloped areas ('3T areas'). The strategy includes a holistic, user-centric, locally contextualized approach to developing infrastructure and connectivity. In Italy, the National Plan for Digital Schools was introduced to help schools in digitalizing their learning processes and methodologies. It focuses on a variety of actions concerning, on one hand, the innovation of learning environments and on the other, methodologies, curricula and competences in STEM subjects, coding, new digital curricula, teacher training, and students' competences. The initiative is based on the vision of the Handbook on Digital Citizenship Education (January 2019) of the Council of Europe, which has made access to digital technologies a precondition for citizenship, as a part of the everyday life of citizens and instrument of equal opportunities in schools. It is resourced both through national and EU funding, including the National Plan for Recovery and Resilience.

Similarly, **Mauritius** aims to use technology to support learners from disadvantaged backgrounds and those with special needs. Recent efforts include the formulation of a policy on open educational resources (OER), as well as tech-enabled programmatic interventions in early learning, primary and secondary schools. Crisis continuity and emergency preparedness are incorporated into the 'policy for resilience in higher education', which is currently being developed in collaboration with Commonwealth of Learning. The policy will outline strategies for technology-enhanced education, and ensure that all public universities are equipped with a modern learning and teaching management information system.

The **United States** is implementing a range of initiatives to reduce inequity in the digital education sector. The initiatives aim to expand access to opportunities for collaboration, critical thinking, creativity and communication, leveraging each student's unique strengths, needs and backgrounds. These goals are included in the National Educational Technology Plan, the visionary policy document to be published in 2024, which will guide how schools and districts across the country can continue to use technology to improve equity and opportunity for all students.

Japan's vision for tech-enabled learning spans the lifelong learning spectrum. The country is working towards the integration of personalized and self-regulated learning with collaborative learning at the primary and secondary education levels, inside and outside of formal learning settings and irrespective of schooling hours. At the level of higher education, Japan has been supporting innovative models of education utilizing digital technology at universities and promoting hybrid education combining in-person and distance learning.

In the **Republic of Korea**, the Ministry of Education has promoted systematic information and communications technology in education by establishing a comprehensive plan for ICT in education every five years. The sixth plan (2019-2023) addresses major tasks to render tech-enabled learning more inclusive, qualitative and collaborative. The ministry's policy on ICT in education has shifted from the creation of infrastructure for its dissemination and advancement to the creation of intelligent educational environments.

Certain countries have turned their attention to safety issues in the use of digital technologies. As part of the implementation of the federal project "Digital Educational Environment" of the national project "Education", the Ministry of Education of the **Russian Federation** continues to work to create conditions for the gradual implementation of a modern and safe digital educational environment in educational organisations by 2024, providing equal conditions for access to quality education for children, regardless of their location. In 2019-2022, the material and technical equipment of 37 per cent of educational organizations was updated with

updated with computers, multimedia, presentation equipment and software. Interactive digital education contents are also being introduced. In 2021-2022, more than 6,000 digital lessons were developed in 29 subjects of general education, covering more than 60 per cent of educational programs in general education.

Finally, the **European Economic Area (EEA)**, composed of the EU plus the three EFTA states, sets three objectives – 'inclusive, qualitative and collaborative' – as common threads throughout its work, underpinned by a holistic perspective focusing on the quality of education, tackling the digital and green transitions, and supporting teachers. Equity is at the heart of the European Union's Digital Education Action Plan. Its 'Pathways to school success' initiative, and Council Recommendation on blended learning approaches for high-quality and inclusive primary and secondary education, offer relevant insights for G20 countries.

Planning, monitoring and evaluation

Several G20 countries, such as **Spain** and the **United Arab Emirates**, are targeting school-level planning and evaluation of tech-enabled learning. In Spain, recent government commitments will ensure that 22,000 schools prepare a Digital School Plan, using the European framework of digitally competent organizations (#DigCompOrg framework) and the SELFIE analysis tool, which is a free, customisable tool to help schools reflect on how they use digital technologies to support learning. Similarly, the United Arab Emirates requires schools to devise a plan to improve the use of technology in teaching and learning, based on the self-evaluation of an e-maturity framework and progress monitoring tool. The framework consists of six criteria and three axes: innovation, support for people of determination and electronic security.

Monitoring & evaluation is a critical part of all ICT interventions supported by the Ministry of Education of **India** through its partner institutions. The disclosure on usage patterns, numbers of students, regions, institutions, and more are readily available as a dashboard on respective web pages. Online portals and tools such as SAMARTH are enabled by block chain and cover the entire student and faculty. SAMARTH offers lifecycle support and monitors progress in universities and other higher education institutions through a digital framework for the planning, management, delivery and monitoring of services for students, staff and other stakeholders. Today multiple state governments and more than 1000 HEIs are using SAMARTH.

To support this endeavor, the Ministry of Education, with the support of the All India Council of Technical Education (AICTE), initiated National Educational Alliance for Technology (NEAT) as a public-private partnership model to bring the popular educational technological products on a single platform for the convenience of learners. Any student of economically and socially disadvantaged status from across the country can benefit from NEAT, as 25 per cent of the coupons are provisioned for them free of cost. 58 EdTech companies are listed on portal, providing 100 products. Around 258,000 students are registered on the portal.

Data-informed governance, data privacy and regulation

Emerging issues in digital data and governance impact on countries abilities to successfully implement tech-enabled learning visions and goals. Predictive, data-informed cycles of planning, governance and improvement should be the norm, with well-defined and effective leadership in schools and public administration, supported by modern data infrastructures. However, advanced digital and data technologies, such as generative AI, are developing so quickly that governance and ethics issues must be revisited regularly.

In **India**, all open data from registries and transaction systems is anonymized when transferred to Vidya Samiksha Kendra systems of schools which enable data-driven observability and decision-making at the policy decision-making level. The Education Ecosystem Registry (EER) seeks to establish a national-level bird's eye view of the country's student and teacher cohorts. In so doing, EER helps users to identify personal learning and growth needs. These anonymised big data can guide better delivery of student services, innovation and research by EdTech companies and the rest of the ecosystem to facilitate the development of personalized learning solutions. EER is expected to be an integral part of the National Digital Education Architecture (NDEAR) and would be within the national identity frameworks.

In 2018/2019, the Federal Government of **Nigeria** supported the development of a tool for the collection of timely, credible and reliable data that is compatible with mobile devices. This means that data can be retrieved from even the most remote school site anywhere in Nigeria, instead of stakeholders waiting for years before data collection and reporting processes are completed. With the help of technology, the Federal Ministry of Education has been able to establish a robust data centre with the capacity to hold data from all levels of education in Nigeria.

In Oman, the Ministry of Education and the Ministry of Higher Education, Research and Innovation issued the National Framework for Future Skills in 2021. As the national policy document of reference, the framework identifies the future skills needed to prepare students in the Sultanate of Oman at the school and higher education levels and alludes to data and information literacy. **Saudi Arabia's** recent Human capability development programme is working to develop and operate a standard educational data management system for all levels. This initiative aims to set criteria for data mapping and sharing, and work with different educational institutions to link them to the system. In doing so, the initiative is increasing transparency and support future decisions and plans.

Box 2: Maximising the potential and minimising the impacts of generative AI in education

Maximizing the potential and minimizing the risks of generative AI in education

Education is at the crossroads of a generative AI revolution. Like any new technology, generative AI is a tool that can have a positive impact, but also presents risks requiring immediate attention. From machine translation and personalized learning at scale to virtual assistants and intelligent tutoring and assessment systems, AI has many promising use cases in education. At the same time, the use of AI in education is raising concerns about data security, unethical use, plagiarism, etc.

Faced with these risks and benefits, governments have adopted drastically different approaches to the recent expansion of such technologies, from restricting access to certain AI language models or strengthening compliance regulations, to authorizing rapid risk assessments of safe use of AI in the public sector or developing blueprints for building public trust and investing in the potential benefits of AI for the economy.

The potential benefits of such technology include: (i) enabling inclusive access to learning programmes, especially for vulnerable groups such as learners with disabilities; (ii) supporting personalized learning pathways; (iii) improving education and the management of learning data to expand access and enhance learning quality; (iv) providing learning insights and suggesting tailored learning pathways to mitigate dropout risks; and (v) improving cybersecurity and data protection.

The potential risks include: (i) amplifying existing biases and discrimination in education systems if the data used to train generative AI models are biased, resulting in unfair grading, prejudiced feedback or discriminatory recommendations about students' career paths, with potential impacts on the most vulnerable populations; (ii) encouraging plagiarism and cheating when students use generative AI to create essays, reports and other assignments; and (iii) job losses for educators and other education professionals due to the automation of tasks such as grading or content creation, reducing or eliminating human-centred learning experiences and support for students.

Cross-sector and cross-country cooperation

If the benefits of digital transformation are to reach the most marginalized, including out-of-school children, then effective and consistent cross-sectoral and multi-stakeholder cooperation is necessary to ensure synergies among national efforts to ensure safe, secure and sustainable digital solutions. Many G20 countries are therefore implementing a cross-sectoral approach to advance tech-enabled learning and improve programmatic coherence and sustainability in their education systems, including through long-term smart partnerships with the private sector, social enterprises and not-for-profits, and the overall interoperability of public digital services and solutions.

In **Belgium**, the Fédération Wallonie-Bruxelles has created strong partnerships between the public sector, EdTech and the private sector to implement Pix in the secondary and higher education systems, as well as make it accessible to civil servants and all citizens. Pix aims to expand its services to other governments and public institutions across the world to help citizens improve their digital skills.

Brazil's Connected Innovation Education Policy (PIEC) aims to combine efforts among agencies and entities of the Federal states, districts and municipalities, as well as schools, the business sector and civil society, to ensure the necessary conditions for the insertion of technology as a pedagogical tool for everyday use in public basic education schools.

France's Digital Strategy for Education 2023–2027 is strengthening national and local cooperation around educational digital projects among education stakeholders. At the international level, France has also developed both a francophone and an anglophone version of its online assessment platform (PIX), which are being used in 17 countries around the world, including Belgium, Tunisia and Madagascar. PIX is also reaching out to a wide audience (students, teachers, job seekers, employees and citizens).

In **India** the National Education Technology Forum (NETF) has been setup, to provide a platform for exchange of ideas on the use of technology and National Education Alliance for Technology (NEAT) brings the best technological products using AI for customized learning in niche areas. Both NETF as well as NEAT have representations from industry, state and the central Government for the benefit of learners in school as well as higher education.

In the **Netherlands**, educational institutions have autonomy over the development of their digitalization strategies. However, the Netherlands facilitates cooperation across educational institutions during procurement processes of IT solutions so that they may negotiate collaboratively with large private actors supplying digital infrastructure and content. Such institutional collaboration creates better products and ensures that schools facilitate digital education that adheres to important public values and ethical aspects, including teacher autonomy and learners' right to privacy.

South Africa's Remote Digital Learning programme (RDL), implemented jointly by the National Education Collaboration Trust (NECT) and the Department of Basic Education (DBE), benefits from agreements signed with 28 different partners in support of its 'Tswelopele' and 'Woza Matrics' campaigns. The country is working with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), CISCO and HuaweiWEI, all of which assist with research, training and content.

In the Arab Region, the **United Arab Emirates** is aiding and advising other Arab countries wishing to develop national strategies and policies in the field of smart learning. Thanks to its Mohamed Bin Rashid Smart Learning Arab Training Programme for Smart Learning National Strategies, the United Arab Emirates has become a regional and international smart learning centre.

The **European Union, France, Spain and Türkiye** are also engaging in cross-border and cross-sectoral cooperation to advance leadership on tech-enabled learning. The Future Innovative Learning Spaces (FILS) project, implemented by the European Union, is a strategic partnership involving professional organizations from across Europe with experience in designing innovative learning spaces for the future. It has adopted an EU-level cooperation approach to output development, organizing pan-European and national trainer-training and teacher-training models.

The models have been implemented synchronously in four countries, two of which are G20 member countries and guest economies: **Türkiye, Spain, Austria** and **Czechia**. Within the scope of the project, Hacettepe University in **Türkiye** was responsible for supporting the methodological framework in terms of designing flexible learning spaces and its extension on pedagogy. European Schoolnet (Belgium) was responsible for providing trainings for trainers, and developing a methodological framework for innovative learning spaces and scenario-based learning. Finally, the Regional Centre for Innovation and Teachers' Continuing Education (CAFI)

in Spain was one of the pedagogical partners for training teachers to ensure the effective use of information and communication technologies in innovative learning spaces.

Table 6: Programmes demonstrating coordination and leadership

Bangladesh: National Blended Education Master Plan (2022-2031)

The Bangladesh National Blended Education Master Plan, introduced in 2022, is a significant effort to harness the power of technology to improve education outcomes and promote equitable access to high-quality learning opportunities for all students. The government of Bangladesh has committed to expanding access to digital learning resources and technologies under the Master Plan, and to supporting the development of digital competencies among teachers on blended learning approaches. The plan emphasizes the importance of creating a supportive policy and regulatory environment for blended learning, as well as promoting innovation and collaboration in the education sector.

Brazil: Innovation Network for Hybrid Education

The Brazilian Ministry of Education, under Ordinance No. 865 issued on November 8, 2022, plays a crucial role in accomplishing Goals 3, 7, and 11 of the National Education Plan (PNE 2014-2024), which aim to enhance the quality of high school education and improve educational outcomes. As part of the implementation efforts of the Innovation Network, the National Observatory for Hybrid Education has been established to conduct studies and evaluations in the different states of the federation. This initiative serves to monitor, coordinate, and evaluate the execution of necessary steps and actions, ensuring the effective oversight and assessment of the Innovation Network for Hybrid Education. The Regional Innovation and Hybrid Education Centres (RIEH) will furnish technological resources, such as state-of-the-art equipment, virtual tools, and software, to the State and District Education Departments, supporting their endeavours in implementing hybrid educational models.

India: National Digital Education Architecture (NDEAR)

NEP highlights a need to invest in creation of open, interoperable, evolvable, public digital infrastructure in the education sector that can be used by multiple platforms and point solutions, to solve for India's scale, diversity, complexity and device penetration. This is now being manifested in the form of National Digital Education Architecture which takes a building block approach. The key objectives of the NDEAR would be a single student lifecycle from preschool to adult learner acquiring skills. NEP further envisages setting up of a National Education Technology Forum (NETF) that helps leadership at various levels in systematic adoption of technology. Such programs help in ensuring that new technologies are seamlessly integrated within the education sector.

France: Digital Strategy for Education 2023–2027

In addition to strengthening cooperation between education stakeholders around digital education projects, France seeks to develop students' digital skills by teaching them digital citizenship, developing their critical thinking and reinforcing their media and information literacy. It also tried to provide them with strong foundational knowledge of the digital world, as well as promote baccalaureate subjects leading to digital professions. Special attention is paid to girls, who remain under-represented in technology fields. Finally, it targets improving the robustness, security, accessibility, quality and eco-responsibility of the Ministry's IT tools for a more user-friendly experience and a higher quality service.

Saudi Arabia: The Human Capability Development Programme

The Human Capability Development Programme ensures tech-enabled learning more inclusive, qualitative, and collaborative at every level. In K12, children are provided with learning experiences that help them develop a resilient and strong education base through maximizing innovative learning methods, using flexible learning options and technology-based solutions. There is a dedicated initiative portfolio that focuses on utilizing tech-enabled learning and making it more inclusive, qualitative, and collaborative. The Ministry of Education evaluated the pandemic experience, which yielded several benefits that will help to improve universal quality education, including enhanced communication between schools, teachers, students, and parents; greater parental and family engagement with schools; more effective and efficient utilization of e-learning and blended learning; and better organization of (e-) learning materials and resources.

Spain: National Plan for the Digitalisation and Digital Competences of the Education System (#DigEdu)

#DigEdu aims to identify the necessary measures to ensure that all citizens have the necessary tools to acquire and develop digital skills. The Plan is fully aligned with the initiatives of the European Commission, and specifically with the new Digital Education Action Plan 2021-2027 and the European Education Area (EEA), focused on digital education as a fundamental means for the necessary digital transformation of all areas of society. The Plan includes several lines of action, including the development of educational digital competence, the digitization of the school, the creation of educational resources in digital format, and advanced digital methodologies and skills.

United States: Various

National Educational Technology Plan: The National Educational Technology Plan is the lighthouse educational technology policy document for the United States. The next update to the plan will be released in early 2024. This document shares a vision for how schools and districts across the country can continue to use technology to improve equity and opportunity for all students. The document also addresses the infrastructure needed to support this vision. The U.S. Department of Education Office of Educational Technology publishes the plan which is available to the government. The NETP also addresses infrastructure needed to support this vision. While this resource informs the technology plans of many state education agencies and local education agencies, the U.S. Department of Education has limited authority and cannot enforce implementation of the NETP at state or local levels.

DEER Initiative: The DEER initiative has produced a publication identifying barriers and strategies related to digital equity in education. This publication is intended to inform state leaders developing digital equity plans to ensure the needs and assets of the education sector are addressed. The DEER initiative publication, Advancing Digital Equity for All, discusses the need for digital inclusion strategies that address human-level adoption barriers, such as lack of access to information, technical support, and digital skill-building opportunities and the need to build public trust and collaboration.

2.2 Content and curriculum

High-quality, accessible, curriculum-aligned content are needed to sustain a long-term vision for digital transformation in education. Multimodal contents should be available on digital platforms in national languages, and support varied pedagogical models and flexible learning pathways that both meet the needs of each learner and empower teachers to create and leverage digital resources as they see fit.

Co creation of digital platforms and content

Many G20 countries are forerunners in the development of digital platforms for learning, and strengthening the interoperability of their digital solutions in ways that reconcile ethics, personal rights and privacy. G20 countries and guest economies are creating smart, user-friendly, affordable, open and interoperable solutions and tools, co-designed with teachers and learners.

In **The People's Republic of China**, the Ministry of Education launched the National Smart Education Platform which is composed of three separate platforms featuring digital resources on basic education, vocational education and higher education, as well as a Service Hall. The Service Hall provides a range of services for teachers and students, including employment, examination and study abroad. Since the platform's launch in March 2022, the number of users has grown to over 945 million.

In **India** under the PM eVidya initiative, DIKSHA (Digital Infrastructure for Knowledge Sharing) has been declared as 'One Nation, One Digital Platform' for school education. It is built on open source technology and has a rich repository of digital content from various sources to aid in teaching and learning processes. DIKSHA has ensured high quality education is accessible to learners from all socio-economic backgrounds, by providing main and supplementary learning content to learners and encouraging digital learning in the school education ecosystem.

Indonesia approaches technology development through a user-centric strategy by asking teachers, principals and students what they really need. These collaborative processes led to the creation of national platforms, including the Emancipated Teaching Platform, ARKAS Platform (for budget planning and reporting), SIPLah Platform (for E-Commerce) and Education Report Card platform.

In **Italy**, methodologies, curricula and competences are promoted under the National Plan for Digital Schools. The main goal is to create, experiment and make available to all schools new innovative, structured, open and educational curricula that can involve the whole school community.

National online learning platforms, such as the **Singapore** Student Learning Space (SLS), provide students with access to quality curriculum-aligned resources for self-directed learning, and teachers with tools and resources to enhance teaching and learning. In the **United Arab Emirates**, the Madrasa Arabic eLearning platform for Arabic-speaking students around the world includes features such as Microsoft Teams; Office 365; the iEN Educational Portal; and interactive tools, including learning resources, question banks, homework, virtual laboratories and self-assessments. Dedicated resources are also made available to students with special educational needs.

In **South Africa**, the RDL Campaign has established or utilized 26 different platforms to ensure that learners, teachers and parents, particularly from the most excluded communities, can access learning resources from multiple access points. These include analogue and traditional channels, such as print media, radio and television, and low-end technology platforms, such as mobile chat from both home and school. In 2022, the RDL partnership network shared 1,654 educational assets (videos) for Tswelopele and 597 assets for Woza Matrics, including video and print.

Future Innovative Learning Spaces (FILS) project, implemented by the **European Union**, has adopted an EU-level cooperation approach to organizing pan-European and national trainer-the-trainer and teacher-training models, including for digital skills upgrading. So far, the model has been implemented synchronously in four countries, two of which are G20 member countries and guest economies: **Türkiye, Spain, Austria** and **Czechia**. The project is a strategic partnership involving professional organizations from Europe with experience in designing innovative learning spaces for the future.

Within the scope of the project, Hacettepe University in **Türkiye** was responsible for supporting the methodological framework in terms of designing flexible learning spaces and its extension on pedagogy. European Schoolnet (Belgium) was responsible for providing trainings for trainers, and developing a methodological framework for innovative learning spaces and scenario-based learning. Finally, the Regional Centre for Innovation and Teachers' Continuing Education (CAFI) in Spain was one of the pedagogical partners for training teachers to ensure the effective use of information and communication technologies in innovative learning spaces.

Table 7: Investments in digital learning platforms

People's Republic of China: National Smart Education Platform

In March 2022, the Ministry of Education launched a national learning platform designed and built with the framework of „three Platforms and one Hall" to house three levels of education: The National Smart Education Platform for Primary and Secondary Schools, the National Smart Education Platform for Vocational Education and the National Smart Education Platform for Higher Education. Following „3C" principles of „Connection, Content, and Cooperation/Communication", and focusing on the five core functions of learning, teaching, school governance, empowering society, and educational innovation, the three platforms provide massive and high-quality digital resource hall that meets the needs of teachers and students at different stages of education for teaching and learning. The Service Hall provides a series of services for teachers and students including employment, examination and study abroad, which provide great convenience for users. Since the launching of the Platform, the total number of visits has exceeded 5.808 billion, and the number of users has exceeded 945 million.

France: The CNED (National Centre for Distance Learning)

The CNED ensured pedagogical continuity during the lockdown with a scheme entitled „my Classroom at Home" consisting of three platforms and a virtual classroom solution for pupils and teachers at all levels (from the early years to the baccalauréat). "My Classroom at Home" enabled pupils to work on all subjects through online activities, lesson sequences, downloadable exercises, workbooks, digital books, modern language resources, illustrations, etc. The virtual classrooms allowed teachers and their pupils to meet, exchange and maintain group dynamics. Access to the CNED's virtual Classroom service ended in July 2022 and a new virtual classroom service is now available on the apps.education.fr platform. This solution is accessible to all teachers; for students, the service is accessible from a recent internet browser and does not require installation. This new service, deployed by the Digital Education Directorate, is hosted on the cloud infrastructure of a French provider, in line with the digital sovereignty strategy.

India: DIKSHA under the PM e-Vidya initiative

DIKSHA has been declared as 'One Nation, One Digital Platform' under PM eVidya Initiative for school education. It is built on open source technology and has a rich repository of digital content from various sources to aid in the teaching and learning processes.   It currently hosts 6558 ETBs of digital content, 306,214 e-contents in 29 Indian and 7 Foreign Languages, sign language and audio books, spanning across 5.13+ billion learning sessions and 60.09+ billion minutes of learning with an average daily page hits of 31.3+ million. DIKSHA has ensured high quality education is accessible to learners from all socio-economic backgrounds, by providing main and supplementary learning content to learners and encouraging digital learning in the school education ecosystem.

Saudi Arabia: E-Courses

The E-Courses project aims to develop online courses that meet approved international and local quality standards. These courses follow a standardized format that caters to the needs of both students and teachers, promoting an integrated learning experience and measuring learning outcomes. The project takes into account various e-learning models, including self-paced, blended, and supportive approaches, to ensure equal access to education and continuity of learning for all students. E-Courses offer several advantages that help bridge the digital divide. First, they provide a standardized learning experience, ensuring consistency and quality across courses. Second, they offer equal learning opportunities, allowing students from different backgrounds to access the same educational resources. Third, the project measures learning outcomes, enabling the assessment of students' progress and the effectiveness of the courses. Finally, the courses are adaptable to different learning styles and needs, catering to individual preferences and promoting personalized learning experiences.

The project includes several components and programming support. Virtual Labs, integrated within the national Learning Management System (LMS) called "Madrasati" provide computer-based simulations of real laboratories, enhancing practical learning. Open Resources encompass multimedia content and materials covering various subjects for K-12 students, providing a wide range of educational resources. The Central School Model offers high-quality education to students in rural and remote areas, with teachers remotely instructing students from a central school to eight elementary schools located in different regions across the country. Additionally, a blended program for high school pathways is implemented to promote equal access to learning opportunities and equip students with the skills necessary for future employment. Students are given the chance to specialize in five different pathways within the high school curriculum.

Singapore: Singapore Student Learning Space (SLS)

The SLS is Singapore's national online learning platform that provides students with access to quality curriculum-aligned resources for self-directed learning, allowing them to learn any subject, at any level and at their own pace, and track their progress. It also provides teachers with tools and resources to enhance teaching and learning. The SLS is continually developing new capabilities and tools to support greater customisation of learning for students and to augment teachers' professional practice. It supports advanced features such as gamification, text-to-speech reader and speech evaluation in Mother Tongue Languages to better support students' self-directed and independent learning. As part of Singapore's National Artificial Intelligence Strategy, the capabilities of the SLS will be further enhanced with AI-enabled features, to support greater customisation of learning, and enable more immediate and targeted feedback for students. Examples of such AI tools which are being developed and planned for integration with SLS include an Adaptive Learning System for Mathematics and a Learning Feedback Assistant for English Language.

United Arab Emirates: Madrasa Arabic eLearning platform

Madrasa is a leading e-learning platform under the Mohammed bin Rashid ALMaktoum Global Initiative. It provides more than 6700 high-quality Arabic language educational video content for all subjects including math, science and Arabic literacy. The platform is available for free for more than 50 million Arab students wherever they are. Math and Science videos lessons were recreated in Arabic based on khan academy lessons. As for Arabic literacy lessons, it was an original product by madrasa.org initiative. Madrasa is a leading e-learning platform under the Mohammed bin Rashid Al Maktoum Global Initiative. It provides more than 6,700 high-quality Arabic language educational video content for all subjects including math, science and Arabic literacy. The platform is available for free for more than 50 million Arab students wherever they are. Math and Science videos lessons were recreated in Arabic based on khan academy lessons. As for Arabic literacy lessons, it was an original product by madrasa.org initiative.

Contents and their quality assurance

Many G20 member and invited countries are also co-creating and continuously updating user-friendly, affordable, open and interoperable learning contents and tools.

The **Bangladesh** Ministry of Education has taken significant steps to create digital contents and resources for the basic education system. These aim to provide students with equitable access to quality education and prepare them for the digital age. Initiatives include the Aspire to Innovate (a2i) Programme under the Prime Minister's Office has partnered with Young Power in Social Action, an NGO, to create digital multimedia books, accessible e-books, digital braille books, and math books for students from class I-X. This initiative has proven to be more accessible and cost-effective than traditional paper books for students with visual, print, and learning disabilities.

In **India**, each state/UT leverages DIKSHA FLN, a separate window on the DIKSHA platform to provide ready-to-use e-learning resources free of cost. The resources include more than 2000 learning outcome-wise videos, infographics, worksheets, and other FLN-related documents linked to the NIPUN Bharat Mission Implementation Guidelines, Vidya Pravesh programme, NIPUN Bharat Anthem, a short film, and others. The DIKSHA platform also offers Energized Textbook (ETB) aimed at providing access to digital content for various topics which can be accessed using QR Codes generated by system administrators. The QR code associated with the book or content enhances the discoverability of the content or the book. For ease of access, QR codes are printed on the textbooks.

The **Republic of Korea**, for example, has launched the "Digital Transformation of Education (DXE) Initiative" and is preparing to adopt AI-embedded digital textbooks. The textbooks, which are yet to be finalized, are driven by AI in the subjects of mathematics, English and computer science, each meeting AI tutoring, speech-recognition and coding practices. Part of the learning data will be collected and shared to provide more personalized education for every student, and the Ministry of Education is currently working on a system for how these data will be collected.

The government of **Türkiye** has funded the creation of an audio library for students with visual impairments', developed by the Ministry of National Education. This supports the audio-description of textbooks to facilitate learning for middle and high school students with visual impairments.

G20 countries also aim to set quality standards for e-learning content, technology and pedagogy in online/offline teaching-learning, and are making efforts to ensure the interoperability of digital learning content. **Australia**, for example, has played a leading role in developing standards for quality assurance in digital and online education, and has shared its expertise in the regulation of online education in forums such as Asia-Pacific Economic Cooperation (APEC). The APEC Quality Assurance of Online Learning Toolkit was developed by Australia in collaboration with a range of education experts and APEC economies. It provides a concise guide for developing online learning capabilities, underpinned by knowledge of best practices and quality assurance measures. At the outset of the pandemic, Australia's Tertiary Education Quality and Standards Agency also developed an online learning hub on good practices to support providers transitioning to online learning.

Regulations in **India** allow universities to offer courses in online mode. SWAYAM is India's massive open online course (MOOC) platform offered to universities to deliver their online degree programmes free of cost. This allows monitoring of quality of online programmes while building sustainability for the SWAYAM platform. To ensure that the quality of the programme and, inter-alia content, examinations, assignments, only those Universities which have consistently attained a very high-quality benchmark, reflected either through accreditation or national rankings are allowed to offer these programmes. More than 50 Universities have been granted approvals to offer 350+ online programmes.

In **Mexico**, a wide set of variables are used to monitor and evaluate the Open and Distance University of Mexico (UnADM), including enrolment, graduates, educational offer, job paths and community engagement. The evidence plays an important role in informing the university's curricular design, resource allocation, educational needs, pedagogical updates and more. UnADM presents the results to the public every year through several events targeting teachers, students, school communities and government officials which allow for the sharing and use of these data.

Curriculum and assessments

In the digital age, curricula and assessments must be adapted to learners, societal and workforce needs at all levels. In 2023, **Bangladesh** introduced new curriculum in secondary education level keeping in mind the labour employability in future market. **France** has rolled out a national online platform (PIX) for the assessment, development and certification of digital skills and job-specific skills development. It is intended for pupils and students taking part in job skills preparation or vocational training, active labour force (employees, those in continuing vocational training and job seekers) and more generally, all citizens. In increasingly digital societies, PIX aims to help all citizens become familiar with the digital environment and develop digital skills throughout their lives so that they can learn, work and participate in social life. It was developed on the initiative of the French Ministries of National Education, Higher Education, Research and Innovation.

At the tertiary education level, **India's** Academic Bank of Credits aims to make education system open and communicable through Credits. Students from higher education institutes of India can today gain a significant portion of their credits through digital mode and the credits earned by students can be deposited on a portal to be transferred and used through the lifetime of the learning journey.

The **Republic of Korea's** 2022 revised national curriculum aims to strengthen students' digital capacities as well as doubling class hours on ICT education among its main objectives. The Australian Curriculum, which sets the expectations for what all young Australians should be taught in school, regardless of their background or where they live, includes a 'digital technologies' as a learning area to empower students with digital solutions and knowledge that can be applied to meet current and future learning needs.

The student profile and assessment system in **Saudi Arabia** leverages data-driven diagnostic tools to provide regular feedback about each student. This will help assess students' skills and detect those at high risk that requires further support. This includes several initiatives geared toward the inclusion of special needs, including the student with disabilities identification. It also ensures that gifted students and those with disabilities receive the support they need. The gifted student's identification test expansion initiative focuses on expanding and investing in identifying gifted students in all areas through an online gifted identification test.

Open educational resources

The G20 countries are in a strong position to promote and foster OER. Indeed, **India** is a global exemplar. The National Mission on Education through Information and Communication Technology comprises a series of projects that include OER across all levels of education, including through Study Webs of Active Learning for Young Aspiring Minds (SWAYAM), which aims to ensure access to the best teaching-learning resources in a massive open online course in a MOOC format. In addition, the Free Open-Source Software for Education (FOSSE) project promotes the use of open-source software in educational institutions.

Beyond the digital learning aspect, SWAYAM Prabha broadcasts high-quality basic and higher education programmes through 34 direct-to-home (DTH) channels 24 hours a day and 7 days a week via GSAT-15 satellite. The programme offers curriculum-based course content covering diverse disciplines. Its primary objective is to make quality learning resources accessible in remote areas, where internet availability is still a challenge. Delivering education through DTH has the potential to reach 160 million homes in India.

In **Mauritius**, an OER Policy has been formulated which sets out to transform the education system and to build inclusive, open, and resilient learning systems. In the secondary sector, grades 7, 8 and 9, students have access to a Student Support Portal – a web portal of free educational resources accessible from multiple platforms. These resources complement classroom lessons.

At the higher education level, **Mexico, South Africa, Türkiye, the Russian Federation** and **Japan** have all made efforts to increase open resources for teaching and learning. As mentioned above, Mexico has strengthened UnADM's educational model. **South Africa** is offering MOOCs to broaden access to learning opportunities and capacity-building for its technical and vocational education institutions and universities. The Department of Higher Education and Training has published 'Guidelines for the planning, establishment and implementation of an effective blended and remote learning system in a TVET college' which provide information, best practices, tips and strategies to help TVET colleges embark on their remote and blended learning journeys.

Building on already existing results and additional consultation with stakeholders and including OER-experts from the Länder, in **Germany** the Federal Ministry of Education and Research has launched its OER strategy in 2022. Its goal is to support and establish a digital ecosystem for OER based on necessary competences, practices, technology, research and networking to leverage the potential of OER for the acquisition of 21st Century Skills along the education chain. The strategy specifically addresses developments, structures and needs that became visible during the Coronavirus pandemic. OER-promoting infrastructures and practices for

schools, which are already being created through the DigitalPakt Schule, will be an important pillar here. The Federal Ministry will specifically complement OER initiatives of the Länder to jointly advance programme and platform structures for an OER-promoting digital ecosystem.

Table 8: Programmes targeting content and curriculum

Bangladesh: Aspire to Innovate (a2i) Programme

The Aspire to Innovate Programme under the Prime Minister's Office has collaborated with various organizations to produce digital multimedia books, accessible e-books, digital Braille books, and math books for students of grades I to X. These contents are converted into the Digital Accessible Information System (DAISY) format, which is further convertible into DAISY full-text full-audio books, Braille, and accessible e-books. This project has transformed all the textbooks from grades I to X into universally designed and cost-effective digital resources. The contents are universally designed and readily available to all students across the country. This technology-based solution provides a cost-effective and less time-consuming alternative to traditional textbooks, making accessible information available to all who need it.

The Ministry of Education has also launched several e-learning platforms, including Sangsad TV, DigiClass, and Amar Ghore Amar School, to provide digital contents and resources for students during the COVID-19 pandemic. These platforms include recorded video lectures, interactive quizzes, and assignments for students from primary to secondary levels. Finally, the National Curriculum and Textbook Board (NCTB) has developed a digital content repository, which contains e-books, videos, and other digital resources for primary and secondary education, which is accessible through the NCTB website and mobile application, and launched a project to establish digital laboratories in secondary schools across the country.

Brazil: Digital Educational Resources for Technical Courses

In Brazil, there are various digital educational resources available for technical courses that aim to provide students with greater flexibility, accessibility, and interactivity in their learning experience. These resources can help students develop technical skills that are critical for their future careers and contribute to Brazil's economic growth and development. Some of these resources include:

Virtual laboratories: Virtual laboratories are software programmes that allow students to conduct experiments and simulations in a virtual environment. These labs provide students with practical experience without the need for physical equipment. Some popular virtual lab platforms in Brazil include QI Escolas and Educaplay.

Educational games: Educational games can be used to teach technical subjects in an engaging and interactive way. These games may include simulations, puzzles, and quizzes that challenge students to apply their knowledge in real-world scenarios. Some popular educational game platforms in Brazil include Kahoot and Quizlet.

Open educational resources: OER are freely accessible teaching and learning resources that can be used, adapted, and shared without copyright restrictions. These resources include textbooks, lesson plans, and multimedia materials. Some popular OER platforms in Brazil include Khan Academy, OpenStax, and MIT OpenCourseWare.

India: National Mission on Education through Information and Communication Technology (NMEICT)

The National Mission on Education through Information and Communication Technology (NMEICT) is Ministry of Education's flagship scheme to leverage the potential of ICT, in teaching and learning process for the benefit of all the learners in Higher Education Institutions in any time anywhere mode. The scheme focuses on development of multimodal content, connectivity, governance while embracing new technologies. Many programmes under the NMEICT Scheme have been emphasized in the NEP and are available to students, faculty, institutions across the country at free of cost.

India had always taken cognizance of the digital divide, and educational content has been broadcasted through 34 PM e-Vidya TV Channels. PM e-Vidya channel addresses students with disability and offer multi-lingual content. PM e-Vidya Channels are soon to be expanded to a bouquet of more than 200 channels to address diverse learning needs in remote geographies. The content ecosystem today also includes unique offerings such as FOSSEE – an open source movement in education, Virtual Labs, e-Yantra robotics lab and National Digital Library. These projects have also attracted global audiences and collaborators. To address the issue of diversity an AI Driven language translation tool has been developed which is helping make the content accessible in major regional languages. Text books, SWAYAM MOOCs and various resources are being translated to multiple regional languages using technology driven tools.

Japan: MEXT Computer-Based Testing System (MEXCBT)

As part of GIGA school programme, from 2020, MEXT began developing the MEXCBT and providing as an open platform allowing all desiring students of elementary, junior high and high schools throughout Japan to study and take assessment. As of April 2023, over 70 percent of all public elementary schools and nearly all public junior high schools in Japan comprising some 8.6 million students have registered in the system, which has amassed around 40,000 questions produced by public institutions such as the national and local governments. The MEXCBT system is expanding its utilization from daily learning to National Assessment of Academic Ability and local governments' own assessments on students' academic ability.

Mexico: Open and Distance University of Mexico (UnADM)

All curricula from the 23 most demanded degrees and engineering careers in Mexico were digitalized and adapted to a student-centred model. A completely free and digital state university was then created in order to overcome the digital divide and make tech-enabled learning more inclusive and equitable. At the centre of the Open University model is the student, and around the student, there are support elements that allow qualitative pedagogies: from the teaching work to the technological tools that, together, constitute the learning environment. The student interacts with all the internal and external agents and elements of the learning process. For 2021, UnADM registered a total enrolment of 101,901 students (47.1 per cent men, 53.9 per cent women). For 2022, it received more than 70,000 applications, of which it could only take 26,000. The Expected output is to eventually accept all applications and fully prevent dropout.

Russian Federation: Russian Electronic School (RES)

The RES is a national online education platform launched by the instruction of the President of the Russian Federation Vladimir Putin with the support of the Ministry of Education of the Russian Federation. The open access platform hosts a free completed course of interactive video lessons on the entire set of general education subjects developed by the best teachers in Russia in accordance with federal state educational standards for general education and taking into account exemplary basic educational programs. Access to the RES is open to users of all countries.

2.3 Capacity and culture

Investing in capacities in people

In the end, technologies are tools wielded by people, and capacities to engage with digital learning approaches depend on familiarity with the technologies and pedagogies that go with them and individual's capacities to engage with data. Investing in the digital competences and capacities of all education stakeholders is therefore key to creating a culture of digital learning, innovation and growth anchored in equity and inclusion, and adapted to local needs.

The results of the EdWG questionnaire under the 2023 G20 Indian Presidency support the global perspective shown in Figure 6 below, as the data show that G20 countries are taking concrete action to improve digital and data skills across all levels of the education system. Such efforts include training education leaders on digital transformation, professional development to help pre- and in-service teachers acquire digital skills, and developing competencies in safely using data and digital technology in education.

In relation to teacher capacities, the results of the 2022 joint survey by UNESCO-UIS, UNICEF, the World Bank and the OECD, which includes data from 93 countries, also provide insights into the renewed focus on digital upskilling for teachers beyond the pandemic. Between the academic years 2020/2021 and 2021/2022, the share of countries that conducted professional development for pre-primary teachers increased from 48 per cent to 62 per cent. Most countries (about 80 per cent globally), reported they planned to maintain or develop in-service digital skill training for primary and upper secondary teachers. Slightly fewer countries (between 67 percent and 71 per cent) reported similar plans for pre-service digital skill training for primary to upper secondary teachers (Figure 6).

Figure 6: Share of respondent countries reporting enhanced provision of digital skills training for teachers beyond the pandemic
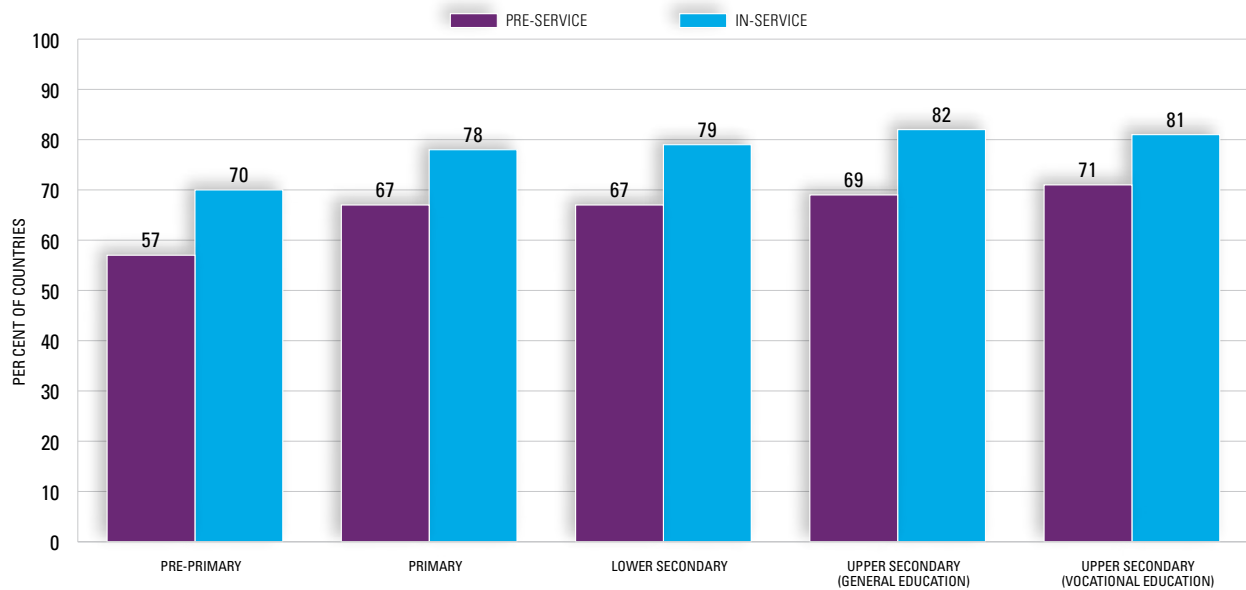
Source: UNESCO-UIS, UNICEF, the World Bank and OECD (2022).

In relation to institutional and organizational capacities to understand and coordinate different types of education data emerging from blended, hybrid and remote teaching, to use it effectively for steering practice, and to engage in a strategic dialogue at different levels based on evidence, certain G20 countries are already investing in these capacities.

As mentioned in the introduction to this report, the G20 Indian Presidency further recognizes the need to mainstream gender perspectives into teachers and learners capacities for using digital platforms, contents and infrastructure. At present, there are large gaps in many countries in women and girls' digital adoption and use compared to men and boys (UNICEF, 2020). With over 90 per cent of jobs worldwide requiring digital skills, women are at a disadvantage when it comes to workforce opportunities. This is evidenced by the fact that women represent only one-third of those working in science RDI, and even less in 'frontier' technologies. Women make up only 17.5 per cent of the tech workforce worldwide and hold just 5 per cent of leadership positions (EQUALS and UNESCO, 2019).

The education sector plays a key role in both making digital platforms available and in accelerating women's digital skills through targeted programmes and policies that increase women and girls' opportunities for tech-enabled learning. Such efforts are part of a broader effort to foster a society-wide digital culture that will increase civic engagement, empower disadvantaged learners and raise awareness of human rights for all.

Culture of innovation and growth

Discussions among EdWG members have highlighted efforts to promote innovation and entrepreneurship through linkages with industry, as well as the mobility of learners and faculty to foster exchange and development within the higher education space. Some G20 countries are stimulating innovation through targeted initiatives to promote a sustainable tech-enabled education ecosystem. The **United Arab Emirates**,

for example, launched the National Innovation Strategy to establish the country as a global hub for innovation and creativity. The strategy includes several initiatives to support tech-enabled learning, such as the establishment of innovation hubs and the promotion of entrepreneurship and innovation in education. In the **United Kingdom**, the education technology industry also faces barriers to start-up and growth. The country has developed a strategy to help the overall education sector and the UK EdTech industry to overcome barriers and work together to drive innovation, in line with the needs of the education system.

Women's empowerment is critical to developing a society-wide culture of innovation through digital technology, supported by the appropriate skills and competencies. The European Union's Digital Education Action plan aims to ensure that girls and young women are equally represented in digital studies and careers.

India's Multidisciplinary Education and Research Improvement in Technical Education (MERITE) aims to modernize the technical education sector in the country through the reforms envisioned in the National Education Policy-2020. The project focuses on modernizing teaching, learning and assessments to enhance employability, strengthen innovation, and advance equitable access to skills growth opportunities.

India has established an 'Innovation cell' with a purpose of systematically fostering the culture of Innovation in all Higher Education Institutions (HEIs) across the country at AICTE. Innovation Cell works closely with Higher Education Institutions (HEIs) to encourage the creative energy of students to work on new ideas and innovation and promote them to create start-ups and entrepreneurial ventures.

Teacher and education leader training

During the G20 EdWG meeting in March 2023, the **Brazil** co-chair spoke of teacher training in the use of digital technologies as a key enabler within the country's policy offerings to enhance learning. The Learning Centred Education (eduCA+) programme provides in-service training for 1,500 teachers (lato sensu specialization or theoretical-methodological tools) in digital education, linked to the Federal Network of Vocational Education and Training (VET) or to the Network of States.

The **People's Republic of China** described an initiative to reduce the digital and knowledge divide among teachers from rural and urban areas. Countries such as **Canada, France** and **Italy** showcased their efforts to train students and teachers in the use of digital technologies. Canada's CanCode supports initiatives that offer training and professional development to help teachers introduce digital skills (e.g. data analytics and digital content development) and coding in the classroom. Provinces and territories in Canada are likewise very active in equipping and supporting their teachers and students in the development of effective and ethical use of digital technologies.

In **Germany**, the federal and Länder governments launched measures to improve teacher training and, for example, jointly initiated the 'Quality Offensive for Teacher Training'. Since 2020, the initiative provides funding for projects focused on digitalization in teacher education. As of 2023, Germany has begun funding research and development of digitization-related advanced training courses for teachers as well as the establishment and expansion of networks among stakeholders through centres of excellence for digital and digitally supported teaching.

The **Netherlands** is aiming for all education institutions to establish their own centres for teaching and learning, where teachers will receive instruction on digital solutions for enhancing the quality of learning. Negotiations are underway with unions to ensure that teachers have the time and space to invest in their own skills (including digital) and can revise curricula to teach FLN. **Nigeria** has provided a professional ICT training

and skill acquisition programme to over 2,000 staff of the Federal Ministry of Education and Federal Government Colleges.

Singapore sees the role of the teacher as a designer and orchestrator of the learning experience, which can be augmented by technology. As such, Singapore is focussed on developing teachers' "e-Pedagogy" through a range of professional development opportunities, including online courses, resources, demonstration lessons and milestone programmes, to enable them to create connected and reflective classrooms.

In **Spain**, the School of Computational Thinking and Artificial Intelligence aims to develop teachers' skills in designing and implementing didactic proposals with students in computational thinking (offline and programming), robotics and AI. Regarding eTwinning for collaborative educational digital projects, nearly 80,000 teachers have registered, and more than 4,000 educational projects are developed each school year. More broadly, the Ministry and regions approved a new Reference Framework for Digital Teaching Competence in 2022, which aims to improve the digital competencies of educational administrations and teachers, and it is based on the European Framework for the Digital Competence of Educators (DigCompEdu); As a result, 80 per cent of Spain's 700,000 teachers are expected to be certified in digital competence by 2024. In **South Africa**, over 50 per cent of the TVET lecturing staff have now received one or more forms of digital skill training.

Links with communities and local stakeholders

To advance digital culture, skills and literacy, engaging with local communities is important to ensure they are invested in and aware of the benefits of tech-enabled learning. **Spain** has proposed a programme that offers families training in the safe use of digital devices and ways to support their children's learning.

In **India**, the ministry of education launched an online Annual Refresher Programme in Teaching (ARPIT) in 2018, a major and unique initiative of online professional development of 1.5 million higher education faculty using the MOOCs platform SWAYAM. In the first instance National Testing Agency (NTA) conducted ARPIT Test in 2019 in 66 disciplines. Currently, 48 discipline-specific National Resource Centres (NRCs) with the support of Course Coordinators have prepared online training material, with focus on latest developments in the discipline. ARPIT is an ongoing exercise, so that every year NRCs will continuously develop new refresher modules in their earmarked discipline each year and the training material will be uploaded and made available through SWAYAM.

Table 9: Programmes targeting capacity and culture

Germany: Qualification Initiative Digital Change Q 4.0

The Federal Ministry of Education and Research is funding the development and testing of new training courses for company trainers to support them in the digital transformation. The focus is on strengthening media pedagogical knowledge as well as technical and social skills. The focus is on media pedagogical knowledge as well as industry-specific and cross-industry technical and social skills in order to appropriately shape the content and processes of dual training in the digital transformation. In addition to current technical content, trainers receive new methodological knowledge and strengthen their role as coaches and learning facilitators. Vocational school teaching staff are also included in the training. In this way, we promote cooperation between learning venues and ensure future-proof and attractive training.

India: SWAYAM

SWAYAM is India's national MOOCs programme and is offered completely free of cost to all learners. India's top educators create MOOCs courses across all major disciplines. Learners can earn SWAYAM Credits upon writing an exam for that course and SWAYAM regulations support the transfer of credits to any university. The acceptance and quality of SWAYAM MOOCs is reflected in its more than 30 Mn enrolment and 10.5%+ completion rates which is also increasing steadily. SWAYAM courses are also offered to international Students in 19 countries through e-Vidhya Bharati project of Ministry of External Affairs. Proctored exams have also conducted for international locations for SWAYAM Courses.

Indonesia: Competency and professional certification and certified industry internship

In Indonesia, vocational HEIs have implemented various programmatic interventions to make tech-enabled learning more inclusive and equitable. These include developing digital content aligned with industry needs, providing access to digital devices and internet connectivity, training teachers in digital tools and technologies, collaborating with private sector partners, and creating awareness and outreach programmes. These interventions have helped to bridge the digital divide and ensure that all students have access to technology and digital content, regardless of their socio-economic background.

United Arab Emirates: The Mohammed Bin Rashid Smart Learning Programme

The Smart School Transformation Framework is a holistic framework and professional development scheme for all school principals and deputy principals that offers them the tools to assess the effective application of technology within their schools. It provides a self-managed framework to empower administrators in their schools' ICT journey and allows them to design suitable roadmaps to achieve goals for technological advancement. The „Distance Learning" initiative was implemented, in cooperation between the Ministry of Education, in cooperation with „Hamdan Bin Mohammed Smart University", by training more than 42,000 trainees to train teaching and academic cadres in various stages of the educational process from inside and outside the country with the skills of managing and operating classrooms. Study via the Internet and help them acquire the necessary experiences related to how to use modern technological techniques to perform their work during the COVID-19 pandemic.

2.4 Connectivity and infrastructure

Education systems should carefully consider the quality and sustainability of their hardware, software, electricity and internet access when determining the viability of tech-enabled learning. Countries should strive for safe and secure online and onsite learning spaces, equipped with fit-for-purpose devices and tools that meet diverse needs and are accessible to all learners and education stakeholders anytime, anywhere. Connectivity coverage should be efficient and based on the needs of the different learning spaces, which are connected through interoperable data systems.

Hardware and software

Countries around the world should strive to ensure that physical classrooms are properly maintained and equipped to support tech-enabled learning at all levels. The infrastructure to support sustainable digital learning environments in schools comprises many elements of hardware and software, including devices, charging stations, smart technologies, WiFi, routers and data storage. Targeted investments are therefore needed.

In **Germany**, the federal government and the Länder launched the DigitalPakt Schule 2019–2024 initiative to noticeably improve the digital infrastructure at schools across the country. The federal government supports the Länder and municipalities in investing in ICT equipment and systems, and bringing schools online to create a digital education infrastructure that is fit for the future.

The **Republic of Korea** has also invested in creating conducive ICT environments in schools. The project facilitates 'minimum wired' and wireless ICT infrastructure in schools to guarantee the right to learning via digital textbooks, education software and remote online classrooms during emergency situations and future health crises (such as a pandemic).

Certain countries have focused on the increasing the supply of tablets and specific types of hardware or software to schools and communities in under-served areas. Under the GIGA School Concept, **Japan** has achieved its aim of providing one computer to each student in all of the nation's elementary and junior high schools, and has initiated full-fledged technology-enabled learning. Now that each student has access to a computer, teachers can better grasp individual learning situations and support children with disabilities, or those struggling with bullying or absenteeism.

Indonesia is tailoring its hardware to the needs of local communities, providing educators who struggle to access the internet with guidelines and training modules on flash discs. The Government of **Nigeria** is providing computer hardware and accessories to the Federal Ministry of Education headquarters, where a data centre is also being established. It is also expanding the provision of mobile tablets and laptops to Federal Government Colleges through PPS. **Türkiye** is making tech-enabled learning more accessible by ensuring that digital resources and training are complemented by the appropriate infrastructure.

In the **United Arab Emirates**, the Smart School Transformation framework supplies students and teachers with Samsung tablets and has placed smart boards in classrooms. The former come installed with software called 'Smart Author' for teachers and 'Smart Reader' for students.

Connectivity

The **United States, Indonesia** and **Saudi Arabia** are adopting an equity-first approach to ensure digital connectivity reaches the most marginalized. For example, through its Digital Equity Education Roundtables (DEER) initiative, the **United States** aims to identify barriers facing learner communities in adopting reliable, high-speed internet and technology tools for learning; recommend strategies to help school leaders navigate these barriers; amplify examples of solutions; and spur community action and commitment to closing the digital divide. In **Saudi Arabia**, the Remote Areas School Development Initiative is ensuring and improving access to education in remote areas. In **Bangladesh**, the Ministry of Education is building a permanent ICT-based learning infrastructure, which should help reduce students' learnings losses during any natural disaster.

India currently has 20 million 5G users. Estimates suggest that by 2024, the 5G user base in India will be 100 million and 4G user base will be about 880 million. BharatNet, the world's largest rural broadband connectivity program aims to connect 250,000 villages across the country that will make e-education possible for all aspiring learners of India. One of the earliest programs in this regard was the Campus Connect programme, proposed in 2014. Today, more than 1700+ institutions are part of the National Knowledge Network (NKN), which is aimed at establishing a strong and robust Indian network which will be capable of providing secure and reliable connectivity. NKN is a state-of-the-art Pan-India network and helps in creating a knowledge society without boundaries.

Indonesia is ensuring that tech-enabled learning reaches all by undertaking needs-based investment that considers school characteristics and the usability of equipment. Through the School Digitalization programme, schools in 3T areas are prioritized to receive ICT devices such as laptops, projectors, Wi-Fi Routers, and active speakers; more than 800,000 ICT devices had been distributed to those schools by the end of 2022. In **Mauritius**, all primary schools are connected to high-speed broadband internet, which is currently being extended to secondary schools. Digital tablets have also been distributed to all pupils. At the upper primary level, the software includes a classroom management system to allow teachers to monitor student learning activities.

Integrated data systems

Countries such as **India**, the **Russian Federation** and **Saudi Arabia** have committed to, and actioned, the rendering their digital platforms fully interoperable to deliver on their vision and goals for improving their education systems. In **France**, a specific monitoring platform ('PIX Orga') allows education and training professionals (teachers, trainers, human resources managers, etc.) to follow students' activity and results on the platform through detailed pedagogical data on individual and collective results, enabling them to adapt their teaching to students' progression and skill development.

As President of the 2023 G20, **India** is offering to share the conceptualization of its Education Ecosystem Registry (EER) with other G20 countries to improve global educational equity and promote cross-country faculty collaboration on research and academics. The digital divide is a global phenomenon, and the EER will ensure that education and skilling opportunities extend to rural areas and underserved communities, as tribal and minorities' online learning opportunities are not always guaranteed. Non-personally identifiable information or metadata are aggregated at a national level for analytics and open data purposes, meaning that the EER will enable macro visualizations that identify learners or teachers who require targeted policy support. Many of the data bases such as All India Survey of Higher Education (AISHE) and Unified District Information System for Education Plus (UDISE+) will be synchronized with the EER. This will help in authenticity and validity of data at all levels while ensuring that the individual is the custodian of all their data.

In the **Russian Federation**, the SuperService 'Online University Admission' has enabled the technological integration of the federal higher education entry and information system, enabling the digital execution of state and municipal functions. The SuperService ensures the final state certification of students who have mastered general and secondary general education levels, and the admission of citizens to vocational and higher education institutions. A total of 975 HEIs and branches (551 parent organizations and 424 branches) have been successfully connected to the SuperService during the admission campaign for the academic year 2022/2023.

Saudi Arabia's initiative on 'Student Profiling and Assessment' is developing a single integrated digital system to make up for the current lack of comprehensive student-assessment tools and the absence of student records that measure learning, behavioural and skill progress at all education levels. The system will feature digital files on students which will include personal information, psychosocial and educational data, and information about their skills and knowledge.

Table 10: Initiatives targeting connectivity and infrastructure

India: Education Ecosystem Registry (EER) and Unified District Information System for Education Plus

As next steps towards a data driven management of education sector, India is planning an Education Ecosystem Registry, which seeks to establish a national-level bird's eye view of the country's student and teacher cohorts. The EER will be synchronized with the Unified District Information System for Education Plus (UDISE+), which is one of the largest Management Information Systems initiated by Department of School Education and Literacy, Ministry of Education, GoI, covering more than 1.48 million schools, 9.5 million teachers and 265 million children. The entire system is online and has been collecting data in real-time since 2018-19. UDISE+ has a mandate of collecting information from all recognized schools imparting formal education from pre-primary to class XII. Similarly, to portray the status of higher education in the country, the Ministry of Education conducts an annual web-based All India Survey on Higher Education. The survey covers all the Institutions in the country engaged in imparting higher education. Data is being collected on several parameters such as teachers, student enrolment, programmes, examination results, education finance, infrastructure, and others. Indicators of educational development, such as institution density, gross enrolment ratio, pupil-teacher ratio, gender parity index, per student expenditure are also calculated from the data collected through AISHE to help make informed policy decisions and research for the development of the education sector. All open data from the registries and transaction systems is anonymised when transferred to Vidya Samiksha Kendra systems, which enable data-driven observability and decision-making at the policy decision-making level.

Russian Federation: Information System and SuperService "Online University Admission"

The target model of SuperService provides for development of the functionality and corresponding step-by- step increase in the number of participants in the pilot testing for more than 80 per cent of educational institutions (taking into account educational institutions with special admission rules) that accept applicants via the SuperService, and providing an opportunity to submit documents for admission to organizations (except for the original documents on education and (or) qualifications) remotely for all categories for the period from 2020 to 2024.

In addition, the information system called "Modern digital educational environment" was established by the Ministry of Science and Higher Education of the Russian Federation. It is a resource which includes a registry of courses and programmes, a digital portfolio of students and a subsystem for quality assessment and evaluation, as well as an opportunity for accounting credits for courses taken at another university.

2.5 Cost and sustainability

Sustainable and equitable tech-enabled learning requires strategic financial engineering to account for the significant cost implications of digital transformation in education. Sustaining digital learning for all carries capital and operational expenditures that must be factored into national budgets both within the education sector and beyond. These costs include investment in infrastructure to provide electricity, internet connectivity, devices, and data storage to all schools and learners. In many regions of the world, connecting rural regions is a costly endeavour, and telecommunications companies may be reluctant to partner with countries to bring connectivity to areas where there is no clear business case.

Given these challenges, it is essential that national governments invest financial resources in the expansion and continuous maintenance of digital learning infrastructures. These infrastructures are becoming increasingly complex, as countries invest in more sophisticated education data systems and learning technologies that require higher-speed internet, stronger cybersecurity measures, and more energy to operate effectively. Many G20 countries and invited members have demonstrated national level commitment to such infrastructural investments over the past few years.

In addition to capital and operational investments in infrastructure and connectivity, a critical component of any sustainable tech-enabled learning plan is to invest in people. The cost to skill and upskill can be substantial, yet G20 countries and invited nations, such as Spain and Germany, have made significant investments in the creation and implementation of training programmes to support the development of skills and competencies of all education stakeholders, including teachers and learners. As advanced technologies continue to evolve and impact the education sector, ushering in new potentialities for tech-enabled learning, it is imperative that such programmes ensure that teachers and learners have not only the operational skills to interact effectively with such technologies, but also to think critically about their impact both within and beyond the classroom.

To finance these 'hard' and 'soft' costs of equitable digital learning solutions, financial engineering that combines resources across sectors may be required. Overall, a range of funding sources, along with cross sector cooperation, can help ensure an optimized, affordable, equitable, impact-driven allocation of resources across schools and regions to foster a thriving education technology ecosystem. Governments play a central role in making sense of the national and international funding landscape for digital transformation in education, as each context may need a unique combination of funding resources to finances sustainable, long-term tech-enabled learning across the entire education system.

In **Brazil**, the Learning Centred Education foresees investment in public VET institutions in Brazil for the acquisition of prototyping environments (maker spaces). This set of actions should support the development of professional and technological education in a technologically integrated world, and the promotion of socio-environmental responsibility and economic development. In 2017, the Government of Canada invested CAD$50 million over two years as part of the Innovation and Skills Plan, a multi-year strategy to create well-paying jobs for the middle class. This initiative aims to create a strong, more resilient **Canada** by providing youth with a pathway to employment, with a focus on inclusion of underrepresented groups, including girls, Indigenous youth, Black youth, youth with disabilities, and youth living in rural, remote and Northern communities.

In **Germany**, the federal government and the Länder work closely together to finance and advance digital transformation in education. The DigitalPakt makes available over €6.5 billion for investments in the digital education infrastructure. As a direct consequence of the school closures caused by the pandemic, another

€1.5 billion were added in 2022 to the original €5 million DigitalPakt to provide IT administration, tools for creating digital content, and borrowable school mobile devices for students and teachers. The Länder, which are also responsible for implementing the agreements, or the school authorities contribute at least 10 percent of this amount and fund additional measures.

Mauritius is also making a significant investment in the digital transformation of its education system, working to ensure that students have access to the digital resources and skills they need to succeed in the 21st century by allocating government funds, securing external funding and establishing partnerships with private-sector companies. In 2021, the government allocated around 17 per cent of its budget to the education sector, which included funding for digital infrastructure, training and content development. Mauritius has also secured funding from international organizations such as the World Bank and the African Development Bank. In 2020, the World Bank approved a US$15 million loan to support the government's efforts to improve the quality of education through digital transformation.

In the **Netherlands**, The Push for digitalization (or NPuls) is funded by the National Fund for Growth, a €5 billion fund focused on sustainable economic growth and welfare. Thanks to this programme, more efficient educational support systems and lower costs per organization compensate for the higher costs of shared infrastructure.

Spain is integrating the digital upskilling of teachers and the School Digital Plan in its national budget. Linking the equipment to teacher training created an integral approach that will be featured in the national budget to ensure digital transition and address the digital divide. The programme's sustainability is evidenced in further initiatives announced by the government, such as 'Código Escuela 4.0', which will provide schools with equipment (robotics, programming boards), teacher support and training, and educational resources, supported by a budget of €360 million (US$381 million).

Table 11: Programmes focussing on cost and sustainability

Australia: Regional University Centre (RUC) Programme

Regional University Centres are community-owned facilities in regional and remote locations in Australia that provide study spaces, video conferencing, computing facilities and high-quality internet access, as well as academic skills and wellbeing support for students studying online at any Australian university or vocational education and training provider. The Australian Government provides funding for the costs associated with the establishment and operation of the Centres including capital works and fit out costs, staff, rent, learning resources and administrative expenses. Funding amounts for each RUC are determined through negotiations between the Australian Government and the Centre. Once funding amounts are agreed, funding is guaranteed for 3-4 years. The programme has ongoing funding available, with the first cohort of Centres entering a second grant period in 2022. All Centres are encouraged to also seek funding through alternative sources such as state and local Governments, university partnerships and private industry to support the ongoing sustainability of the Centre.

Canada: CanCode

CanCode aims to equip Canadian youth (K-12), from kindergarten through the end of secondary education, with skills to participate in the digital economy and prepare them for further studies in digital skills and science, technology, engineering and math (STEM) courses. The programme was part of the 2017 Innovation and Skills Plan, a multi-year strategy to create well-paying jobs. This initiative aims to create a strong, more resilient Canada by providing youth with a pathway to employment, with a focus on inclusion of underrepresented groups, including girls, Indigenous youth, youth with disabilities, and youth in rural, remote, and Northern communities. CanCode also supports initiatives that provide teachers with training and professional development opportunities to help them introduce digital skills such as data analytics and digital content development, as well as coding in the classroom. Since the launch of the CanCode program in 2017, the program has provided over 4.5 million students and over 220,000 teachers with coding and digital skills training. In the latest iteration of the program, the Government of Canada will deliver 3 million additional training opportunities to students and 120,000 teachers.

Germany: *DigitalPakt*

In Germany, the federal government and the 16 Länder have jointly developed a programme called the "DigitalPakt Schule" to support digital transformation in schools. Under the DigitalPakt, the federal government has pledged to provide five billion euros over a period of five years (2019-2024). While the federal government provides around 90 per cent of the funding, the Länder contribute 10 per cent and fund additional measures. The Länder are responsible for implementing the programme. The federal government and the Länder have agreed on a set of priorities for the use of DigitalPakt funds, including the improvement of digital infrastructure in schools, the provision of digital equipment and tools, and the development of digital learning infrastructures and platforms used in common.

2.6 Conclusions

Technology has the potential to extend the right to education for all, including for groups who miss out on learning in formal classrooms. As was seen with the explosion of WhatsApp groups and peer networks during the pandemic, technologies are also useful for improving support, communication and collaboration between students and teachers, and expanding participation in broader learning communities or communities of practice.

To this end, many G20 countries are striving to cultivate equitable, innovation-friendly digital learning ecosystems through coherent and parallel investments in digital platforms, contents, curriculum and teaching training, as well as upgrading and revising standards, regulations and procurement practices that allow for effective, equity-focused, bias-free, transparent and socially negotiated digital applications.

As the experiences across and within the G20 members demonstrate, the benefits of tech-enabled learning are currently unavailable to population segments in all countries. There should be realistic possibilities for countries to absorb digital learning into their systems and classrooms in order to expand access, increase

system efficiency and support learning. At present, however, many countries do not have the data architecture or connectivity to incorporate the most dynamic elements of digital learning into their education delivery.

The challenges facing countries in optimizing the promise of digitized education systems and unleashing the power of educational technologies are multifaceted. These include lack of access to digital technologies; limited digital capacities; insufficient connectivity and infrastructure; inadequate access to free and accessible high-quality online/offline content; an absence of sustainable funding for digital solutions; and the lack of differentiated interventions for women and girls, or children with special needs. Another major concern is that, without careful oversight, the widespread use of technologies in both formal and informal learning spaces could conflict with the best interests of the child and other human rights, such as the right to privacy and freedom from discrimination.

This chapter acknowledges these challenges and highlights the efforts of G20 member and invited countries to overcome these barriers.To ensure that all learners and teachers can benefit from tech-enabled learning, countries should make parallel – and substantial – investments and commitments across a range of areas. This might require additional or innovative partner financing, technical know-how and resources to adjust education systems as needed. Recommendations for G20 countries in advancing along this path may include:

Seeking out innovative financing and partnerships to support investments in infrastructure and access: Access and equity in education are still major concerns across the G20 countries and governments should strive to ensure that education technologies do not widen existing gaps in access to education. To this extent, further exploration to increasing investments in infrastructure, such as broadband internet, making Wi-Fi available in public spaces and reliable power supply, will be important to ensure that learners from low-income and marginalized families can access online or tech-enabled learning even in the most rural and remote areas. As during the pandemic, governments should also consider schemes for providing devices like laptops or tablets to learners in the lowest-income households. Both areas will also require innovative financing and partnerships across sectors and stakeholders.

Developing digital skills among educators and learners: A priority for policy coherence is to invest in the digital skills of teachers and educators so that they can use technologies effectively in the classroom. This includes digital skill training, pedagogical training, and training on how to integrate education technologies into the curriculum. It also includes training in cybersecurity, safeguarding, and safely using digital tools for teaching and learning.

Cost-sharing in the development of digital contents and resources: The development and sharing of open education resources and digital contents should be considered as a viable and cost-saving policy alternative to traditional production mechanisms. These can be accessed by learners and educators anywhere, and governments could provide incentives for educators to create and share their own digital content.

Using data analytics to inform decision-making: Going forward, governments should leverage technology more widely and consistently in order to collect and analyse data on student learning outcomes, and compile evidence on what works. This can help educators tailor instruction to meet the needs of individual students. To this end, countries should support the development and use of learning analytics tools, and support research on the effectiveness of technology-enabled learning.

Discussions around digital learning and data should not leave out information on what is happening at the furthest reaches of the data frontier, even if trends do not seem applicable at first sight to many low-income countries. AI is increasing the potential usability of data of varying quality across state and non-state sources,

and across formal and non-formal learning spaces and settings, and could therefore play a central role in facilitating individual's lifelong learning pathways.

Advanced AI and machine learning can analyse data across census, administrative and learning assessments, alongside structured and unstructured data gathered from internet navigation, social networks, network devices, surveys and rapid assessments, and so on. Until recently, such capabilities were held back by differences in data quality, the lack of interoperability of different data-gathering systems and sources, and the lack of possibilities for integrating such sources within a single data system. But countries' growing investments in cloud-to-edge technologies and other advanced analytic platforms as the basis for their education management and learning management systems are beginning to change this.
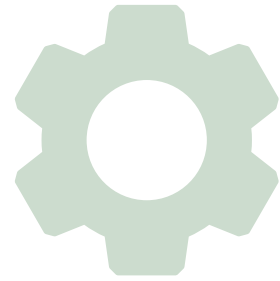
Chapter 3

Building capacities, promoting life-long learning in the context of the future of work

This chapter analyses how G20 member countries and guest economies are enhancing education and training opportunities, and promoting lifelong learning in the context of the future of work. It focuses on vocational, postsecondary and adult education and training, as well as cross-cutting issues of governance and skill recognition. Within these spheres, the chapter discusses the challenges and opportunities for developing labour-market relevant skills in lifelong learning, and related good practices from G20 member countries.

The world of work is undergoing a significant transformation. Recent advances in technology have increased automation, human-machine interactions, and the use of mobile communication and big data. Advanced technologies are also informing the contours of new design tools, new business models and new approaches to manufacturing, repair, upgrading, reusing and resale that bring us closer to the sustainable and circular economic models needed for Industry 5.0[1] and the sustainable transition to a green economy.[2]

These technologies will disrupt some jobs and create new ones, and increase the need for adults to learn new skills, upskill and reskill (International Labour Organization [ILO], 2021). In parallel, mitigating climate change will require many workers from high-CO_2-emission sectors to shift to emerging or growing sectors (Cedefop, 2022), and the transition towards a greener economy will generate growing demand for green occupations and skills.

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[1] The European Union suggests that, in order to remain the engine of prosperity, industry 5.0 must lead the digital and green transitions. This approach provides a vison of industry that aims beyond efficiency and productivity as the sole goals, and reinforces the role and the contribution of industry to society. It places the wellbeing of the worker at the centre of the production process and uses new technologies to provide prosperity beyond jobs and growth while respecting the production limits of the planet. It complements the existing "Industry 4.0" approach by specifically putting research and innovation at the service of the transition to a sustainable, human-centric and resilient European industry.

[2] Source: Industry 5.0: A Transformative Vision for Europe Governing Systemic Transformations towards a Sustainable Industry ESIR Policy Brief No. 3.

Globalization has allowed companies to expand their operations and stages of production across borders, creating an interconnected world where production occurs in global value chains. Such dynamics have significantly impacted the distribution of income and locations of jobs. They have also increased competitiveness among countries, making it essential for economies to have a skilled workforce that can remain competitive and add value in global value chains (IMF, 2017).

The COVID-19 crisis accelerated the speed of many megatrends and their impacts on the world of work (OECD, 2021). But such megatrends were already intensifying labour-market demand for high-level cognitive skills, and the skills needed in complex social interactions such as autonomy, independence in the organization of tasks, self-organization and self-management.

Meanwhile, increasing life expectancy and declining birth rates are leading to population ageing in many G20 countries. The decreasing cohort of youth entering the labour market and longer life expectancy are creating pressures for societies to prolong adults' working lives and bring more underrepresented groups, including women, into work. By extension, workers will need to develop new capacities over the life course (OECD, 2021).

Developing the right skills for the needs of society and the economy

Under the Indonesian G20 Presidency in 2022, the G20 Employment Working Group (EWG) and Education Working Group updated the G20 Skills Strategy that was adopted under the Türkiye Presidency in 2015. The purpose of the update was to account for the evolving impacts of megatrends and the COVID-19 pandemic on skills. The updated Strategy identified 18 priority policy principles for countries (see the Conclusions section of this chapter for further details).

Organizations such as the OECD have also recognized the importance of developing the right skills that respond to the needs of 'greener' societies and labour markets within Industry 5.0, and ensuring these skills are fully utilized by individuals and employers (OECD, n.d., 2019). Research shows that individuals with postsecondary education and training, for example, achieve better labour market outcomes, better social and health outcomes, and are more engaged in civic life. Individuals will need to build strong foundations and keep building capacities throughout their lives. This requires investments in education, training and lifelong learning systems to ensure that learning opportunities are responsive, equitable and inclusive (OECD, 2021).

3.1 AI and its implications for worker retraining and lifelong learning

Advances in AI are transforming the technological landscape at an unprecedented pace. This process is evolving faster than previous technological revolutions owing to steady improvements in computational power, storage capacity and algorithms. Compared to past technologies, AI can also match or surpass humans in a larger number of tasks, especially those including image and speech recognition, predictions and pattern identification.

Although the full extent of this AI progress is not yet known, available indicators suggest that the future is likely to see periodic surges of AI capabilities in key skill domains, which could quickly shift skill demand and the associated need for retraining. This raises concerns about the future of work and the role of education in preparing individuals for the jobs of tomorrow.

On the one hand, AI may lead to technological unemployment, by replacing workers at the workplace. This may make education and training programmes preparing for traditional occupations obsolete and generate pressure on education systems to upskill people in ways that enable them to compete with computers. On the

other hand, the new technologies can complement and augment people's capabilities, raising productivity, creating new jobs and boosting demand for labour. However, this may require new types of skills that allow people to work with AI to seize the opportunities created by technological advances.

A comparison of the long-term trends in human skills with the recent trajectories of AI progress suggests that AI will likely soon outperform most adults in many of the areas linked to formal schooling. Some observers suggest that humans can continue to outperform AI in competencies such as critical reasoning, creativity or social perceptiveness for many years to come. However, it is hard to maintain that confidence in the face of the progress shown by large language models over the past twelve months: generative AI systems have performed exceptionally well on tests designed to precisely measure aspects of critical thinking in different subject areas (OpenAI, 2023); the inventive creations of ChatGPT and its visual counterpart DALL-E 2 show astounding results with respect to creativity (New York Times, 2022); and the empathy exhibited in chatbots through exchanges with people struggling with mental health or social issues show substantial facility with social perceptiveness as well (Martinengo, Lum, & Car, 2022).

Advancements of AI and robotics with regard to motor and sensory capabilities have not been as impressive when contrasted with the progress made in purely cognitive domains. For instance, self-driving cars still struggle to understand their surroundings, and warehouse robots struggle to pick up diverse objects (Wall Street Journal, 2023). Asking a computer scientist to design a robot to replace a hairdresser, childcare worker or plumber is likely to be met with laughter, as the challenges in these areas are still overwhelming. It appears, therefore, that in the coming years, physical competencies may be an area where humans will have the edge over AI. Nonetheless, it is plausible that we may eventually witness rapid and startling progress in AI and robotics in these areas too. Already, progress is underway, with robotic systems becoming increasingly agile, thanks to advances in machine learning and the greater availability of sophisticated sensor systems (Littman, et al., 2022).

Policy challenges and potential responses to evolving AI

Fast-evolving AI cognitive capabilities in key skill domains raise questions about employment and the ways in which education systems need to respond. Recent technological advancements in language processing particularly indicate that AI can reproduce human skills that are in high demand on the labour market. Across 39 countries and economies that participated in the programme for the International Assessment of Adult Competencies (PIAAC),[3] 70 per cent of workers on average, use literacy skills every day at work. The majority have a literacy proficiency that is comparable, or below, that of AI (OECD, 2023). By extension, AI could affect the literacy-related work tasks of 59 per cent of the workforce.

As one likely response, education systems will need to upskill substantial parts of the population to help them keep up with improving AI capabilities. In the domain of literacy, this would mean elevating the working population to the highest proficiency level that would enable workers to understand, interpret and critically evaluate complex texts.

Countries with high proportions of highly proficient adults in their workforce can serve as examples of good practice. However, the top-ranking countries in PIAAC have only between 21 per cent and 25 per cent of workers with high literacy proficiency. This shows that even the best performers to date cannot supply more

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[3] PIAAC is an international survey conducted by the OECD to assess the skills and competencies of adults aged 16 to 65 in participating countries.

than a quarter of their workforce with the literacy skills needed to outperform AI. For median performers, these shares are much smaller: around 10 per cent of workers have strong literacy skills. Those countries would need to devote considerable efforts to lifting most workers to a literacy proficiency level beyond that of computers.

As AI capabilities in cognitive areas continue to improve, the objective for education systems would need to shift substantially, to focus more on working with powerful AI systems. AI systems may help workers and learners to undertake tasks more effectively than they could do on their own. However, students will need far more support in understanding how to use AI systems effectively, and how to work regularly with AI systems to perform tasks in the workplace and everyday life. India's YUVAi ('Youth for Unnati and Vikas with AI'), for example, provides an innovative method of offering applied learning experiences to help students understand and identify how AI can be used to tackle complex problems (Table 11).

Before the widespread adoption of computers, the internet and smartphones, most adults around the world were likely to be insufficiently familiar with technology. Nowadays, the population in most countries has at least basic ICT skills. However, gaps remain. As shown by PIAAC results, around one-third of respondents in several countries either reported having no prior computer experience or were unable to perform basic computer tasks (e.g. using a mouse or scrolling through a webpage) to participate in PIAAC's computer-based assessment (OECD, 2019).

On a more intermediate level, education systems will need to ensure that all people possess and strengthen their digital skills to thrive in digitized societies and economies, contribute to innovation and avoid the risks presented by the AI revolution. Having diverse skills sets, including digital skills, would enable people to adapt to potential changes in their occupations induced by technology. It would also facilitate their mobility between occupations since diverse skills apply to different work contexts. PIAAC data show that in many countries, less than one-third of the population can demonstrate strong skills in all three key areas of literacy, numeracy and problem-solving in technology-rich environments (OECD, 2023).

To anticipate all these changes, it is critical to monitor AI developments systematically in different capability areas, and to assess their implications for education and skills. Knowing what AI can do compared to humans can help predict which work tasks may be automated, which skills may become obsolete, and which skills may become more significant in the years ahead. This knowledge base can help develop effective labour market policies to tackle the challenges of technological change. It can also enable policy-makers to reshape education systems in ways that best prepare today's students for the future.

REPORT I Education Policies and Programmes in G20 Countries

Table 12: Policies tackling technological change

China: Academy of Future Technologies

The Academies of Future Technologies cover more than ten key technological fields such as aerospace, intelligent manufacturing, future energy, quantum technology, AI, big data, deep space, deep sea, deep blue, and deep earth. These Academies aim at contributing to innovation by cultivating leading talent in cutting-edge technologies in the next 10 to 15 years. Such talent should provide foresight and shape future trends in science and technology. In addition, the Academies explore possibilities for cooperation among professions and disciplines and promote cross-disciplinary research.

India: YUVAi (Youth for Unnati and Vikas with AI) and Skill India Digital

YUVAi (Youth for Unnati and Vikas with AI): This is an initiative launched by the Ministry of Skill Development and Entrepreneurship (MSDE) in collaboration with IBM India. The programme aims to provide Indian youth with skills in AI and equip them for the jobs of the future. It offers a 4-week online learning experience to students across India, focusing on building knowledge and understanding of AI, its applications, and hands-on experience through various real-life use cases. The curriculum covers topics such as data science, machine learning, deep learning, neural networks, computer vision, and natural language processing.

The programme also provides an opportunity for participants to showcase their skills and receive recognition through a nationwide AI challenge. The AI challenge is a platform for students to work on real-life industry problems and come up with innovative AI solutions. Through the YUVAi program, the Indian government aims to provide young people with skills that are in high demand and equip them to take on the challenges of the future job market. The initiative is part of the Indian government's broader efforts to promote skill development and entrepreneurship in the country.

Skill India Digital: India's National Education Policy 2020 promotes flexible and modular learning pathways that allow students to pursue education and training in a personalized and self-directed manner. Accordingly, Skill India Digital is an innovative initiative by the Ministry of Skill Development and Entrepreneurship to enable candidate centric skilling. It allows discoverability of courses, AI based recommendations, training centres and aligned employment opportunities. Through its online platform, individuals can access high-quality educational resources, interactive tutorials, and virtual classrooms, enabling them to learn at their own pace and convenience. It provides a trainee lifecycle management and a digital learning management system catering to government funded as well as paid courses. It also enables digitally verified credentials and provides linkages with the world of work in the form of entrepreneurship and employment opportunities

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3.2 Postsecondary education

Across G20 member and guest countries, postsecondary education and training have become a prerequisite for a significant share of available jobs. However, demand for advanced skills relevant to knowledge-intensive sectors is continuously evolving in the context of the future of work. As a result, young people transitioning into work and adult life now require both robust foundational skills and the capacities and motivation for continuous learning that allows them to skill, upskill and reskill throughout their professional careers.

Many G20 countries have invested in expanding their postsecondary education sectors in recent decades by increasing enrolment capacity in higher education systems, providing new entry routes to higher education and extending more accessible student support. In **South Africa**, for example, the 'Unfurling Post-School Education and Training' programme establishes 'articulation hubs' in the country's nine provinces and regions to facilitate student mobility between different institutions and levels of postsecondary education. South Africa has also adopted policies to promote the provision and uptake of upskilling and reskilling opportunities in postsecondary education.

In broad terms, national policies seek to advance upskilling and reskilling through two main channels:

↘ Supply-side policies: direct support and incentives for postsecondary education and training providers to develop and deliver programmes specifically targeting adult populations wishing to upskill or reskill, with a particular focus on short and flexible learning offerings.

↘ Demand-side policies: expanding financial support and incentives for learners (and sometimes employers), to remove barriers to adults accessing and completing advanced upskilling and reskilling opportunities.

On average across OECD countries in 2021, 47 per cent of individuals aged 25–34 had obtained a tertiary education qualification (levels 5 to 8). Attainment rates stood at over 50 per cent in 14 OECD countries, including the Republic of Korea, Canada, Japan, the United Kingdom, the Netherlands, Australia, the United States and France (OECD, 2022).

Training, upskilling and reskilling can occur through mainstream programmes (VET programmes, bachelor's degrees, etc.) for students in their 'initial' education and training trajectory, or in tailored programmes (in terms of study intensity, delivery modes or timing of in-person instruction). In addition, postsecondary providers are increasingly delivering less formal education and training offers and new, alternative credentials, including various micro-credentials.

Several countries are building bridges between postsecondary education and the world of work. For example **India**, **Oman** and the **United Arab Emirates** have internship programmes for higher education students to help them develop industry-relevant skills and transition into the workforce.

In terms of policies that support the supply side, an increasing number of G20 countries provide temporary targeted funding to HEIs to support the development of new, flexible continuing learning offerings. In **Australia**, a 'micro-credentials pilot in higher education' was launched in 2023. HEIs in India are also offering various certificates, diplomas and other courses to help meet industry requirements.

The **European Union** has sought to encourage and guide the development of national systems of micro-credentials through a Council recommendation to Member States, adopted in 2022, which identifies and defines building blocks for developing micro-credentials (which, in practice, are typically offered at the postsecondary level), with a view to ensuring that national systems and credentials are comparable across EU countries.

In **Saudi Arabia**, the "Skills Accelerator" initiative aims to establish short, industry-specific skill accelerator programmes that are driven and co-delivered by the private sector. These are designed to upskill and reskill the labour force, addressing both current and future skill gaps in the labour market. The "Micro and Nano Degrees" initiative also introduces short university degrees focused on specific professional or career disciplines, with a duration of less than 12 months. These degrees are designed to develop specific skills that are relevant to the labour market, such as cybersecurity, entrepreneurship, and culture. The initiative works closely with the private sector and universities to identify and design micro-credentials that align with the needs of the labour market, ensuring the credibility and recognition of these micro-programmes.

Policies to stimulate the take-up of (or demand for) advanced upskilling and reskilling in postsecondary settings have been introduced. Such policies typically seek to reduce both the direct costs and opportunity costs for individuals associated with participation in education and training.[4] Various options are open to policy-makers seeking to direct resources to learners. One option is to expand eligibility for established student aid mechanisms, to make it easier for adults to obtain support for upskilling and reskilling.

The **Canada** Student Financial Assistance (CSFA) Programme, administered jointly with, and with additional programming by, provinces and territories, provides targeted grants and needs-based loans to eligible students enrolled in postsecondary education programmes and the 'Education Savings Programme' encourages Canadians to save for their children's postsecondary education. In **England (United Kingdom)**, the government proposes to introduce a 'lifelong loan entitlement', expanding the scope of the existing system of public, income-contingent student loans. From 2025, the new system will provide individuals with a loan entitlement equivalent to four years of post-18 education which they can use over their lifetime. The loans will be available for both modular and full-time study at higher technical and degree levels (International Standard Classification of Education [ISCED] levels 4 to 6).

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[4] Direct costs include both the costs of tuition and training fees for upskilling and reskilling programmes, and individuals' living costs during their training. Opportunity costs include, notably, earnings lost during time taken to participate in upskilling and reskilling; these costs which can be particularly significant when individuals are seeking to retrain for new occupations and professions.

Table 13: Programmes supporting postsecondary education

India: Post-Secondary Vocational Education and National Credit Framework

Post-Secondary Vocational Education: Skill based programs across education levels are offered based on the National Skills Qualifications Framework (NSQF), which organises qualifications according to a series of levels of knowledge, skills, and aptitude. Higher educational institutions can offer skills-based Certificate, Diploma, Advanced Diploma, Undergraduate and Postgraduate programmes, as well as apprenticeship-embedded degree programmes. The curriculum in the skill-based programmes is a suitable mix of general education (which includes communication skills, environment studies, entrepreneurship development studies and others) and vocational education in the relevant trades.

The National Credit Framework of India: This is a pioneering system that provides a standardized framework for recognizing and accrediting academic and vocational qualifications across the country. It serves as a comprehensive credit transfer and accumulation system, allowing learners to seamlessly move between different educational institutions and programmes while ensuring the recognition and portability of their credits. The framework facilitates lifelong learning by enabling individuals to accumulate credits over time and build their qualifications progressively. It promotes flexibility and learner-centricity, allowing students to pursue a diverse range of subjects and programmes according to their interests and career goals. The National Credit Framework also enhances transparency and quality assurance in the education system by establishing clear guidelines for credit assignment and transfer. This ensures that the qualifications obtained by learners are recognized and valued by employers and educational institutions alike.

Netherlands: Stimulering Arbeidsmarkt Positie (STAP)

STAP, or the stimulus programme for improvement in labour market position, aims to stimulate the participation in lifelong learning among all adults, especially people with lower incomes, by providing every citizen with the opportunity to receive a fund of 1000 euros in a year toward the costs of education and training. Apart from the two ministries, two additional governmental organizations are responsible for the implementation (UWV and DUO) alongside other cooperating partners, such as educational institutions. Implemented by the Ministry of Social Affairs and the Ministry of Education, Culture and Science, the STAP replaced the system of a fiscal tax deduction for educational cost, which entailed a large reduction of 'dead weight' and less usage among the poor, who could not afford to pay the education or training in advance. The programme generated great interest. However, the Dutch government also found points for improvement, such as ensuring all trainers and courses meet programme conditions. The government therefore recently decided to discontinue the programme and to allocate the money differently. It will review the STAP-programme and look into possible other ways to stimulate lifelong learning and development.

Saudi Arabia: Madrasti Codes

Madrasti Codes is a national coding competition aimed at fostering a culture of computer programming and enhancing students' performance in public, private, and international education. The competition focuses on developing students' higher-order thinking skills through engaging methods that relate to their daily lives and prepare them for international competitions. The main drivers of the competition include strengthening capacities for lifelong learning in the context of the future of work, developing measures for skilling, reskilling, and upskilling learners to bridge skill gaps, creating a future-ready workforce, and building robust digital learning ecosystems while facilitating digital skills and literacy among children and youth. Technologies used in the competition include Minecraft Education Edition for coding, Python and coding blocks, the App Design Journal from Apple, presentation creation programs, and video shooting and editing applications.

In Phase 1 of the competition, the total number of participants reached 4,766,205, including students, teachers, parents, and community members. The competition also emphasizes digital training and upskilling for teachers and leaders. Professional development, peer coaching, train the trainer courses, webinars, and self-paced learning packages were implemented to support skill building and lifelong learning among educators. The goal was to provide diverse skill-building channels to empower learners. Similarly, digital training and upskilling initiatives were developed for students. Teachers, trained by experts, played a role in developing students' skills and supporting them through various training sessions, including extracurricular activities. Customized training packages, localized learning platforms, webinars, and competitions like Madrasti Codes were implemented to support students' self-paced learning, promote lifelong learning, and enhance digital skills in preparation for the future of work.

United Kingdom: Lifelong Loan Entitlement (LLE)

From 2025, the LLE will provide individuals in England with a loan entitlement to cover tuition costs for the equivalent of four years of post-18 education to use over their lifetime. It will be available for both modular and full-time study at higher technical and degree levels (levels 4 to 6), regardless of whether they are provided in colleges or universities. This marks a shift from the current public loan system to cover tuition fees for a first qualification in higher education. The entitlement will cover four years for everyone, it will cover technical education at sub-bachelor's level and individual modules, rather than just full qualifications and it will allow individuals to receive funding for a second qualification at any level between levels 4 and 6. The current system does not provide funding for individuals who have already completed a first higher education qualification. The objective is to increase flexibility and promote upskilling and reskilling at advanced levels. The final eligibility criteria for the LLE are still under development in 2023, but the loan system will cover online and hybrid provision in relevant fields.

3.3 Technical and vocational education and training

TVET supports young people's school-to-work transition and provides opportunities for adults to upskill and reskill in the context of the changing skill needs in economies and societies, including those resulting from the green and digital transition. Improving access to and ensuring high-quality TVET represents an important opportunity to equip youth and adults with the skills required to succeed in rapidly changing economies and societies. TVET provides opportunities to better integrate underrepresented groups in education and the labour market, including female learners, indigenous populations, learners with disabilities, migrant populations, provided they have access to support if needed and training is adapted to their needs.

It is now widely acknowledged among G20 countries that TVET is a powerful means to improve equity in learning and life, and to develop the skills demanded by the labour market. In their responses to the survey commissioned by the EdWG under the Indian Presidency, most countries reported initiatives to increase and diversify learning opportunities through TVET to assist people in upskilling and reskilling to meet the needs of the future of work. National priorities vary widely among G20 countries and guest economies.

The financing for Technical and Professional Education (ETP) in **Argentina** is institutionalized in law and various regulations (ETP Law No. 26058). Lifelong training is overseen by the National Council for Education, Labour and Production, and part of a tripartite system for ensuring representation of state government areas, workers and enterprise owners. The **European Union** has also taken a broad perspective, situating TVET provision within the context of creating skills ecosystems for innovation, regional development and social inclusion. Centres of Vocational Excellence share knowledge at the national and international levels to promote good practices that improve vocational education.

In the **People's Republic of China**, the Vocational Education Special Training Programme for Field Engineers programme is designed to meet the high-end digital, intelligent and green development requirements of key areas such as advanced manufacturing, emerging industries and modern service industries. The programme does so by deepening the integration of industry and education through school-enterprise cooperation; and fully implementing the Chinese apprenticeship system. Schools and enterprises jointly undertake employee apprenticeship and training, creating synergies in the talent pipeline between education, industry and innovation to meet the urgent need for professionals with technical skills.

In **France**, for example, hubs for vocational education and training excellence (Campus des métiers et des qualifications d'excellence) are networks that bring together all stakeholders in pioneering and priority sectors. Their purpose is to anticipate and develop the skills required by emerging industries and the industries of tomorrow. This includes, on a regional scale: schools (general, technological and vocational upper secondary schools); higher education institutions; training organisations; research laboratories; companies and associations. By offering initial and continuing education in a cutting-edge sector, the Campuses help expand sectors of excellence and improve vocational training opportunities. They can therefore deliver relevant solutions to the local socio-economic needs.

In **Italy**, decrees have been introduced to reform the ITS Academies (Tertiary VET) and technical and vocational training more generally. The aim is to connect the system of vocational and technical education to the real needs of enterprises and the labour market, with particular reference to the ecological and digital transition and the innovations developed within the Plan Industry 4.0. The reforms also seek to establish a system of continuous technical education, starting in secondary education institutions and continuing into the tertiary system of ITS Academies and create a better match with the new qualification frameworks and the age of

achievement. The requirements to create a new ITS Academy are to have at least one upper secondary school of the provincial territory, with a relevant educational offer; a training structure accredited by the Region; one or more companies using the technologies that will be part of the training pathway; a higher education institution or a research institution.

Reforms to modernize TVET have also played an important role in improving the way that TVET is designed, implemented and evaluated. **India's** Multidisciplinary Education and Research Improvement in Technical Education scheme aims to modernize the technical education sector through the reforms envisioned in the National Education Policy-2020. The project focuses on modernizing teaching, learning and assessments to enhance employability and strengthening equitable access, on research for better skills and innovation, and on sector steering, including governance and HEI-internal and external quality assurance.

In line with **India's** National Education Policy 2020, its overarching school education sector programme, Samagra Shiksha, has incorporated vocational education from upper primary level onwards, and integrated vocational courses in the curriculum at the secondary level. Outside the general school system, the Industrial Training Institutes (ITIs) under the Directorate General of Training provide post-secondary TVET in various trades under the Craftsmen Training Scheme (CTS).

In **Brazil**, the 'Professionals of the Future' and 'Qualify More' programmes aim to increase enrolments and employment outcomes in VET, including in sustainable sectors of the Brazilian economy such as professional and technological education, bio-economy and renewable energy.

In **Oman**, building national capabilities in vocational training is a target of the Oman Vision 2040 and will involve preparing an effective governance system, attracting private-sector investment and meeting the needs of the labour market. In some countries, advancements in technology have played an important role in boosting innovation and improving the way TVET is designed, implemented and evaluated.

Stimulating demand for, and accessibility to information on, countries' TVET offers is also policy concern. In **Germany**, the innovation competition 'INVITE' helps learners to find the right continuing professional training on demand and establish stronger collaborative networks. The 'Innovationswettbewerb' also uses AI and other technologies to support the individualized design of learning processes in VET. To increase the chances of employability in India, the national skilling portal and national internship portal, SAMARTH connects non-urban students with skilling and internship opportunities across India and worldwide. The SC Technological programme in **Mauritius** offers two-year programmes at mid-secondary level to provide students with a vocational qualification and the opportunity to continue to higher vocational or technical fields.

VET learners can also participate in workplace training, often in the form of apprenticeships and internships. **Indonesia** and **Spain** have both sought to increase the work-based learning component of TVET. **Indonesia** has implemented project-based learning in 55 per cent of its VET programmes to ensure students are equipped to face real-world challenges and meet future work needs. It has also strengthened its 'partnership ecosystem' between VET units, business and industry, which is expected to boost regional economies. Meanwhile, **Spain** is focusing on providing people with skills that are relevant for emerging and rapidly changing jobs through dual VET programmes combining school-based and work-based learning in every VET programme.

Table 14: Programmes supporting technical and vocational education

India: National Educational Alliance for Technology (NEAT)

Ministry of Education with the support of All India Council of Technical Education (AICTE) has initiated National Educational Alliance for Technology as a Public-Private Partnership model to bring the popular educational technological Products on a single platform for the convenience of learners. Any student of economically & socially weaker sections across the country can benefit from NEAT as 25 per cent of the coupons are provisioned for them free of cost. 58 Ed-Tech Companies are listed on Portal, providing 100 products. Around 2.58 Lakhs Students are registered on the Portal.

Indonesia: Project-Based Learning

Project-Based Learning is a student-centred, experiential, and multidisciplinary approach to education that supports "deep learning". This approach involves students in an active exploration of real-world problems and challenges. Through this learning model, Indonesia is supporting students to acquire the skills required to face the current and future world of work through projects, internships or learning in factories. This project has required strong collaboration with industry to provide students with the opportunity to work.

Italy: New structure of vocational pathways

With the new reform of vocational schools, Italy has introduced a new structure of the 11 vocational pathways, according to the competencies of the different vocational profiles, and a greater flexibility of curricula, in order to allow a dynamic adjustment to the evolution of demand of the different production chains and adaptation to the vocations and needs of the territories. Through the reform of ITS Academies, tertiary VET and its connection to professional degrees has been strengthened. The reform aims at gradually filling the gap between labour demand and supply, in relation to the technological areas considered strategic for the ecological and digital transition. It also improved the legal status of qualifications, allowing further education in tertiary pathways, according to a lifelong learning perspective. Other key measures for the success of the reform include the identification of new technological pathway areas to facilitate the green and digital transitions; the definition of criteria for final examinations; the table of correspondence of the qualifications obtained, the recognition of credits in tertiary education pathways and the vertical continuity in professional degrees pathways implemented by Higher Education Institutions. Finally, to guarantee the skills of the adult population, through the ITS Academies National Plan, upskilling and reskilling initiatives have been launched, along with the release of micro-credentials.

European Union: Centres of Vocational Excellence (CoVE)

Centres of Vocational Excellence (CoVE) create skills ecosystems for innovation, regional development, and social inclusion. These centres establish a bottom-up approach to vocational excellence by involving a wide range of local stakeholders to ensure VET institutions rapidly adapt skills provision to the evolving economic and social needs. CoVEs collaborate at national levels as well as in international collaborative networks.

Germany: Innovationswettbewerb INVITE

The innovation competition INVITE aims at the development of innovative solutions that – with the help of AI – enable all people to find the right continuing professional training on demand. The INVITE funding in three development fields is directed to enabling and realizing connection and interoperability of platforms, a stronger user orientation of platforms and the use of AI technologies for an individualized design of learning processes. In addition, standards for the design of an innovative digital ecosystem for continuing education and training are identified by a meta project. A total of 35 projects is funded within the framework of the competition. The funding volume is approximately EUR 80 million. Projects in the development fields are funded for 36 months, the meta project for 46 months.

Mauritius: SC Technological Programme

Mauritius is planning to introduce from 2024 onward a new two-year programme (SC Technological) at mid-secondary level which enables a learner to gain a qualification oriented towards applied knowledge. The programme will include streams in ICT, Engineering, Hospitality and Health - with an emphasis on STEM. The learner can subsequently continue studies towards vocational or technical fields with the objective of enhancing suitability for the needs of the world of work. The SC Technological programme provides an avenue for learners to start gaining experience in applied knowledge right as from the secondary schooling sector - while at the same time engaging in continuing their learning trajectory. This contributes towards building their resilience and their ability to adapt to the new and emerging needs in Mauritius.

3.4 Adult education and training

Adult education and learning is another precondition for individuals, enterprises and economies to harness the benefits of rapidly changing labour markets, and is a critical goal for G20 lifelong learning systems seeking to build capacities for the future. Adult upskilling and reskilling can help accelerate and magnify the benefits of the green and digital transitions, and promote gender equality in labour markets. Adults can learn in formal settings, such as vocational training and general education; in non-formal settings, such as workshops and employer-provided training; and in informal learning situations (OECD, 2021).

To date, willingness to participate in adult learning across the G20 is modest: among G20 countries with available data, 43 per cent of adults report they have participated in formal or non-formal training during the last 12 months (Figure 7).

Figure 7: Participation in adult learning (share of adults who participated in formal or non-formal training in the past 12 months)
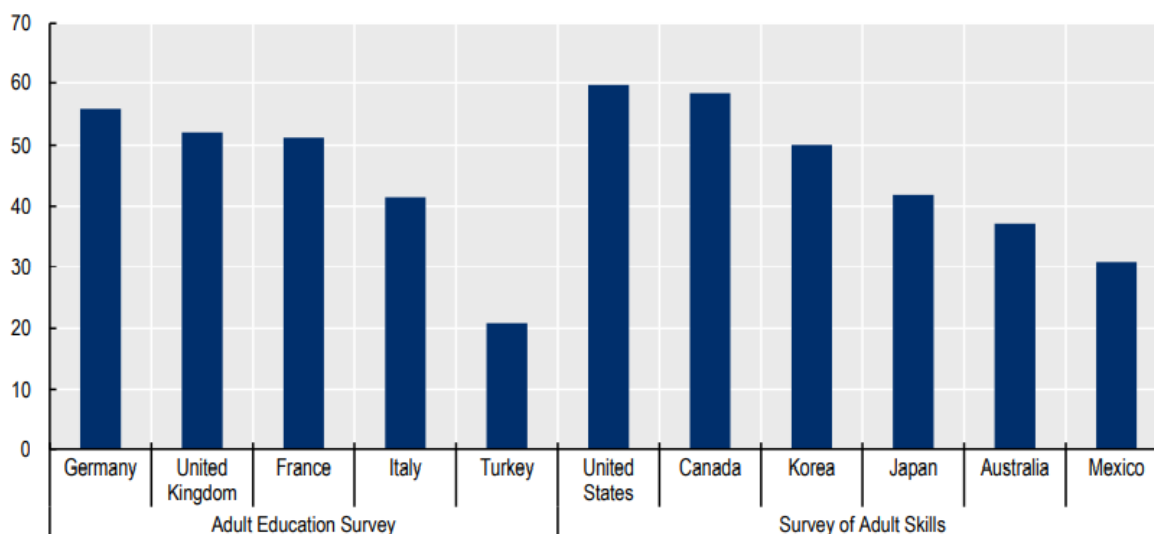
Note: Data from the Adult Education Survey refer to 2016; data from the Survey of Adult Skills to 2017 for Mexico and the United States, and to 2012 for Australia, Canada, Japan and the Republic of Korea.
Source: OECD (2021), Education at a Glance 2021.

In the G20 countries included in PIAAC, women, adults with low levels of education, adults with weak literacy and/or numeracy proficiency and older adults were significantly less likely to participate in formal or non-formal training than other groups (OECD, 2019; (ILO, 2016). Workers in micro, small and medium-sized enterprises (SMEs) and in non-standard jobs are also less likely to participate in training than their peers in large companies and in permanent full-time employment, which can exacerbate social inequalities. Social norms or discrimination in the workplace can play an important role in influencing who can receive training. For instance, gender, disabilities and age tend to influence companies' decisions (OECD, ILO and UNESCO, 2022).

Acknowledging the influence of different barriers, including financial costs, time constraints and other factors limiting participation is critical to increasing the take-up of adult education and training (OECD, 2023). Designing training pathways that enable adults to combine training with other responsibilities, including family and work, can make training more accessible. Modular programmes and part-time training can also increase adult learning's flexibility. Likewise, recognition of prior learning (see Section 3.6) can allow adults to focus only on their learning gaps.

A first cluster of interventions among G20 countries targets the attractiveness and accessibility of adult education and training programmes. The **Japanese government**, for example, has introduced the 'Brush Up' programme to promote and publicize practical and specialized programmes for working adults, offered at HEIs. The government also offers an online portal to support learning for working adults. In **France**, under the 'One Young Person-One Solution' scheme, a platform was created to facilitate young adults' search for professional training (OECD, 2023). The innovation competition INVITE fosters solution via digital platforms in **Germany** to help learners find the right continuing professional training on demand and establish stronger collaborative networks. In **India**, the 'NASSCOM FUTURESKILLS' platform provides upskilling and reskilling opportunities in emerging technologies such as Artificial Intelligence, Machine Learning, Big Data, Internet of Things and Cybersecurity, etc.

Adult learning interventions and programmes in G20 countries often target underrepresented or disadvantaged groups. The **United States** has developed the 'Integrated Education and Training Programme', which provides targeted adult education opportunities to low-income adults, migrants and refugees. The programme aims to ensure that everyone has an opportunity to complete occupational training while developing a proficiency in English. **India's** Pradhan Mantri Kaushal Vikas Yojana (PMKVY) programme aims at providing short duration skill-development training to Indians aged 15–45 to enhance their employability and career opportunities. In **Nigeria**, the Federal Government established the National Commission for Mass Literacy, Adult and Non-Formal Education, with a mandate to eradicate adult illiteracy and offer second-chance education programmes for adults and youths.

Several countries have established national funding schemes to support upskilling and reskilling opportunities. The **Netherlands** has a €200 million budget to help 200,000 adults cover the costs of an educational programme. In **Singapore**, each Singapore Citizen aged 25 and above is given S$500, as part of the SkillsFuture Credit initiative, to offset course fees for skills training, on top of the generous course fee subsidies provided by the government. Additionally, Singaporeans aged 40 to 60 in 2020 are provided an additional S$500 in SkillsFuture Credit to access industry-relevant reskilling and upskilling opportunities as part of Singapore's mid-career skilling support. Singapore also provides financial incentives targeting employers to encourage their training participation, including subsidies, absentee payroll and tax breaks.

Individual learning accounts in countries such as **France** have gained attention as a means of supporting learners' training needs in a flexible manner. These accounts allow adults to develop their own learning trajectory, and to access their entitlements independently of their employment status and employer. Some G20 countries have also prioritized adult education and training for relevant skills in emerging sectors, including digital and green skills. France has also introduced training leave entitlements for employees. Another example is the 'Stimulering Arbeidsmarkt Positie' (STAP) programme in the Netherlands, which provided an annual training budget to workers and job seekers (but has recently been discontinued).

In **Canada**, the Upskilling for Industry Initiative works with a broad range of stakeholders to foster a more responsive skill ecosystem by scaling up employer-led approaches to upskill and redeploy workers to meet the needs of the following high-growth sectors: digital technology, cybersecurity, agriculture technology, advanced manufacturing, clean technology, and bio-manufacturing. Similarly, **Japan** focuses on growing industries with the 'Producing Professional Human Resources in Growing Fields' project, which provides financial assistance for relevant skill development for adults.

The **Bangladesh** Non-formal Education Bureau works on two different streams: providing education to drop-out students from primary education levels (Grade I-V) and literacy programs for adults. The National Skill Development Authority was established to research skill demand and supply, forecast labour employability, interlink skill development institutions, formulate a universal curriculum for skill development, and accredit skilled labourers. So far, it has set 147 skill standards, 149 course accreditation documents, 27 curricula, and 14 competency-based learning materials.

Table 15: Programmes targeting adult education and training

Canada: Upskilling for Industry Initiative

Implemented by Innovation, Science, and Economic Development Canada, the initiative has established relationships between a broad range of stakeholders including academia, not-for-profits, and businesses. It aims to foster a more responsive skills ecosystem by scaling up employer-led approaches to upskill and redeploy workers to meet the needs of six identified high-growth sectors: digital technology, cybersecurity, agriculture technology, advanced manufacturing, clean technology, and bio-manufacturing. This is done by providing non-repayable contributions to a lead recipient who, along with their network and delivery partners, engages employers in the upskilling ecosystem to identify skills needs and develop new curricula and upskilling programmes for mid-career workers, to meet those industry needs.

France: Personal Training Account (CPF)

The Personal Training Account (CPF) allows all individuals who are active in the labour market to accumulate a personal, training fund, which they can use to pay for training activities. Training rights are accumulated at different rates, depending on the initial level of education of the individual. For example, individuals with at least a lower secondary qualification accumulate EUR 500 per year, capped at a maximum of EUR 5 000 accumulated funding, while those with a lower level of qualification can accumulate EUR 800 per year. The accumulated funds can be used to fund training programmes recognized by government.

India: Pradhan Mantri Kaushal Vikas Yojana (PMKVY) and NASSCOM FUTURESKILLS

Pradhan Mantri Kaushal Vikas Yojana: The PMKVY programme is aimed at providing short duration skill development training and Recognition of Prior Learning for people in the age group of 15 to 45 years to enhance their employability and career opportunities. The short duration training is usually targeted towards candidates not in employment and drop-outs from the formal education system. The programme aims to impart industry-relevant skills to individuals to make them job-ready for various sectors such as manufacturing, healthcare, construction, retail, BFSI, IT, and others. It is implemented by the Ministry of Skill Development and Entrepreneurship (MSDE) and National Skill Development Corporation (NSDC). It also involves partnerships with various industries to provide training through a network of 37 Sector Skill Councils, which are also recognized as Awarding Bodies. The programme has leveraged technology to provide access to high- quality training and learning resources.

NASSCOM FUTURESKILLS. This is an online learning platform that aims to upskill and reskill the Indian workforce in emerging technologies such as AI, Machine Learning, Big Data, Internet of Things, Cybersecurity, and more. The programme is designed to be self-paced and allows learners to complete the courses at their own convenience. The duration of the programme varies depending on the course and the learner's pace, with each course having a specific number of hours of learning content associated with it. It is a joint initiative of the Ministry of Electronics and IT and a trade body and chamber of commerce of the tech industry. The programme uses feedback from industry partners to develop new courses and training programmes.

Japan: 'Brush UP' programme

The Brush UP programme offers certification of practical and specialized skills training conducted by HEIs that meet the needs of working adults and industry. Companies and local governments collaborate to develop training initiatives within higher education institutes, which includes setting the level and the skills to be acquired through them to meet required skills needs. Brush-Up is implemented by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) which also shares information and collaborates with the Ministry of Economy, Trade and Industry and the Ministry of Health, Labour and Welfare, who also implement measures for education for working adults.

United States: Integrated Education and Training

Integrated education and training are offered to adults by the U.S. Department of Education from low socio-economic background and refugees. Adults who have not completed secondary schooling and adults who are not proficient in English must typically complete basic skills and English language instruction before they can access occupational training in the United States. Integrated education and training combine the two programmes and teaches basic skills and English in the context of careers, saving learner's time and helping them advance in the labour market more quickly than if they had to complete basic skills/English language instruction and occupational training sequentially. There also is research evidence that this method of instruction is more effective in improving education and labour market outcomes than the typical sequential method. However, it is more difficult and costly to implement than the sequential approaches to adult education and training.

Singapore: National Centre of Excellence for Workplace Learning (NACE)

As part of MOE's efforts to strengthen the role of employers in the skills and training ecosystem, NACE was set up in 2018 to enhance the capabilities of companies, in particular SMEs, to deliver quality training at the workplace. In 2022, NACE supported close to 500 enterprises in building their workplace learning capabilities.

3.5 Implications for the governance of lifelong learning beyond schooling

The governance of future-ready skill systems begins with recognition of the opportunities and challenges of transitioning toward more digital, green and gender-balanced economies, as well as the complexity of skill policy, which is located at the intersection of diverse policy domains and implicates a wide range of actors. The diverse stages of individuals' educational and professional lives may also be governed by different sets of rules and regulations; the governance of skills therefore remains disjointed across levels of government, as well as across different ministries and agencies (OECD, 2020).

National skills strategies

To facilitate the implementation of a whole-of-government and whole-of-society approach to skill policy, countries should consider establishing national/sub-national skills authorities, coordination bodies and strategies that span diverse levels and departments of government and integrate non-governmental stakeholders.

In the former case, **Bangladesh**, the establishment of the National Skill Development Authority aims to conduct research on skill demand and supply, forecast labour employability, establish connections between skill development institutions, develop a universal curriculum for skill development, and accredit skilled labourers. To date, the Authority has established 147 skill standards, 149 course accreditation documents, 27 curricula, and 14 competency-based learning materials. Under **Germany's** National Skills Strategy, the national and subnational governments (Länder), agencies and stakeholders pool and advance their efforts to promote continuing education and skill development. In the **Republic of Korea**, the national and local governments are collaborating with each other and with various institutions to implement the Lifelong Learning Promotion Plan. Since 2002, the plan has sought to guarantee the right of all citizens to learn and receive education throughout their lives.

Various countries have also developed national and subnational skills strategies (ILO, 2020), which formalize and outline a broad strategy to coordinate and prioritize skill policies. **Canada's** Youth Employment and Skills Strategy is a horizontal Government of Canada initiative involving 12 federal departments, agencies, and Crown Corporations to support youth, especially youth facing barriers, in their transition to the labour market. Singapore's SkillsFuture movement aims to help individuals make well-informed choices in their education, training and careers, develop an integrated high-quality system of education and training that responds to evolving needs, promote employer recognition and career development based on skills and mastery, and foster a culture of lifelong learning.

In 2021, the **United Kingdom** published the White Paper 'Skills for Jobs: Lifelong Learning for Opportunity and Growth', which describes how the country will reform further education with the objective of supporting people in developing the skills needed by the economy. The reforms seek to put employers at the centre of training, and to reform funding for and the accountability of skill systems.

In **Saudi Arabia**, the standard educational data management system for all levels, which is being developed as part of the Human Capability Development Programme is expected to facilitate the design of a national skills framework (NSF), including digital skills, and standardize skills nomenclature and definitions in alignment with global definitions and standards, and identify required skills for different jobs. To support this, the country has created a labour market supply-demand foresight unit is responsible for demand and supply forecast through which the gap between labour market requirements and the number of qualified human resources is measured. The system predicts labour market needs in terms of numbers and skills required through a number of input sources. The unit aims to unify government efforts by assessing the state of the labour market and educational outcomes according to the needs of different sectors and regions.

Evidence and high-quality data

Evidence and high-quality data are also key to making good governance decisions (UNESCO, 2019). Skills strategies and policy interventions to address skills imbalances should be based on reliable information on current and future skill needs in economies and societies. One of the main challenges facing countries in making data-driven decisions is the multiplicity of data sources, which tend to be fragmented and only cover

parts of the skill system. Developing integrated information systems can provide data on educational outcomes and trajectories, and facilitate collaboration between stakeholders (OECD, 2020).

Saudi Arabia, Singapore and the **United Arab Emirates** have adopted approaches/strategies that seek to better inform policy-making by gathering high-quality data on the labour market. **Saudi Arabia** has created a labour market supply-demand foresight unit, which will act as a data source for all government agencies in determining the future needs of the labour market. It has also developed a lifelong learning RDI and innovation programme to promote RDI in lifelong learning. The **United Arab Emirates** has designed a data-gathering programme for higher education graduates to identify employment outcomes and skill mismatches. **Singapore** publishes an annual Skills Demand for the Future Economy report to point individuals, enterprises and training providers towards priority skills, relevant job opportunities and suitable courses in the following growth areas: the Digital Economy, the Green Economy and the Care Economy.

Engaging with the private sector and social partners

Due to the complexity and multiplicity of skill policies, effective skill governance implicates not only the public sector at all levels, but also the private sector. Engaging with stakeholders throughout the policy cycle strengthens the political legitimacy of policy-making decisions, and also contributes valuable information for the design and implementation of new policies and programmes (OECD, 2020).

In the effort to engage with the private sector, the governments of G20 member countries and guest economies are swiftly establishing relationships with employers. In **France**, the State, regions and social partners contribute to the elaboration of a pro-active lifelong education and training policy, beginning with the government's setting of the overall policy framework for lifelong education and training, and the creation of regulations and standards for vocational training, which is provided by a range of public and private organizations. The State also concretely provides financial support for lifelong learning activities through various mechanisms, including the Personal Training Account.

The 13 regions in France also have responsibilities for education and training, with significant autonomy and responsibility for funding and overseeing vocational training programmes. The regions also work closely with local employers, social partners and other stakeholders to identify training needs and develop programs that meet those needs. Finally, social partners negotiate agreements on training and education issues, such as collective agreements that establish training rights and obligations for employees and employers. These agreements can provide additional resources and opportunities for training and lifelong learning.

Japan is focusing on strengthening a tripartite collaboration (industry-academia-government) by promoting joint research and private companies. Oman and Spain are building partnerships with employers to adapt curricula and provide learners with the opportunity to learn at the workplace.

Financing

The governance of skill systems is also inherently linked to financing. On average, G20 governments spend relatively more on primary and secondary schooling, and less on early and postsecondary education (Figure 8). Spending on adult learning is likely to be lower still, although internationally comparable data are limited. Governments that are keen on promoting better skill policies must find ways to ensure a sufficient level of investment in education and skills at all stages of lifelong learning. For this purpose, governments should align and coordinate financing arrangements between different ministries and levels of governments (OECD, ILO and UNESCO, 2022).

Figure 8: Government expenditure on educational institutions per full-time equivalent student

In equivalent USD converted using PPPs for gross domestic product (GDP), by level of education in selected countries*, 2018
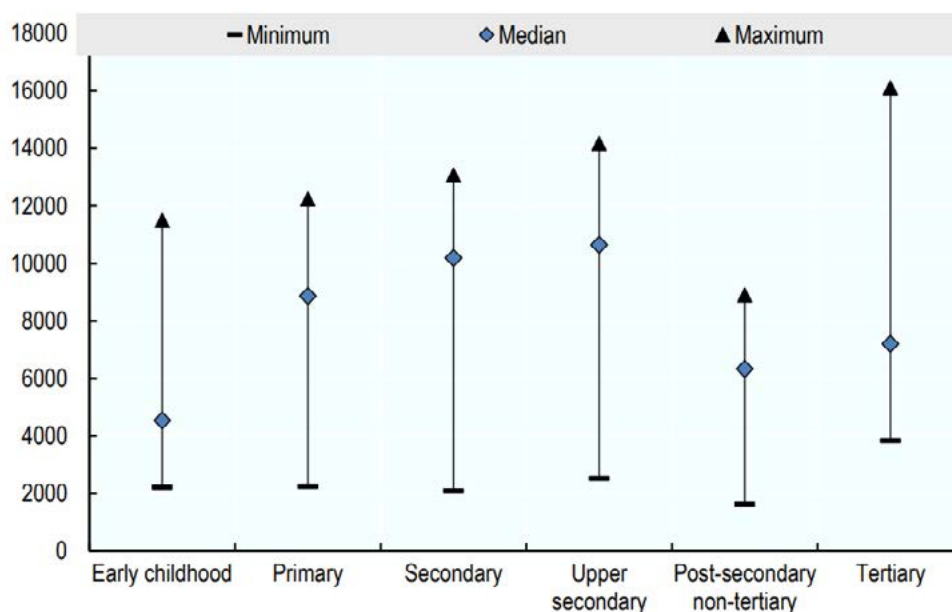
Note: Total direct expenditure by all levels of government on all public and private educational institutions, per full-time equivalent student.

*Data come from the following G20 countries: Australia, Brazil, Canada, France, Germany, Italy, Japan, the Republic of Korea, Mexico, South Africa, Türkiye, the United Kingdom and the United States.

The manner in which governments allocate funding can influence the types of skills people will gravitate towards and the prevalence of skill imbalances in the labour market. A first step in prioritizing skill investments and expenditures is therefore to identify priority areas. Lifelong learning is largely subsidized in most G20 countries, so that funding agreements for adult education and training are commonly used to foster the development of strategically important skills (ILO, 2018). Some countries have subsequently prioritized skills training programmes that focus on providing people with the skills needed in emerging sectors (G20 Countries Questionnaire, 2023).

One of the main financial constraints facing governments is that individuals could underinvest in skill development if educational aspirations compete with short-term pressing needs (OECD, 2023). Given the need to increase the participation of disadvantaged and underrepresented groups (including women, older adults, the self-employed, youth and migrants) in education and training, financing mechanisms are a key tool for targeting policies and ensuring inclusion in skill-development opportunities. Targeting these mechanisms at specific populations has proved to be more efficient than untargeted financial mechanisms (ILO, 2018).

All of the above require efficient governance and skills-financing arrangements that support greater inclusiveness and responsiveness from skill systems. Lessons learned in G20 countries show that this is particularly important with regard to incentive structures for individuals with low incomes. The **Netherlands** recently transitioned from a fiscal tax-deduction system, which limited opportunities for people with low incomes who could not afford to pay for education or training in advance, to a new financing system in which every citizen can receive funds for education on an annual basis.

Table 16: Initiatives addressing the governance of lifelong learning

Germany: National Skills Strategy

With the National Skills Strategy the Federal Government, the so called Länder, businesses, trade unions and the Federal Employment Agency are seeking to pool and advance their efforts to promote continuing education and skills development. The public launch of the updated National Skills Strategy took place in September 2022 with publication of the update paper jointly developed by the 17 partners. The focus is to simplify the pathways to continuing education, use digital opportunities as well as modernize and strengthen VET with innovative qualification concepts.

The Republic of Korea: Lifelong Learning Promotion Plan

The Republic of Korea's Lifelong Learning Promotion Plan is a model of local government-led lifelong education, in operation since 2002, with cooperation across levels of government and with stakeholders at the heart of the model. The purpose of the Plan is to contribute to the quality of life and happiness for all citizens by guaranteeing the right of all citizens to learn and receive education throughout their lives. Under the plan, events to raise public awareness are implemented, and adults can access basic and digital literacy education programmes, or more advanced online lectures in digital fields (K-MOOC, university online lectures, and corporate online lectures) such as meta-verse, AI, and SW to obtain a degree. Another example is Match-Up, an industry-tailored short-term job competency certification process whereby companies and educational institutions collaborate to develop and operate online-based curriculum to help improve job skills in new industries and new technologies. The national government establishes a plan for promoting lifelong education, local governments establish and support an action plan for lifelong education promotion, and various institutes and agencies support implementation of lifelong learning programmes.

Oman: The National System for Capacity Building and Talent Management

The system aims to establish a unified system for assessing and strengthening national skills and capabilities, ensuring the long-term preservation and utilization of talent data for future business development. It focuses on bridging the gap between education/training outputs and labour market requirements, enhancing human capital, and promoting lifelong learning. Key objectives include developing a comprehensive information infrastructure, defining standards for professional and leadership paths, and improving the Sultanate's global competitiveness index. The project targets students, teachers, school leaders, administrative staff, and various sectors of society. With a budget of 18,183,207 USD, the project is set to be implemented from 2021 to 2025, with a strong emphasis on flexibility, continuous development, and aligning with the evolving needs of the labour market.

Saudi Arabia: Labour market supply-demand foresight unit

Saudi Arabia's recent Human capability development program initiative is working to develop and operate a standard educational data management system for all levels. This initiative aims to set criteria for data mapping and sharing, and work with different educational institutions to link them to the system. In addition, to create a system and a platform for data sharing. This initiative aims to increase transparency and support future decisions and plans. Also, to design a national skills framework, including digital skills, to standardize skills nomenclature and definitions in alignment with global definitions and standards, and identify required skills for different jobs. Based on the skills framework, develop a skills accreditation system to assess skills of individuals, and collect the data related to education, certificates, languages, work experience (local and international), voluntary work, etc.

United Arab Emirates: Data-gathering for Higher Education Graduates Programme

The Data-gathering for Higher Education Graduates Programme aims to inform policy decisions by collecting comprehensive evidence from employers and graduates on skills outcomes. It seeks to provide a comprehensive 360-degree evidence-base to inform policy decisions on practices and other interventions that support skills development in new graduates. To identify employment outcomes and skills mismatches, the programme consists of three surveys which have been benchmarked against international best practice: The Graduate Destination Survey; The Longitudinal Graduate Destination Survey; The Employer Satisfaction Survey. The Abu Dhabi Department of Education and Knowledge is a partner in the Destinations Surveys and Ministry-accredited institutions collects survey responses from their own graduates.

3.6 Recognizing and certifying skills

Authorities increasingly recognize the importance to individuals of being able to showcase their skills and connect with different levels of education, training and labour market opportunities. As young people and adults pursue learning throughout their careers and lifetimes, the processes of validation and certification of learning are becoming increasingly digitized, and digital credentials such as open badges are gaining in popularity as they offer key information on qualifications and their learning outcomes.

Regional initiatives

Regional Qualifications Frameworks (RQFs), such as the African Continental Qualifications Framework, the Association of Southeast Asian Nations (ASEAN) Qualifications Reference Framework and the European Qualifications Framework (EQF), enable comparisons across countries and facilitate the international and regional mobility of learners and workers.

In the **European Union**, the European Skills, Competences, Qualifications and Occupations (ESCO) online portal also identifies and classifies professional occupations and skills relevant to the EU labour market and education and training, and systematically shows the relationships between the different concepts. The ESCO dataset of occupations and skills can be consulted and downloaded free of charge. ESCO's **common reference terminology** helps make the European labour market more effective and integrated, and allows the worlds of work and education/training to communicate more effectively with each other.

The European Qualifications Passport for Refugees is another standardised framework and document that explains the qualifications a refugee is likely to have, based on available evidence. Although the EQPR does not constitute a formal recognition act, it summarizes and presents available information on the applicant's educational level, work experience and language proficiency. The EQPR is a Council of Europe initiative. UNESCO has expanded this initiative internationally through its UNESCO Qualifications Passport (UQP).

Last but not least, the Common European Framework of Reference for Languages (CEFR) as an international standard for describing language ability. The CEFR describes language ability on a six-point scale, from A1 for beginners, up to C2 for those who have mastered a language. This makes it easy for anyone involved in language teaching and testing, such as teachers or learners, to see the level of different qualifications. It also means that employers and educational institutions can easily compare our qualifications to other exams in their country.

National initiatives

In the majority of G20 countries, a National Qualifications Frameworks (NQFs) are in place to explain where different formal qualifications are located within the national education and training system. NQFs increase the transparency and comparability of formal qualifications in national contexts, assisting education and training providers and employers in understanding the relative value of different qualifications.

Non-formal and informal learning, by contrast, often lack appropriate recognition or certification, and plays a limited role in signalling individuals' skills and competencies. Many non-formal and informal learning opportunities do not result in qualifications; even when qualifications are offered, these are outside the scope of NQFs and RQFs, making it challenging for education and training providers and employers to understand the relative value of these learning opportunities. On the other hand, the equivalency frameworks are open for non-formal learning and several national frameworks already added qualifications outside the formal education systems. Improving the recognition of skills obtained through formal, non-formal and informal learning can give marginalized learners alternative pathways to access education and training, and land jobs that match their skills.

Recognition of prior learning (RPL) is an approach that is embraced across the world, including in **India, Indonesia** and **Mauritius**. UNESCO's Global Convention on the Recognition of Qualifications concerning Higher Education and other regional conventions promote the recognition of partial studies and prior learning, making RPL a global norm. Some countries also use an NQF as a mechanism to connect formal, non-formal and informal learning. One example is **India's** NSQF, which organizes qualifications according to levels of knowledge, skills and aptitudes, defined in terms of learning outcomes which learners must demonstrate, regardless of whether they were acquired through formal, informal or non-formal learning.

Nonetheless, current RPL practices do not appear scalable, as this is a manual process where programme directors individually review each RPL application. Learners are also often not aware of the possibility of having their previous experience recognized. Moreover, educators, who make the final decision, may harbour doubts about the quality of learning obtained elsewhere.

Alternative credentials (such as micro-credentials and digital badges) are receiving growing interest as a tool for recognizing and certifying skills developed through non-formal and informal education and training. Micro-credentials – short, targeted and flexible learning opportunities – can help individuals cultivate and acquire

skills, and communicate the skills acquired to education and training organizations and employers. Additionally, when micro-credentials can be stacked towards a formal qualification, they can create new educational pathways.

Micro-credentials are also expected to contribute to social inclusion by facilitating access to lifelong learning for a wide range of learners, including those from disadvantaged and vulnerable backgrounds. However, prior to the pandemic, micro-credentials and other lifelong learning opportunities usually lay outside the scope of public funding, and the costs of learning were largely borne by learners and employers. Learners are also often not aware of micro-credential learning opportunities that match their needs.

This situation is gradually changing, with many G20 countries launching government-funded micro-credential initiatives in response to the COVID-19 pandemic. The next challenge for G20 governments is to make micro-credential financing more sustainable. As one notable example, the **Australian** Government recently launched a Micro-credentials Pilot in Higher Education to design and deliver micro-credentials covering newer, shorter forms of industry-focused learning. As part of the pilot, the government is also considering whether extending the student loan scheme to micro-credentials will increase participation in education by underrepresented groups.

Countries are also moving towards developing online platforms dedicated to lifelong learning and micro-credentials. In **Spain**, the Ministry of Universities has a €50 million budget programme from 2023 to 2026 for micro-credentials targeted to people aged 25 to 64 especially for reskilling and upskilling. In **Saudi Arabia**, based on the skills framework developed as part of the Human Capability Development Programme, a skills accreditation system will be developed to assess skills of individuals, and collect the data related to education, certificates, languages, work experience (local and international), voluntary work, etc.

Table 17: Promises, risks and policy challenges of micro-credentials

Promises	Risks	Policy Challenges
Micro-credentials can create new pathways to the completion of a formal qualification by permitting the accumulation of recognized learning in small and portable increments	Widespread recognition of micro-credentials by education and training providers is not yet well-established, making micro-credentials neither stackable nor portable	What should be done to ensure the quality and recognition of micro-credentials?
Micro-credentials can increase the flexibility of education and training provision and widen access to non-traditional learners	Micro-credentials could deepen inequalities in access to lifelong learning if they are available only on a fee basis or with employer funding	Should there be public funding? If so, what share of the cost should be borne by the public, how should funding be provided, for which persons, and which micro-credentials?
Micro-credentials can swiftly and efficiently reduce the mismatch between skills supply and demand	Learners may have poor information about the micro-credential offer, and micro-credentials may not be well-understood or trusted by employers	How do we provide information to support good learners' choices, and how do we promote understanding and trust among employers?

Source: OECD (2023).

Assessment frameworks play a key role in providing evidence of learning outcomes and underpin the recognition and certification of skills. In this regard, international cooperation and dialogue are essential to promoting the fair, flexible and precise recognition of individuals' skills across borders. In Europe, the **European Commission's** European University Initiative finances alliances between HEIs enabling automatic recognition of formal and partial learning across allied HEIs, thus contributing to scaling up the use of RPL schemes.

When it comes to facilitating the comparison of vocationally oriented skills and recognition of learning outcomes internationally, the OECD's International VET Assessment[5] has the potential to make a significant global contribution: into addition comparing qualifications, it compares learning achievements across different VET systems in key occupational areas, including automobile mechatronics, business and administration, electricians, healthcare, and tourism and hospitality.

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[5] The International VET Assessment project supports countries in strengthening their skills systems by developing, piloting and implementing an internationally standardized assessment of outcomes of initial VET programmes. The analysis of the results will enhance comparative policy insights on how to improve the relevance, quality, equity and effectiveness of initial VET programmes.

Table 18: Initiatives expanding how skills are recognized and certified

Australia: Microcred Seeker Website (and National Micro-credentials Framework and Micro-credentials Pilot in Higher Education)

Implemented by the Australian Government Department of Education, "Microcred Seeker" is an online one-stop-shop for micro-credentials, which allows users to compare micro-credential offerings. The process of developing the portal started in 2020. The government first launched a National Microcredentials Framework in early 2022, which sets out information microcredential providers are required to make available on the portal. The framework suggests that providers must publish title, provider, content/description, learning outcomes, language, delivery mode, delivery date, learner effort, inherent requirements, price and financial assistance, assessment, certification, credit/other recognition, quality assurance and prerequisite (s). Where possible, providers are also recommended to present other information, i.e., expiration of the micro-credential, depth of learning, jurisdiction, industry support, recommended prior experience, stackability, industry/occupation and industry alignment. The Microcred Seeker portal was built in collaboration with the Universities Admissions Centre and went live in late 2022. The government is currently also running a micro-credential pilot in higher education, and programmes funded through the pilot are listed on the portal.

Germany: ProfilPASS

ProfilPASS is a tool to assist individuals in identifying and showcasing skills they developed in formal, non-formal and informal settings, facilitating their access to lifelong learning opportunities and entry and re-entry to the labour market. It was launched in 2006, and it has been continuously evolving since then. It now offers different versions targeting different groups of individuals, from pupils at the age of 13 to retirees and from adult workers to youth not in employment, education or training. ProfilPASS is available as a printed workbook and in a digital format.

Saudi Arabia: National skills framework and skill recognition system

National skills framework and skill recognition system" which aims to Design a national skills framework, including digital skills, to standardize skills nomenclature and definitions in alignment with global definitions and standards, and identify required skills for different jobs. Based on the skills framework, develop a skills accreditation system to assess skills of individuals, and collect the data related to education, certificates, languages, work experience (local and international), voluntary work, etc.

European Union: Council Recommendation on a European approach to micro-credentials for lifelong learning and employability

Adopted in June 2022, the Recommendation seeks to support the development, implementation and recognition of micro-credentials across institutions, businesses, sectors and borders. As a non-binding guideline to EU member states, the Recommendation provides building blocks for developing national micro-credential systems including a definition, standard elements for describing micro-credentials, and principles for designing and issuing micro-credentials. The objective is to allow micro-credentials to be developed, used and compared in a coherent way among member states, stakeholders and different providers across different sectors, fields and borders and to build trust in micro-credentials across Europe. The EU-level framework has already incentivized the development and piloting of micro-credentials in postsecondary education in several EU member states, with more national implementation to follow.

3.7 Conclusions

Lifelong learning can help workforce entrants and working adults obtain the skills and knowledge they need to succeed in evolving job markets, or transition between jobs and industries. It can also provide the most entrepreneurially minded with the skills and training needed to bring new products, services and processes to the market, creating in turn new jobs and industries. Regardless of socio-economic background or geographic location, inclusive and equitable access to quality education and lifelong learning opportunities key to reducing learning, skills and employment gaps.

The need to review existing mechanisms for lifelong learning is made all the more urgent by rapid advancements in AI, Industry 5.0 and the green transition. A large portion of future job creation and new skill development will happen in high-growth and emerging technology sectors, and by catalysing net-zero carbon, circular and regenerative production and supply chains. Advances in technology are already leading to the automation of many tasks and the emergence of new jobs and industries. Technological change and globalization have also generated job displacement as certain jobs become obsolete or are outsourced to other countries.

Fast evolving labour markets will thus require measures enabling all learners, job-market entrants and working adults to prepare for the future through education, skills preparation and (re)training, along with social innovation to ensure the continuation of decent work. This will no doubt require the review and updating of existing policy, governance and legislation mechanisms.

Strengthening governance for future-ready skill systems

Given the complexity of the upcoming challenges around Industry 5.0 and the green transition, ministries responsible for education and skill policies should coordinate and cooperate across the whole of government, and engage social partners and other stakeholders meaningfully on skill policies and strategies at the sectoral, national and regional levels. To function properly, coordination bodies need to have a clear mandate with real substance, underpinned by strong internal governance structures. Moreover, they should be monitored and evaluated regularly to increase their effectiveness and efficiency.

Strategic and coordinated approaches to building capacities in the context of the future of work and promoting lifelong learning also require efficient skill-financing arrangements. This is increasingly urgent as governments continue to face major political, financial, technical and resource challenges when designing and implementing skill policies located at the intersection of education, social, labour-market, migration, industrial, innovation and economic development policy domains. Public funds should be allocated carefully to promote better policy outcomes, and ensure equitable access to skill-development opportunities for all learners and businesses. When making financing decisions, countries should therefore consider mechanisms for mobilizing resources from both public and private sources, as well as creating incentives for partnerships between employers, educational institutions and training providers to increase the supply of work-based technical and vocational education and training (TVET) across different sectors and employer types, and ensure equal access to other work-based learning opportunities.

Another central challenge lies in ensuring coherence and mutually reinforcing linkages between skill policies and employment, trade and other national development priorities, and encouraging institutionalized engagement of social partners and stakeholders at the national, sector and subnational levels (OECD, ILO and UNESCO, 2022).

Investments are also needed in comprehensive policy approaches for developing and renewing skills for resilient labour markets and societies that:

- ⭧ increase access to affordable and accessible skilling/reskilling/upskilling opportunities for all people across further and higher education systems (including through postsecondary, technical and vocational education, employment-linked training programmes and certification systems)

- ⭧ pay particular attention to equity-based approaches for learners from low-income families, at-risk and disadvantaged groups, and drive a culture of continuous learning and making up for lost learning opportunities experienced by many children, youth and adults during the pandemic

- ⭧ support the diversification of learning pathways that enable individuals to engage in learning at their own pace and on their own terms by improving access to part-time and online courses, and creating opportunities for individuals to earn credentials or certifications that are recognized by employers

- ⭧ support the digitalization of learning in a way that bridges the digital divide

- ⭧ enable the development of common skill frameworks at all appropriate levels (local, subnational, national, regional and international) and participation in internationally comparative assessments

To promote lifelong learning across the G20 membership, countries and their partners may also consider investing in research in technology-based areas, including research which looks at:

↘ AI capabilities versus human skills in education and the work place: This might mean the development of systematic and periodic assessments of the AI capabilities, comparing them with human skills in domains of key importance to employment and education. Understanding how AI capabilities develop over time is also important, not only to grasp the ongoing technological transformation but also to inform the design and development of learning opportunities. This knowledge base will help policy-makers and educators to better anticipate the impact of technological change on the workforce and prepare individuals for the demands of the future.

↘ How to better leverage technology for learning: Education systems must explore the use of technology to facilitate lifelong learning, including through increased access to digital resources and tools (such as online courses, webinars and mobile apps) and support for the development of digital literacy skills among learners at all stages of life.

Rethinking skills strategies

In a climate of evolving megatrends and multiple crises, the above necessitates a continuous revisiting of 'skills in demand' across G20 countries, along with policy and investment priorities and appropriate mechanisms for meeting them. Both traditional and emerging labour markets would benefit from training programmes that are tailored to the needs of different sectors and industries (this includes upskilling workers to help them keep up with growing AI capabilities and teaching students to work with AI). At the same time, the training offer must speak to the needs of marginalized communities and address barriers (such as lack of access to technologies, transportation or childcare).

From the demand side, individuals need access to opportunities to upskill and reskill in response to changing workplace demands. To stimulate such demand, governments will need to promote a culture of lifelong learning through awareness-raising campaigns, combined with high-quality, timely and lifelong career and learning information and guidance, in addition to providing incentives for individuals to participate in lifelong learning activities.

Against this backdrop, under the Indonesian G20 Presidency in 2022, the G20 Employment Working Group with the support of the G20 Education Working Group updated the G20 Skills Strategy that was adopted in 2015. The revised G20 Skills Strategy identifies 18 priority policy principles for countries to consider.

Box 3: Agreed policy principles for the G20 Skills Strategy (2022)

Agreed policy principles

1. Remove barriers to accessing ECEC, while strengthening its quality and enhancing its coverage

2. Provide targeted, gender-responsive support to low-performing students, students from disadvantaged backgrounds and students with special education needs and those at risk of falling behind

3. Equip young people with high-levels of cognitive, socio-emotional and technical skills, for their full social inclusion and to meet the needs of the labour market

4. Develop young people's digital skills and environmental literacy, to prepare them for a technology-based future and a just transition to an environmentally sustainable economy and society

5. Expand access to high-quality TVET opportunities, including community-based TVET and apprenticeships, which respond effectively to the needs of the labour market and society, with the involvement of private sector especially MSMEs and social partners

6. Provide all young adults, including those from vocational pathways, access to high-quality postsecondary (non-tertiary and tertiary) education and training

7. Promote participation in adult education and training through appropriately funded and more flexible learning opportunities, including through public funding entitlements for learning such as individual learning accounts, where appropriate

8. Provide high-quality, lifelong and timely career and learning information and guidance, enriched by the engagement of social partners, to youth and adults to support informed field of study and training choices across the life course

9. Harness new technologies to personalize, adapt and recognize high-quality learning for all individuals across the life course, while supporting those lacking digital skills

10. Develop reliable skills assessment and anticipation systems with relevant stakeholders, which leverage technology and data analytics to generate evidence that feeds into skills policies

11. Provide effective active labour market policies that address the needs of youth, jobseekers, workers and employers, including policies aiming at gender equality and disability inclusion

12. Improve access to the RPL as well as alternative credentials (including micro-credentials) to facilitate flexible and diverse learning pathways

13. Support employers, especially MSMEs, to assess, recognize, develop and make better use of their employees' skills (including through high performance workplace practices)

14. Enhance and promote a strategic, coordinated, multi-level and cross-sectoral approach to develop and use skills within and across countries, including through coordinating bodies at all appropriate levels (local, subnational, national, regional and international)

15. Involve private sector employers, workers organizations and civil society representatives (including youth associations) in the governance of skills systems, for example to contribute to curricula, pedagogy, quality assurance and labour market information

16. Agree through social dialogue on how to share the costs of developing the skills of adults among government, enterprises and individuals, with greater support given to low-skilled and/or low-income groups and MSMEs

17. Monitor and evaluate funding levels, outcomes and impacts at all stages of learning, and for different groups, where feasible

18. Develop country-level baseline gender-disaggregated data, where available, and report on progress related to key elements of countries' skills systems and SDG4 related skills targets, including skills development, skills use and skills governance, to generate lessons learned that can inform the efforts of G20 member states

Source: Annex V "Update of the G20 Skills Strategy - 2022" of the Chair's Summary: Labour and Employment Ministers' Meeting 2022, Bali, September 13-14, 2022, http://www.g20.utoronto.ca/2022/220914-labour.html; Update of the G20 Skills Strategy: Background Paper, 24 August 2022, Prepared by the OECD, ILO and UNESCO.
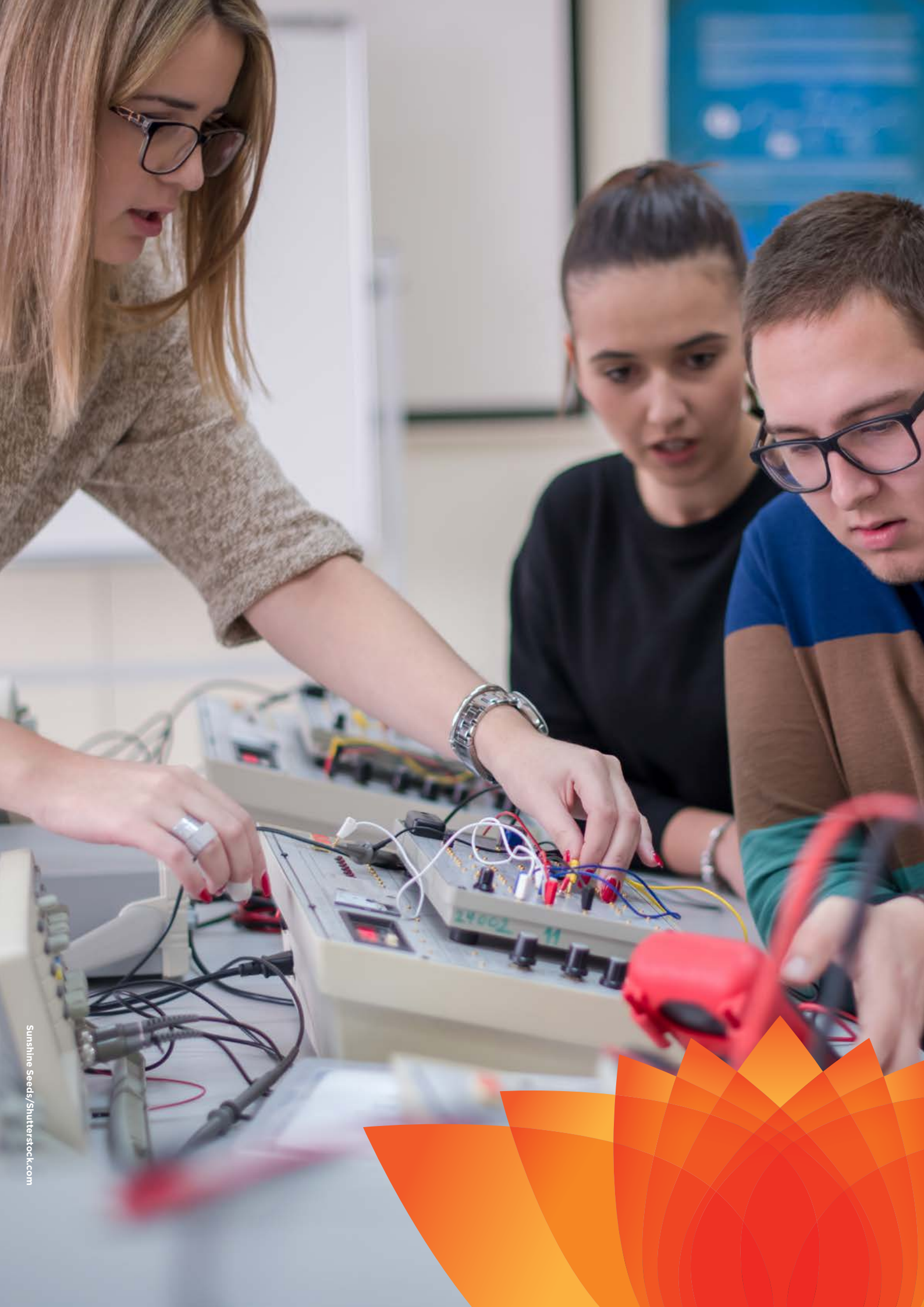
Chapter 4

Strengthening research and promoting innovation through richer collaborations in education and training

This chapter looks at promising practices in the landscape of research, development and innovation (RDI) within, and across, the G20 member countries and guest economies, to get a better sense of the modalities and impacts of higher education and multi-partner research for addressing social, economic, technological, scientific and environmental challenges. In terms of cumulative strengths, it can already be noted that the G20 countries represent some of the leading nations in terms of research capabilities and scientific publishing, and are favourable partners for other nations to seek collaboration with (Clarivate, 2023). In fact, G20 countries represent 93 per cent of global spending on RDI, employ 89 per cent of the world's researchers (UNESCO World Science Report, 2018) and publish 82 per cent of global research papers (Web of Science, 2021).

The G20 countries represent 65 per cent of world's population (World Bank, 2021). Given the multiplicity of crises the world is currently experiencing, and the longer-term push towards a 'sustainable transition to a green economy', the urgency for G20 countries to embark on a journey of systemic transformation and develop evidence-based solutions to national, regional and global challenges is evident. But today's urgent challenges are inherently complex, and transformative solutions will not emerge from individual governments, businesses or territories in isolation (European Commission, 2022).

Working together towards global common goods: Role of Higher Education Institutions

Seizing opportunities that arise in times of increased complexity and disruption will require a better alignment of actions between public actors, the private sector, foundations, non-state actors and civil society to generate the common goods associated with sustainable, greener and more inclusive models of growth. More specifically, it will require combining the latest research and knowledge from across higher education, academia and public policy institutions with the latest technical and digital know-how and innovations from the industrial

and business sectors to find solutions for all groups and sectors in society (and especially women) who are impacted by the current crises and stand to gain or lose from the transformations ahead.

In the education sector, higher education plays a key role in producing and sharing research outputs, especially for interdisciplinary work around health, engineering and technology issues related to sustainable development and system transformation. In this regard, HEIs are integral to democracy-building and social justice through greater engagement by all actors – especially at-risk and vulnerable communities, civil society and other non-state actors – in co-creating research projects (Locatelli, 2018a; Boyadjieva and Ilieva-Trichkova, 2019).

Investments in multi-partner, cross-sector collaboration

The importance of multi-partner, cross-sectoral collaboration around RDI, and of dedicated government investments in research breakthroughs targeting social, economic and health priorities, have become increasingly evident over the past years. Knowledge creation and research are critical to growing and sustaining large and vibrant economies, resolving challenges, uplifting society, and continuously inspiring countries to achieve their aspirations.

Technological breakthroughs around AI are already creating efficiencies and improvements in public-sector management and governance, transforming service delivery, widening access to public services and improving outcomes at scale. In the business and industrial sectors, multi-stakeholder collaboration between RDI clusters and higher education has enabled the application of AI to diverse supply chains and distribution practices, especially within inefficient industrial and energy markets, which is helping to reduce waste and negative externalities created by current economic models.

Perhaps most importantly, cross-sectoral RDI collaboration is saving human lives. As demonstrated during the COVID-19 crisis, joined-up research between government institutes, RDI laboratories in the pharmaceutical sector and university-led medical research teams around vaccine development and global health supported scientific breakthroughs that helped safeguard millions of people against the pandemic.

The discussions on subjects like global health, energy supply, food access and climate policy on the G20 platform can also help policy makers to 'understand the strengths and opportunities of G20 member nations during this global crisis and beyond' and ensure that the pursuit of social and economic recovery and environmental sustainability are *beneficial for all*, in line with the 2030 Agenda for Sustainable Development and with respect to the fundamental rights of all people, irrespective of any public or private origin (UNESCO, 2015, p. 77).

Focus areas for this chapter

G20 member countries possess differentiated expertise, knowledge, and financial and scientific capacities. Their experiences in developing innovative solutions can be shared as an act of solidarity with countries facing similar challenges. Importantly, the volume and collective outputs of G20 countries' research capacities suggest a leadership role for the G20 in creating new knowledge and resources to create global common goods, and generate data and evidence for policy-making. Following a brief discussion on the linkages of RDI to the three proposed accelerators and the notion of 'common goods,' the chapter addresses questions such as:

Vertical collaboration within G20 countries at national level: How are governments supporting and funding cooperative research between industry, higher education, academia, the RDI sector, public policy institutes and other actors? What kinds of policies, funding and facilitation are in place? To what extent do

these build on digital transformations to bring potential partners together? Are there any emerging trends in the types of collaboration? What sorts of incentives and support initiatives are available to encourage women's participation in RDI efforts, as well as the participation of minority, indigenous populations and other underrepresented groups?

Horizontal collaboration across higher education institutions in G20 countries: The chapter also looks at issues related to mechanisms for promoting cross-national collaboration among higher education institutions around research, including through skill transfer, joint degree programmes, academic credit bank to promote mobility and other such mechanisms.

4.1 National policies and practices supporting multi-partner RDI

The industrial sector and the business community have a particular and much publicized responsibility as an engine for systemic transformation (including a sustainable transition to a green economy) by reconfiguring their value chains and scaling solutions for net-zero emissions and environmental regeneration. Such purposes are aligned with the 2030 Agenda. In the current climate of economic and energy instability, however, they cannot take on the world's problems alone. Business, government and academia should work together to co-create context-appropriate, scalable solutions.

Such cooperation and fluidity require shifts in national RDI policy and dedicated funding mechanisms to enshrine the principles of cooperation, co-creation and mutualism among key stakeholders and provide enhanced support to higher education systems and academia. It also requires spaces for dialogue among all actors, especially those representing the interests of the most marginalized and least influential population groups in society.

Policies to support multi-partner collaboration around RDI

Several policy initiatives and strategies are underway across the G20 member countries and guest economies to incentivize and/or reduce barriers to research partnerships between governments, universities, industry and society. These policy initiatives share the following features: i) they often situate RDI at the centre of smart, sustainable and inclusive growth; and ii) they seek to create bridges between applied research, and the development and commercialization of innovative ideas and technologies.

In **India** the Government has made significant efforts to create robust research ecosystems, with several programmes to provide funding for multidisciplinary research. These include IMPacting Research INnovation and Technology (IMPRINT) which is a multi-stakeholder mission program that focuses on practical applications of scientific research through engineering invention and technical innovation for societal improvement; Ucchatar Avishkar Yojana with joint funding of projects by government and industry to promote innovation of a higher order that directly impacts the needs of the industries; Scheme for Promotion of Academic Research and Collaboration; Impactful Policy Research in Social Science (IMPRESS); Scheme for Transformational and Advanced Research in Sciences (STARS).

Countries such as **Oman, Saudi Arabia, Singapore, South Africa, the United Arab Emirates** and the **United Kingdom** have initiated national innovation systems, strategies and five-year plans to support their long-term national development visions. **Saudi Arabia's** Human Capability Development Programme supports a research and innovation investment strategy through partnerships between the private sector and private and public universities. **Singapore** leverages its five-year Research, Innovation and Enterprise (RIE) plans to

raise its competitiveness and productivity through science and technology. Singapore's RIE efforts also contribute towards national imperatives such as overcoming resource constraints (e.g. water) and mitigating the impact of climate change (e.g. extreme weather and rising sea levels). As part of the RIE2025 Plan, Singapore committed S$25 billion from 2021 to 2025. These investments will go towards enhancing basic research capabilities, strengthening the innovation capabilities of enterprises and nurturing a strong base of research and innovation talent.

In countries such as **France, Indonesia** and **the Netherlands**, national budgets earmark funds for strengthening multi-partner collaboration around research and innovation. In **the Netherlands**, for example, the Research and Science Fund will €5 billion over the next ten years for advanced research on issues relevant to the economy and society, and yielding sustainable impacts. Across countries, financing is allocated for research centres, dedicated RDI ecosystems, networks and online platforms to facilitate collaboration and research conversion across industry, academia and international partners. In order to create an investment-friendly environment and generate employment opportunities through the development and growth of high-tech industries, the **Bangladesh** Hi-Tech Park Authority has established 28 Hi-Tech Parks, Software Technology Parks, and IT Training and Incubation Centres across the country. By 2022, construction of 4 parks was completed and business activities are ongoing. Work on the remaining parks is underway.

India has also invested in the created several technology parks across the country, including in the IITs -the country's premier institution to provide infrastructure and support services to technology-intensive companies and provide a platform for technology transfer and collaboration between companies from different countries. The government has also implemented several policies and programmes to promote technology transfer, such as the Technology Transfer and Commercialization of Intellectual Property (TT&CIP) Scheme which provides financial support to technology transfer initiatives.

Meanwhile, countries such as **Argentina** are generating funding and technical support for RDI through bilateral and/or multilateral agreements. Here, the National Directorate for the Promotion of Science Policy, within the Ministry of Science, Technology and Innovation (STI) has generated joint research funding and cooperation agreements such as: the Ecos Programme with France, Latin American Centre for Biotechnology with Brazil, Uruguay and Colombia; the Argentine-German University Centre; Export Knowledge Programme, etc. The STI internationalization strategy is aligned with the following points: Scientific and technological development; Technology transfer, RDI; Strategic industrial sectors; human resources training; federal policy; gender; liaison with scientists abroad (RAICES Programme).

The **People's Republic of China** and **the Russian Federation** have created spaces for interaction between academia and the RDI sector. In the former country, the International Conference on the Cooperation and Integration of Industry, Education, Research and Application was held for the first time in 2018. The gathering contributes to scientific and technological innovation, joint cultivation of talents and the commercialization of research findings. Under the theme of "Harmonious Co-development in Industry, Academia, Research and Application", the 2022 conference explored new modes for cooperation in integration of industry, education, research and application in the post-COVID era. In the Russian Federation, the Single Digital Platform for Scientific and Scientific-Technical Interaction between Researchers, is aimed at automating the processes for fostering interaction between researchers, interdisciplinary scientific groups, customers and other parties interested in research, development and other activities to create scientific products, as well as accounting and analysis of the outcomes of these activities

Saudi Arabia is keen to support and develop the innovation and entrepreneurship system in various fields as one of the goals of Vision 2030 and to strengthen the position of the Kingdom as an attractive environment for pioneers, innovators and creators. The Human Capability Development Programme is specifically supporting the move toward digitization, the green economy and clean energy through a platform which enhances data management and partnerships in RDI. In **Indonesia**, the 'Kedaireka' platform serves as a 'matchmaking app' to help universities find prospective partners for joint projects or joint research.

Countries such as **France, India, Japan, the Netherlands** and **Singapore** offer specific financial and investment incentives and direct support to the business community to invest in research and development and adopt new technologies and to engage in RDI of interest to the common good. In **India**, several initiatives provide entrepreneurs, start-ups and small businesses with access to finance, including through the Start-up India Fund, the India Aspiration Fund, and the National Investment and Infrastructure Fund. Technology Business Incubators also support start-ups and entrepreneurs in the early stages of technology development and commercialization. These centres provide infrastructure, resources, and mentorship to help start-ups grow and succeed, and often work closely with academic institutions to provide access to research facilities and expertise.

In terms of integrating new technologies with the green energy transition, for example, the Japanese government is backing RDI efforts by various Japanese companies – even if both government and lenders are deciding which green technologies to 'back', as it is difficult to predict which technologies will become successful in both upstream and downstream supply chains.[1]

Countries also support non-financial incentives to create an enabling environment for joint research, including through the creation of innovation boards, the provision of laboratory equipment and access to databases (**Indonesia**); and open information exchanges, seminars and conferences bringing together different actors (**Japan, Saudi Arabia**). Japan has also launched a programme to support the establishment of a management system for institutional joint research between universities and private companies.

Singapore recognises that different enterprise segments have different innovation needs, and thus adopts a customized approach in supporting them to leverage cutting-edge technologies to build new products and solutions. This includes supporting multinationals to anchor a sustained RDI presence in Singapore, supporting small and medium enterprises to access RDI capabilities in the public research ecosystem, and catalysing private sector investments into deep-tech start-ups through government co-investment. In France, meanwhile, financial support includes grants, loans and equity investments in public-private RDI projects, as well as tax breaks for companies engaged in multi-partner cooperation.

Finally, measures are emerging to quantify partner participation in research production and outputs. For example, the G20 Research Performance Scorecard has introduced a Collab-CNCI indicator that measures research output by collaboration type. The Collaboration-CNCI (Collab-CNCI)[2] indicator assigns author credits from the Institute for Scientific Information for five types of collaboration, based on the author's affiliation data in the Web of Science: domestic single institution, domestic multi-institution, international bilateral, international trilateral and international quadrilateral plus. This enables a fair comparison of similar research papers and a more nuanced assessment of impacts.

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[1] Source: The nexus between DX and GX: How tech can accelerate the green energy transition. Accessed 1 April 2023

[2] For more details on Collab-CNCI, see Making it count: Research credit management in a collaborative world.

Table 19: Policies to support multi-partner collaboration around RDI

Canada: Canada Innovation Corporation

The Canada Innovation Corporation has recently been established with a budget of CAD 2.6 billion (just under USD 2 billion) over 4 years. Its aim is to drive business investment in RDI and foster economic growth. At the provincial government level, the Ontario Centre of Innovation supports the Province of Ontario in taking a leadership role in industry-academic collaborations. It accelerates the development, commercialization, and adoption of advanced technologies, thereby creating jobs and supporting the province's next generation of innovators and entrepreneurs. Similar programmes and centres exist in other Canadian provinces and territories.

The government is also collaborating with industry and academic partners to support research and innovation in digital learning. For instance, the Canadian eLearning Network (CANeLearn) is a non-profit organization that brings together educators, researchers, and industry partners to share best practices and promote the use of digital technologies in education. In specific industrial sectors, the pharmaceutical industry in Canada is also becoming more collaborative with externalized RDI, which is supported through national science organizations. This has led to the development of Centres of Excellence for Commercialization of Research, Business-led Networks of Centres of Excellence, and other innovation initiatives such as the Structural Genomics Consortium. Currently, there are 12 Canadian health research and commercialization centres that partner with private industry and academia.

European Union: Policies to support multi-partner collaboration around RDI

The European Union places significant emphasis on promoting research, development and innovation as an important Union objective laid down in Article 179 of the Treaty, which states that "[t]he Union shall have the objective of strengthening the scientific and technological bases by achieving a European research area in which researchers, scientific knowledge and technology circulate freely, and encouraging it to become more competitive, including in its industry, while promoting all the research activities deemed necessary (...)".The EU's policies aim to foster multi-partner collaborations that involve universities, research institutions, industry, and other relevant actors to drive innovation, enhance competitiveness, and address societal challenges. These policies encourage the sharing of knowledge, resources, and expertise to maximize the impact of RDI efforts. Articles 180 to 190 of the Treaty determine the activities to be carried out in that respect and the scope and implementation of the multi-annual framework programme. European Union-wide initiatives include; the 2022 RDI Framework and Roadmap adopted on 19 October 2022, State aid modernization and the revision of the RDI rules, Horizon 2020 and state aid rules. The EU has also been working to enhance the synergies between research and innovation funding through initiatives like the European Innovation Council (EIC). The EIC seeks to support breakthrough innovations by providing grants, equity investments, and other support mechanisms to startups, scale-ups, and small and medium-sized enterprises. It promotes collaborations between these innovative companies, research organizations, and investors to bring cutting-edge technologies and solutions to the market.

France: Funding to innovation

The main tool used at national level by the French government to lower entry barriers to innovation is financial support to innovative start-ups and companies. An estimated €10 billion euros is dedicated to innovation support each year, with the funding allocated in different forms including grants, loans and equity investments. The French government has also initiated several schemes to facilitate cooperation between academia and industry as a powerful way to fuel innovation and create sustainable growth. These range from support to public-private RDI projects (on different scales), to tax breaks for companies engaged in research cooperation.

India: Funding for multidisciplinary research

Certain schemes in India collectively support and foster multidisciplinary research, technological advancements, and innovation across various domains, thereby contributing to the overall growth and development of the research landscape in India. One such scheme is IMPacting Research INnovation and Technology, which focuses on the practical applications of scientific research through engineering invention and technical innovation. Another scheme is Impactful Policy Research in Social Science (IMPRESS), implemented by the Ministry of Education in collaboration with the Indian Council of Social Science Research. IMPRESS promotes research in the social sciences across 11 key domains. The Scheme for Transformational and Advanced Research in Sciences (STARS) is another initiative, conducted in partnership with the Department of Science and Technology. STARS aims to promote translational, India-centric research in six basic thrust domains. Additionally, the Scheme for Promotion of Academic Research and Collaboration encourages research collaboration with foreign institutes from 28 select countries. To incentivize young talent and foster research uptake, the Prime Minister's Research Fellowship (PMRF) and Junior Research Fellowship have been established. These fellowships provide support to young researchers and encourage their active participation in research endeavours. Another scheme, Ucchatar Avishkar Yojana, facilitates joint funding of projects by the government and industry, with the objective of promoting innovation of a higher order.

Indonesia: Kedaireka platform

Key pillars in Indonesia's research and innovation strategy are: i) the strengthening of the countries research ecosystem; ii) bringing diverse forms of knowledge and expertise together by bridging gaps between academia and industry; iii) facilitating the translation of research findings into practical applications and the commercialization of innovative ideas and technologies. To this end, funding and facilitation is provided to research centres and networks bringing together academic institutions, industry partners and government agencies. The Kedaireka platform, for example, serves as a "matchmaking app" for universities to find their prospective partners for joint-project or joint research. Selected proposals receive research grants through a matching fund programme in which every 1$ given by the industry partner to the university is matched by the government. This includes financial support such as research funding, or non-financial contributions such as laboratory equipment, access to databases and faculty exchange programmes.

Japan: Collaboration between industry and higher education

The Japanese government is working to strengthen industry-academia-government collaboration by promoting joint research between national research institutes and private companies, including through investments in corporations that take-up the outputs of national research institutes and the revised law on the revitalization of science, technology and Innovation.

Netherlands: Research and Science Fund

The Research and Science Fund is an investment of 5 billion euros over the next ten years (and a structural budget for advanced programmes and research, eventually 700 million euros per year). The focus of the fund is on long-term investments that are still effective after ten years. This includes the development of entrepreneurial talent with start-up grants, the creation of research-industry networks, research facilities and the driving of research-innovation transitions. The Netherlands further focuses on practice-oriented research and large-scale scientific infrastructure for applied research.

Oman: National Innovation System

The National Innovation System is a network of relationships boosting RDI collaboration between government, academia, and the industrial sector. There are two main strands seeking to integrate knowledge, technological development, and business creation: the National Innovation Strategy, and the National Strategy for Scientific Research and Development. One of the commitments of the National Innovation Strategy is to achieve science and technology breakthroughs, including through Research and Innovation Partnerships. Direct RDI investments to priority areas include a focus on the local economy and commercial and industrial activities and lifelong learning. Financial support to research is co-funded by the private sector (Investment Matching). Under the National Strategy for Scientific Research and Development, the Ministry of Higher Education, Research, and Innovation operates *Ejaad Programme* (or platform) to bridge gaps in the fields of applied and innovative research. The programme receives industrial challenges from the business community and industry sectors and assigns these challenges to be investigated by research teams in academic community. It also stimulates cooperation through the facilitation of private sector spending on RDI. The Omani National Innovation System is backed by political will as stated in the first royal speech delivered by His Majesty Sultan Haitham bin Tarik.

Saudi Arabia: Research and innovation partnerships, including around technology transfer and commercialization

Research and innovation partnerships aim to develop a research and Innovation investment strategy through partnerships between the private sector and private and public universities. Direct RDI investments to priority areas that address national and regional needs by focusing on the local economy and commercial and industrial activities and by providing financial support to research co-funded by the private sector (Investment Matching) and regulate the support for other research areas.

The Ministry of Education in Saudi Arabia has also introduced several programmes and initiatives to support technology transfer and commercialization. These include: i) the Entrepreneurial Professors programme which empowers university professors and faculty members to actively contribute to university curriculum in innovation and entrepreneurship, engage in business activities and launch potential projects for the commercialization of their innovations, research, patents, and intellectual property. The programme facilitates profit-sharing agreements between the faculty members and the university; ii) the Entrepreneurial University which involves enhancing existing initiatives and implementing new measures to support the development of entrepreneurial universities; iii) the Entrepreneurship Capacity Development initiative focuses on designing entrepreneurship curricula for courses to be taught in Saudi universities; iv) Public Policies for Innovation and Entrepreneurship play a crucial role in formulating general policies and procedures to activate and organize the innovation and entrepreneurship ecosystem. It collaborates closely with the Secretariat of the Universities Council to create an enabling environment for innovation and entrepreneurship.

Singapore: Research, Innovation and Enterprise initiative

Given Singapore's small size and lack of natural resources, the country has invested in the development of its science and technology capabilities through its ongoing RIE efforts, with the aim of enhancing its economic competitiveness and addressing national imperatives. This includes building a local pool of teaching and academic research talent and forging diverse university partnerships with overseas universities and top scientists globally. As part of Singapore's transition towards an innovation-driven economy, it has invested steadily to (i) increase RDI activity in enterprises, (ii) build a vibrant local start-up ecosystem, (iii) develop entrepreneurial mind sets and capabilities in researchers, and (iv) build up the translational capacity of its public research institutes. It is also strengthening technology translation platforms to enable enterprises to better tap on the science and technology capabilities of public research institutes and other innovation ecosystem players. Singapore is also forging strong international networks for local enterprises to access global and regional markets, innovation expertise and resources.

United Arab Emirates: National Strategy for Advanced Innovation

The National Strategy for Advanced Innovation is a comprehensive plan outlining the UAE's goals for innovation and research over the next decade. The strategy is designed to drive innovation and creativity across all sectors of the economy, with a focus on developing emerging technologies such as AI, robotics and the Internet of Things. To achieve these goals, the strategy includes a range of initiatives and incentives, including increased domestic investment in RDI, expanded partnerships with national and international institutions and organizations, and the establishment of innovation hubs and centres and the development of a skilled and knowledgeable workforce. The UAE's Research and Development Governance Policy also provides a framework for managing and coordinating RDI activities. The policy is designed to promote collaboration between government, industry, and academia, with a focus on developing innovative solutions to societal challenges.

United Kingdom: Integrated Review, Innovation Strategy & Education Endowment Foundation (EEF)

The Integrated Review (2021) sets out the vision for the United Kingdom in 2030, putting science and technology at the centre of the UK's overarching national and international strategy. One aim of the review is to secure the UK's status as a Science and Tech Superpower by 2030 by enhancing domestic investment in RDI, especially during later stages of RDI, driving tech adoption, creating opportunities for UK talent to thrive within the UK system, and bolstering the global network of innovation partnerships.

The UK Innovation Strategy (2023) sets out the government's vision to make the UK a global hub of innovation by 2035, and includes the four following pillars: 1.Unleashing businesses through fuelling businesses who want to innovate; 2.People, making the UK the most exciting place for innovation talent; 3.Institution and places – ensuring the UK's research, development and innovation institutions serve the needs of businesses and places across the UK; four. Missions & Technologies – Stimulating innovation to tackle major challenges faced by the UK and the world and drive capability in key technologies.

The Education Endowment Foundation (EEF) is an independent charity that aims to support teachers and senior leaders in raising the attainment of disadvantaged pupils, by funding high quality research to improve teaching and learning in schools, nurseries and colleges. It was set up in 2011 through an upfront £125 million grant from the Government. Its main aim is to build a high-quality evidence base on "what works" in education practice and support schools, colleges and early years providers to access and effectively mobilise this evidence to raise attainment of disadvantaged 2-19 year olds.

Support for higher education participation in RDI clusters and technology transfer

Governments are supporting universities in strengthening collaboration and reciprocal relationships with government, business and industrial sectors, and within RDI clusters, with the aim of bridging applied research gaps and stimulating the commercialization of academic research outputs and breakthroughs. Diverse types of cooperative relationships are emerging with reciprocal benefits.

For example, when the business sector communicates its commercial and industrial challenges to the higher education sector, it taps into the scientific and technological capabilities already built up in countries' private and public universities. It is also stimulating opportunities for cross-sector pollination of ideas, including the conversion of applied research outputs into policy and product innovations.

At the same time, when the world's leading businesses and industry activate their considerable RDI capacities (and operational know-how) to achieve breakthroughs in the energy, manufacturing, health and education sectors, they are supporting the development of innovative and cutting-edge solutions for current and future problems, identifying new opportunities for investment and scaling, and accelerating learning. In both cases, partners initiate and advance work together around issues of common interest, and pursue scientific and technology breakthroughs that support the common good.

In **India**, higher education institutes are encouraged to be a part of science and technology clusters to increase collaboration between all stakeholders involved in research ecosystems. Innovation Councils and IDEA (Idea Development, Evaluation and Application) Labs have been established in HEIs to systematically foster the culture of innovation and start up ecosystem at the college/university level. In order to make research journals, periodicals and other research material accessible for all, there are schemes like E-Shodh Sindhu, One Nation One subscription Research Information and Management System (RIMS). In **Saudi Arabia**, the Ministry of Education has launched many programmes and initiatives supporting technology transfer and commercialization, including the Institutional Funding Programme, Sustainable Partnerships, Entrepreneurship University and Entrepreneur Professor.

In **Oman**, the Ministry of Higher Education, Research and Innovation operates the 'Ejaad programme' (or platform) to bridge gaps in applied and innovative research. Under the programme, universities receive industrial challenges from industry sectors, and dedicated research teams are supported in investigating these issues.

In **Singapore**, universities work closely with: (i) public-sector agencies (e.g. with the Public Utilities Board on the Coastal Protection and Flood Management Research Programme), and (ii) industry partners (e.g. through corporate laboratories such as the Cisco-NUS Accelerated Digital Economy Corporate Laboratory), enabling them to leverage the scientific and technological capabilities built up in universities to develop new products, while universities and research institutes achieve impact by developing cutting-edge solutions for problems faced by the industry. In **Spain**, the Ministry of Universities is promoting the Industrial Doctorates to develop research projects closer to the industries.

Table 20: Support to the higher education sector in research and technology transfer

Indonesia: Unbundling higher education to allow for cross-sectoral collaboration between universities and industry

The country's innovation strategy supports universities in unbundling higher education to allow for cross-sectoral collaboration between universities and industry. To this end, the country has encouraged university/private sector collaboration around five national priority research areas: the green economy, blue economy, tourism, digital technology, and medical equipment and technology.

Japan: matching support for joint university/private sector research

The Ministry of Education, Culture, Sports, Science and Technology provides support to facilitate collaborative research between universities and the private sector, with the aim of transferring technology to industry. Additionally, MEXT offers a programme to assist universities in establishing management systems for institutional collaboration. The government is actively planning to offer flexible and sustained support for the restructuring of motivated universities and colleges of technology, commonly known as 'KOSEN,' focusing on growth areas such as digital and green technologies. This initiative aims to foster highly specialized human resources capable of leading these fields. To invigorate science, technology, and innovation in these domains, it is crucial to incorporate diverse perspectives and outstanding ideas, making the active involvement of female researchers indispensable. Support for female researchers is not limited to the context of the reorganization of universities and 'KOSEN', but is essential to revitalizing the science and technology field as a whole. Furthermore, MEXT organizes seminars and information sessions on emerging technologies, providing a platform for academic researchers to showcase their work to private companies. Additionally, events are held to encourage collaboration among industry, academia, and government, fostering a conducive environment for knowledge exchange.

Singapore: Cambridge Centre for Advanced Research and Education in Singapore (CARES) and NTUitive

The National Research Foundation partners universities from several G20 countries to set up research centres in the Campus for Research Excellence and Technological Enterprise (CREATE). One example of a research centre is the Cambridge Centre for Advanced Research and Education in Singapore (CARES), which brings together researchers from the University of Cambridge, National University of Singapore (NUS) and Nanyang Technological University (NTU). CARES and NTUitive, the innovation and enterprise company of the Nanyang Technological University, are collaborating on a project, Accelerated, Manufacturing Platform for Engineered Nanomaterials (AMPLE), that develops both software and hardware infrastructure supporting higher efficiencies and productivity of nanomaterials. The technologies will be scaled up in an automated factory adopting Industry 4.0 practices. Compared to conventional technologies, the AMPLE approach is expected to be over 100 times more efficient, significantly reducing experimental workload and improve nanomaterial quality. This enables businesses to rapidly innovate nanomaterial-based products with fewer polluting manufacturing processes. During the project, a Singapore-based spin-off is expected to be created to exploit the emerging technology for the benefit of Singapore and beyond.

Nurturing research and entrepreneurship talent

To cultivate innovative leaders of future science and technology, the **People's Republic of China** launched the Academy of Future Technologies in May 2020, and announced the first batch of 12 academies in May 2021. These academies stand at the frontier of technological change, targeting strategic fields that are vital to future innovation and cultivating leading talent with the foresight and ability to shape trends in science and technology.

In **France**, the "Industrial Contract for Training through Research" (CIFRE) scheme allows companies to develop an R&D project through the association of a company, a PhD student and a research laboratory, which supervises the student's PhD. The CIFRE scheme therefore supports PhD students working in a public-private partnership. The objective is to encourage the development of public-private partnership research and to place doctoral students in employment conditions. The company recruits a Master's level graduate to whom it entrusts a research mission. The work will be the subject of the thesis of the employee-doctorate. The academic research laboratory supervises the work of the employee-doctoral researcher, and as such the latter is registered in the doctoral school to which the laboratory is attached.

In **Germany**, the Alexander von Humboldt Foundation provides grants and fellowships to researchers. The government also supports the German Academic Exchange Service (DAAD), which provides grants and scholarships for promoting the mobility of students and young researchers.

In **India**, schemes such as the Prime Minister's Research Fellowship attract young talent towards research. Candidates are provided with fellowship stipend ranging from INR 70,000 to INR 80,000 (approximately USD 100) per month across five years. Atal Innovation Mission (AIM) is Government of India's flagship initiative to create and promote a culture of innovation in schools and an ecosystem of entrepreneurship in universities, research institutions, private and MSME sector. It works through Atal Tinkering Labs in schools and Atal Incubation Centres in universities, institutions and corporates.

The **Japan** Society for the Promotion of Science provides fellowships for researchers at all levels. The government also supports the Japan Student Services Organization, which provides scholarships for international students studying in Japan. The Social Sciences and Humanities Research Council in **Canada** provides funding for research in the social sciences and humanities, while the Natural Sciences and Engineering Research Council provides funding for research in the natural sciences and engineering. The government also supports the Canada Research Chairs programme, which funds research positions at Canadian universities.

The "University Start-ups" initiative in **Saudi Arabia** aims to foster an environment conducive to successful entrepreneurship across all sectors. It seeks to encourage and empower individuals and groups to transform their ideas into leading and successful projects. This initiative achieves its goals by integrating the existing efforts of various entities within the entrepreneurship ecosystem and fostering increased coordination with educational and training institutions. The initiative encompasses all stages of the entrepreneurship journey, starting from instilling an entrepreneurial culture and creating a conducive environment, to establishing and supporting the growth of start-ups and preparing them for success. It aims to enhance the general population's awareness of available entrepreneurship opportunities and nurture promising emerging ideas, ultimately fostering the development of nationally successful projects.

The **United States**, the National Science Foundation (NSF) funds partnerships between academic institutions and other organizations to broaden participation in STEM fields among underrepresented groups. The National Science Foundation's ADVANCE programme in particular supports colleges and universities and professional societies in creating policies and practices that promote equity and inclusion that leads to systemic

organizational change and gender equity in STEM fields. The NSF was established by Congress, in part, to promote the progress of science and fulfils its mission chiefly by making grants. Its investments account for about 25 per cent of federal support to America's colleges and universities for basic research. The Fulbright Programme, led by the United States government in partnership with more than 160 countries worldwide, also offers international educational and cultural exchange programs for passionate and accomplished students, scholars, artists, teachers, and professionals of all backgrounds to study, teach, or pursue important research and professional projects.

Countries also support and empower aspiring entrepreneurs to create and develop their early-stage ventures. In **Singapore**, strong innovation and entrepreneurship support is provided within the Institutes of Higher Learning to empower aspiring entrepreneurs in the creation and development of early-stage ventures. Entrepreneurship support includes training programmes and masterclasses, makerspace facilities, start-up incubators, industry partnerships and overseas exchanges with global innovation hubs. Start-up hubs, such as LaunchPads by JTC Corporation, foster vibrant start-up ecosystems that allow entrepreneurs to research and test-bed new innovations, as well as gain access to corporate and investor members to tap into their resources, knowledge and expertise.

Table 21: Support for academic research and entrepreneurship talent

France: BpiFrance

HEIs provide (future) business creators with dedicated training, combining technical and business-oriented courses to help them develop more mature products and more sophisticated business plans for their ventures. Meanwhile, under the supervision of several ministries, BpiFrance is charged with implementing a dedicated scheme (i-PhD) for PhD candidates/ young laureates, with the objective of supporting their project of creating a start-up based on the results of their research.

India: Atal Innovation Mission

AIM is the scheme to promote innovation and entrepreneurship at the school and college/university levels. Under AIM, 69 Atal Incubation Centres have been set up in universities and institutions which provide world-class technology, mentorship, funding support, partnerships, and lab facilities to budding start-ups More than 2900 start-ups have been supported by these AICs of which 900+ start-ups are led by women and have created 30000+ jobs in the ecosystem. Atal Community Innovation Centres are serving Unserved and Under-Served regions of India. In schools AIM has launched the Atal Tinkering Lab (ATL) program. ATL is a state-of-the-art space established in a school with a goal to foster curiosity and innovation in young minds. Over 10,000 ATL have been set up in the country with over 2 million students using them.

Saudi Arabia: Various initiatives to support the goals of Vision 2030

To enhance the Kingdom's position as an attractive environment for pioneers, innovators, and creators, a significant effort has been made to integrate entrepreneurship courses into the curriculum of over 80 per cent of Saudi universities. This has been made possible through the establishment of 47 innovation and entrepreneurship centres across the country's universities. As a result, Saudi Arabia has attained global recognition for its excellence in entrepreneurship, as evidenced by its top ranking among G20 countries in terms of entrepreneurs' response to the Corona pandemic and the government's handling of the crisis when compared to 45 other nations. Additionally, the Kingdom ranks second in terms of the number of start-ups and third in youth entrepreneurship activity.

The Kingdom is also actively implementing the "Developing Entrepreneurship Capabilities in Higher Education Programs" initiative. This initiative focuses on creating specialized educational materials for entrepreneurship in areas such as financial technologies and educational technologies, drawing upon global experiences. Moreover, it aims to strengthen partnerships between universities, colleges, and departments with local start-ups, providing students with practical and experiential learning opportunities in relevant fields. Additionally, the initiative aims to develop general materials that equip graduates of university programs with the necessary skills to establish their own businesses, fostering a culture of entrepreneurship.

United Arab Emirates: National Strategy for Higher Education 2030

Launched in 2017 by Ministry of Education, the National Strategy for Higher Education 2030 aims to develop and achieve the highest scientific and professional education standards to serve the UAE's future generations. The strategy seeks to provide future generations with the necessary technical and practical skills to drive the economy in both public and private sectors.

4.2 National and cross-border support to strengthen higher education RDI capacity

The global response to the COVID-19 pandemic demonstrated the societal benefits that can be reaped through cross-border collaboration and open sharing of scientific knowledge and research. The commitment of G20 countries to open science was evident in the 2021 Declaration of G20 Ministers on Leveraging Research, Higher Education and Digitalisation for a Strong, Sustainable, Resilient and Inclusive Recovery, signed during the Italian Presidency. Today, global and national universities across the G20 collaborate and participate actively in the pooling of scientific resources across academic units and institutions, sharing knowledge through their academic and professional networks.

Open science and open education support the democratization of knowledge by increasing access to information for all through free online content, databases and research results that facilitate the acquisition and dissemination of knowledge to a broader part of the population. The UNESCO Recommendation on Open Science, adopted in 2021, and the UNESCO Recommendation on Open Educational Resources, adopted in 2019, represent frameworks and guidance for collaboration.

Strengthening RDI capacities within higher education institutions

Across the G20 countries, support mechanisms are growing to strengthen RDI capacities within universities and institutes of higher education, and to drive university-led innovation. Schemes include subsidies for the set-up of RDI cells on campus to support faculty-student research collaborations, to ensure academia-industry linkages, and to promote inter-HEI collaboration. Guidelines facilitate the work of faculty leaders in gathering the enabling infrastructure and organizational capacities needed for faculty and students to work together on different types of research. Meanwhile, indicators have even been developed to identify high-performing Higher Education Institutions and rank them based on indicators related to innovation and entrepreneurship development.

The **Australian** Government announced six Trailblazer Universities to work with industry partners in creating innovation ecosystems that support the translation and commercialisation of university research. This will help build world-leading research commercialisation capabilities in priority areas. To achieve these ambitious objectives, the Trailblazer Universities will implement targeted reforms that reduce barriers to collaboration with industry.

In **India**, a National Research Foundation is being established as recommended under National Education Policy 2020, to provide a reliable base of merit based and equitable peer-reviewed research funding, and helping to develop a culture of research in the country through suitable incentives. The establishment of Institution Innovation Cells (IICs) in most HEIs systematically fosters a culture of innovation through lecture series, national innovation contests, mentor-mentee programmes, as well as the creation of a National Innovation Repository known as YUKTI.

The Ministry of Higher Education, Research and Innovation in **Oman** has established the Strategic Research Programme to support and fund research projects that address national priority challenges and provide scientific and practical solutions aligned with sustainable development goals. Key objectives include increasing the number of researchers, promoting research excellence, building national research capacity, fostering collaboration among stakeholders (government, academia, and the private sector), and contributing to the development of a knowledge-based economy.

One of the mandates of the Innovation Communities of the **European Institute of Innovation and Technology (EIT)** is to strengthen the innovation capacity of higher education. EIT operates in various fields such as climate, digitization, renewable energies, health, sustainable materials, food, manufacturing, urban mobility, culture, and creativity. It supports higher education institutions in teaching innovation and entrepreneurship, building their capacities, and developing concrete actions to increase their impact. The EIT also equips universities with the necessary tools to promote innovation throughout their campuses and beyond.

Table 22: Strengthening RDI capacities within higher education institutes

India: National Research Foundation

The National Research Foundation is being established as recommended under National Education Policy 2020, to provide a reliable base of merit based and equitable peer-reviewed research funding, and helping to develop a culture of research in the country through suitable incentives. The NRF will competitively fund research in all disciplines across the academic landscape – from subjects such as Medicine, Physics, Sustainable Farming, Artificial Intelligence, and Nanoscience to Education, Sociology, Archaeology, Art History, and Literature. NRF will also help seed centres of research in select disciplines at various universities, through providing institutional funding. will also act as a liaison between researchers, Central and State governmental bodies, and industry, helping to ensure that the most urgent national issues of the day (e.g., clean water, sanitation, clean energy) are well-studied by researchers, and that the latest research breakthroughs are implemented for the public good through policy in an efficient manner.

Oman: Strategic Research Policy Network Operation (Strategic Research Programme)

The programme functions as a platform for announcing research topics, receiving proposals, and ensuring adherence to high-quality standards and objectives. It primarily benefits academia, higher education institutions, and industry partners, focusing on PhD-level researchers, while the programme's outcomes can contribute to informing public policies and legislation by providing valuable recommendations to decision-makers. Currently, it supports 48 academia members and 10 government institutions. Funding allocation depends on submitted proposals, with a maximum of 50,000 OMR (approximately 129,872.88 USD) per project. The electronic system, RIMs, facilitates result dissemination to stakeholders, beneficiaries, and researchers. Projects run for two years. Government institutions have shown significant interest, seeking scientific research approaches to address challenges instead of relying solely on traditional methods.

Diversifying supply chains or channels for research dissemination

The availability of research findings to support public- and private-sector collaboration, expedite fast-track solutions for ongoing or new policy challenges and take advantage of emerging opportunities is crucial. In different G20 countries, investments are being made in expanding dissemination channels, including 'open access' to peer-reviewed research and more agile methods for repackaging research in easier-to-digest formats for decision-makers.

In **India**, the E- Shodh Sindhu platform merges three consortia initiatives of the Ministry of Education (namely UGC-INFONET Digital Library Consortium, NLIST and INDEST-AICTE Consortium) to provide current and archival access to more than 10,000 core and peer-reviewed journals, and a number of bibliographic, citation and factual databases in different disciplines from a large number of publishers and aggregators to its member institutions. These include centrally-funded technical institutions, universities and colleges that are covered under 12(B) and 2(f) Sections of the UGC Act.

Countries such as **South Africa** have contributed to global knowledge production through initiatives such as the Research Outputs Policy (2015), which provides a framework for evaluating and allocating subsidies to research outputs (publications) produced by the country's public universities. To further strengthen research productivity in the higher education sector, the Policy on the Evaluations of Creative Outputs and Innovations produced by Public Higher Education Institutions (2017) recognizes an array of disciplines, patents and plant breeders' rights. The implementation of such policies enhances research productivity in recognized fields, paving the way for universities to think creatively about innovation in higher education.

More generally across the G20 countries, open access research publication, where the author or funder pays for research dissemination instead of the reader, or university libraries paid for by journal subscriptions, are on the rise in response to demands from research funders, including governments. In **India**, the Ministry of Education has also announced a One Nation One Subscription initiative through which all citizens can have open access to national and international journal publications and research papers from April 1, 2024.

Equitable access to research and innovation opportunities

As the Indian G20 Presidency has underlined, effective education, training and research systems, where opportunities are equally distributed (especially for women), form the basis for sustainable development and the construction of fair, peaceful and democratic societies. Inadequate or insufficient research systems also contribute to gender inequality and social inequities.

Regional blocs and countries have introduced affirmative policies and initiatives that demonstrate their commitment to promoting equitable access to research and innovation opportunities, and fostering a more inclusive and thriving scientific community. In **Brazil**, the government has implemented several programmes to promote access to research opportunities for underrepresented groups. The Science Without Borders programme provides funding for Brazilian students to study and conduct research abroad, while the Quotas programme reserves a percentage of university admission spots for students from low-income families, Indigenous communities and Afro-Brazilian communities.

With a specific focus on increasing women's take-up of roles in the RDI field and academia, **Canada** has undertaken consultations to examine barriers to accessing research opportunities for women in science and underrepresented groups (e.g. Indigenous Peoples, minorities and people with disabilities). The Natural Sciences and Engineering Research Council's Equity, Diversity, and Inclusion (EDI) Action Plan lays out programmes and initiatives such as the Chair for Women in Science and Engineering, which supports women in STEM fields, and the Dimensions programme, which encourages universities and colleges to address systemic barriers to EDI.

In **India**, the Knowledge Involvement in Research Advancement through Nurturing (KIRAN) is a fellowship scheme offered to women in science and engineering domains. Female researchers are offered research grants for a period of 3 years which includes operational expenses. The Council for Scientific and Industrial Research (CSIR) provides an upper age relaxation of 5 years to women to enable them to pursue doctoral and postdoctoral research. The IIT Madras has launched a mentor-mentee programme for female PhD scholars where they are connected with alumni working in similar domains who provide both emotional and professional support to these scholars.

Countries have also introduced instruments to stimulate or facilitate the demand side. This includes scholarships and grants to help women and disadvantaged groups pursue higher education degrees in research and technology (**India, Indonesia**); and foster research skills for academics from minority population groups and

increase the attractiveness of STEM fields for women and learners of school age **(European Union)**. For example, the Travel Grant Scheme from the All-India Council for Technical Education (AICTE) in India sponsors up to Rs 1.5 Lakh for travel to students/researchers/faculty presenting research papers at international conferences/symposiums/workshops.

The **United Arab Emirates** hosted the Women's Economic Empowerment Global Summit, which brings together women leaders and experts from around the world to discuss issues related to women's economic empowerment.

Table 23: Equitable access to research opportunities

European Union: Supporting STEM graduates and fostering entrepreneurial and transversal skills
Increasing STEM graduates and fostering entrepreneurial and transversal skills is one of the objectives of the European Skills Agenda. The programmes are reflected in the EU's competences framework which sets three dimensions and eight agreed areas of competence including mathematics, science, technology and engineering alongside literacy, multilingualism, digital, personal/social, citizenship and cultural awareness and expression. An eighth competence group is considered vital: i.e., entrepreneurial skills. This link between STEM disciplines and entrepreneurial skills is important: many of the techniques used to successfully launch new businesses are the same as those learned in STEM fields: a willingness to experiment, a reliance on logic and evidence and a focus on creative problem-solving.
The European Union particularly encourages skills training for girls and women in digital and EU STEM-related areas in cooperation with European Institute of Technology and Knowledge and Innovation Communities. Several programmes are currently funded including: 1) Girls Go Circular; 2) Entrepreneurship, Science, Technology, Engineering, Arts and Mathematics (ESTEAM) Project 'Enhancing the digital and entrepreneurial competences of girls and women.' In 2021, the first women and girls in STEM Forum was organized with over 500 participants (28 October 2021). The aim was to reach an additional 10,000 girls in 10 countries by the end of 2022. So far in 2022, 5.308 users have completed the programme of which 3.370 girls. The second Women and Girls in STEM Forum took place on 26 October 2022. The first ESTEAM Girls and Women Fests were organized in May and June 2022 in Belgium.

Indonesia: Addressing women and disadvantage groups under-representation in research and innovation

In Indonesia, the government works to ensure that women and disadvantaged groups have equitable access to research and innovation opportunities. One such initiative is implemented through the Bandung Institute of Technology, in which the university has created a Women's Innovation and Entrepreneurship Centre providing resources, training, mentorship, and networking opportunities to women entrepreneurs, researchers and innovators in STEM fields. The STEMpreneur Programme also provides training and resources to women entrepreneurs in STEM fields, while the Indonesian Young Scientists Network offers training, mentorship, and networking opportunities to young scientists, including women and the disadvantaged groups. In addition, scholarships and grants are available for women and the disadvantaged groups to pursue higher education degrees in research and technology. The Indonesian government provides scholarships for women to pursue doctoral degrees in STEM fields, while the L'Oréal-UNESCO for Women in Science Programme offers fellowships and grants to female researchers in Indonesia to support their research projects.

United Arab Emirates: Women's Economic Empowerment Global Summit

The UAE recognizes the critical role of women in digital and green transformations. The country has developed a range of policies and initiatives to support and encourage women's participation in the innovation ecosystem. For example, the UAE has established the Women's Economic Empowerment Global Summit, which brings together women leaders and experts from around the world to discuss issues related to women's economic empowerment. Additionally, the country has established the Dubai Women's Business Council and the Abu Dhabi Businesswomen Council, which provide support and resources for women entrepreneurs.

Most colleges, institutes, centres also offer scholarship programmes and grants to students and researchers. For instance: Emirates Nuclear Energy Corporation offers scholarships; Federal Authority for Nuclear Regulation offers education and training; Mohammed Bin Rashid Space Centre offers Entaliq Scholarship Programme; ICT Fund (within the TRA) offers scholarship and funding for education and RDI; UAE Space Agency offers educational programmes and scholarships; The Ministry of Education's research grants / collaborative research grants.

Opportunities for cross-country research, cooperation and collaboration in higher education

International collaboration between universities in G20 countries is an increasingly common trait of academic research and has grown considerably since the 1980s (Adams, 2013).[3] Closer cooperation between leading HEIs across G20 countries is supporting the production of global common goods. The ease of accessing student and academic capacities across countries also helps fill the global talent supply chain for future research and international collaborations.

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[3] Source: Annual G20 Scorecard of research performance for 2022.

In **India**, the Global Initiative of Academic Networks (GIAN) is aimed at tapping the international talent pool of scientists and entrepreneurs to encourage their engagement with national Higher Education Institutes to augment the country's existing academic resources, accelerate the pace of quality reform, and elevate India's scientific and technological capacity to global excellence. VAJRA (Visiting Advanced Joint Research Faculty) is a dedicated programme exclusively for overseas scientists and academicians with emphasis on non-resident Indians and Persons of Indian Origin/Overseas Citizens to work as adjunct/visiting faculty for a specific period of time in Indian public-funded academic and research institutions.

India is also involved in joint activities to promote technology transfer and collaboration. For example, the **United States-India** Science and Technology Endowment Fund promotes joint research and development initiatives in science and technology. The Scheme for Promotion of Academic Research and Collaboration (SPARC) is another research collaboration between Indian universities and top-ranked foreign HEIs or research institutes. Approximately 392 proposals have been approved till date. India is also using the mechanism of joint Hackathons where students from India come together with international students to develop innovative solutions for increasing long-term resilience of our planet Several international hackathons have been organized, like India-Singapore, India-Australia, UNESCO India-Africa in which students from more than 20 African countries participated for problem solving under key themes such as water and others.

In **Japan**, the Virtual Campus is an online platform that allows universities inside and outside of Japan to share educational resources, with the objective of enhancing the international competitiveness of Japanese universities. In **Singapore**, The National Research Foundation partners universities from several G20 countries to set up research centres in the Campus for Research Excellence and Technological Enterprise (CREATE). One example of a research centre is the Cambridge Centre for Advanced Research and Education in Singapore (CARES), which brings together researchers from the University of Cambridge, National University of Singapore (NUS) and Nanyang Technological University (NTU).

Countries have also implemented various initiatives to reduce barriers to cross-institutional research within higher education, including fellowship programmes and other incentives (India and Türkiye), joint degree programmes (**Canada, France and Indonesia**), collaborative funding with partner countries (Germany and Brazil) and research mentoring and peer skill training (Indonesia and United Kingdom). In India, guidelines have also been released to hire distinguished experts in their professional fields with proven expertise for at least 15 years in a senior role as professors.

In **Türkiye**, an International Fellowship for Outstanding Researchers Programme and International Fellowship for Early Stage Researchers Programme aim to support qualified researchers/young researchers under the age of 40, particularly Turkish scientists operating at top level scientific and/or technological achievements in their fields and with experience to work in an international environment. The aim is for them to conduct their research in Türkiye in leading state or foundation universities, public research infrastructures deemed competent within the scope of Law no. 6550, private sector companies with RDI or design centres or equity companies settled in Türkiye within the bodies of techno parks.

Finally, the **European Universities Initiative** has two flagship initiatives which promote cross-national cooperation between HEIs around RDI. These include: i) the European Universities Alliances which aims to create transnational alliances of higher education institutions across Europe that collaborate on education, research, innovation, and societal engagement, and; ii) the European Network for Teaching Excellence in Higher Education: This initiative aims to support the professional development of higher education teachers by providing training and resources on innovative teaching practices and pedagogies.

Certain G20 countries have also established bilateral agreements to promote joint degree programmes and academic mobility, such as the **Joint Declaration on Germany-Japan Cooperation in Higher Education and Research** signed in 2019 between Germany and Japan. Joint degree programmes enable students to study at multiple institutions and gain exposure to different academic cultures, research environments and industry partnerships. This can help reduce barriers to innovation by promoting cross-disciplinary collaboration and the sharing of educational resources through credit and certification processes. India has brought out Regulations for Joint/ Dual/ Twinning Degree programmes with foreign universities with the objective of promoting collaboration between them.

One of the most well-known is the **Erasmus+ Programme, a flagship of the European Universities Initiative**, which supports mobility and cooperation between universities across Europe by providing funding for student and staff exchanges, joint degree programmes, and capacity building projects. To further facilitate joint degrees and student mobility, countries have introduced academic banks of credits or systems allowing students to accumulate credits from multiple institutions and transfer them between programmes.

Table 24: Opportunities for cross-country research and collaboration in higher education

Brazil: Partnership with the German government
The Ministry of Education in Brazil has established a partnership with the German government in the development of policies focused on research, innovation, and employment prospects, especially in sectors of the green economy and sustainability, as well as in the areas of bio-economics, energy, and digitalization.

Canada: Work-integrated learning opportunities and professional skills training
Domestic and international collaboration provides opportunities through work-integrated learning opportunities and professional skills training for postsecondary students, postdoctoral fellows, and recent graduates. For instance, short-term work permit exemptions for researchers to exit and re-enter Canada help support the in-person collaboration aspects of international partnerships. This is coupled with Canada's exchange scholarships to create new opportunities and to further encourage development of professional competencies in industry and research institutions in Canada and abroad.

India: Multiple instruments for enhancing international collaboration

SPARC (Scheme for Promotion of Academic and Research Collaboration) - Research collaboration with top-ranked foreign institutes from 28 select countries helps in transfer of knowledge, infrastructure and technological capabilities between institutes and nations to develop intellectual property in emerging areas of technology.

GIAN and VAJRA are schemes under which international faculty, scientists and experts come and teach in Indian institutions. Regulations have been put in place to enable Indian institutions to enter into Joint/ Dual/ Twinning Degrees arrangements with international institutions. International Hackathons encourage the spirit of innovative problem solving and collaboration across countries in the youth.

Indonesia: Cooperation with the University of Warwick (U.K.)

Scientists from Indonesia have received training at the University of Warwick, UK, to develop and analyse materials that can help exploit abundant biomass as a source of energy and useful industrial chemicals. Academics in Indonesia and the UK collaborated on a project to train scientists from Indonesia in the advanced techniques needed to support efforts to find environmentally friendly energy sources and new routes to commercially useful chemicals.

Mauritius: Hubert Curien project

The country promotes academic and research linkages between local and international universities, specifically for early career researchers and exclusively for women researchers. Initiatives, like *Hubert Curien project*, co-financed by the Government of Mauritius and Government of France, allow for inter-country collaboration in the field of research, co-financed by the Government. Financial incentives and academic writing training have been put in place to enhance the publication of research and patenting to improve the global ranking of Mauritius, and the ranking of public universities in world ranking lists.

Singapore: CREATE

CREATE: CREATE was established by the National Research Foundation in 2006 to increase the vibrancy and diversity of Singapore's RDI ecosystem. It is an international research campus of institutional partnerships with leading academic institutions. Currently, researchers from 9 partner universities are co-located in CREATE, and collaborate with Singapore's universities on 14 interdisciplinary research programmes. By bringing together international research talent to work on projects of important scientific, societal and economic importance, CREATE represents a unique model for research collaboration. Research at CREATE is highly interdisciplinary, and addresses large and important problems, especially those that are best conducted in or from Singapore. CREATE enables effective and coherent collaborations for challenges to be addressed at a scale that enables them to achieve greater impact, and to provide solutions and options both for Singapore and internationally.

Türkiye: Scholarship Programme

The Scholarship Programme Scholarship Programme has been implemented since 2012. In the scope of this programme Turkish universities accepts students at Bachelor, Master and Doctorate level and researchers for research programmes from other countries. Turkish Government pays monthly allowance, accommodation, health service, language course and international transportation. Currently there are about 15.000 scholars that are studying in Turkish Universities.

4.3 Conclusions

Within the G20 countries, governments and regional blocs have encouraged increasing levels of research investment to drive national competitiveness and address the need for innovations that support green economies and digital transformation strategies, in line with the SDGs. Higher education holds an important place at the crossroads of education, research and innovation, serving society and the economy. In today's climate of uncertainty, disruption and rapid technological change, a rethinking of the role and contribution of universities to finding solutions to global energy, health and socio-economic challenges is clearly needed. The potential of trans border cooperation also needs to be explored.

Today, transformational change is still frequently hampered by fragmented research and innovation policy capacities. Higher education/academia, businesses and non-state actors that are making technological and scientific breakthroughs often work in silos, separately navigating a multitude of government agencies with different expertise and mandates. To move forward at greater speed, countries must encourage the alignment of all potential research and innovation partners with capacities to advance circular and regenerative economy solutions, greener value chains and scalable solutions. Countries' support for consolidated RDI capacities should go hand-in-hand with the stimulation of captive demand for such breakthroughs.

The growing role of RDI, and particularly of higher education in this landscape, requires much greater attention and investments from decision-makers. This is all the more urgent as policy briefs from regional groupings suggest that public-sector decision-making and processes are still largely out of sync with the speed of change needed to develop sustainable social and economic models, new employment markets with advanced capacities and the sustainable transition to a green economy in many countries.

To achieve such objectives, decision-makers should act to improve platforms for collaboration between countries' RDI capabilities, and the research capacities embedded in their universities and higher education systems. This may require customized approaches tailored to the country context, with considerations framed within a broader review of governance and policy frameworks, infrastructure, incentive structures and competencies for RDI.

Governance of RDI by disruptive and system-changing actors: A review of governance should start with decisions on appropriate policy instruments and objectives for creating RDI collaborations between the higher education sector, tertiary education, business and industry. Governments should also consider options for widening dialogue and permanent coordination with higher education institutions, RDI clusters and knowledge-production centres, also improving vertical and horizontal coherence by encouraging action at all levels of government and through international standards.

Infrastructure: The infrastructure for expanding cooperation between universities, academia, RDI clusters and the private sector, and linking university research outputs to real-world applications, also needs to be reviewed. This could entail: i) greater funding agility (i.e. the ability to quickly allocate and reallocate budgets and other resources) to allow a quick response as promising research and solutions requiring deeper investments emerge, and circumstances change; and ii) increased public funding for portfolios of early- and mid-stage RDI initiatives that take informed risks and offer transformative options for large scale, systemic change.

Higher education institutions should be encouraged to collaborate internationally on RDI so that they can jointly develop sustainable solutions to common problems.
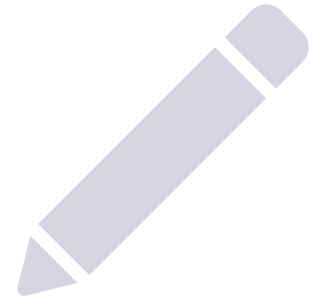
Chapter 5

Lessons learned and recommendations

Based on the country practices and analysis in this report, lessons and examples of promising practices are emerging across the G2O community that could help peer learning, knowledge-sharing and collaboration. Lessons are broadly applicable to all countries, irrespective of their development status or current performance in lifelong learning. With further development, they could eventually enable G20 countries to collaborate even more closely to design initiatives that scale up each other's best practices across the four priority areas addressed in this report. Overall, addressing the lessons and scaling best practices requires more, better and smarter investments in education and training. There is a need to augment and mobilize investments in human capital, backed by continued and sustained action to broaden the resource base for such investments. Strengthened national and international solidarity, as well as cross sector and multistakeholder partnerships, can widen horizons and ultimately produce education-led solutions to global challenges.

5.1 Foundational literacy and numeracy in the context of blended learning

As country examples show, the G20 community has the capacity to lead a global commitment to enhance investments in children's foundational learning (literacy, numeracy and socio-emotional skills). Many countries have recognized that foundational learning is the critical building block for successful education, employment and lifelong learning, without which children and adults will be unable to realize their full potential throughout life and to participate productively in society.

This recognition is accompanied by concrete financial and institutional commitments to increasing access to affordable, equitable and quality early learning that is safe, gender-sensitive and inclusive. The enrolment and retention in schools of all learners, especially the most vulnerable, has become a priority. To this end, countries are putting in place the necessary supports to remove barriers to learning and ensure children's health, nutritional and socio-emotional well-being and their holistic development, while recognizing the valuable role of parents, community and other workers in ECEC in this regard.

The country practices also highlight the need to prepare teachers for rapidly shifting learning environments, and their central role in ensuring better foundational learning. Greater investments are being made in continuous professional development opportunities, with special attention paid to their initial training, including capacities for supporting innovative teaching-learning processes and digital upskilling.

Notwithstanding this progress, reducing gaps in foundational learning in the foreseeable future requires considerably quicker progress – and at scale – than has occurred so far, along with political commitments that translate into sustained change in the classroom. In the G20 Education Ministers' Declaration in 2019, countries recognized the importance of early childhood education and called for 'policies that ensure access to and quality of ECEC programmes'. The declaration also acknowledged the need for workforce development and training for ECEC practitioners.

The Commitment to Action on Foundational Learning, one of seven global initiatives launched at the UN Secretary-General's Transforming Education Summit held in September 2022, also suggests a framework for accelerating progress toward SDG4 targets in every country. The commitment calls on governments and the rest of the global education community to prioritize foundational learning, especially for the most marginalized children, including girls. To date, 23 countries and over 30 organizations have signed up.

Although progress has been made, it is still not sufficient if governments are to meet their 2015 commitment to SDG target 4.2, 'ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education' by 2030.

Across the diverse G20 membership, countries will chart their own path to ensure that all learners are ready for learning now and acquire various skill sets to make them 'future-ready'. As a membership group, however, the G20 countries can play a crucial role in sharing their experiences and promising practices to steer conversations and initiatives at the global, regional and national levels. The UNESCO UIS,[1] which collects and disseminates data on education and literacy worldwide, can also support G20 countries with data collection on foundational learning, alongside existing national mechanisms for this purpose.

5.2 Making tech-enabled learning more inclusive, qualitative and collaborative

The diverse examples in this report demonstrate the potential of digital technologies to provide inclusive, equitable, accessible and quality education and training, and to complement face-to-face education. They also emphasize the importance of overcoming digital divides by developing affordable and easily accessible technology ecosystems and learning resources, including in local languages.

Recognizing that rural and remote geographical areas are often underserved by public education infrastructure and resources, and that many vulnerable and at-risk learners have limited access to computers, the internet and mobile phones at home, countries' efforts to ensure equitable and inclusive digitized education for all have been accompanied by investments in digital infrastructure, devices and learning contents. Standardized frameworks for developing educational curricula, contents and pedagogy, as well as effective mechanisms for assessing learning outcomes, are also emerging. Open educational resources are growing, and digital resources are increasingly interoperable.

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[1] The UIS works closely with G20 member countries to improve the quality and availability of data on education and literacy, and ensure these data are used to inform policy decisions and improve education outcomes.

The goal is to increase opportunities for all learners to acquire necessary digital skills, while also ensuring their privacy, protection and safety in digital environments. To this end, investments in the capacities and culture of the education workforce (including education managers, teachers and trainers) to ensure the coordination and safe stewardship of tech-enabled learning are growing. Finally, while the benefits of data and analytics in education should be leveraged, ethical practices in the use of digital technologies in education are vital to all G20 countries' efforts to support inclusive and equitable education systems.

Looking ahead, the G20 EdWG may explore sharing information on successes and challenges of the impact of digital technologies within education systems, particularly in relation to rapid advances in generative AI. However, more information and documentation of country experiences is needed to understand how governments are achieving an affordable digital transformation and overcoming challenges, especially in their attempts to enhance connectivity, support and access to affordable data in underserved and remote areas, where many learners from low-income families and communities struggle to access online and other forms of blended learning.

Facilitating cooperation and knowledge sharing across G20 countries through policy learning is a way to support countries to address the challenges facing the education ecosystem in the 21st century. A Global Public Digital Platform Repository (GPDPR) that identifies exemplary PDPs of G20 member countries may accelerate the process of cooperation for digital transformation. Emerging areas of potential collaboration, in accordance with the extant policies of member countries, might include identifying and sharing norms of tech-enabled learning, quality standards of digital learning platforms, education resources and assessment tools. Other areas could include creating and maintaining a G20 gateway to existing strategies and policy documents for digital transformation of education employed by G20 countries, which could provide information about transformational tech-enabled education programmes, building on previous G20 compendiums. Lastly, areas to explore could include identifying and sharing nationally recognized digital education platforms and resources, within a lifelong learning perspective, raising awareness of cybersecurity issues, and promoting the ethical use of digital technology.

5.3 Building capacities, promoting lifelong learning in the context of future of work

Many G20 countries have taken up the challenge of transforming education and training systems to endow learners with the skills required for life, society and emerging labour markets. Learners of all ages are being supported in acquiring digital and environmental literacy; financial, cognitive and citizenship skills; and science, technology, engineering, arts and mathematics competencies to prepare them for a technology-based future, and a just and inclusive transition to an environmentally sustainable economy and society. Countries are acknowledging the impact of AI on teaching and learning and making efforts to adopt holistic approaches to ensure the equitable and inclusive use of AI in education and skilling.

Education and training sites are increasingly emphasizing flexible, evolving career and lifelong pathways founded on skilling, reskilling and upskilling. Equitable access to training opportunities is especially important for vulnerable and underrepresented groups, and efforts are being made to expand postsecondary education and access to high-quality TVET opportunities, including digital learning environments that effectively answer the needs of the labour market and society.

In this section, special attention is being paid to the transition between academic and vocational education and training, where many people may be unsure of which pathway to take. Recognizing prior learning,

proposing alternative credentials and accrediting skills, work experiences and knowledge throughout life and beyond formal education is also paramount here.

As global challenges require global solutions, cooperation at the international and regional levels is becoming increasingly vital. G20 members will need to implement a strategic, coordinated, and cross-sectoral approach to lifelong learning within and across countries, including through comparative assessments and common frameworks at all appropriate levels (local, subnational, national, regional and international).

This report recognizes the work on skill frameworks and competencies undertaken under previous G20 presidencies, and the revised G20 Skills Strategy developed under the Indonesian Presidency. When it comes to promoting VET and measuring the outcomes of initial VET programmes internationally, the OECD's International Vocational Education and Training Assessment (commonly referred to as PISA-VET) can also make a significant global contribution, along with other national programmes and mechanisms developed by countries for this purpose.

Looking ahead, G20 countries may consider working together on initiatives supporting the future of work within a lifelong learning perspective. Such initiatives for consideration might include:

1. Further sharing of best practices in developing micro-credentials recognizing different types of skill acquisition and training, irrespective of where and when these are acquired. This could build on important documentary work already undertaken by the OECD and UNESCO (OECD, 2021, 2021, 2023; Van der Hijden and Martin, 2023). UNESCO, for instance, has published a report entitled *Micro-credentials and Quality Assurance: A Literature Review* (UNESCO, 2020), which explores the opportunities and challenges of micro-credentials, in addition to their quality assurance.

2. Exploring the potential for comparable standards for the presentation, credentialing and quality assurance of skill assessments. These might build on references and standards already available at the global level, including the International Classification of Education, the International Standard Classification of Occupations and national Regulated Qualifications Frameworks (RQFs) developed by countries or regions to standardize and organize qualifications based on their level of difficulty and achievement. RQFs provide a structure for understanding and comparing qualifications within a particular education or training system. Guiding principles governing the quality assurance of assessment and recognition of skills might also build on the UNESCO/OECD Guidelines on Quality Provision in Cross-border Higher Education.

3. Looking at best practices in national learning management systems offering digitized credentials. One example is the National Open Badge, a European Social Fund project coordinated by the Oulu University of Applied Sciences (Finland) to develop a nationwide open badge constellation, which enables the verification of adults' problem-solving skills in technology-rich environments by identifying and recognizing competencies acquired outside the formal education system (OECD, 2023). The open badges created by the project will be piloted within different target groups in VET and adult education, including preparatory training for VET, integration training for migrants, adult student basic skill development and upper secondary VET.

4. Looking at best practices in advanced technologies for the recognition of skills and competencies across borders. Digital technology increasingly supports the credentialing ecosystem through credentialing platforms, interoperable technologies, AI, blockchain and data analytics. Some countries are looking into creating unique IDs for learners and teachers in order to manage student transfers between schools both

within and across countries, as well as trace resources and track service delivery. Examples include the EU Student eCard, which aims to create a digital student card that will facilitate mobility and access to academic and administrative services for students across Europe.

5. Looking closer at issues related to the interoperability of credential databases (including privacy and security) that would allow employers, education and training providers, and governments to collaborate more closely to verify and validate data on skills and credentials. When systems are interoperable, data on skills and qualifications can be linked to other data, including on learning and validation opportunities, labour markets and job vacancies, and integrated into guidance, counselling and other tools and services to support lifelong learning pathways. The eventual development of a network could facilitate a global infrastructure for quality control and fraud prevention which on the one hand, offers workers and learners more data privacy and mobility, and on the other hand, offers employers and educational institutions more transparency and confidence in the value and legitimacy of foreign-earned credentials.

5.4 Strengthening research and promoting innovation through richer collaborations

The challenges the world faces today require multi-sectoral responses, interdisciplinary research and coordinated efforts among countries. The country examples in this report show that governments are moving towards the integration of their higher education, research and innovation capacities as part of their efforts to achieve a sustainable transition to a green economy, Industry 5.0 and inclusive growth.

Policy initiatives and strategies are underway across the G20 member countries and guest economies to promote inter-sectoral vertical collaboration by reducing barriers to research partnerships between governments, universities, industry and society. A variety of modalities are deployed, including online matching platforms and monetary investments, shared facilities within research hubs and techno-parks, and industrial placements and doctoral programmes. These policy initiatives often share the following features: i) they situate RDI at the centre of smart, sustainable and inclusive growth; and ii) they seek to create bridges between applied research and the development and commercialization of innovative ideas and technologies.

Higher education institutions across G20 member and invited countries are also increasingly collaborating and facilitating joint academic and research initiatives. These include developing joint, dual and twinning degree programmes; encouraging the mobility of students, faculty and staff; encouraging the wider dissemination of scholarly knowledge and research outputs; and sharing evidence and resources among educational institutions.

In 2019, UNESCO's Member States adopted the Global Convention on the Recognition of Qualifications concerning Higher Education, a unique international instrument that entered into force in March 2023. Together with the regional recognition conventions, this instrument can provide a guideline and frame of action to facilitate the mobility of students, researchers and teachers, with the goal of kindling a productive, fair, agile and timely exchange of knowledge and skills.

More regular opportunities are needed to foster an exchange of ideas around vertical and horizontal collaboration between higher education and industry, and explore how such collaboration is contributing to the scientific breakthroughs needed to address societal challenges. Proposals to this end might consider some of the recommendations in the UNESCO report on Knowledge-driven actions: Transforming higher

education for global sustainability. The various initiatives from G20 and invited countries discussed in this report can also provide valuable learning and guidance concerning the way forward.

Legal frameworks will play an important role in enabling and supporting alliances between universities engaged in RDI across G2O countries by providing a clear legal basis for collaborations, protecting intellectual property rights, and facilitating the exchange of knowledge and expertise. Lessons can already be learned from the European Universities initiative. The initiative is supported by the **European Union's** legal framework for higher education and research, including the Bologna Process, which sets common standards and guidelines for European higher education, and a unified and open European Research Area.

Many countries also have their own legal frameworks, laws or regulations supporting university alliances and collaborations in RDI. These frameworks usually cover governance issues related to intellectual property rights, research partnerships and funding for joint projects. In the **United States**, for example, the Bayh-Dole Act of 1980 provides a legal framework for universities to retain ownership of intellectual property resulting from federally funded research, and to license it to industry partners.

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