DIGITAL DEVELOPMENT PARTNERSHIP

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UNLEASHING THE POWER OF EDUCATIONAL TECHNOLOGY IN TVET SYSTEMS

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ABOUT THE DIGITAL DEVELOPMENT PARTNERSHIP

This report is supported by the Digital Development Partnership (DDP), administered by the World Bank Group. DDP offers a platform for digital innovation and development financing, bringing public and private sector partners together to advance digital solutions and drive digital transformation in developing countries.

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ACKNOWLEDGMENTS

The report was produced jointly by a team comprised of staff from the IFC's Disruptive Technologies unit, the World Bank's Digital Development Global Practice (GP), the Education GP's EdTech team, and the Education and Social Protection and Jobs GPs' Skills Global Solutions Group (GSG), with financial support from the Digital Development Partnership multi-donor trust fund.

The report was developed under the overall guidance of Edward Hsu and Davide Strusani. The report was prepared by Iain Bain, Neil Butcher, Anselm Dannecker, Sarah Hoosen, and Mohini Baijnath and supported by Merridy Wilson-Strydom and Wen Kang Chow. The authors also received guidance from an advisory panel composed of Shannon Atkeson, Edward Hsu, Victoria Levin, Davide Strusani, Alex Twinomugisha, and Michael Weber. The report benefited from review and feedback from Diego Angel-Urdinola, Ramtin Amin, Samia Melhem, William Sonneborn, Harry Moroz, Inés Rodríguez Caillava, and Robert Hawkins.

Appreciations are extended to Rikki Campbell Ogden for composition and design, and Matt Benjamin, the editor of the report.

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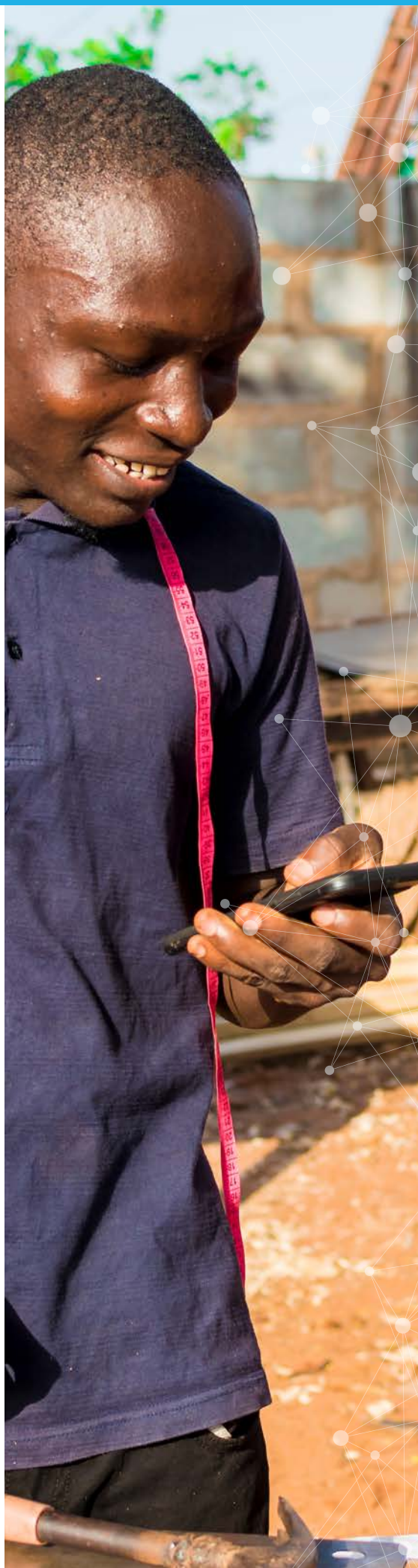


FIGURES, TABLES, AND BOXES

ABBREVIATIONS AND ACRONYMS

4IR	Fourth Industrial Revolution
ADB	Asian Development Bank
AI	Artificial Intelligence
AQF	Australian Qualifications Framework
AR	Augmented Reality
AVR	Augmented and Virtual Reality
B2B	Business-to-Business
B2C	Business-to-Consumer
B2G	Business to Government
CAL	Computer Assisted Learning
CAQDAS	Computer-Assisted Qualitative Data Analysis Software
CC	Creative Commons
CEDEFOP	European Centre for the Development of Vocational Training Co-operation and Development
COL	Critical Occupations List
COL	Critical Occupations List
CPD	Continuing Professional Development
CSI	Corporate Social Investment Initiatives
CSIR	The Council for Scientific and Industrial Research
CSR	Corporate Social Responsibility
E&S	Environmental and Social
EAfA	European Alliance for Apprenticeships
EASTRIP	East Africa Skills for Transformation and Regional Integration Project
EDTECH	Educational Technology
EMIS	Education Management Information Systems
EMs	Emerging Markets
EQAVET	European Quality Assurance Reference Framework for Vocational Education and Training
ETF	European Training Foundation
ETTI	Educational Technology Tax Incentive
GER	Gross Enrollment Rate
ICDL	International Computer Driving License
ICT	Information and Communications Technology
IFC	International Finance Corporation
ILO	International Labor Organization
IMAILE	Innovative Methods for Awards Procedures of ICT Learning in Europe
IP	Intellectual Property
IPP	Innovative Public Procurement
IT	Information Technology
KENET	Kenya Education Network
KIOSC	The Knox Innovation, Opportunity and Sustainability Centre
KRIVET	Korea Research Institute for Vocational Education and Training
KSP	Knowledge Sharing Platform
LEA	Learning Technology Accelerator
LMICs	Low-to-Middle-Income Countries
LMIS	Labor Market Information System
M&E	Monitoring and Evaluation
MIS	Management Information Systems
MOE	Ministry of Education
MOOCs	Massive Open Online Courses
MORA	Ministry of Religious Affairs
NAMCOL	Namibian College of Open Learning
NC	National Certificate
NORRAG	Northern Policy Research Review and Advisory Network
NQF	National Qualifications Framework
NREN	National Research and Education Network
NSDC	National Skills Development Council
NSP	National Skills Passport
NVQ	National Vocational Qualification
OECD	Organisation for Economic
OER	Open Educational Resources
OLEI	Online Lifelong Education Institute
OPM	Online Program Management
PCP	Pre-commercial Procurement
PPL/A	Public Procurement law or Act
PPP	Public-Private Partnership
QA	Quality Assurance
R&D	Research and Development
RFP	Request for Proposal
RFQ	Request for Quotation
RPL	Recognition of Prior Learning
SACPO	South African College Principals Organization
SDC	Swiss Agency for Development and Cooperation
SDGs	Sustainable Development Goals
SENESCYT	Secretariat of Higher Education, Science, Technology, and Innovation
SFEC	SkillsFuture Enterprise Credit
SLCM	Student Life Cycle Management
SMEs	Small and Medium Enterprises
SSG	SkillsFuture Singapore
STEP	Smart Training Education Platform
TCO	Total Cost of Ownership
TESDA	Technical Education and Skills Development Authority
TORs	Terms of Reference
TTIs	Technical and Technological Institutes
TVET	Technical and Vocational Education and Training
UAE	United Arab Emirates
UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States
US$	United States Dollar
VC	Venture Capital
VR	Virtual Reality
WB	World Bank
WBG	World Bank Group
WIL	Work Integrated Learning

Note: All dollar amounts are U.S. dollars unless otherwise indicated

KEY MESSAGES

- EdTech is now an essential feature of a well-developed national technical and vocational education and training (TVET) system, put into the spotlight by the COVID-19 pandemic.
- EdTech is transforming how people engage with learning, enabling people to access, and companies to seek, both learning and work opportunities removed from the physical location of the institution or company.
- EdTech also offers new ways to customize the learning experience, such as advancements in data analytics and using artificial intelligence (AI) to support continuous skills development and lifelong career and learning pathways.
- EdTech is driving enhanced skill recognition and transferability across markets by fostering closer collaboration between learners, institutions, employers, and government.
- Companies that do not embrace EdTech will not attract the best talent. TVET institutions that do not integrate EdTech will not attract learners. Learners who do not use EdTech will miss out on the best education and employment outcomes.
- EdTech models offer the potential for low-capacity emerging markets to integrate global standard learning from developed markets into their national TVET.
- Scalable EdTech solutions can play a critical role in supporting national TVET in emerging markets by overcoming capacity constraints and meeting the unmet demand for services.
- Private sector EdTech products have the potential to close skills gaps within emerging markets through different channels and business models, but will require government to work in partnership with private EdTech companies to truly unlock its potential.
- Private sector and government have an incentive to work together to deliver EdTech solutions. EdTech models cannot flourish if the digital infrastructure and enabling environment that underpin a digital ecosystem don't exist. Meaning, there is common cause for private sector and government to pursue EdTech solutions that solve substantial societal problems.

EXECUTIVE SUMMARY

SCOPE OF THE REPORT

This report explores the opportunities presented by Educational Technology (EdTech) for technical and vocational education and training (TVET) systems around the world, with particular emphasis on developing countries. EdTech for TVET is a relatively new area that focuses on the intersection of technology and TVET. As such, it is an area that it not yet supported by in-depth research and literature. This report seeks to further an understanding of the role of EdTech in transforming the TVET system. It focuses on emerging EdTech trends and the opportunities for both the private sector and government to capitalize on using EdTech to support education and employment outcomes. The report goes beyond the formal definition and role of TVET and considers the broader technical skills landscape—that is, any educational offering that supports technical skills and employability.

The report discusses how digitization is transforming the role of EdTech in TVET and skills development, though a discussion of specific digital technologies is outside of the report's scope. Further description of specific technologies and how they change skills needs can be found in ILO (2020), *The Digitization of TVET and Skills Systems*.

The report does not explore management and administrative functions of TVET, as technology associated with these functions may not necessarily be specifically relevant to education only (for example, it may have applications in other business settings). Rather, it focuses on functions related to curriculum development and teaching, learning, matching, and assessment processes.

Additionally, as the report focuses on the opportunities for EdTech to support systemic TVET outcomes, it also examines opportunities to support more accessible and affordable TVET outcomes. However, the report does not seek to provide detailed analysis of how EdTech can support specific challenges affecting inclusive access. It does, however, include a dedicated review of procurement models and policy levers for governments to consider when seeking to catalyze greater use of EdTech in TVET.

INTRODUCTION

In the age of the fourth industrial revolution (4IR), skills adaptability, upskilling, and reskilling will become critical attributes for workers and job seekers alike. The 4IR is characterized by increasingly blurred lines between the physical, biological, and virtual worlds, which will usher in unprecedented scientific and technological advances.[1] A core element of this is the use of disruptive technologies, which are continually emerging and changing economic development paths. The pace of disruption is increasing, which means that new skills are constantly required to adapt to a changing environment. This is changing both how traditional markets are operating and the skills that will enable workers to stay relevant and benefit from the 4IR, as well as the methods through which workers learn and gain these new skills.

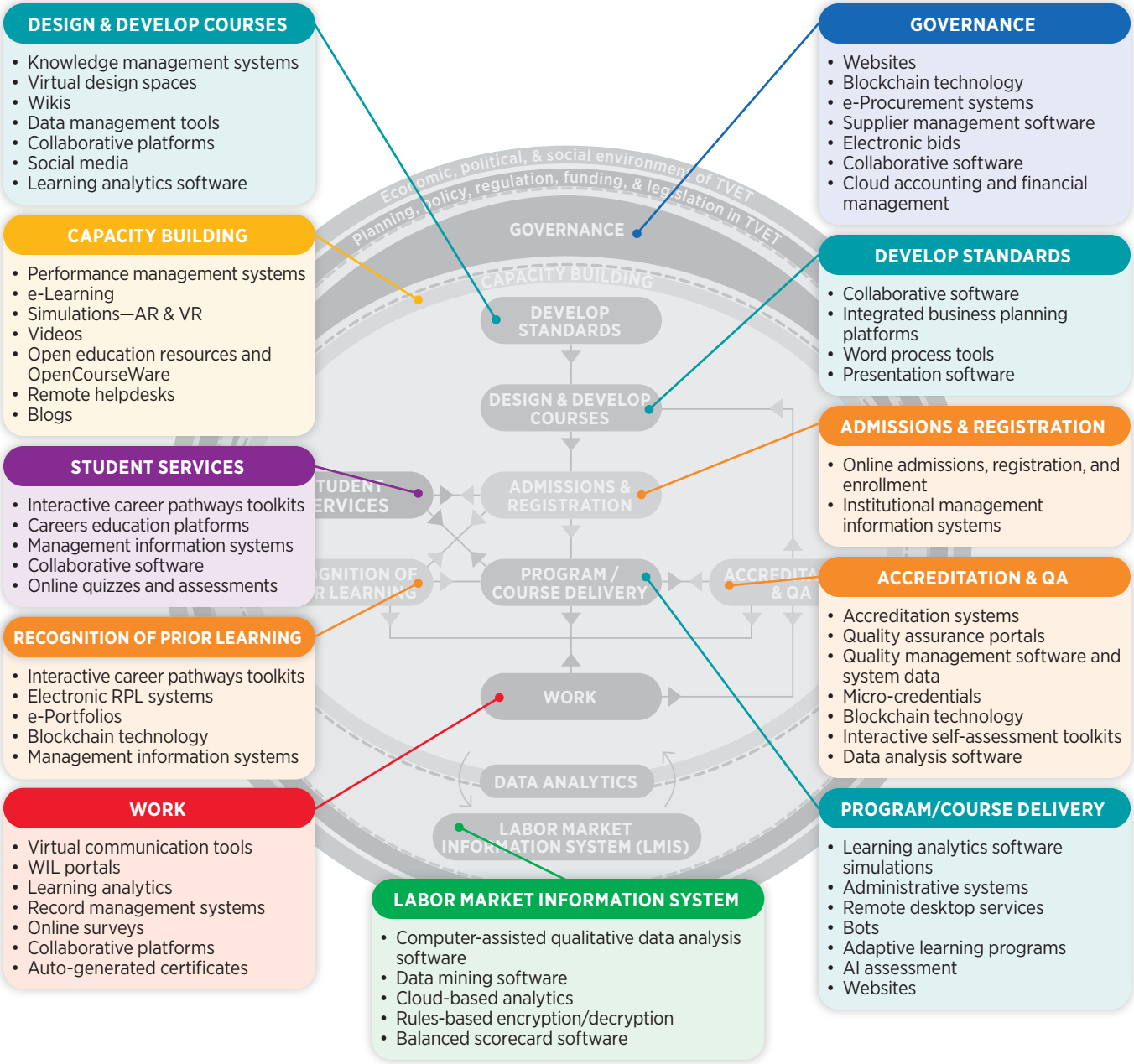
The COVID-19 pandemic has accelerated the need for new digital learning models and the digital skills required to access them. It has rapidly accelerated the digital economy and caused substantial disruption to supply chains and job markets. There have been significant shifts in industry structures and functions, resulting in

[1] World Economic Forum. no date. "Fourth Industrial Revolution." https://www.weforum.org/focus/fourth-industrial-revolution

cyclical and structural unemployment and changing the prospects for job seekers and workers in emerging markets. The crisis has also highlighted the importance of digital skills, as remote work and remote learning have become more prevalent.

Against this background, technology-led solutions are emerging in the technical and vocational education and training (TVET) space that can support this transition and lead to a rapid diffusion of skills. These solutions also have the potential to improve access, relevance, and quality compared with traditional TVET methods. Yet there is limited knowledge of what these solutions may entail, the funding available to develop them, their impacts on education outcomes and jobs, and the policy levers and procurement mechanisms that governments can put in place to accelerate their development and deployment.

FIGURE E.1 Technology deployment in TVET systems



Innovative EdTech business models offer a potential game-changing disruption to traditional TVET systems and will support the sector's ability to expand access. EdTech was initially developed as a series of niche products to supplement traditional educational methods (i.e., adding computers to traditional programs). However, as internet and mobile connectivity has expanded, it has evolved quickly as a disruptive force that can provide affordable, skill-specific training and skills development options to augment and sometimes replace traditional offerings. EdTech can operate across the entire learner lifecycle, and examples can now be found at every point of the learning journey, in both formal and informal education settings. This ranges from platforms to support discovery of educational opportunities, new ways of generating content and experiencing learning, and software to support management and administrative processes of education institutions through the delivery, assessment, and credentialing of learning on the pathway to employment. Figure 1 illustrates potential roles of EdTech for each core function of the TVET system.

VOCATIONAL EDTECH TRENDS AND BUSINESS MODELS IN EMERGING MARKETS

Key global trends are shaping the lives of people both within and across countries, which can be categorized across three broad areas:

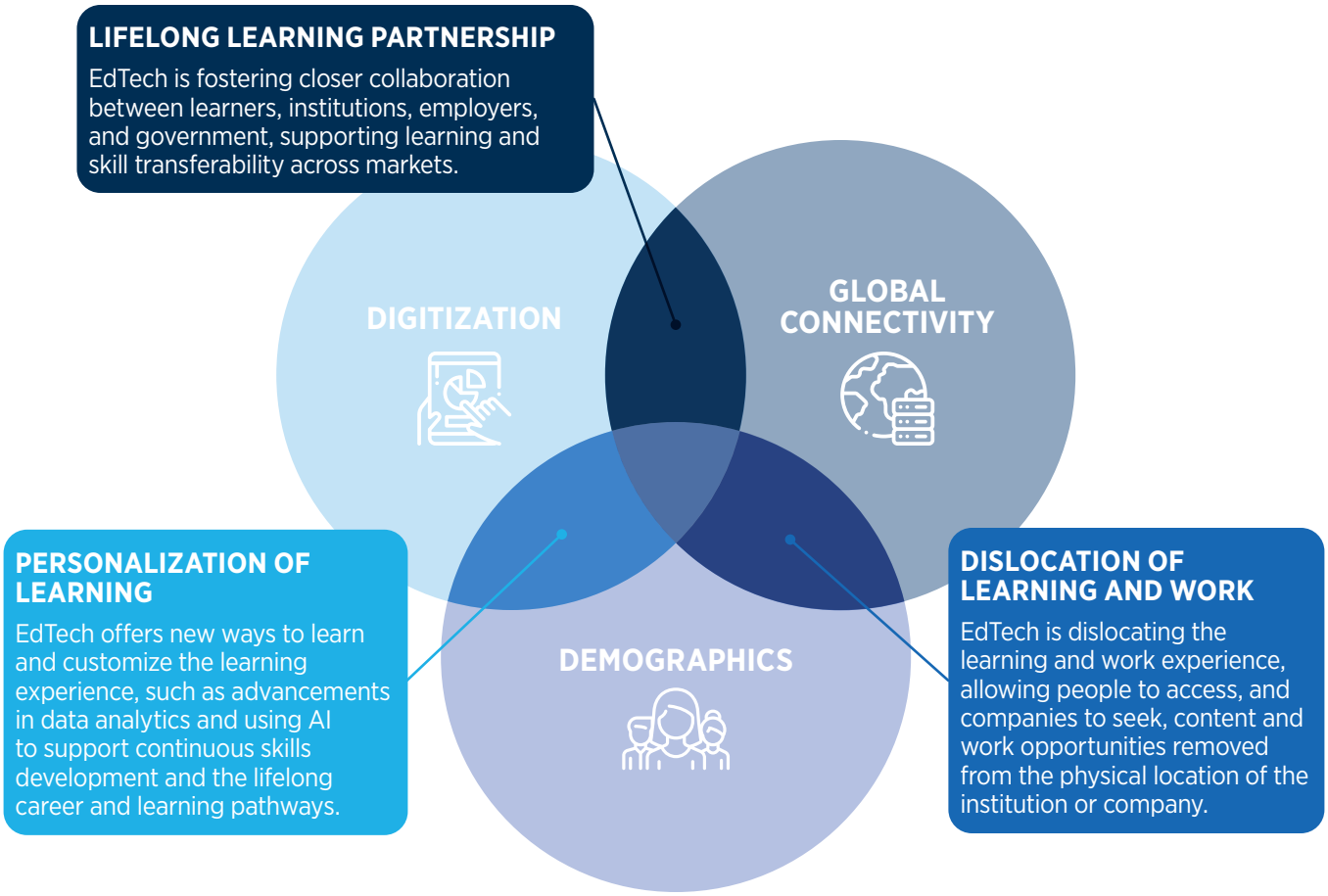
1. **Demographics:** People will enter the TVET system at both younger and older ages, so systems will need to incorporate multigenerational learning needs.
2. **Global Connectivity:** TVET systems will need to cater to, and compete in, both local and global markets.
3. **Digitization:** Various technology-led solutions are emerging in the TVET space that can support this transition and lead to a rapid diffusion of a variety of skills.

TVET is being shaped by these global trends, and EdTech could enable the TVET sector to keep pace and expand its role as a critical link in equipping emerging market populations with 4IR-ready job skills, as illustrated in Figure 2.

Dislocation of learning and work: EdTech is allowing people to access, and companies to seek, both learning and work opportunities that are removed from the physical location of the institution or company. It is allowing dislocation along three mutually reinforcing fronts: (i) dislocation between the physical location of the learner and the training provider; (ii) dislocation between the physical location of the training provider and the source of the content they can offer; and (iii) dislocation between the employer and the employee at whom the learning or skills development is targeted. For example, online platforms are enabling learners to access global standard courses through EdTech platforms such as Coursera and Springboard, and enabling training providers to license top-tier content to augment their in-house offerings. Similarly, talent can potentially work remotely for a company, opening new possibilities and leveling the playing field between employer and talent. However, these dislocated models can only be made possible through EdTech offerings that connect learners and institutions with global standard content that provides relevant and necessary skills to compete in regional or global job markets. This is particularly relevant for emerging markets that may not have capacity to provide high quality training, as they can draw on third-party content and services through EdTech platforms.

Personalization of learning: EdTech also offers new ways to learn and customize the learning experience, such as advancements in data analytics and using artificial intelligence (AI) to support continuous skills development and lifelong career and learning pathways. As the pace of digital transformation of traditional industries accelerates, there is significant interest and investment in new

FIGURE E.2 The intersection of trends shaping vocational education



digital technologies for TVET due to increasing demand from employers. Approaches such as simulation-based learning (including VR and AR), flipped classroom learning through open educational resources (OER), plug-and-play learning, conversational AI, adaptive learning, robotics, blockchain, and gamification, among others, can enhance the learning experience and make learning more flexible, particularly where access to face-to-face learning is challenging (as has been the case with the COVID-19 pandemic). These techniques are being used extensively in EdTech to analyze learning differences and automatically adjust coursework to a student's best style of learning. For instance, language learning platforms such as Duolingo capture every interaction the learner makes with the application and use AI to gamify and incentivize progression. Integration of data and AI is also extending into integration of learning with talent management and recruitment services as companies such as SMRT.bio and eightfold.ai deconstruct traditional interview-based recruitment to develop data-based skills needs and talent profiles to better match talent to the skills needs of companies.

Lifelong learning partnerships: EdTech is fostering closer collaboration between learners, institutions, employers, and government, supporting learning and skill recognition and transferability across markets. Increasingly, employers want to minimize disruption in the workforce and seamlessly integrate training options to workflows as required. This is driving demand for top-up skills development that is short and flexible enough to manage alongside work, and of recognizable quality to be transferrable across employers. EdTech solutions such as Crehana

and Linkedin's Lynda meet these needs by changing the traditional course-based learning model and promoting the use of micro-credentials that focus on specific skills. Offerings through recognizable EdTech providers and/or companies may also allow these micro-credentials to be branded and used to provide recognition of skills development beyond the employer that provided the training. EdTech also offers new ways for governments to facilitate educational outcomes and support economic objectives. For example, by using AI and real-time data collection on EdTech platforms, training can be more closely aligned to skills needs, which can lead to higher incomes for learners and result in greater tax revenue for government.

Venture Capital (VC) investing is driving the rapid growth of EdTech. In 2010, VC investment in EdTech was around $500 million. By 2020, this had surged to around $16 billion (it doubled in 2020 alone). This trend is expected to continue, with around $15 billion already recorded by Q3 2021, and there are now 27 EdTech unicorns around the world that have collectively raised over $16 billion of total funding in the last decade and are now collectively valued at $80 billion.[2] While these figures include EdTech funding across a spectrum of EdTech services beyond TVET, they underscore the dramatic acceleration of a trend toward integrating EdTech into the education market and the opportunity for the private sector to support this transition.

Yet EdTech is still relatively nascent in emerging market TVET systems. In some emerging markets such as India and China, EdTech is rapidly expanding. But there is substantial room to support further growth across all emerging markets. Given the critical role of education in powering growth and inclusion, supporting EdTech providers to adapt and offer services in emerging markets will assist in solving some of the most acute global education issues. Judicious investments in EdTech solutions can respond to changing conditions both by enhancing traditional TVET delivery models and creating new services that are currently unavailable to emerging market populations. These solutions can reduce the role of intermediaries, improve price transparency, and expand the reach of services. In markets where investees grow rapidly and become sizeable market players, innovation at scale can generate large impacts on sector competitiveness by pushing traditional players to innovate, including by introducing digital solutions, improving their offerings, and reducing traditional incumbents' market share.

Scalable EdTech solutions can overcome capacity constraints and support national delivery of TVET to meet the unmet demand for services. There are a range of established EdTech models, particularly those offering online content to augment traditional TVET, such as Coursera or Crehana, that are now relatively proven in terms of technology architecture and revenue pathways. Given the still relatively low use of EdTech in emerging markets, the existing models already being demonstrated by established EdTech players offer a blueprint for emerging players to replicate. Scalable EdTech solutions can overcome capacity constraints and support national delivery of TVET to meet the unmet demand for services. For example, under current institution-based learning models, supporting the necessary scale-up to meet demand projections would require an additional 1.5 million teachers per year, or 100 million teachers in total, to meet the world's education needs.[3] As such, EdTech platforms that create delivery efficiency offer significant potential to scale up access to international standard vocational education and training opportunities for emerging market populations that do not currently have access through TVET institutions.

[2] HolonIQ. 2021. "Global EdTech Funding 2021—Half Year Update". https://www.holoniq.com/notes/global-edtech-funding-2021-half-year-update/

[3] Refers to total teachers across all forms of education—HolonIQ. 2020. "Education in 2030." https://www.holoniq.com/wp-content/uploads/2020/01/HolonIQ-Education-in-2030.pdf

Other emerging EdTech models are also integrating frontier technologies to push the capability of EdTech and expand its reach. These frontier technologies are expanding EdTech offerings, allowing EdTech to incorporate traditionally 'hands-on' or 'soft-skills' into the suite of offerings. Together, this is allowing the emerging EdTech models to push past EdTech's heavy core of data science and into other white- and blue-collar professions. These models offer learners in emerging markets the potential to gain skills in an increasingly wider set of professions, while remaining dislocated from either the training provider or employer where they can utilize them.

These EdTech models also offer the potential for national TVET systems in low-capacity emerging markets to integrate with EdTech services in developed markets. The opportunities EdTech allows through dislocation, and the innovations and scalability of models, demonstrate that TVET need not explicitly come from ground-up development in each emerging market. Models using an integrated approach allow emerging market TVET to potentially overcome capacity constraints and leverage established high-quality EdTech products and services that are unavailable in the local market. These in turn support skill diffusion through both training and employment opportunities.

There is room to accommodate the growth of EdTech and substantial benefits from closer integration of EdTech solutions into existing national TVET systems, but existing players that do not adapt and demonstrate outcomes may not survive. Surging VC investment and strong incentives to provide innovative and attractive services to learners mean EdTech platforms may provide competition to the existing traditional TVET institutional model. There is room for both; but at its core, TVET is about delivering employment outcomes. Traditional TVET models that do not integrate EdTech will likely not keep pace with the accelerating demand for digital skills and digitization of training methods, and thus may not be able to demonstrate good employment outcomes from training. In contrast, the inherently digital nature of EdTech also embeds data capture and analytics into business models and will be able to provide real-time outcomes to learners.

EdTech's unique scalability also offers governments the ability to scale TVET delivery and meet unmet demand for skills development more rapidly than could be done through bricks-and-mortar TVET institutions. Through partnerships with EdTech providers, high-quality content can be made available to underserved populations and delivered simultaneously to unlimited locations, bringing content directly to learners in their preferred location. However, EdTech models can only flourish if the digital infrastructure exists to support the necessary connectivity. This is particularly necessary to ensure that low-income and vulnerable populations are able to access EdTech products; otherwise these products will be unable to reach underserved populations and reduce the digital divide. Additionally, accommodating policy and regulatory settings can promote a digital ecosystem that supports EdTech offerings. The challenge for governments is to ensure they support effective EdTech products that improve employment outcomes for learners. For instance, governments may be able to foster an enabling environment for EdTech investment and engage in constructive partnerships to access outcome data from EdTech companies to improve evidence-based policy making and integrate findings into national TVET system design.

There is a common cause for the private sector and government to pursue EdTech solutions that solve substantial societal problems. Private sector EdTech products have the potential to close skills gaps within emerging markets through different channels and business models, yet this will require governments to work in partnership with private EdTech companies to unlock EdTech's potential. Emerging EdTech models offer significant potential to complement and augment

existing national TVET offerings in emerging markets; however, they also challenge established models. Companies that do not embrace EdTech will not attract the best talent. TVET institutions that do not integrate EdTech will not attract learners. Learners who do not use EdTech will miss out on the best education and employment outcomes. For the private sector, developing solutions for the large unmet demand will require the ability to rapidly scale successful models. For government, EdTech meets a critical development need and supports inclusive employment and economic development. EdTech is no longer a nice-to-have feature at the margins of TVET. Brought into focus by the COVID-19 pandemic, EdTech is now an essential feature of a well-developed national TVET system.

EVIDENCE OF THE EFFECTIVENESS OF EDTECH DEPLOYMENT ON SKILLS DEVELOPMENT AND ACCESS IN TVET

The rapid pace at which educational technologies have been deployed has come at a cost. Scholarship has not kept up in rigorously assessing what works and what does not, nor with how interventions interact with the contexts in which they take place. The literature on EdTech is comparatively small; the subset assessing EdTech in TVET is even smaller. Where it exists, it is often lacking in quality and rigor. Given this limitation, it remains essential to look more widely at literature on EdTech in general, focusing on technologies that are particularly relevant to TVET contexts: computer-assisted learning, various forms of online learning, and virtual reality (VR) applications. The body of research comes together as a patchwork of differing technologies applied in very different educational and occupational fields, and in different geographic and institutional contexts. Consequently, the jury is still out regarding the extent to which, and through which channels, EdTech models in TVET can improve learning, skills acquisition, and ultimately labor market outcomes of students.

Experimental evidence suggests that the use of certain educational technologies can be effective in augmenting traditional teaching methods. Computer assisted learning programs and tutoring software have been effective in supporting the development of cognitive skills such as quantitative skills and language acquisition. While these findings indicate substantial potential for software use, especially for the off-the-job portions of TVET trainings, the precise mechanisms by which they facilitate improved learning—for example, why certain programs work and others do not—remain unclear. On the plus side, computer-assisted learning programs appear to be particularly effective in developing countries and emerging economies. Likewise, the use of computer-assisted learning programs in TVET appears particularly promising for the formation of cognitive, theoretical skills, insofar as they are relevant to the occupation.

In TVET contexts, online learning may be particularly promising in increasing access and more closely integrating theoretical, off-the-job components of training with on-the-job components. Questions remain regarding its effectiveness in teaching practical professional skills, though nascent research on using virtual reality for teaching professional skills indicates strong potential. Online learning has been successfully leveraged in many postsecondary educational settings, with research focusing mainly on statistics, economics, and mathematics courses. Existing research gives little confidence that online learning on its own can achieve the quality of face-to face-learning, though blended learning models have achieved similar results in terms of quality in several settings. To the extent that TVET comprises off-the-job educational elements, online learning might be a cost-effective mode of delivery. Indeed, the fact that online learning transcends geographical boundaries might lead to a tighter integration of on-the-job and off-the-job learning, since key concepts can be reinforced theoretically at the same time as they are being applied practically.

Some evidence suggests that online learning leads to better access and higher enrollments for groups that otherwise would not seek further education. More promisingly, a meta-assessment on 92 experiments found that VR instruction on average is more effective than traditional teaching in developing student skills across technical, cognitive, and socio-emotional domains.

The lack of generalizable evidence to date indicates the crucial need to combine the deployment of EdTech in TVET with rigorous monitoring and evaluation systems. Deploying new educational technologies is, by virtue of adopting frontier systems, experimental. Making better decisions requires an understanding of EdTech reform in TVET as both an attempt to solve existing problems and a learning experience to assess its success rigorously. A particular gap that remains is the lack of telling outcome metrics. Learner success in test results is easy to measure, yet it is less appropriate for evaluating the actual desired outcomes, including post-degree job attainment, salaries, (lifetime) income, satisfaction with job outcomes, and others. These aspects are disproportionately relevant for TVET, with its goal of equipping students with job-relevant technical skills and creating improved labor market matching.

A review of the relevant literature indicates that it is imperative to collect data, especially on the labor market outcomes of graduates. Technologies have altered the ways that education is delivered, but there is still little systematic knowledge about what works and what does not. Where studies exist, they focus on skills rather than labor market outcomes. Given the goal of TVET to create matches between labor market needs and skills supply, this component is critical to measuring success. Any reform of TVET systems or piloting of interventions should, from its inception, integrate strategies to measure labor market outcomes so as not to repeat prior mistakes in creating reform with unmeasurable outcomes.

PROCUREMENT MODELS FOR GOVERNMENT

Procurement is a simple concept that has far-reaching consequences for the TVET sector because it determines the efficiency of product and service supply in the sector, as well as the effectiveness of what is supplied. Growth of the EdTech industry has led to various EdTech business models, products, and services. Public procurement of EdTech in TVET is unique because it requires a thorough evaluation of learner and teacher/trainer needs, how to balance these requirements with policies and legislation relevant to the TVET sector, available resources, infrastructure, and EdTech product or service development. Despite this, there is a dearth of information on EdTech procurement in TVET and its implications for the TVET system. With the EdTech sector being a rapidly changing landscape with new innovations and developers entering the market constantly, it provides an advantage to the public sector by expeditiously improving the available technology and presenting new products. But this also makes procurement processes more complex due to the constantly shifting functionality of EdTech solutions. Despite these complexities, innovation is crucial to EdTech procurement in TVET because it ensures that students are provided the solutions that are best suited to their requirements. Innovation also ensures that the procurement process evolves to become increasingly safe and is infused with integrity and efficiency.

Around the world, public sector procurement has been conceptualized and implemented in innovative ways within the education sector and beyond, often relying on partnerships for successful implementation. For example:

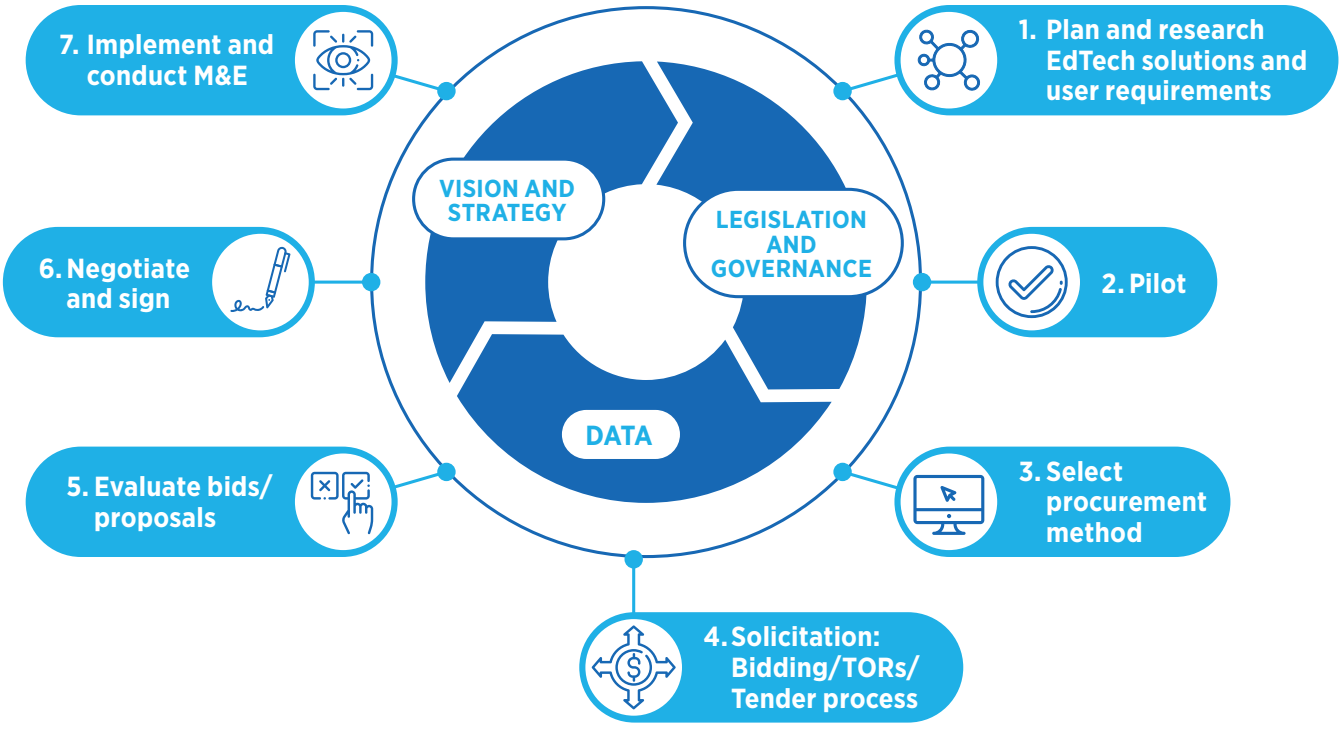
- **Public procurement for innovative solutions** (PPI) is a concept that offers novel solutions to the market. It occurs when the public sector exerts its purchasing power to become an early adopter of existing innovative solutions that are currently unavailable on a large-scale commercial basis. PPI supports more widespread diffusion

of innovations by creating a large enough demand that incentivizes industry to invest in commercialization, creating products or services with the quality and price required for mass market deployment.[4]

- **Pre-commercial procurement** (PCP) can be used when there are no near-to-market solutions yet and new research and development (R&D) is required. In this model, the public sector funds R&D to steer development of solutions to meet its needs, gathers information about the benefits and potential pitfalls of alternative solutions, and uses the information to de-risk the most encouraging innovations through systematic solution design, prototyping, development, and product or service testing.[5]
- **Innovative public procurement** (IPP) focuses on innovation within the procurement process itself and includes solutions such as e-procurement services (the use of ICT in public procurement), framework agreements, or public-private partnerships (PPPs) as a means of procuring goods or services.

Drawing from the literature, models, and frameworks presented in this report, it is possible to distill a hybrid EdTech procurement framework suited specifically to the TVET system. The framework is general, as it seeks to maintain its relevance to all emerging markets and relate to the procurement of EdTech products and services.

FIGURE E.3 A proposed EdTech procurement process for TVET systems



[4] European Commission. 2021. "Public Procurement of Innovative Solutions." https://ec.europa.eu/digital-single-market/en/public-procurement-innovative-solutions

[5] European Commission. no date. "Innovation Procurement." https://ec.europa.eu/digital-single-market/en/innovation-procurement

At the center of the system are three elements that feed into one another and pervade the procurement process. First, the **vision and strategy** for the government entity or institution informs procurement activities and determines how an EdTech product or service fits into the overarching vision for the TVET system. Second, **legislation and governance** mechanisms influence the legal obligations to which the procurement process is subject. Third, **data** from training institutions and the Labor Market Information System (LMIS) determines what vocational EdTech solution is procured (by determining EdTech needs and data requirements), as well as how data from the EdTech that is procured feeds into the system and promotes data interoperability with existing vocational EdTech. Its core focus is to enable data-driven decision-making.

The EdTech procurement process for TVET may differ across countries, regions, and cities. The report outlines best practice examples in Indonesia, the United States, and Chile. However, there are some key takeaways that are common to many country contexts:

- **There are procurement models that can facilitate the growth of EdTech in TVET at scale in emerging markets.** Although there is a dearth of use cases available regarding EdTech in emerging markets' TVET sectors, procurement models that are predominantly from K-12, together with information on EdTech use in developed countries, provide valuable insights into procuring EdTech for TVET in emerging markets.
- **Governments and training providers would likely gain significant benefits from analyzing available inventory before seeking out new solutions.** This ensures interoperability between existing and newly purchased solutions, eliminating duplication in functionality.
- **At the national level, undertaking pilots of new EdTech provides an invaluable tool for measuring an EdTech solution's effectiveness before rolling it out at scale.**
- **Electronic procurement systems can expedite the purchasing process,** but key to this is ensuring that these systems do no replicate paper-based systems and instead prioritize efficiency and a good fit between requirements and available EdTech products and services.

- **When using procurement to drive innovation, procuring entities should avoid being too prescriptive in tender specifications.** Finding a balance between defining essential functionality and removing excessive details can enable greater innovation and creativity for a product or service instead of restricting it. To achieve maximum practicality, requests for proposals (RFPs) should focus on educational delivery requirements instead of product or service features.
- **A core competency for any procurement process should be prioritizing data-driven decision-making and data interoperability.** Data-driven decision-making enables buyers to make an informed decision about what EdTech products or services to procure for users. Data interoperability allows different EdTech solutions to work together and exchange data, which provides more comprehensive insight into different aspects of educational delivery, thus creating a holistic picture of education delivery instead of a segmented view that individual EdTech solutions provide.
- **Encouraging greater transparency in the interactions between public and private actors regarding EdTech issues is vital to ensuring that governments can implement practical, sustainable, scalable, and equitable policies and governance mechanisms.** Transparency also promotes buyer confidence, greater innovation, and responsiveness in EdTech for TVET, and enables a more efficient procurement process.
- **Student privacy should be a non-negotiable priority throughout the procurement process.** This means that EdTech companies should clearly define the measures they take to protect student privacy. Governments should hold EdTech companies accountable by only procuring EdTech solutions from those that meet government-approved privacy standards.

POLICY LEVERS TO SUPPORT EDTECH IN TVET

Good policies are essential, but they are only effective when the right policy levers are defined in the policies and then actively deployed throughout the system to ensure implementation. Policy levers are the tools and mechanisms that government and its agencies have at their disposal to direct, manage, and shape changes in public services. Various policy levers can be applied by governments, with the choice of lever influenced by the political climate and any constitutional and legal restrictions on government authority. The potential of EdTech can only be realized when it is embedded in a context that is open to innovation and supported by a favorable policy environment.

There is no commonly accepted typology of policy levers, with different researchers and disciplines proposing different typologies and categorizations. However, below is a summary of some key policy levers that can be applied to promote the effective use of EdTech in TVET.

- **Strengthen and streamline governance:** Governance systems play an important role in generating and guiding the relevance, access and participation, and quality/innovation components for effective EdTech delivery. They set out the vision for the TVET system, together with how EdTech complements the system's functions. This includes making strategic decisions regarding direction and roles, ensuring that all stakeholders' interests are addressed, and coordinating different government entities, as well as the private sector.
- **Establish a strong investment climate:** The economic, financial, and socio-political conditions of a country influence whether individuals, banks, and companies are willing to lend to and invest in EdTech businesses operating within that country. Thus a policy environment that encourages investments and partnerships has the potential to facilitate rapid growth in the TVET EdTech space.

- **Provide financing mechanisms:** Finance levers involve control of the overall allocation and distribution of funding across government (national, provincial, and local) and cover the private and not-for-profit sectors. Financial incentives encourage rather than mandate TVET investments and can take various forms, such as grants that result in some monetary benefit to companies. There can also be financial incentives for citizens to participate in TVET skills development. Likewise, loans, scholarships, and stipends can provide significant opportunities for business-to-consumer (B2C) EdTech programs, as well as improve access to educational opportunities. Finally, companies can be encouraged to embrace ways to upskill and reskill their workforces to keep pace with technological changes in a cost effective and socially responsible way, through the provision of tax relief.
- **Improve ICT infrastructure:** Infrastructure levers involve the deployment of ICT infrastructure and services such as networks, high performance computing facilities, cloud storage services, and access to equipment. Robust infrastructure is a foundation of EdTech and, as a key component, requires strategic planning and implementation. This calls for reliable and regular funding mechanisms (at institutional and national levels) to source, develop, maintain, and upgrade existing infrastructure and equipment. Some governments are supporting the development of broadband activity to training institutions, usually with assistance from the private sector. Donors are involved in the provision of infrastructure to support training institutions, while partners can also be encouraged pool resources to create the necessary infrastructure.
- **Enhance digital skills:** Digital skills are essential to support and leverage the opportunities provided by EdTech and to bridge the digital divide. Digital skills are defined as a range of abilities to use digital devices, communication applications, and networks to access and manage information. Countries that place a strong focus on developing citizens' digital skills are in a better position to adopt EdTech technologies, as citizens are likely to be more familiar with using digital devices and navigating digital resources.
- **Develop capacity of teachers/trainers to use EdTech effectively:** In addition to digital skills, teachers/trainers should have the pedagogical capacity to align instruction to the modality being used. These skills need to be promoted in pre-service training so that new teachers/trainers have a good understanding of why and how digital information should be used. They should also be updated during in-service training so that they keep abreast of the latest EdTech innovations. Skilled teachers/trainers are crucial to ensuring quality and maintaining training standards, which enhance the employability of learners.
- **Develop effective institutional leadership and management:** Effective institutional leadership and management directly influences and changes the culture (values, norms, vision, skills, and practices) of training systems. As a result, institutional leaders should be able to develop a clear vision for the institution, which includes a vision for EdTech adoption and integration. Further, it is important to build institutional leaders' capacity in planning for and managing ICT investments.
- **Support development and sharing of relevant technology-enabled educational content:** While the potential of new technologies to transform skills development and TVET is unprecedented, actual benefits can only be realized if digital education content is locally contextually relevant or based on local curriculum frameworks. Governments can define educational content standards to which institutions need to adhere or create policies for using open licenses for educational content and resources that facilitate the reuse of content in order to ensure scaling.

- **Strengthen verification and certification processes:** Governments and credentialing authorities can provide quality assurance systems that are responsive to the changing landscape, to make credentialing information from multiple sources more accessible, to provide the methodologies for comparing credentials, and to understand how these combine meaningfully.
- **Establish and sustain monitoring systems and ongoing evaluation processes:** Monitoring and evaluation allow for lessons to be learned and help inform changes in relevant TVET policy, programs, and practices. Accurate data and information support the continuous formulation of improved evidence-based policies, following monitoring and evaluation. Governments can also set and recommend standards for accurate data and proper data management.
- **Facilitate partnerships:** Well-functioning partnerships and networks can accelerate innovation and help deliver EdTech solutions across all of the above policy levers. Within EdTech, there can be a range of different types of partnerships at different levels of the education system (local or national). For example, there can be PPPs between the private sector and government, as well as partnerships between industry and training institutions, between governments and donors/NGOs, and between government and companies.

Policies are important to foster the development of EdTech within the TVET sector, but initiatives run the risk of being irrelevant and unsustainable unless the right policy levers are used. Significantly, almost all of the policy levers highlight the importance of building partner networks to ensure that initiatives and solutions are tailored appropriately. To successfully leverage policies, it may be useful for governments to establish accountable agencies to lead the development, regulation, and implementation of relevant policies/strategies related to EdTech in TVET.

Table E.1 summarizes some of the key levers and their potential effects and impacts on stimulating private sector growth of EdTech in TVET.

TABLE E.1 Summary of policy levers

POLICY LEVER	POTENTIAL IMPACT	EFFECT ON PRIVATE SECTOR GROWTH	EXPENSE
FINANCES AND PROCUREMENT			
Develop procurement standards that outline central procurement guidelines	HIGH	Highlights requirements for EdTech products and services, thereby promoting quality, competition, and innovation.	LOW
Implement the use of e-procurement systems	HIGH	Expedites the procurement process and allows the private sector to get its products to market (and scaled) faster.	MEDIUM
Provide financial incentives including tax incentives	MEDIUM	Attracts more investors and private sector partners as the tax relief/financial incentive may be a more attractive proposition.	LOW
Incentivize innovative practices in EdTech and innovative solutions through, for example, tax incentives for PPPs	MEDIUM	Encourages innovation at scale, impacting sector competitiveness by encouraging all players in the EdTech field to innovate and improve their offerings.	LOW-MEDIUM
Subsidize broadband to education institutions	HIGH	Allows service providers to extend their reach beyond urban areas, attracting more subscribers.	HIGH
Establish zero-rated access to education websites	HIGH	For telecommunications providers, users are likely to use a telecommunication network if they zero-rate educational content, and providers can still charge for uploads (when assignments are submitted), communications, and social networking apps (learning communities usually also have networks outside the platforms or content, for example, on Facebook, WhatsApp, Signal, etc.). Provides a massive opportunity to grow customer/subscriber base.	LOW
Create incentives for citizens to engage in lifelong learning	HIGH	Stimulates online training markets to meet training needs. Encourages employers to invest in company transformation to keep up with latest trends and developments.	LOW-MEDIUM
POLICY AND REGULATORY ENVIRONMENT			
Establish governance structures and strategies to coordinate the work of different governmental entities, as well as the public and private sectors	HIGH	Creates a common decision-making structure across government ministries, consolidates spending on TVET, and prevents fragmentation and duplication of efforts.	LOW
Create enabling regulations for importing digital infrastructure	MEDIUM	Allows for increasing access to digital devices and hardware to grow businesses, thereby widening their offerings in the EdTech space.	LOW
Open access to business opportunities for nontraditional TVET global service providers	MEDIUM	Increases sector competitiveness by pushing all players to innovate and improve their offerings (though this may carry risks if local players are unable to rise to this challenge).	LOW-MEDIUM

POLICY LEVER	POTENTIAL IMPACT	EFFECT ON PRIVATE SECTOR GROWTH	EXPENSE
PARTNERSHIPS			
Establish partnerships to test infrastructure models before scaling	MEDIUM	Provides opportunities to showcase and market EdTech solutions to government, diversify offerings, and grow businesses.	LOW
Coordinate public agencies and leverage multi-stakeholder partnerships and collaborative teams to develop digital skills	HIGH	Fosters the development of digital economy and meets the needs of workplaces and employers. Allows for continuity and scaling of effective programs.	LOW-MEDIUM
Harness PPPs for infrastructure procurement	HIGH	Provides opportunities to develop private sector capabilities in the short and medium term.	HIGH
Establish collaborative taskforce teams, which include training providers, industry players, and EdTech providers to enhance the development and provision of curricula and programs	MEDIUM	Drawing on industry-specific and education sector expertise allows EdTech providers to develop and tailor context-appropriate technology solutions.	LOW
GENERAL			
Promote the use of piloting for EdTech products before rollout at the national level	MEDIUM	Enhances the value-add of the final product and creates opportunities for the private sector to measure the impact of EdTech solutions before they are rolled out at scale.	MEDIUM
Promote online educational content platforms (including virtual training content) and the use of open licenses for educational resources	HIGH	Private companies can market and sell their content and provide customized content that is aligned with latest industry standards, are part of learning pathways that lead to accreditation, or directly address the skills needs of local employer. It also opens certification opportunities.	LOW-MEDIUM
Strengthen digital skills and EdTech use in trainer capacity development	HIGH	Provides opportunities to promote platforms and develop marketing and distribution channels.	LOW-MEDIUM
Promote openly licensed content for trainers and learners	HIGH	Creates the potential for new players in the content development market, reducing the duplication of investments. For example, businesses can offer two levels of service—basic, which provides free access to a set of openly licensed resources and tools, and premium, which gives users additional services for a fee.	LOW
Implement rigorous evaluation to reinforce EdTech evidence of impact	HIGH	Utilizes trends and evidence-based data to improve products and offerings.	LOW

CONCLUSION

EdTech is now an essential feature of a well-developed national TVET system, put into the spotlight by the COVID-19 pandemic. It is transforming how people engage with learning, enabling people to access, and companies to seek, both learning and work opportunities removed from the physical location of the institution or company. The private sector and government have an incentive to work together to deliver EdTech solutions; EdTech models cannot flourish if the digital infrastructure and enabling environment that underpins a digital ecosystem does not exist, meaning there is common cause for the private sector and government to pursue EdTech solutions that solve substantial societal problems.

Creating TVET systems that harness EdTech effectively will require a willingness to reconsider many of the core principles and operational models on which TVET systems are currently based. Holistic approaches that encompass policy, implementation, funding, and partnership are critical to ensure that all students have opportunities to access and cultivate necessary and relevant skills. Importantly, efforts to deploy EdTech in TVET within countries cannot assume a cookie-cutter approach to EdTech implementation and should preferably commence with investigation of the specific context before proposing any interventions.

There is thus significant scope for additional research on this topic, particularly regarding the implications of EdTech implementation. Potential areas for future research are outlined below.

- The scarce body of existing research comes together as a patchwork of differing technologies applied in very different educational and occupational fields in different geographic and institutional contexts. Further research is needed to consolidate these findings into a coherent set of lessons that low-to-middle-income countries (LMICs) can use in practice.
- For policy application, the question of how the impact of EdTech deployment interacts with the institutional environment in which it takes place is crucial. Yet it remains insufficiently answered. Identical interventions in different setting have led to widely differing outcomes.
- While technologies such as computer assisted learning have demonstrated positive impacts on learning, it remains unclear why some applications work and others do not. Research assessing specific advantages of technology design is needed.
- Existing research largely focuses on cognitive and socio-emotional skills, while the use of technologies for attainment of practical on-the-job skills remains understudied. Some of the most exciting frontier technologies such as VR are, in principle, well-suited to advancing education in applied settings such as assembly, machine maintenance, and network configuration. Yet, more research is needed to understand specifically which settings work.
- Evidence tends to focus on proximate outcomes such as program completion; or if more advanced, learning and skills acquisition. Evidence on labor market outcomes of students over time remains scarce.
- Further consideration is needed to understand how effective EdTech is in closing disparities between educational outcomes by gender or other underserved groups.
- Evaluation is needed of the gaps between policy intentions and implementation.
- There is merit in undertaking research on how best to align procurement processes with intended learner outcomes and available resourcing in LMICs.
- Evaluation is needed of procurement systems in LMICs, in addition to research on how to make procurement processes for EdTech in TVET more efficient and effective.

INTRODUCTION

Technical and vocational education and training (TVET) provides a critical link in a country's learning architecture. Historically, TVET differs from primarily classroom-based formal learning programs such as secondary (school) and tertiary (university) education by offering learners technical training with a more hands-on, practical focus. TVET is generally thought of as training that provides employment-ready technical skills and learning experiences, which may include reinforcing foundational learning requirements that relate to being work-ready. It can occur in formal settings such as accredited programs in training institutions, as well as in more informal settings such as skills development in the workplace and self-directed micro learning by an individual.

Definitive data on the number of TVET learners globally is difficult to source given the different structures and definitions of TVET across countries. The UNESCO Institute of Statistics (UIS) estimates that as of 2018 there were 73.7 million formal TVET learners worldwide. Within this formal space, most TVET is provided at the upper-secondary level, where 57.8 million TVET students make up 22 percent of the total global student population.[6] Indicative evidence on user growth from the private sector providers also suggests a large and rapidly expanding digitally focused user-learner base, over and above those captured in formal TVET statistics. For example, Learn Capital, a global fund manager focusing on educational technology (EdTech) that was founded in 2008, now has $430 million in assets under management across 230 portfolio companies and reports a total user base of over 260 million users. In another example, Coursera is now one of the largest online learning platforms in the world, with 77 million registered learners, with over half in emerging markets; and more than 6,000 institutions have used Coursera to upskill and reskill their employees, citizens, and students. While this reflects a broad spectrum of EdTech services, including K-12, it is indicative of the scale of the informal vocational education market and its ability to extend access to TVET opportunities beyond institutional settings.

The advancement of EdTech is increasingly blurring the lines between formal and informal TVET and skills development and recognition offerings. As such, the scope of this report goes beyond the formal definition and role of TVET and considers the broader technical skills landscape, that is, any educational offering that supports technical skills and employability. This includes services that provide training directly, as well as services and platforms that improve the reach, efficiency, administration, and facilitation of TVET (beyond general business efficiency tools). It also includes services and platforms that provide connectivity between learner and employer and thereby facilitate improved employment outcomes.

TVET is focused on technical skills and its role within an economy is related to the mix and prevalence of industries within an economy. Compared to other forms of learning through schools and universities, TVET programs are generally designed with specific occupations or functions in mind to provide job-ready skills and the necessary certifications to meet regulatory requirements. Sectors that require training in specific technical skills often rely on TVET certification to augment traditional school

[6] Hoftijzer, Margo, Victoria Levin, Indhira Santos, and Michael Weber. 2020. "TVET Systems' response to COVID-19: Challenges and Opportunities." World Bank. https://openknowledge.worldbank.org/handle/10986/33759

or university education including, for example, administration, healthcare, education, and trades, as well as information and communications technology (ICT) and business-related skills. Skill augmentation through TVET is also a critical link in lifelong learning, as people take shorter courses to improve their existing skill sets. For example, augmenting a tertiary education degree in finance through a certification in financial planning; or formalizing potentially existing knowledge to demonstrate food safety standards and meet government or industry requirements to operate in the hospitality industry. As such, a potential advantage of TVET is that its focus on practical skills means courses are often shorter and cheaper, and more directly lead to employment outcomes, a particularly important feature of TVET given the rapid digitization of sectors and need for skills to keep pace with these advancements. From a systemic perspective, this means that TVET can more readily meet national skills gaps by offering training aligned to in-demand skills, provided the overall system enables this kind of agility, flexibility, and responsiveness.

TVET systems in emerging markets are fragmented, with responsibility diffused across government, industry/employers, and individuals. Given the broad nature of skill requirements and practical focus of TVET, its role has emerged differently across countries, with significant differences in the skills, programs, and methods through which leaners interact with training. Countries with advanced systems can benefit from integrated TVET that forms part of an overall national education framework, making it more institutionalized, focused on specific credentialing, and aligned to certifying that learners are meeting regulatory requirements for industries and employers. For example, the Organisation for Economic Co-operation and Development (OECD) describes Germany's TVET system as:

> *Well-developed and institutionalized VET research capacity, including the Federal Institute for VET, (BIBB), and a national network of research centres that study different aspects of the system to support continuous innovation and improvement in the VET system.*[7]

This is very different from many emerging markets, where secondary and tertiary attainment is lower and there are typically fewer formal institutionalized structures to develop technical skills. For example, in Sub-Saharan Africa, the Gross Enrollment Rate (GER) in tertiary education is only 9 percent, which contrasts sharply with the GER in middle and high-income countries, at 33 and 74 percent, respectively. Likewise, UIS estimates that the share of upper-secondary level TVET students is 15 percent in low-income countries, compared with 21 and 28 percent in middle- and high-income countries, respectively.

Digital disruption provides both challenges and potential solutions for TVET in emerging markets. Disruptive technologies are changing the way that traditional markets operate and the skills needed to enable them to stay relevant within and benefit from the fourth industrial revolution (4IR), as well as the methods through which workers learn and gain these new skills. However, these technologies also offer potential solutions, and multiple EdTech innovations within TVET have been emerging over the last ten years that can help to close skills gaps in emerging markets. EdTech was initially developed as a series of niche products to supplement traditional educational methods (i.e., adding computers to traditional programs). However, as internet and mobile connectivity has expanded, the use and accessibility of EdTech within TVET have evolved quickly as a disruptive force that can provide affordable, skill-specific training and skills development options to augment and sometimes replace traditional offerings. EdTech for TVET can operate across the entire learner lifecycle

[7] OECD Directorate for Education, Education and Training Policy Division. 2010. "Vocational Education and Training in Germany—Strengths, Challenges and Recommendations." https://www.oecd.org/education/skills-beyond-school/45938559.pdf

and examples can now be found at every point of the learning journey, in both formal and informal education settings. This ranges from platforms to support discovery of educational opportunities, new ways of generating content and experiencing learning, and software to support education institutional management and administrative processes through to the delivery, assessment, and the credentialing of learning on the pathway to employment. Figure 2 in Chapter 1 maps key EdTech uses within the TVET system, demonstrating the kinds of EdTech that can be used to perform key functions in TVET.

COVID-19 has accelerated the existing need for both digital skills and new digital learning models. The pandemic has served to highlight and accelerate the need for nontraditional, digital options for training. For instance, distance learning options such as online offerings are strongly linked to improving learner equity by allowing learners who are not able to participate in a classroom at a fixed location, and at fixed times, to still follow courses.[8] During COVID-19, in-person classroom-based training has been disrupted in many locations, adding urgency to efforts to harness technology effectively both for teaching and learning purposes, and to support managerial and administrative operations. A recent survey of TVET providers, policymakers, and social partners implemented during the early stage of the pandemic showed that, as of May 2020, in 114 countries (out of 126), complete closure of TVET facilities was reported by the most respondents.[9] While improving vaccine availability may alleviate some of the disruption and allow for gradual reopening of facilities, the pandemic has shown the fragility of the current TVET system and its reliance on physically based learning, highlighting the need for alternative solutions through digital models.[10]

EdTech will touch the lives of generations of the world's population and become a critical feature of supporting access to TVET. Most of the approximately six million people who join the labor force globally every month (one million in Sub-Saharan Africa alone and another million in India) have very little training and lack employability due to low levels of foundational or job-specific skills.[11] This figure highlights the significant scale of TVET training required to support employability and the potential global market for education technology solutions. Given the variety of students and skills within the labor force, it also highlights the different learning techniques and styles that will be needed to develop the workforce of the future. The ability of EdTech platforms to use data and AI to customize the learning experience and automatically adjust it to a student's style of learning at scale brings a new dimension to the TVET learning experience.

> *Educational literature has long indicated that different students learn in different ways and that a more personalized approach, with learning customized to the learning needs of each student, would bring about greater individual benefits. However, until now, it has been impossible to scale such techniques for an affordable cost.*[12]

[8] International Labour Organization. 2020. "The Digitization of TVET and Skills Systems." https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_752213.pdf

[9] ILO, UNESCO and WBG. 2020. "ILO-UNESCO-WBG Joint Survey on Technical and Vocational Education and Training (TVET) and Skills Development during the time of COVID-19." https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---ifp_skills/documents/publication/wcms_766557.pdf

[10] Hoftijzer, Margo, Victoria Levin, and Michael Weber. 2021. "COVID-19 highlights the urgency of TVET reforms." https://blogs.worldbank.org/education/covid-19-highlights-urgency-tvet-reforms

[11] World Bank. 2018. "World Development Report 2018: Learning to Realize Education's Promise." https://www.worldbank.org/en/publication/wdr2018

[12] International Labour Organization. 2020.

The Sustainable Development Goals (SDGs) place an emphasis on learning and equity: SDG4 is to 'Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.' However, there remains a significant gap to meeting the needs of underserved populations and contributing to SDG4, with the United Nations Educational, Scientific and Cultural Organization (UNESCO) estimating a potential annual funding gap of $200 billion to achieve SDG4.[13] There is significant opportunity for EdTech to augment traditional learning experiences and become an enabler for students outside of formal education systems. EdTech can foster democratization of education as digitization allows education to be more scalable and more affordable, potentially dramatically expanding the accessibility of TVET to currently underserved populations, and bringing TVET to the learner in their preferred location. TVET can promote lifelong learning, as online education offers nontraditional students (including full-time workers, single parents, and career changers) convenient access to education at various stages of their lives.

SCOPE AND STRUCTURE OF THE REPORT

This report explores the opportunities presented by EdTech for TVET systems around the world, with particular emphasis on developing countries. EdTech for TVET is a relatively new area that focuses on the intersection of technology and TVET. As such, it is an area that is not yet supported by in-depth research and literature. This report seeks to further an understanding of the role of EdTech in transforming the TVET system. It focuses on emerging EdTech trends

[13] UNESCO. 2021. "Global Education Monitoring Report 2020. "Act now to reduce the impact of COVID-19 on the cost of achieving SDG4." https://en.unesco.org/gem-report/COVIDcostSDG4

and the opportunities for both the private sector and government to capitalize on using EdTech to support education and employment outcomes. The report goes beyond the formal definition and role of TVET and considers the broader technical skills landscape—that is, any educational offering that supports technical skills and employability.

The report discusses how digitization is transforming the role of EdTech in TVET and skills development. However, a discussion of specific digital technologies is outside the scope of this report. Further description of specific technologies and how they change skills needs can be found in ILO (2020), *The Digitization of TVET and Skills Systems*.

The report does not explore management and administrative functions of TVET, as technology associated with these functions may not necessarily be specifically relevant to education only (for example, it may have applications in other business settings). Rather, it focuses on functions related to curriculum development and teaching, learning, matching, and assessment processes.

Additionally, as the report focuses on the opportunities for EdTech to support systemic TVET outcomes, it covers opportunities to support more accessible and affordable TVET outcomes; however, it does not seek to provide detailed analysis of how EdTech can support specific challenges affecting inclusive access. It does, however, include a dedicated review of procurement models and policy levers for governments to consider when seeking to catalyze greater use of EdTech in TVET.

The report is structured as follows:

Chapter 1: A Framework for analyzing the opportunities and risks of EdTech in vocational education—Proposes a new framework to guide the analysis of EdTech opportunities and risks presented in the rest of the report.

Chapter 2: Vocational EdTech trends in emerging markets—Describes the key trends shaping the TVET industry and the opportunities for EdTech to be harnessed within TVET.

Chapter 3: Emerging business models and funding sources for EdTech in vocational education—Identifies the characteristics of EdTech business models and where innovative EdTech models are pushing the frontiers and capitalizing on new opportunities.

Chapter 4: Evidence on the effectiveness of vocational EdTech deployment skills development and access—Summarizes existing evidence on the effectiveness of EdTech deployment and highlights the importance of combining EdTech deployment with systems to monitor outcomes.

Chapter 5: Procurement models for governments—Explores how public procurement relates to EdTech in TVET, together with existing models and frameworks in EdTech. It then uses this information to develop a hybrid procurement framework for TVET EdTech and outlines imperatives for operationalizing the framework.

Chapter 6: Policy levers to support EdTech in vocational education—Illustrates, using practical examples, how different policy levers can be applied to promote the effective use of EdTech in TVET.

CHAPTER 1

A Framework for Analyzing the Opportunities and Risks of EdTech in TVET

To analyze the opportunities and risks of EdTech in TVET, it is first necessary to understand all the functions of TVET systems and how they interrelate. This is growing in importance, as technology solutions are increasingly cutting across skills development systems, functions, and levels as they become more sophisticated and integrated. This chapter proposes a new framework to guide the analysis of EdTech opportunities and risks presented in the rest of the report.

TVET usually refers to a range of learning experiences relevant to the world of work, which may occur in various learning contexts. The nature of TVET systems and the way that vocational skills are developed, organized, and regulated differs substantially across countries and regions.[14] In many countries, TVET systems are also fragmented and have a proliferation of qualifications. Further, contextual factors—political, institutional, economic, and cultural, as well as labor market regulation, the role of industry bodies, and the power of national/provincial governments—interact with each other in complex ways and influence the configuration of TVET within and across contexts.[15] Factors that cause national TVET systems to acquire unique characteristics include:

- TVET covering a diverse spectrum of learning activities[16] such as 'formal learning'[17] within institutions where outcomes are accredited, and 'non-formal learning'[18] and 'informal learning'[19] within or outside the workplace, and within or outside educational institutions
- Varying conceptualizations of TVET within countries (what it includes/excludes)
- TVET spanning both formal and non-formal education and the public and private spheres
- Where TVET takes place (training institutions such as colleges, in workplaces, online, and/or in hybrid spaces)
- When TVET takes place (before entry into an occupation, between/during studies such as learnerships or internships, after one enters an occupation, or when one becomes unemployed)
- Level of education (TVET can occur at various levels of education from very basic or primary to secondary and post-secondary)

[14] Allais, Stephanie, and Volker, Wedekind. 2020. "Chapter 15 Targets, TVET and Transformation." In *Grading Goal Four - Tensions, Threats, and Opportunities in the Sustainable Development Goal on Quality Education.* Edited by Antonia Wulff. Brill. https://www.academia.edu/43469453/TVET_Targets_and_Transformation

[15] Allais, S., and V. Wedekind. 2020.

[16] Oketch, Moses, Andy Green, and John Preston. 2009. "Trends and Issues in TVET across the Globe." In *International Handbook of Education for the Changing World of Work: Bridging Academic and Vocational Learning.* Edited by Rupert Maclean, and David Wilson. https://www.researchgate.net/publication/226903425_Trends_and_Issues_in_TVET_across_the_Globe

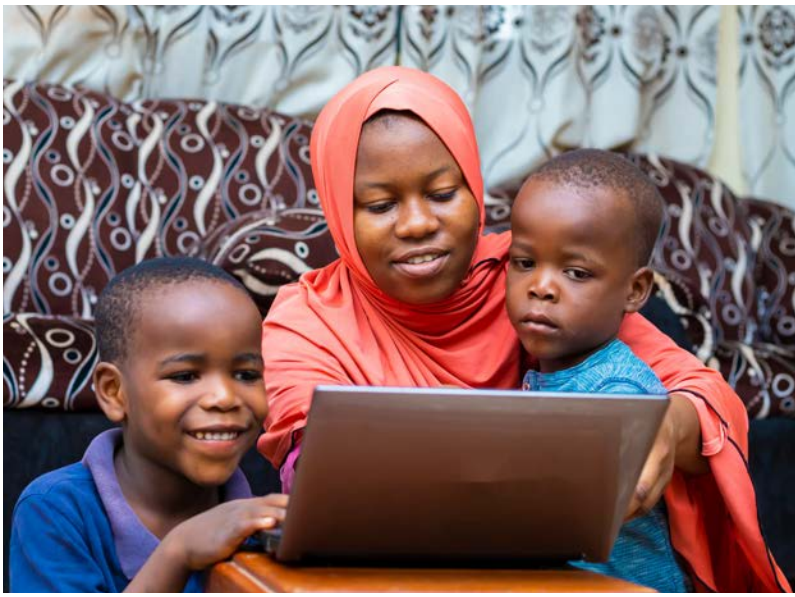
[17] Formal learning is education normally delivered by trainers in a systematic intentional way within a training institution.

[18] Learning that is not provided by a training institution and typically does not lead to certification.

[19] Any learning that is not formal learning or non-formal learning, such as self-directed learning or learning from experience.

- Differences in when specialization starts
- Varying pathways to other education and training programs (For example, recent reforms and developments in postsecondary education across many countries indicate 'a blurring conceptual distinction' between TVET and higher education and are moving toward a single ecosystem of postsecondary education, which highlights the need to promote the permeability of educational pathways between vocational and higher education)
- Where responsibility for TVET resides; with government, the private sector, or a combination of both
- Vocational programs emerge in different ways in different economic sectors within countries, resulting in a wide range of different types of programs, providers, and award systems (within and between countries)

Thus, TVET systems are complicated and complex due to their many and diverse component parts and how they connect with each other. This is further complicated by the reality that TVET systems are no longer just national in scope or scale, given the growth in both regional/global standards-setting processes, the increasing importance of multinational companies operating in this space, and the ease of deploying online learning across national borders. Worldwide, TVET systems operate at multiple levels that extend beyond national and regional borders. There are international, regional, and national systems that influence how TVET is implemented, delivered, quality assured, and assessed. These vary depending on country and region, as well as on the industry to which they cater.



CORE FUNCTIONS OF TVET SYSTEMS

In developing a framework that captures the scope of TVET systems (while recognizing the complexities outlined above), it is simplest to focus on core elements and functions of TVET systems rather than structures. Figure 1.1 outlines the core functions of TVET systems, while the key denotes the color coding scheme for the overarching functions in TVET systems.

This is a generic framework focused on the core functions that are essential in any TVET system, rather than a mapping of how TVET systems are typically structured. This is because structures would vary across contexts and technological solutions cut across skills development systems. Further, these processes do not necessarily occur sequentially, and thus, while the framework is presented as linear, implementation involves back and forth between the various functions. Table 1.1 provides a description of each element in the TVET system.

[20] Majumdar, Shyamal, and Volker Rein. 2017. "TVET and Academic Education: A Blurring Distinction- New Opportunities for the Future." https://www.cpsctech.org/2017/07/tvet-and-academic-education-blurring.html

FIGURE 1.1 The Technical and Vocational Education and Training System

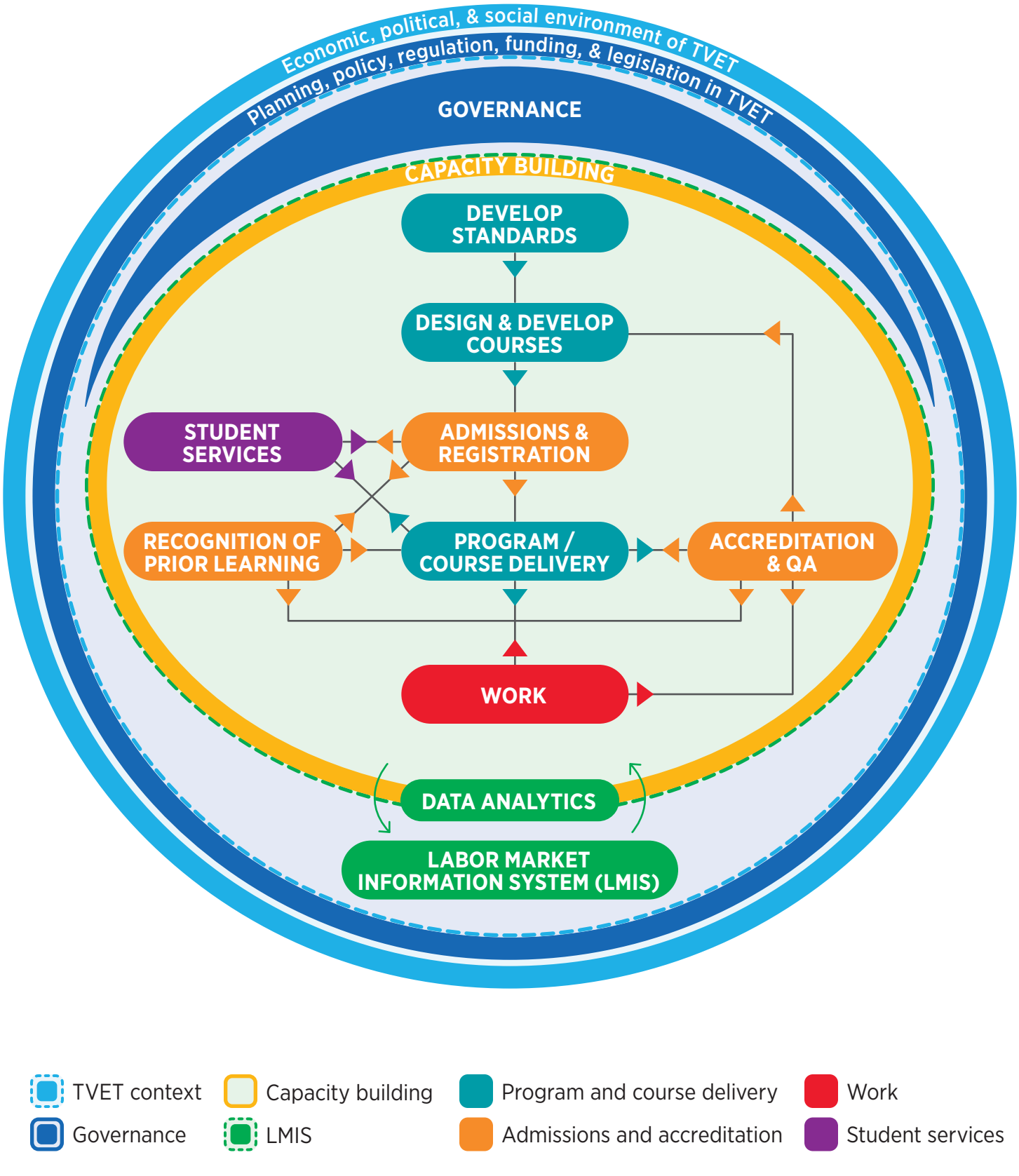


TABLE 1.1 TVET system elements

SYSTEM ELEMENT	DESCRIPTION
SOCIAL, POLITICAL, AND ECONOMIC CONTEXTS, WHICH INFLUENCE PLANNING, REGULATION, FUNDING, AND ASSOCIATED LEGISLATION IN THE SECTOR	These two elements inform and pervade the entire TVET system, influencing each individual function as well as the overall system. Two examples of how the social, political, and economic context pervades all functions of TVET are the COVID-19 pandemic and the 4IR, both of which have required changes in how TVET systems are implemented through accelerated shifts to online learning, the use of new EdTech, and general changes to education delivery, for example.
GOVERNANCE	Governance plays a key role in overseeing the implementation and funding of TVET at the country level, creating a supportive regulatory environment for TVET, overseeing the management of training providers, ensuring that quality assurance (QA) agencies function well, incentivizing employers, overseeing monitoring and evaluation of the TVET system, and raising awareness of skills development issues and opportunities.
DEVELOP STANDARDS	The core of TVET systems, where much of the implementation occurs, involves several key functions. One of the key functions is developing standards, which is the process of defining occupations, standards/learning outcomes, and qualifications/learning pathways (usually at the national level, but this might be regional or global for certain industries). This is often aided by national qualifications frameworks (NQFs), which assist in developing and classifying skills, knowledge, and competencies according to a hierarchy of levels. Developing standards is informed by labor market and work needs/priorities.
DESIGNING AND DEVELOPING TRAINING COURSES	This includes the process of mapping the curriculum, which typically involves identifying learning objectives, mapping content to outcomes, and defining teaching, learning, and assessment strategies and activities mapped to learning objectives (this typically happens at the level of the training provider/in-house training unit). It also includes materials development, which is the process of creating teaching and learning materials for skills development, using various media forms (for example, audio, video, print [both digital and physical], computer-based multimedia, simulations, virtual reality, gaming, etc.)
ADMISSIONS AND REGISTRATION	Learners who wish to pursue training courses need to apply and usually go through an admissions process (the requirements of which vary across countries and training providers). Ideally admissions systems should provide options for learners to access the growing range of flexible and informal learning opportunities beyond the formal TVET sector.
RECOGNITION OF PRIOR LEARNING (RPL)	Learners who have obtained knowledge and skills through informal and non-formal learning and work experience can apply for RPL to obtain credit for admissions purposes. RPL is a means of formally certifying prior learning as per accreditation standards. Such certification will allow learners entry into the training course/program or could qualify them for a specific job. Micro-credentialing, which is a small/short competency-based recognition/credential can be recognized using RPL procedures and may have explicitly defined learning outcomes at a particular accreditation level.

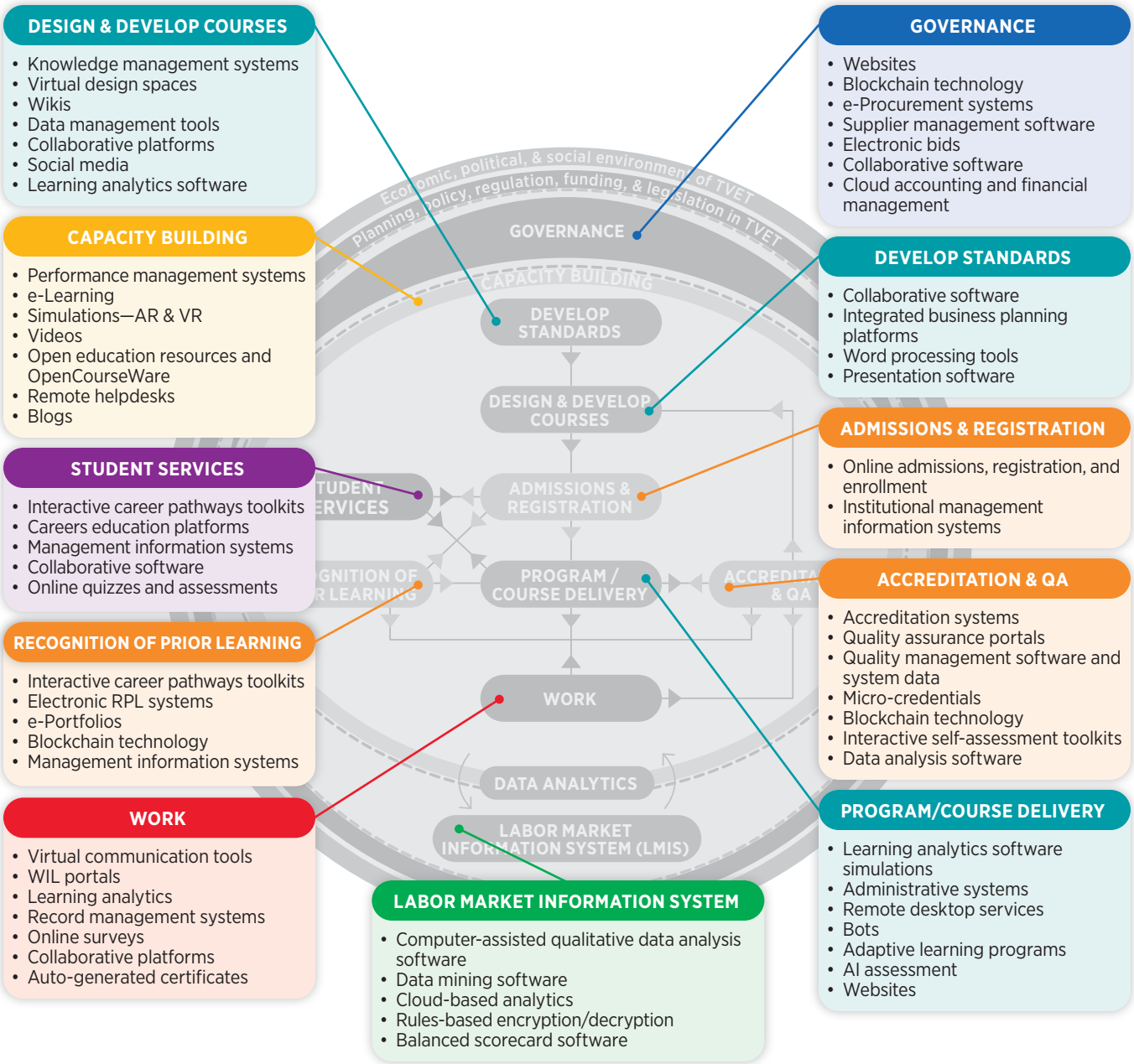
SYSTEM ELEMENT	DESCRIPTION
PROGRAM/COURSE DELIVERY (INCLUDING ONLINE AND BLENDED LEARNING)	This process includes designing, implementing, and maintaining administrative systems and functions, ensuring efficient and effective student support, conducting audits and implementing feedback, monitoring program/course, assessing learners, and ensuring that record-keeping and data collection processes are efficient and feed back into the system.
ACCREDITATION AND QA	QA focuses on ensuring the quality of programs or courses usually by QA certification and recognition agencies, and frameworks that may operate at national and/or regional levels. It involves developing standards to inform qualification frameworks and internal and external approval processes. Accreditation is a mechanism of external quality assurance under which services and operations of training institutions or courses/programs are evaluated by an external body (accrediting agency) to determine if applicable standards are met before qualifications can be awarded.
WORK	The training provided prepares learners for effective participation in the world of work. This includes work-integrated learning (WIL), which is the provision of apprenticeships and learnerships to give practical experience of work while learning. From a lifelong perspective of the working individual, the workplace is also a place of vocational learning for informal learning and work-based learning. Where there are skills gaps, employees can also return to participate in programs or courses to address skills gaps (and enter different levels of education depending on their prior learning).
CAPACITY BUILDING	Underpinning these core functions, a key requirement is staff capacity building at all levels—to develop and improve teachers/trainers, administrators, workplace staff, and managers' skills to better meet the needs of learners and organizations and to respond to the labor market.
STUDENT SERVICES	Student services are also a core function within a well-functioning TVET system, ensuring that students get the support they require to complete their studies, make appropriate decisions about what to study, and understand how this ultimately informs their career pathway. Such services include remediation, job counselling, support to prevent dropouts, and provision of information to guide career choice and enrolment.
LABOR MARKET INFORMATION SYSTEM (LMIS)	The core functions are constantly informed by data in the Labor Market Information System (LMIS), which includes all quantitative or qualitative data and analysis related to employment and the workforce (for example, employment data by location and occupation, labor supply and demand, earnings, unemployment, and demographics of the labor force). Implementation of an LMIS involves producing information and analysis for policymakers and labor market stakeholders to inform the design, implementation, monitoring, and evaluation of policies that are better focused and targeted.[21] The LMIS also allows for the exchange of information to inform functions such as governance, developing standards, designing and developing courses, and accreditation. Data analytics drawing on LMIS data and TVET providers data in Education Management Information Systems (EMIS) plays an important role in revealing labor market trends and metrics that would otherwise be lost in the mass of information.

[21] International Labour Organization. no date. "Labour Market Information Systems. https://www.ilo.org/global/topics/dw4sd/themes/lm-info-systems/lang--en/index.htm

ROLES FOR TECHNOLOGY IN TVET SYSTEMS

Figure 1.2 presents the same overview, but this time illustrating potential roles of EdTech for each core function. This is derived from a detailed matrix highlighting the key functions and sub-functions of TVET systems, as well as the range of technology applications across the various functions, which is presented in Appendix 2. The Matrix also highlights key risks associated with the applications of EdTech. Note that some of the EdTech solutions presented below can fulfill multiple functions or sub-functions and that the solutions have varying potential to disrupt traditional TVET processes.

FIGURE 1.2 Technology deployment in TVET systems



We consider EdTech to encapsulate 'the technological tools and media that assist in teaching and learning, and its development and exchange'.[22] Building from the framework, Appendix 1 outlines key opportunities for expanding the role of EdTech within the TVET system and the opportunities and risks the public and private sectors will need to consider. It is illustrative rather than comprehensive, given the range of technologies and their applications, as well as the complexity of TVET systems.

KEY STAKEHOLDERS

The range of stakeholders operating within TVET reflects the complexity of vocational education systems. At the national level, governance structures vary regarding who is responsible for skills development and related sectors. Within countries, there are often numerous stakeholders responsible for, and participating in, the sector. For example, in South Africa, a situational analysis revealed that at least seven different types of institutions besides government departments share responsibilities for TVET at the national level.[23] At the regional economic and social bloc level, there are often multiple bodies and councils operating at multiple levels within the sector. For example, within the European Union, the European Centre for the Development of Vocational Training (Cedefop) helps to develop European VET policies; the European Training Foundation (ETF) contributes to the development of professional skills and competences; the European Quality Assurance Reference Framework for Vocational Education and Training (EQAVET) is a community of practice that promotes European collaboration in developing and improving quality assurance in VET; and the European Alliance for Apprenticeships (EAfA) aims to strengthen the quality, supply, and overall image of apprenticeships across Europe.

At the international level, there are stakeholders that fulfill regulatory and quality assurance functions, as well as training providers for staff capacity development and some that offer training to learners. For example, the Working Group for International Cooperation in Skills Development serves as a forum for dialogue concerning good practices and trends in skills development. Its secretariat is jointly hosted by the Swiss Agency for Development and Cooperation (SDC), the International Labor Organization (ILO), and the Northern Policy Research Review and Advisory Network (NORRAG). The Global Public Private Knowledge Sharing Platform (KSP) collects and shares information from TVET institutions on how they respond to changing labor market needs, adopt new training technologies, expand the outreach of their training, and improve the quality of their services including in the areas of governance, financing, teacher/trainer education, and industry partnerships.[24] The UNESCO Inter-Agency group on TVET promotes knowledge-sharing and a common understanding of key matters on TVET, and ensures effective coordination of activities by international organizations involved in policy advice, programs and research.[25] The OECD reports regularly on skills, with its July 2021 Skills Outlook on 'Learning for Life' highlighting the importance of TVET.[26]

[22] Lathan, Joseph. no date. "What is Educational Technology?" https://onlinedegrees.sandiego.edu/what-is-educational-technology-definition-examples-impact/

[23] Rajab, Rooksana, Sebolelo Nomvete, More Manda, and James Keevy. 2020. "Unlocking the power of data: A review of the state of readiness of the post-school education and training sector in South Africa for enhanced data interoperability." Johannesburg: JET Education Services and merSETA. https://www.jet.org.za/resources/unlocking-the-power-of-data-final-web-nov2020.pdf

[24] International Labour Organization. no date. "Skills for Employment – TVET Institutions." https://www.skillsforemployment.org/KSP/en/Sources/TVETinstitutions/index.htm

[25] UNESCO. no date. "Inter-agency cooperation on TVET." https://en.unesco.org/themes/skills-work-and-life/interagency-cooperation

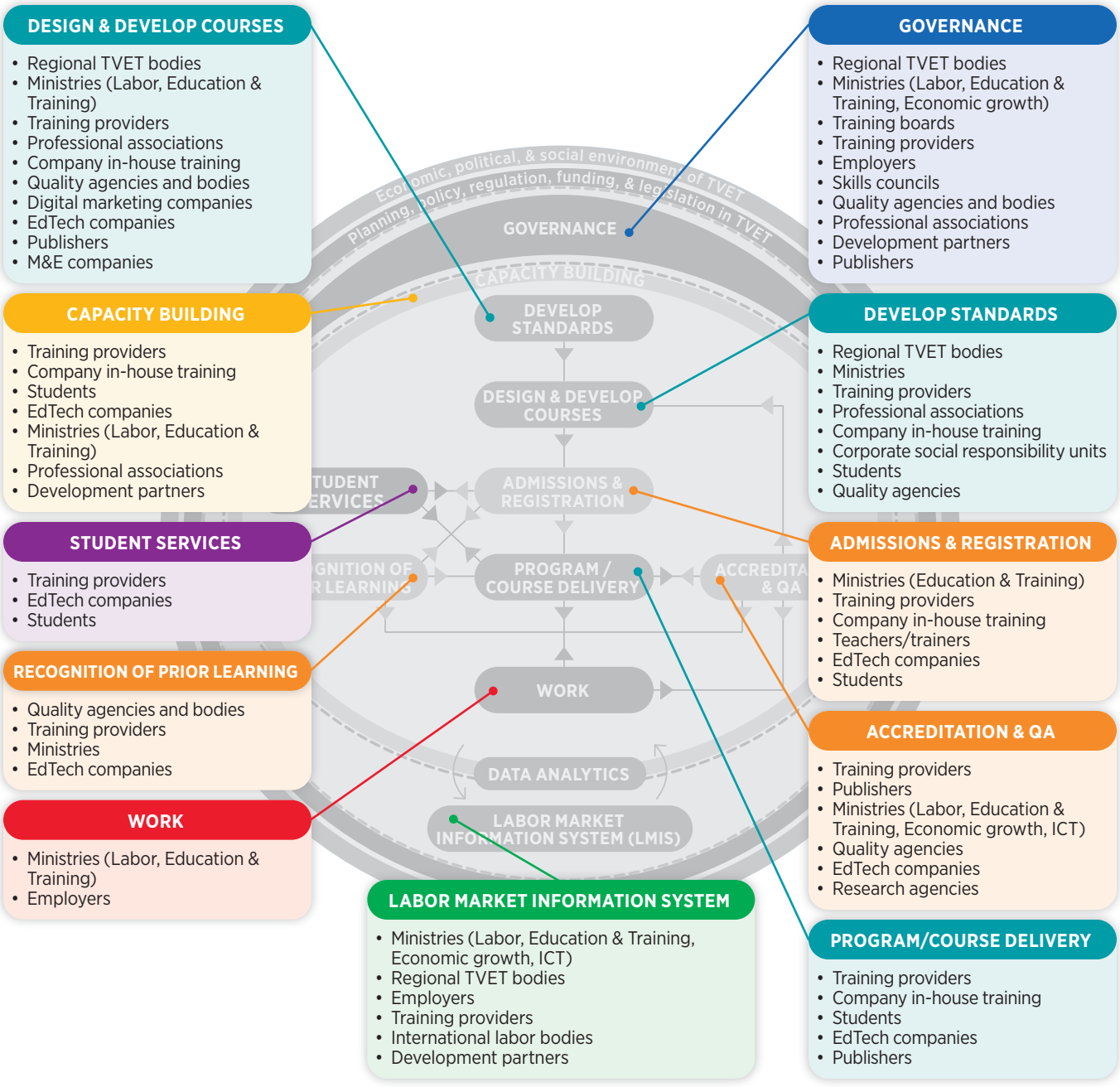
[26] OECD. 2021. "OECD Skills Outlook 2021: Learning for Life." OECD Publishing, Paris, https://doi.org/10.1787/0ae365b4-en

Some stakeholders operate at multiple levels (locally, nationally, across multiple national systems, regionally, and internationally). Examples of these include professional associations, which may set standards for professions, training providers, and companies that have in-house training units. Thus, we developed generic descriptors of the stakeholders that will likely be involved in the various TVET functions presented in the Framework, presented in Figure 1.3.

CONCLUSION

The Framework presented in this chapter highlights the complexity of the TVET sector, which encompasses several functions, responsibilities, and stakeholders. A comprehensive TVET system ideally should influence pipeline students coming from formal schooling as well as create better alignment with higher education programs that are much more strongly aligned with economic and social development priorities. Understanding and acknowledging this complexity is vital to leveraging business opportunities that present themselves and are applicable to the sector, particularly those related to EdTech. Thus, the Framework provides a basis to explore roles for EdTech in the TVET system in greater detail, including market trends, procurement models, policy levers, and business models.

FIGURE 1.3 TVET stakeholders



See Appendix 3 for a more detailed overview of key stakeholders and their roles within the TVET sector.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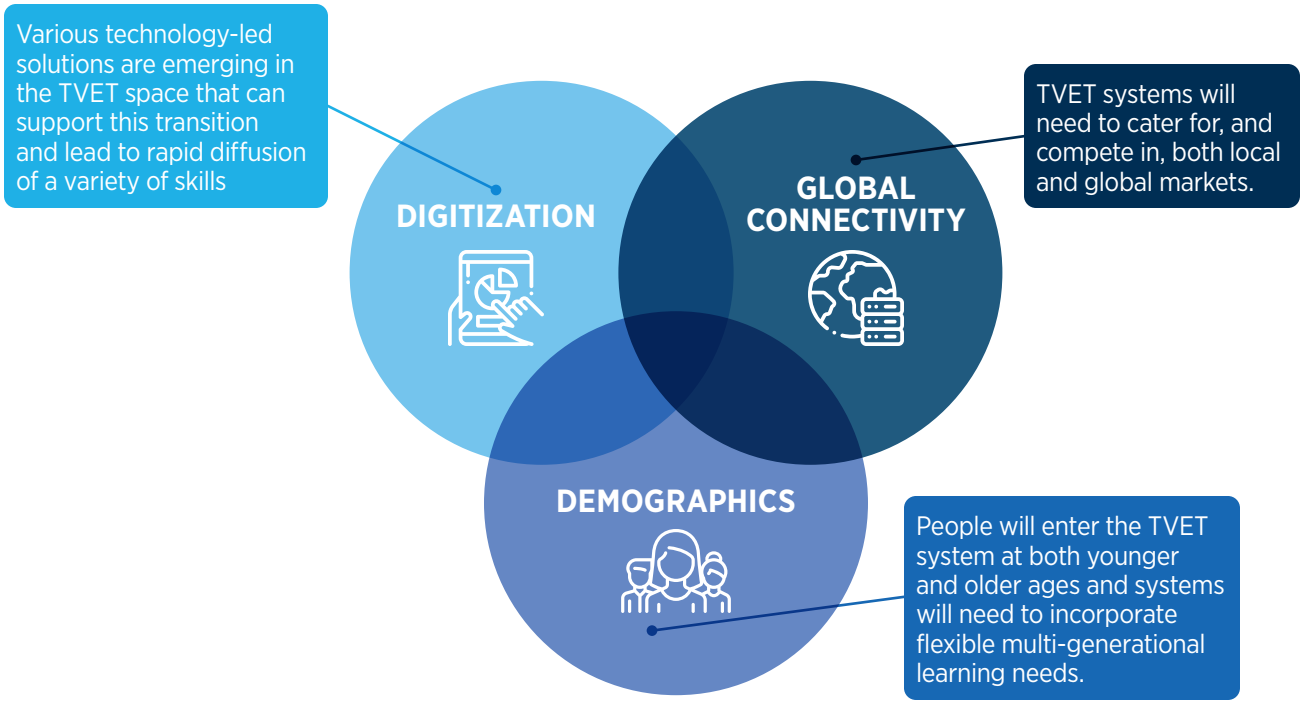
CHAPTER 2

Vocational EdTech Trends in Emerging Markets

Before focusing on the role of EdTech within TVET, it is important to understand the TVET system in context of the global trends that are shaping the lives of people both within and across countries. Even prior to the COVID-19 pandemic, these underlying trends had been shaping the nature of TVET. For instance:

- Technological change and digitization are rapidly changing the skills needed in various fields through AI, AR, VR, automation, and big data.
- Traditional markets are being disrupted at a quickening pace, necessitating improved skills matching needs for learners to identify employment pathways.
- Job mobility is increasingly important, while the model where individuals enter the workforce and remain with a single employer or even within the same career for their working lives is losing relevance. People require adaptable skills and the ability to acquire skills through continuous learning.
- Increasingly, employers look for skills rather than qualifications, which demands a more customizable and modular approach to skills development.

FIGURE 2.1 Global trends shaping vocational education



- People are increasingly connected and open to learning and work opportunities beyond their physical location.

We classify these global trends broadly across three areas: (i) demographics; (ii) global connectivity; and (iii) digitization.

Demographics: People will enter the TVET system at both younger and older ages, so systems will need to incorporate multigenerational learning needs. While population trends vary among countries and regions, the world's population growth has slowed, with the global working-age share having peaked in 2012 and now declining. The centers of global poverty will experience increases in working-age populations, offering the opportunity to reap a demographic dividend from rising incomes. In contrast, some engines of global growth, such as China, are aging rapidly and many will experience outright population contraction alongside dwindling working-age shares.[27] To support an aging global population, workers will need to remain longer in the workforce and will thus require retraining and continual learning to adapt to changing skill requirements. In contrast, the United Nations estimates that three quarters of Africa's population will be below 35 years of age by 2030, and its youth (15–24 years) are expected to account for around 50 percent of global youth. TVET will need to keep pace with demand for more innovative learning methods and emerging skills.[28]

Global Connectivity: TVET systems will need to cater for, and compete in, both local and global markets. Increasingly, talent can operate in a regional and global market through greater connectivity. Global connectivity facilitated through communications platforms and digital infrastructure can remove physical barriers to learning and opportunity. For example, globally there are over five billion mobile phone users, making mobile connectivity nearly universal in both developed and emerging markets. With the anticipated adoption of 5G, mobile phones hold even greater promise for delivering education and training. While 5G is not a necessary condition for connectivity, it delivers the coverage of 4G LTE, but at far higher speeds, with greater reliability and without noticeable delays, and with an expanded range of services that can be accessed.[29] It is expected to support a deeper digitalization of various sectors of the economy, with the scaling up of technologies like artificial intelligence (AI), robotics, and augmented/virtual reality.[30] Connectivity is transforming the ability of training providers and people to access content and learning opportunities. For learners, this means being able to access learning and work opportunities outside their physical location, and they may look to TVET providers to offer regional or globally recognized skills or certifications. For providers, this means access to new training content and markets, and they may need to cater to both domestic and international learners while facing increasing competition from nontraditional competitors. However, connectivity gaps still exist, limiting the ability of providers and learners to interact beyond their physical locations. For example, evidence from a remote learning program in India[31] suggests that students from lower-income

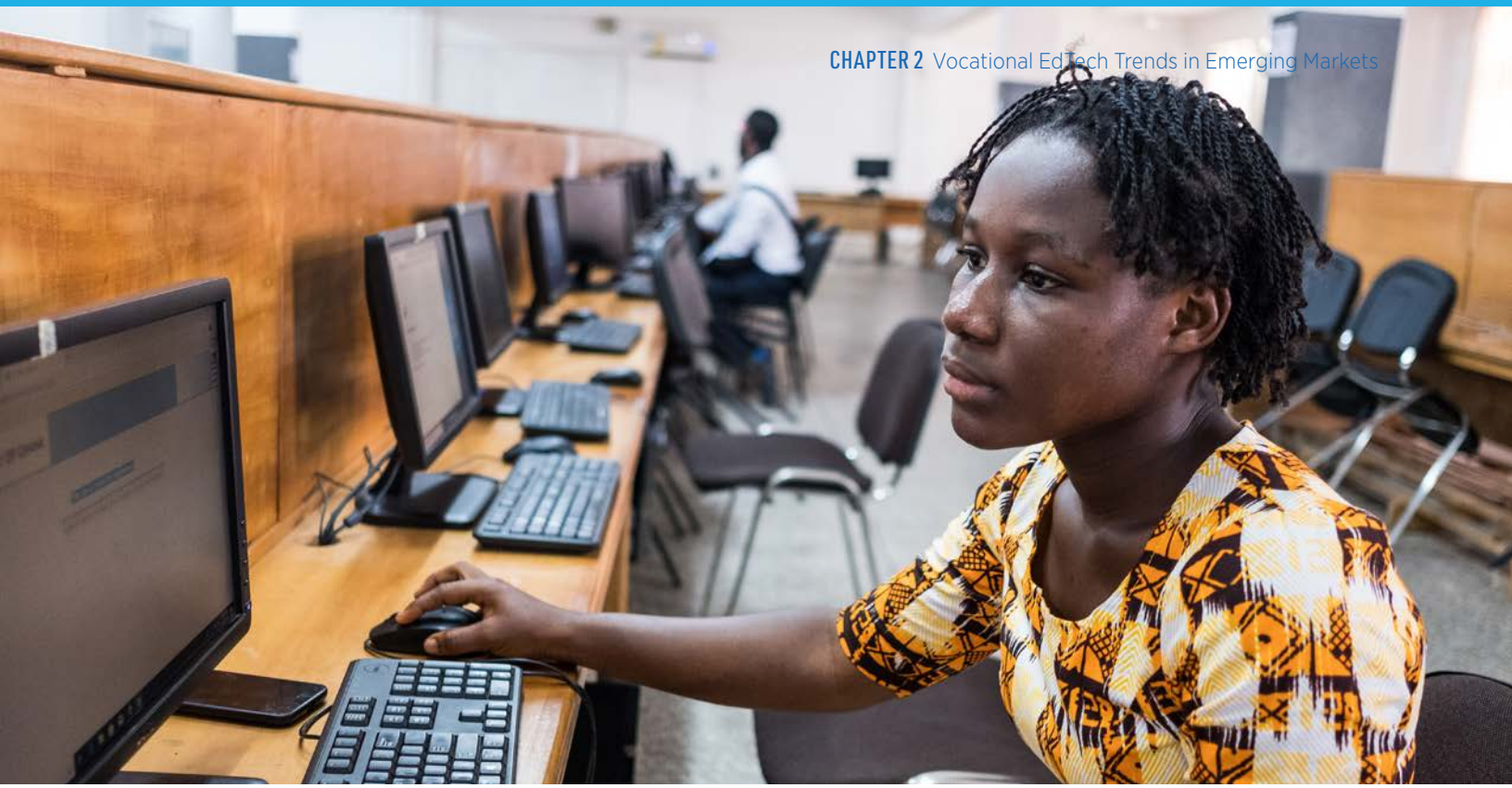
[27] World Bank Group. 2016. "Global Monitoring Report 2015/2016: Development Goals in an Era of Demographic Change." Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/22547

[28] United Nations. 2015. "Population 2030:Demographic challenges and opportunities for sustainable development planning". https://www.un.org/en/development/desa/population/publications/pdf/trends/Population2030.pdf

[29] Houngbonon, Georges V., Carlo M Rossotto, and Davide Strusani. 2021. "Enabling Private Investment in 5G Connectivity in Emerging Markets: An Assessment of Challenges and Policy Options." EMCompass; Note 102. International Finance Corporation, Washington, DC. https://openknowledge.worldbank.org/handle/10986/35668

[30] Baloko, Makala, Maud Schmitt, and Alejandro Caballero. 2021. "How Artificial Intelligence Can Help Advance Post-Secondary Learning in Emerging Markets." EMCompass; No. 97. International Finance Corporation, Washington, DC. World Bank. https://openknowledge.worldbank.org/handle/10986/35054

[31] Bansal, Seema, Shoikat Roy, and Garima Batra. 2021. "How COVID-19 Advanced Digital Learning for Lower-Income Populations". https://www.bcg.com/publications/2021/covid-19-advanced-digital-learning-for-lower-income-populations



households had limited access and difficulties engaging with remote learning sessions due to internet charges, device quality, and electricity outages. Specifically, 5G may take longer to reach maturity in emerging markets than previous generations of mobile technologies under the current enabling environment. For instance, in Sub-Saharan Africa, limited availability of broadband and data infrastructure is the biggest barrier to 5G availability[32] and the estimated total cost of connecting African higher education institutions over the next five years (2021–2025) is $52 billion.[33]

Digitization: Various technology-led solutions are emerging in the TVET space that can support this transition and lead to rapid diffusion of a variety of skills. Technological change is an ever-present factor for which TVET systems need to adapt. Digitization is impacting TVET through both accelerated demand for digital skills in learning outcomes and digitization of how the trainer and learner interact during training provision. As disruptive technology forces emerging economies to change their economic development paths, new skills are constantly required to adapt to a changing environment. The COVID-19 pandemic has further highlighted the importance of digital skills as the digital economy has boomed and remote work has become more prevalent.[34] Economies will need to adjust rapidly to post-COVID circumstances such as reduced reliability of global supply chains, reduced ability to travel, shifting remote working requirements, and changing consumer demand patterns. TVET can support this adaption through reskilling and upskilling, supporting people to build employment resilience and improve their lifetime incomes. However, the expansion of high-tech solutions such as virtual learning environments can exacerbate digital divides, both within and between countries.[35]

[32] Houngbonon et al. 2021.

[33] World Bank; Knowledge Consulting Ltd. 2021. "Feasibility Study to Connect All African Higher Education Institutions to High-Speed Internet". World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/36042

[34] Hoftijzer et al. 2020.

[35] Saavedra, Jaime. 2021. "A silent and unequal education crisis. And the seeds for its solution." https://blogs.worldbank.org/education/silent-and-unequal-education-crisis-and-seeds-its-solution

INTERSECTION BETWEEN EDTECH AND GLOBAL TVET TRENDS

EdTech is rapidly emerging as a transformative force in TVET in emerging markets. Chapter 1 has identified emerging areas of opportunity for EdTech to complement, augment, and, in some instances, transform TVET systems. In this Chapter, we examine key trends shaping EdTech in TVET in emerging markets and present conclusions from our research on the potential opportunities and barriers of each.

TVET is being shaped by global trends. EdTech is where these trends intersect and is at the forefront of enabling the TVET sector to keep pace and expand its role as a critical link in equipping emerging market populations with 4IR-ready job skills.

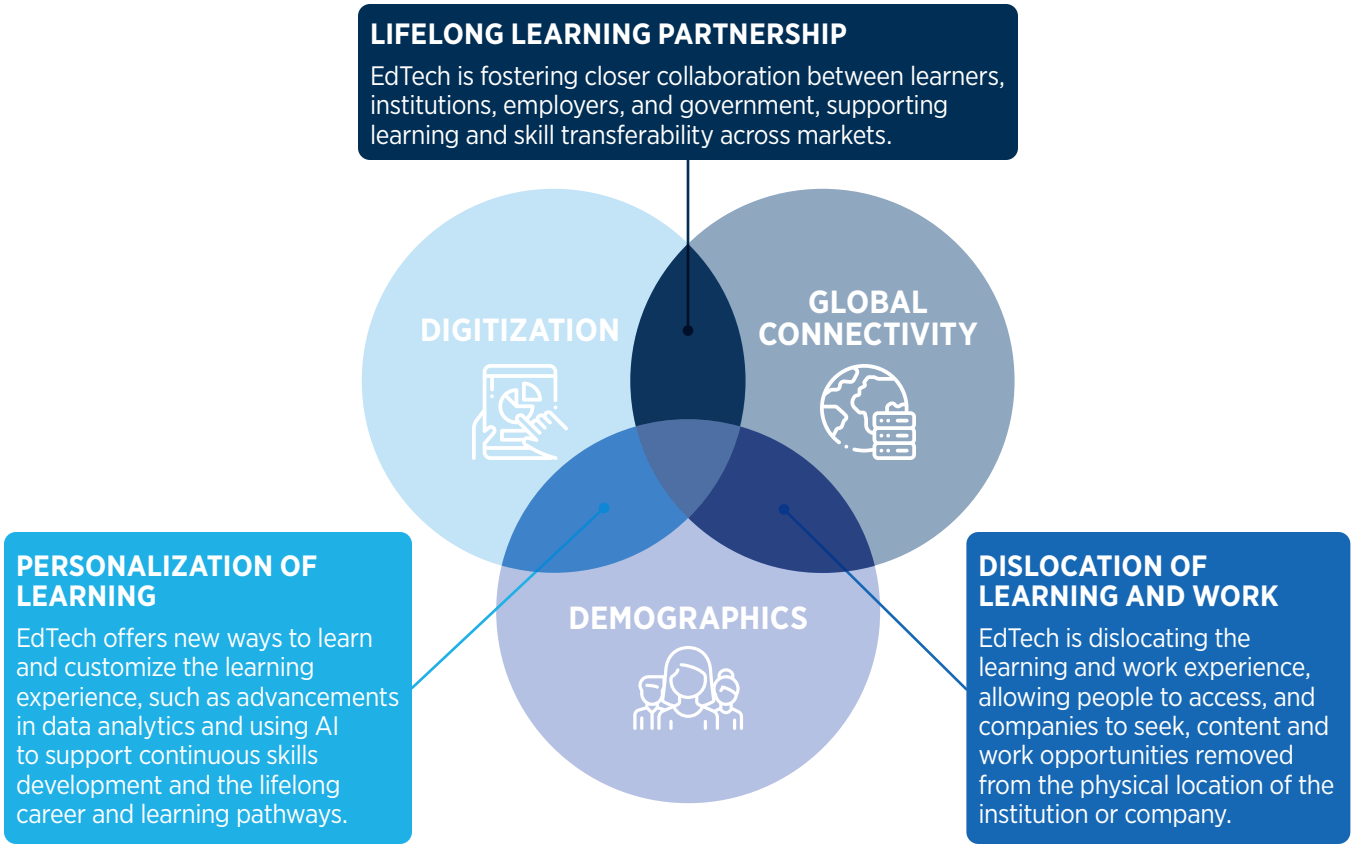
Dislocation of learning and work

EdTech is allowing people to access, and companies to seek, both learning and work opportunities removed from the physical location of the institution or company.

EdTech is allowing dislocation along three mutually reinforcing fronts: (i) dislocation between the physical location of the learner and the training provider; (ii) dislocation between the physical location of the training provider and the source of the content they can offer; and (iii) dislocation of the employer and the employee to whom the learning or skills development is targeted.

Dislocation between learner and training provider: Improving global connectivity has enabled training to move online. Online platforms are enabling learners to access international standard courses

FIGURE 2.2 The intersection of trends shaping vocational education



through remote learning platforms such as Coursera and online coding bootcamps like Springboard. This means that people are not bound to the institutional infrastructure (or lack thereof) and are able to develop internationally recognized skills and, in some cases, supporting mentorship. The increasing ability to digitize content is also expanding the boundaries of the types of learning that can be offered online, as well as their reach. Facilitated by connectivity platforms such as Zoom or Educate!, online offerings can also support virtual live interaction between learner and trainer, regardless of physical location.

Dislocation between the training provider and the source of their content offering: Traditionally, due to the necessity to conduct in-person training, content has been developed and offered at best at the national level, but often developed and offered in-house at training institutions. EdTech is changing this relationship by enabling training providers to license top-tier content to augment their in-house offerings. This is particularly relevant for emerging markets that may not currently have training capacity to offer global standard content and can draw on third-party content through EdTech platforms such as Google Certificates to offer their learners training courses that provide them relevant and necessary skills to complete in regional or global job markets. In turn, this augmentation could support the diffusion of digital skills and training capacity within the market.

Dislocation between the employer and employee: Changing global demographics mean there is some disconnect between economic weights and the sources of population growth. The COVID-19 pandemic has highlighted the possibilities and potential benefits for companies to pursue a distributed workforce model. This model breaks the physical link between employer and geography; meaning companies can look for the right person for the role among a global talent pool, and not just the best potential hire within travel distance to a physical office. Talent can increasingly work remotely for a company without leaving home and disrupting their lives, opening new possibilities and levelling the playing field between employer and talent. However, this distributed workforce model can only be made possible through EdTech offerings such as Andela and Revelo that match talent with global companies and identify and fill skills gaps. This is particularly relevant in solving the global demographic challenge where population growth is occurring in low-capacity emerging markets, and economic weight is concentrated in developed markets with aging populations. EdTech platforms can provide the critical link in unlocking capacity to both improve incomes for people in emerging markets and maintain living standards for people in developed markets. It also enables employers to achieve greater diversity and inclusion through dispersed workforces.

Opportunities unlocked through EdTech models that promote dislocation include:

- More flexible learning programs through use of multi-modal platforms
- Ability for populations in emerging markets to access higher-quality training opportunities, with globally recognized content
- Ability of global companies, particularly in technology, to access talent in emerging markets and to foster greater diversity and inclusion in their workforces
- And diffusion of digital capacity and awareness of emerging skills within emerging markets, as people and institutions integrate higher quality content into curricula.

Barriers and challenges to dislocation models include:

- Low-income and vulnerable populations may be unable to access online learning due to technical limitations in connectivity and equipment.
- Access could also be limited by factors such as limited learning structure and guidance that can be provided within the household. People may also face additional constraints in terms of time zones and availability due to competing

responsibilities such as caring for children and elderly family members.

- Relatively low levels of existing digital capability and awareness of EdTech opportunities could hinder take-up and ability to directly connect with current EdTech offerings.
- Lack of trainer capacity to provide sufficient guidance to learners if providers are offering third-party content to augment in-house capabilities.
- Long term engagement issues in remote learning as indicative evidence from institutions that have switched during COVID-19 suggest potential online learning fatigue and difficulties in maintaining learner engagement in long-term, online-only environments.

TABLE 2.1 Examples of dislocation models

COMPANY/ PROGRAM	DESCRIPTION	EDTECH OPPORTUNITY
Coursera[36] (Global)	Is one of the largest online learning platforms in the world, with 77 million registered learners, around half of whom are in emerging markets. Coursera works with over 200 international university and corporate partners to offer over 4,500 top-tier courses and 20 degrees	Online and blended learning Work Integrated Learning Micro-credentialing and certification
Andela[37] (Africa/Global)	Beginning in Lagos, Nigeria, and now across multiple continents, Andela supports a talent network to train and connect engineering talent, particularly in Africa, with the world's top companies	Online and blended learning Work Integrated Learning
Revelo[38]	An online business-to-business (B2B) recruiting marketplace that uses machine learning to streamline the hiring process by efficiently connecting job candidates with employers who are hiring for open positions. The Company uses its data to conduct candidate sourcing and matching that removes human interaction from the curation process for candidates. Revelo's reports 83% hiring success vs. 46% for offline recruiting agencies.	Technology-enabled Materials Design and Development Work Integrated Learning
Springboard[39] (Global)	Provides online mentor-supported training courses focused on digital design, data science, and coding to enable students across 100 countries to find technology jobs.	Online and blended learning Work Integrated Learning Micro-credentialing and certification
Zoom[40] (Global)	Offered many resources on 'educating through Zoom' and has been increasing servers and equipment in data-center locations to prevent data centers from reaching peak capacity due to the increase in remote learning	Online and blended learning
Google[41] (Global)	Launched its 'Teach From Anywhere' platform, providing resources for virtual learning such as Google Classroom, Google Meet, and Google Workspace for Education	Online and blended learning
Educate![42] (Africa)	Educate! had to rapidly transform its evidence-based, in-school model, which delivers hands-on transferable skills, entrepreneurship, and workforce readiness training for secondary school students. As COVID-19 closed schools, Educate! responded by delivering a flexible distance learning experience, utilizing accessible technologies like radio, SMS, and phone calls	Online and blended learning

36 https://www.coursera.org/
37 https://andela.com/about/
38 https://revelo.io/
39 https://www.springboard.com/about/
40 https://zoom.us/docs/en-us/covid19.html
41 https://teachfromanywhere.google/intl/en/#for-teachers
42 https://worldbankgroup.sharepoint.com/sites/education/SitePages/Detail.aspx/Events/mode=view?_Id=5320&SiteURL=/sites/education

Personalization of learning

EdTech offers new ways to learn and customize the learning experience, such as advancements in data analytics and using AI to support continuous skills development and the lifelong career and learning pathways.

EdTech is becoming increasingly digitized and integrated at all levels of the learning and career pathway: (i) integrating new technologies to push the frontiers on online or digitized learning; and (ii) integrating data capture and analytics through AI to support learning and career pathways.

Integrating new technologies into learning:

The World Economic Forum estimates that 65 percent of today's children will grow up to work in positions and jobs that do not exist yet.[43] As the pace of digital transformation of traditional industries accelerates, there is significant interest and investment in new digital technologies for TVET due to increasing demand from employers. This has been driven by a greater degree of industrial automation, an increase in complexity of tasks and equipment, multidisciplinary workflows, and a greater emphasis on research and development (R&D) to gain economic advantage. More complex

[43] World Economic Forum. 2020. "The Future of Jobs Report 2020." https://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf

digital workflows in industry also need to be reflected in TVET institutions and require training to adopt new forms of digital technology to deliver learning. Approaches—such as simulation-based learning (including VR and AR); flipped classroom learning through open educational resources (OER); plug-and-play learning, conversational AI; adaptive learning; robotics; blockchain; and gamification; among others—can enhance the learning experience and make learning more flexible, particularly where access to face-to-face learning is challenging (as has been the case during the COVID-19 pandemic). This can create a foundation to build more inclusive, effective, resilient, and efficient TVET systems. Further, introduction of frontier technologies into learning can provide novel ways to conduct practical hands-on training digitally, which previously was thought to require physical use of specialized equipment, for instance EdTech companies such as 3DBear and EON Reality that use VR or AR to provide hands-on training.

Integrating data analytics and AI into lifelong learning: Use of data capture and AI into learning and careers planning is enabling EdTech services to track outcomes and customize learning experiences. These techniques are being used extensively in EdTech to differentiate learning differences and automatically adjust coursework to a student's best style of learning. For instance, language learning platforms such as Duolingo capture every interaction the learner makes with the application and use AI to gamify and incentivize progression. Companies like upGrad in India are using AI to extract data from job classifieds (such as Indeed, LinkedIn, local classifieds, and company surveys) to predict employability, and then suggest to learners the skills they should learn to increase their probability of improved employment outcomes. Integration of data and AI is also extending into integration of learning with talent management and recruitment services as companies such as SMRT.bio and eightfold.ai deconstruct traditional interview-based recruitment to develop data-based skills needs and talent profiles to better match talent to company skills needs. The ability of EdTech to support data intensive ways of learning and recruitment potentially signals a trend toward data and algorithmic recruitment, in a similar way to how major sports use the concept of 'Moneyball' to develop teams based heavily on statistics.

Opportunities unlocked through EdTech models that integrate frontier technology:

- Adoption of new forms of digital technology for TVET delivery and digitizing previously hands-on content
- Embedded user data capture of EdTech platforms will enable customer behavior analysis and future evidence-based policy making
- Closer matching of talent to employer skills needs
- Greater accessibility to an expanding range of digitized learning options
- Improved student engagement and retention through personalization.

Barriers and challenges to integrating frontier technology models include:

- Frontier technologies are relatively unproven and may lack depth of supporting evidence on effectiveness
- Skepticism of industry to vocational EdTech initiatives, the 'new' way of doing things and the technological infrastructure barriers to enable use of these emerging tools
- Lack of industry or institutional support to take up and recognize new technologies
- Lack of capital to finance initial costs of frontier technologies such as VR/AR platforms
- AI tools rely on algorithms which may have limitations or biases depending on the availability of good quality data to inform matching and learning pathways.

TABLE 2.2 Examples of frontier technology models

COMPANY/PROGRAM	DESCRIPTION	EDTECH OPPORTUNITY
Nalendi, UNIDO, Government of Finland[44] (South Africa, Malawi, Zambia, Zimbabwe)	Virtual Reality training app to learn how to properly operate chainsaws in forest industries. This partnership between UNIDO and Government of Finland will be piloted in South Africa and replicated in Malawi, Zambia, and Zimbabwe.	Technology-enabled Materials Design and Development
Festo Didactic[45] (Global)	Festo LX, an online portal for teachers and learners, allows access to online vocational courses (e.g., hardware-related courses including hydraulics and metal working). The portal allows for individual learning and learning analytics while undergoing mobile learning.	Technology-enabled Materials Design and Development Work Integrated Learning
3DBear[46] (Global)	3DBear creates customized AR/VR to teach hands-on skills remotely and is working on a development project with Global Education Services Taitaja (a Finnish vocational training school) to help their teachers produce VR-learning materials for vocational fields.	Technology-enabled Materials Design and Development Work Integrated Learning
EON Reality[47] (Global)	Focused on technical vocational training solutions, EON Reality's EON-XR platform allows teachers and students to create AR/VR lessons without basic coding knowledge.	Technology-enabled Materials Design and Development Work Integrated Learning
Duolingo[48]	A language learning service with over 300 million users globally in both developed and emerging countries. It breaks language learning into micro-lessons and uses machine learning algorithms to constantly adjust learning content to personalize questions and progress the learner toward fluency.	Technology-enabled Materials Design and Development Work Integrated Learning
upGrad[49]	An online higher-education platform providing industry-relevant programs designed and delivered in collaboration with world-class faculty and industry.	Work Integrated Learning Micro-credentialing and certification
SMRT.bio[50] (Global)	Employers can use SMRT.bio to advertise and promote vacancies and internships. Individuals are able to use the system to take psychometric tests and profile themselves, the logic being that the better a person is able to articulate his/her profile, the easier it is for an employer to match that person with a relevant job. Individuals can generate their own CVs, apply for vacancies and internships, and access personal learning advice.	Technology-enabled Materials Design and Development Work Integrated Learning
Eightfold.ai[51]	Eightfold.ai's deep learning AI uses neural networks that learn from 1 billion+ profiles, billions of global data points and 1 million+ unique skills to deliver bias-free, data-driven insights. It enables companies to identify the prevalence of capabilities on a global scale—which capabilities are increasing, which are diminishing, and where to find people with desired capabilities in real-time.	Technology-enabled Materials Design and Development Work Integrated Learning

44 https://www.unido.org/stories/virtual-reality-training-southern-africa

45 https://lx.festo.com/en/

46 https://itslearning.com/global/com/reinventing-vocational-learning/

47 https://eonreality.com/

48 https://www.duolingo.com/approach

49 https://www.upgrad.com/us/about

50 https://smrt.bio/international

51 https://eightfold.ai/why-eightfold/talent-intelligence-platform/

Lifelong learning partnerships

EdTech is fostering closer collaboration between learners, institutions, employers, and government, supporting learning and skill transferability across markets.

Driven by global connectivity and demand for new ways of working, EdTech is facilitating closer collaboration between employees (as learners) and employers and between learners and governments.

Collaboration and partnerships between employees (as learners) and employers: As disruptive technology forces emerging economies to change their economic development paths, new skills are constantly required to adapt to a changing environment. Increasingly, workers require continuous learning to augment their current skill sets and stay relevant in response to new technologies and digitization of current tasks. While it is becoming less likely that a person stays with one company or even one career over their entire lifetime, employers need to work with their employees to both stay relevant and attract and retain talent. Employees are increasingly conscious of the need to maintain and improve their skills and are looking for these skills to be transferrable in a global marketplace. Employers want to minimize disruption in the workforce and seamlessly integrate training options to workflows as required. This is driving demand for top-up skills development that is short and flexible enough to manage alongside work, and of recognizable quality to be transferrable across employers. EdTech solutions such as Crehana and Linkedin's Lynda meet these needs by changing the traditional course-based learning model and promoting the use of micro-credentials that focus on specific skills.

Offerings through recognizable EdTech providers and/or companies may also allow these micro-credentials to be branded and used to provide recognition of skills development beyond the employer through which the training was conducted, for example by adding Coursera or Google Certificates content into CVs. These recognizable micro-credentials can in turn be stackable and integrated into more traditional institutional settings.[52] For example, a partnership between the University of London and Coursera is recognizing Google IT Support Professional Certificate as recognition of prior learning credit toward its BSc Computer Science degree programs.[53] This certificate is available on demand through Coursera for anyone interested in IT, regardless of prior training or qualifications. The closer partnerships between the employee (as learner) and employer represent a significant opportunity to evolve the traditional course-based TVET industry and use EdTech to open lifelong learning and career pathways for underserved populations in emerging markets.

Greater collaboration can also be seen in partnerships between private sector entities facilitated through EdTech. For example, in the United States the T3 Network[54] at the US Chamber of Commerce Foundation is working on educational and workforce data standards to create competency-based lifelong learner records so that all learning counts, no matter where it takes place. This network has grown to more than 500 organizations working together to change the way educational and workforce data is used; this is being done using AI, blockchain, and other advanced technologies to create an open and decentralized public-private data ecosystem. Achieving seamless sharing of data throughout a person's education and career path will empower individuals with a validated record of their skills and competencies in a way that all employers can understand.

[52] World Economic Forum. 2020.

[53] Rai, Binda. 2018. "Fast-track your degree with Google's IT Support Professional Certificate." University of London. https://london.ac.uk/headstart-with-computer-science

[54] https://www.uschamberfoundation.org/t3-innovation

Collaboration and partnerships between learners and government (and institutions): EdTech also offers new ways for government to facilitate educational outcomes and support economic objectives. For example, by using AI and real-time data collection on EdTech platforms, training can be more closely aligned to skills needs and lead to higher incomes for learners, and in turn support higher taxation revenue collection for government. The opportunity for collaboration to augment existing education offerings is dramatically highlighted in response packages to the economic consequences of COVID-19. When the COVID-19 pandemic closed industries almost overnight, governments needed to respond and provide retraining opportunities to meet the specter of rising unemployment. Through EdTech, governments were able to rapidly collaborate with EdTech companies such as Coursera to offer retraining opportunities that were unavailable through formal institutional settings. However, these opportunities have yet to be fully explored due to limitations in capacity and readiness of governments to integrate new technologies into TVET. For instance, the ILO reports:

> *Very few countries have a coherent strategy to digitize TVET and skills systems. Despite multiple readily available technologies for improving TVET and skills development, our study only found limited evidence of explicit macro-level strategies to increase efficiencies and/or the impact of TVET through the use of digitization—nor has digitization of TVET or skills development been mentioned as a potential accelerator for desirable social changes.*[55]

Opportunities unlocked through EdTech models that foster closer collaboration between stakeholders:

- Greater demand for modular learning and recognition of micro-credentials offered by the private sector to enable workers to signal gained skills
- Ability to offer employer-recognized micro-credentials and for employers to participate more directly in training design
- More timely and relevant information of skills needs for training providers to offer training in
- Greater access to upskilling opportunities for underserved/workers who are left behind by structural change, or improved resilience to cyclical fluctuations via skill diversification
- Greater collaboration that could lead to faster adoption of vocational EdTech in TVET providers and could also result in a wider acceptance of vocational EdTech as a learning tool in the industry
- Reduced burden on government to fund TVET
- Enhanced government tax revenues as a result of higher income of populations that have upskilled to match employment opportunities

Barriers and challenges to promoting EdTech models that foster closer collaboration between stakeholders:

- Readiness of employers to recognize and hire talent with EdTech or employer branded micro-credentials
- Potential employer capture of workforce by directing employee training toward employer-specific micro-credentials that may not be relevant beyond that employer, restricting transferability between jobs and/or countries
- Larger firms may be better able to provide resources to support lifelong learning than small and medium enterprises (SMEs), potentially leaving these smaller firms at a disadvantage in attracting talent and reskilling employees
- Alignment and recognition of employer led or micro-credentialled training initiatives within the national TVET system and their transferability between jobs/countries
- Lack of coherent EdTech strategy from governments and industry bodies

[55] World Economic Forum. 2020.

TABLE 2.3 Examples of collaboration models

COMPANY/PROGRAM	DESCRIPTION	EDTECH OPPORTUNITY
Crehana[56] (Latin America)	Crehana is an upskilling platform that offers over 500 courses on platform to around 5 million users; and 250 companies are using the platform to upskill employees. Crehana users report: 46% increased their income after taking a course in Crehana; 79% considers their life improved after taking a course in Crehana; 65% of students consider that Crehana was very helpful in the process of finding their current job.	Work Integrated Learning Micro-credentialing and certification
Linkedin Lynda (Global)	Provides more than 5,700 courses and 255,000 video tutorials across mobile and desktop taught by recognized industry experts. Companies can buy access to the platform for their employees, using the platform to track and assign employees skill development modules.	Work Integrated Learning Micro-credentialing and certification
T3 Network[57] (USA)	This network has grown to more than 500 organizations working together to change the way we provide, access, and use educational and workforce data by using advanced technologies like AI, blockchain, and others to create an open and decentralized public-private data ecosystem.	Work Integrated Learning Micro-credentialing and certification
IBM[58,59] (Egypt/Nigeria)	IBM is partnering with Egypt's Ministry of Education to establish Egypt's first ICT school operating on the P-Tech model system to provide specialized educational opportunities in the field of technology. IBM also partnered with Nigeria to create the IBM Digital Skill Training Program. Due to the COVID-19 pandemic, the program has moved to online learning and 7,000 Nigerian youths have received IBM certifications.	Work Integrated Learning Micro-credentialing and certification
Microsoft (UAE)	As part of their wider program to support digital skills development through government partnerships, Microsoft has partnered with the government of Dubai to upgrade tech skills and support the United Arab Emirates' (UAE's) transformation plans. Emirati workers will shadow Microsoft employees and Microsoft will offer internship and secondment opportunities to UAE nationals.	Technology-enabled Materials Design and Development Work Integrated Learning
Google[60] (Global)	Offers Google Career Certificates (three new six-month programs on data analytics, project management, and user experience design).	Assessment of learning Technology-supported RPL Micro-credentialing and certification
Coursera[61] (Global)	Coursera's Workforce Recovery Initiative provided free access to courses through government organizations that serve unemployed citizens and other target groups. The program eventually reached over 100 countries, with over 1.1 million learners enrolled in 8.5 million courses.	Online and blended learning Technology-supported RPL Micro-credentialing and certification

56 https://www.crehana.com/sobre-nosotros/

57 https://www.uschamberfoundation.org/t3-innovation

58 https://egyptindependent.com/egypt-cooperates-with-imb-to-launch-its-first-it-school/

59 https://www.pmnewsnigeria.com/2020/06/25/7000-nigerian-youths-certified-by-ibm-in-digital-skill/

60 https://grow.google/certificates/#?modal_active=none

61 https://learner.coursera.help/hc/en-us/articles/360049172132-Coursera-Workforce-Recovery-Initiative-The-Initiative-FAQ-s#h_01EJEW5X60SCGGF62Q7WYE4NQ9

COMPANY/PROGRAM	DESCRIPTION	EDTECH OPPORTUNITY
Udacity (Global)	Provides free access to Nanodegree programs, discounts on online learning, and offers free tech training to laid-off workers during the COVID-19 pandemic.	Online and blended learning Technology-supported RPL Micro-credentialing and certification
Certif-ID International and TÜV Rheinland[62] (Philippines)	Alongside government partners, launched an initiative to help unemployed seafarers create a digital community to find jobs. This involves using a SkillPass, which seafarers can use to showcase their skills, record and share online interviews, and store all relevant information in a digital portfolio secured with blockchain technology.	Technology-supported RPL
Fundación Carlos Slim[63] (Mexico/Honduras/ Guatemala)	The Capacítate Para El Empleo online portal is currently offering free access to hundreds of courses and several diploma degrees for technical occupations and has developed partnerships with organizations to expand this access to several Central American countries.	Online and blended learning Micro-credentialing and certification
Microsoft (India)	Microsoft has partnered the with the National Skills Development Council (NSDC) to reskill 100,000 Indian women from underserved populations with digital skills in October 2020. Free courses include digital literacy, enhancing employability, nano entrepreneurship, and communication skills.	Online and blended learning Micro-credentialing and certification
Facebook (Mexico/Colombia / Argentina)	Facebook is supporting small enterprise upskilling in Mexico, Colombia, and Argentina via free sessions to be led by program partners, which will provide training on leadership and gender inclusion, sales and business model, innovation during crises, and how to present the business to investors.	Online and blended learning Micro-credentialing and certification
Microsoft (Nigeria)	The African Development Bank, the government of Nigeria, and Microsoft launched the Digital Nigeria eLearning Platform to provide marketable digital skills to the country's youth. The platform offers courses in web development, content creation, and data science and other digital skills and will use gamification to teach problem solving, collaboration, creative thinking, and basic coding. Within 24 hours of launch the platform recorded over 16,000 user registrations.	Online and blended learning Micro-credentialing and certification

CONCLUSION

This chapter highlights how the opportunities for EdTech arise at the intersections of global trends of demographics, global connectivity, and digitization. Models that can align with these trends may be able to capitalize on the unmet demand that exists in emerging markets and offer an opportunity to develop globally scalable EdTech solutions that: (i) are unbound by geography—addressing the gap between low-capacity, high-growth emerging markets, with the demand from developed markets and the workforce needs of global companies; (ii) can personalize the learning experience—through use of frontier technologies and AI to promote enhanced learner engagement; and (iii) utilize closer collaborations and stackable micro-credentials to provide more flexible lifelong learning and career pathways.

[62] https://insights.tuv.com/blog/certif-id-joins-forces-with-t%C3%BCv-rheinland-philippines-and-multiple-government-agencies-to-support-seafarers-impacted-by-covid-19

[63] https://capacitateparaelempleo.org/

BOX 2.1 SMRT.bio leverages technology to connect labor market stakeholders, aligning skills supply and demand

SMRT.bio focuses on talent acquisition and development. It aims to connect four key stakeholders in the labor market—individuals, employers, education representatives, and regional representatives—enabling better matching of individuals with required labor market skills and educational offerings that are better aligned with graduate skills. It is active in the Netherlands, the United Kingdom, Germany, Poland, Ukraine, Finland, Canada, the United States, New Zealand, and South Africa. SMRT.bio is available for free to all stakeholders, while regions, employers, and education stakeholders can add additional services at a cost. SMRT.bio has developed a social architecture to allow these four key stakeholders to collaborate and gain specific benefits.

Individuals are able to use the system to take psychometric tests and profile themselves, the logic being that the better a person is able to articulate their profile, the easier it is for an employer to match that person with a relevant job. Individuals can generate their own CVs, apply for vacancies and internships, and access personal learning advice.

Employers can use SMRT.bio to advertise and promote vacancies and internships. They also have access to the job library, which contains 26,000 template job descriptions and can use a fully automated selection process. As soon as a company joins the platform, it can go into the library and select jobs it offers, together with any vacancies.

Education representatives can publish their learning catalogues on SMRT.bio and access big data analysis via CockpitWork, SMRT.bio's data analysis tool. The platform allows Education stakeholders to align their offerings with skills requirements and ensure that their offerings are competitive.

Regions can also conduct data analysis and can integrate the platform with existing job boards and coaching applications. Representatives of regions can use the platform for economic development, mobilizing talent and assets and improving labor market cooperation.

This social architecture is complemented with four dedicated programs: Jobs of Today, Entrepreneurship, Innovation, and Jobs of the Future. All four programs are linked with the concept of lifelong learning. A key element of the Jobs of Today program is the SupportersDesk, a personal development program that supports unemployed people to gain work experience and to find work through a network of micro SMEs. It allows unemployed people to be trained and coached to become certified supporters. These supporters reach out to employers and enrol them onto the platform. SMRT.bio partners with local organizations to implement SupportersDesk in their own regions.

SMRT.bio is an example of an innovative EdTech initiative because it harnesses data analytics in its efforts to align labor market demand with supply, the ultimate goal being to use collaboration and partnership to 're-invent the economy making it more robust and agile for the post-COVID era.'

Sources:
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SMRT.bio.2021. "Home". https://smrt.bio/international
Supplementary resources provided courtesy of SMRT.bio.

BOX 2.2 India is receiving a surge of interest in EdTech offerings to provide upskilling and skill matching opportunities, as well as alleviate access challenges to vocational education

With approximately 45 percent of India's population being below 24 years of age, the country's education sector provides great growth opportunities. The sector is expected to reach $1.96 billion by 2021 with around 9.5 million users, and has become the second largest market for EdTech after the United States. Typical learners on EdTech platforms are young workers with Bachelor's degrees from Tier 2+ universities, who are seeking to complement their skillsets in specialized fields such as data analytics, technology, and management. These courses can lead to a certificate or a college degree and are skill-specific and industry-relevant, with a focus on individuals' employability. EdTech offers an opportunity to assist India in meeting the skills requirements of a growing and rapidly digitizing economy. Business productivity and employment of high-skill workers remain challenging throughout the country as the unemployment rate for individuals with tertiary education is 15 percent and the share of firms identifying an inadequately educated workforce as a constraint to growth is 11 percent, both above the regional and income-group averages. These gaps reflect a skill mismatch in the Indian labor market, potentially exacerbated in non-metropolitan areas where access to traditional means for upskilling is more limited. For instance, 60 percent of employers report difficulties in filling vacancies, and the incidence of underqualification in India is among the highest in lower-middle income countries.

Further, these challenges come against the background of limitations to access to offline upskilling services as a result of physical distancing measures induced by the COVID-19 pandemic. The closures of higher education institutions and their relatively limited adoption of digital tools to continue educational programs have impeded learning, especially for learners in remote areas, and at least two-thirds of work-based learning opportunities were completely interrupted due to the mobility restrictions. Young individuals were especially affected—the youth unemployment rate was expected to rise from 23 percent in 2019 to around 30 percent in 2020. Responding to these challenges, the upskilling segment has seen a substantial increase across skilling platforms such as SP robotics, Toppr Codr, Udacity, and SOAL, with hybrid approaches to education becoming the norm. Newer, more sophisticated types of technology have become popular, including gamification of learning, edutainment, and use of AI in personalizing education (for example, data-driven insights). However, while upskilling and skill matching services are growing, most new investments have targeted specific areas of EdTech (for example, after-school study, targeted tuition, or test-prep products), and focused on the K-12 and entrance examination space. With EdTech funding still largely concentrated on EdTech giants such as Byju, Unacademy, and Vedantu, new EdTech products are also likely to find significant unmet demand. A GreyMatters Capital report found, for example, that around 89 percent of Indians are willing to pay for educational apps. For example, IFC recently backed upGrad, one of India's largest online higher-education platforms with certificate, diploma, and degree offerings across data, management, technology, and law domains. upGrad will help meet India's skills development needs by creating an alternate digital platform for college students and working professionals and providing industry-relevant certifications and degree courses in partnership with universities and corporates.

India's Ministry of Education is supporting the drive to expand vocational education and has implemented the scheme of vocationalization of School Education under the Samagra Shiksha scheme, which serves to integrate TVET with general academic education. One such example is the inauguration of 607 vocational labs, education portals, and GIS portals in Jammu and Kashmir. India also proposed virtual labs called National Educational Technology Forums (NETFs) to bring more technological interventions in primary and higher education, and is planning to set up India's first AR and VR-based skill training center at IIT Varanasi. Vernacular learning could be one of the biggest trends, given the fact that only 10 percent of India's population can speak English.

Sources:

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CHAPTER 3

Emerging Business Models and Funding Sources for EdTech in Vocational Education

Chapter 2 outlined the trends intersecting in the vocational education and skills development space, and the potential role EdTech can play in transforming the TVET sector in emerging markets. Yet despite the need for innovation, the education market is severely under-digitized. Given the rapid pace of digitization and increasing need for digital skills, this means TVET is not keeping pace with labor market needs. While there have been some prominent cases of education technology advancements and rapid growth, such as those described in Chapter 2, expenditure on technology within the education sector is still marginal, estimated at around 3 percent of global education spend.[64]

EdTech is still relatively nascent in emerging market TVET systems. In some markets—in India for example—EdTech is rapidly expanding; however there is substantial room to support further growth across all emerging markets. Given the critical role of education in powering growth and inclusion, supporting EdTech providers to adapt and offer services in emerging markets will assist in solving some of the most acute global education issues. Judicious investments in EdTech solutions can respond to changing conditions both by enhancing traditional TVET delivery models and creating new services that are currently unavailable to emerging market populations. These solutions can reduce the role of intermediaries, improve price transparency, and expand the reach of services. In markets where investees grow rapidly and become sizeable market players, innovation at scale can generate large impacts on sector competitiveness by pushing traditional players to innovate, including by introducing digital solutions, improving their offerings, and reducing traditional incumbents' market share.

The COVID-19 pandemic has amplified the need for innovations in the TVET business model. Many governments and training providers were insufficiently prepared to respond to the crisis. Few countries and providers had sufficient equipment, connectivity, remote learning software and platforms, and pedagogical resources.[65] TVET learners and trainers also lacked digital skills to use TVET EdTech services. The increase in safe distancing measures, precautions, and general economic uncertainty has led to disruptions in TVET delivery due to institutional closures, cancellation of assessment and certification examinations, a fall in the number of certifications, and a sharp decrease in the number of potential students in these programs. In turn, the fall in enrolment numbers has resulted in the closure of many TVET providers, with negative repercussions for employment outcomes. Programs with more hands-on skills application, or

[64] Holon IQ. 2021. "10-charts-that-explain-the-global-education-technology-market". https://www.holoniq.com/edtech/10-charts-that-explain-the-global-education-technology-market/

[65] ILO, UNESCO and WBG. 2020.

more specialized computer use, are comparatively worse off during the pandemic and the process of preparing students for industry certifications and performance assessments has also become more difficult due to the practical, hands-on nature of many TVET programs.[66]

There is a common cause for the private sector and government to pursue EdTech solutions that solve substantial societal problems. For the private sector, developing solutions for large unmet demand will support them being able to rapidly scale successful models; for government it meets a critical development need and supports inclusive job and economic development. EdTech is no longer a nice-to-have feature at the margins of TVET. Put into the spotlight by the COVID-19 pandemic, it is now an essential feature of a well-developed national TVET system.

The remainder of this section will outline a taxonomy of EdTech business models, and then outline the roles of the private sector and government in supporting models. Note that some companies are present in multiple segments, providing services to all customer types.

TABLE 3.1 Taxonomy of emerging EdTech business models

CUSTOMER SEGMENT	CHANNEL TO MARKET	MODEL CHARACTERISTICS
Business to Consumer (B2C)—Web or App Based	**Learning Marketplaces**	• Platforms linking individual teachers/tutors/facilitators, who have content they have developed, with learners in a wide range of areas • Act as host for training providers to hold online sessions and provide a facilitation role, rather than content development **Typical funding model:** • Receive revenue by charging a take-rate, or percentage of the course fee.
	Massive Open Online Courses (MOOCs)	• Platforms aggregating and hosting content developed by name-brand education providers, usually universities (or private companies) • Provider owns IP for the content and issues certificates issued in name of MOOC and provider (or private company) • Provider is able to track students **Typical funding model:** • May offer freemium component, subscription, or course-based charge
	Own-content Providers	• Develop unique in-house content to meet a specific market need • EdTech company owns the IP and certificates issued in name of EdTech company • Customized and marketed to specific target learner groups for specific outcomes. Examples include coding bootcamps **Typical funding model:** • EdTech company would receive revenue by charging at enrollment per course / certificate
	Co-creation Platforms	• Learning and social platform for like-minded learners in a target area to network, share and co-create content (peer-to-peer) • Community based around content users, and could be hosted by specific service providers based around their products (e.g., technology companies) • Usually combined with some in-house or external content / courses **Typical funding model:** • Typically charge subscription, or offered free as a cross-funded service for business products

[66] Michaud, Anne. 2021. "Covid-19 Forces Vocational Schools to Adjust". The Wall Street Journal, 3 February, 2021. https://www.wsj.com/articles/covid-19-forces-vocational-schools-to-adjust-11612348201

CUSTOMER SEGMENT	CHANNEL TO MARKET	MODEL CHARACTERISTICS
Business to Business (B2B)—Training Institutions/ Universities	**Online Program Management (OPM) Companies/ Hosting Platforms and Trainer Tools**	• Develop online courses/certificates/degrees for training institutions to offer (e.g., institution staff teaches and owns IP for the content) • Offer services to help design format, produce video or other materials • Develop online assessment and teaching materials, recruit and enroll students, track student progress, operate platforms hosting live/synchronous components and handle data security • Trainer tools, interfaces, or software to help trainers design and run effective online classes, develop and manage online student projects, and may include unique content that can be integrated in **Typical funding model:** • EdTech company develops program upfront, selling content and services outright and/or earns revenues share from the training institution per learner using the services over time
	Own-content Provider Partnerships	• EdTech companies that have developed successful B2C offerings and content in high-demand areas (e.g. coding bootcamps) license the content to third-party training institutions which don't have the capacity to develop their own content • Focus on high-quality online courses in a specialist area where B2C content has gained reputation and acceptance **Typical funding model:** • EdTech company receives revenue through licensing content and/or earns revenues share from the training institution per learner using the services over time.
Business to Business (B2B)—Corporate	**Recruitment Platforms**	• EdTech company offers services to help corporates identify (in some cases train) and recruit candidates • Offer services to help job seekers understand company needs and obtain training • Offer services to identify candidate prior skills and channels to recognize them **Typical funding model:** • Typically raise revenue through fee-for-service agreements with corporates, or from job seekers when assisting skill recognition and placements
	Corporate Learning Providers	• Provide either off-the-shelf or custom designed courses and curated learning content for a company's employees –grooming top talent, general training, upskilling, and certifications **Typical funding model:** • Typically raise revenue through fee-for-service agreements with corporates and/ or direct from employee as a fee per learner enrolled (that likely is reimbursed by employer to employee)
Business to Government (B2G)—Government	**N/A**	• Could be all the above depending on target segment the government wants to assist, channel, local partners or stakeholders **Typical funding model:** • May be developed and funded directly by government or via government procuring services from a third-party EdTech provider • Many B2G engagements are fully or partially supported by philanthropy, donors or corporate CSR initiatives

The role of the private sector in supporting EdTech business models

Innovative EdTech business models offer a potential game-changing disruption to traditional TVET systems and will support the sector's ability to expand access to education and training opportunities.

There are a range of established EdTech models, particularly those offering online content to augment traditional TVET, such as Coursera or Crehana, that are now relatively proven in terms of technology architecture and revenue pathways. The significant advantage these models have is that they rely on relatively low/mature technology solutions, and once established, have relatively low marginal cost to scale up. Described in Chapter 2, there are examples of private companies, TVET institutions, and government engaging these services. Providing that the relevant digital infrastructure is in place, these services have significant scale potential across markets. Given the relatively low use of EdTech still in emerging markets, the existing models already being demonstrated by established EdTech players offer a blueprint to emerging players to replicate. Scalable EdTech solutions can overcome capacity constraints and support national delivery of TVET to meet the unmet demand for services. For example, under current institution-based learning models, supporting the necessary scale-up to meet demand projections would require an additional 1.5 million teachers per year or 100 million in total to meet the world's education needs.[67] As such, these scalable EdTech solutions offer significant potential to scale up access to global standard vocational education and training opportunities for emerging market populations that do not currently have access through TVET institutions.

In addition to meeting vocational education needs through existing scalable models, other emerging innovative models are integrating frontier technologies to push the capability of EdTech and expand its reach. This includes expanding into areas that are currently thought of as requiring face-to-face or hands-on training, such as EON Reality's use of extended reality (AR/VR) technology to simulate equipment or safety-intensive training; as well disrupting long-established recruitment and talent management processes, such as the AI driven skill recognition and matching services through SMRT.bio and Education.ai. These frontier technologies are expanding EdTech offerings, allowing it to incorporate traditionally 'hands-on' or 'soft-skills' into the suite of offerings. Together, this is allowing emerging EdTech models to push past EdTech's heavy core of data science and into other white- and blue-collar professions. These models offer learners in emerging markets the potential to gain skills in an increasingly broader set of professions, while remaining dislocated from either the training provider or employer at which they can utilize them.

In the absence of Government EdTech strategy, Venture Capital (VC) investing is driving rapid growth in EdTech. In 2010 VC investment in EdTech was around $500 million; by 2020 this had surged to around $16 billion, including doubling in 2020 alone. This trend is expected to continue, with around $15 billion already recorded by Q3 2021; and there are now 27 EdTech unicorns around the world that have collectively raised over $16 billion of total funding in the last decade and are now collectively valued at $80 billion.[68] While these figures include EdTech funding across a spectrum of EdTech services beyond TVET, they underscore the dramatic acceleration of the trend toward integrating EdTech into the education market and the opportunity for the private sector to support this transition.

[67] Refers to total teachers across all forms of education—HolonIQ. 2020. "Education in 2030." https://www.holoniq.com/wp-content/uploads/2020/01/HolonIQ-Education-in-2030.pdf

[68] HolonIQ. 2021. "Global EdTech Funding 2021 – Half Year Update". https://www.holoniq.com/notes/global-edtech-funding-2021-half-year-update/

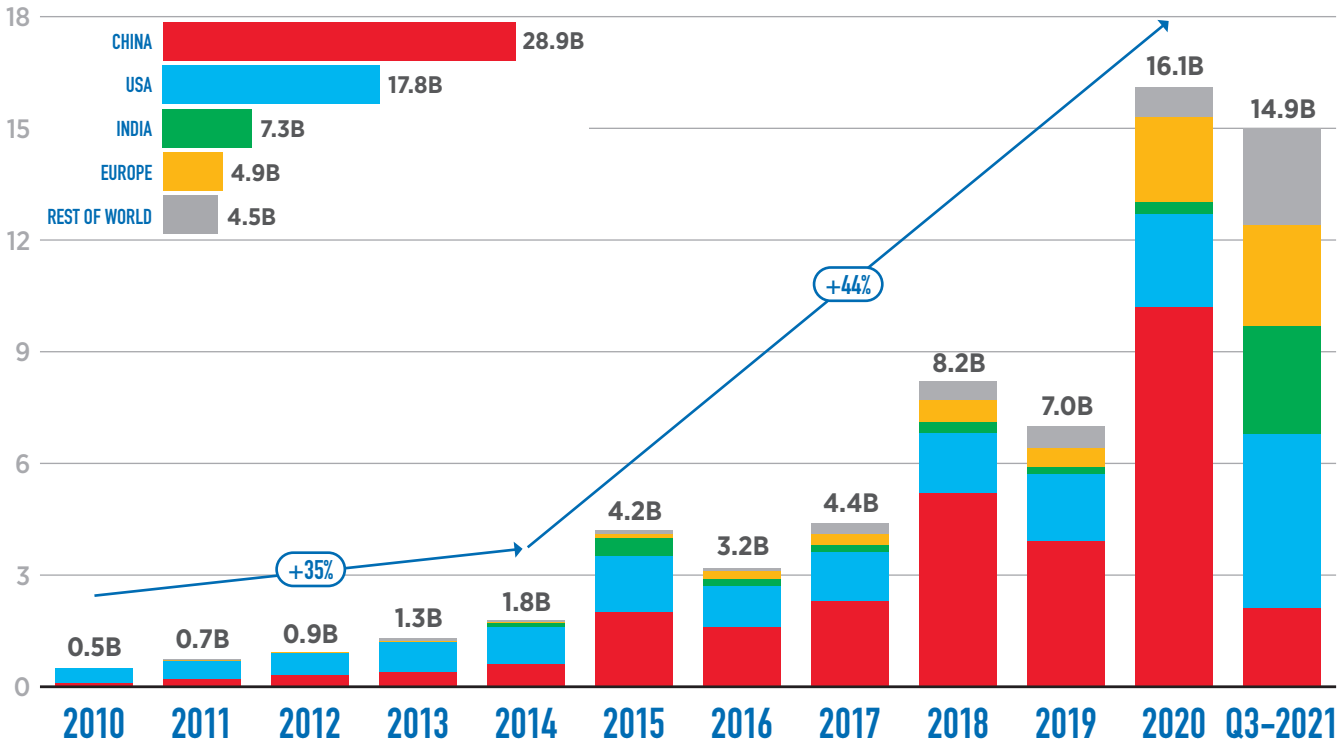
"COVID-19 accelerated Education Technology with both public and private leaders acknowledging we've seen at least 3-5 years of normal technology adoption in just over 12 months with the disruption driving the sector to think completely differently about the way the world learns. From Early Childhood to K12 and Vocational to Higher Education, new models and technology from startups to global giants are growing rapidly to support learners, parents, teachers and administrators looking to lower the cost and price of education, spend more time learning and teaching and accelerate outcomes in the learning to work and up-skilling journey."
—Holon IQ[69]

While to date much of this activity has been concentrated in a few markets such as China, the United States, and India, significant opportunities exist to extend this activity to other emerging markets. Emerging markets in regions such as Africa, Latin America, and Southeast Asia are growing rapidly and have large underserved populations looking to leapfrog traditional institutional education systems through use of technology-based options that lower access costs and improve outcomes.

The role of private sector EdTech is still relatively nascent compared to traditional institutional TVET education provision. However, surging VC investment and strong incentives to provide innovative and attractive services to learners

FIGURE 3.1 Growth in EdTech VC investment

Global education venture capital funding, 2010–Q3 2021 in USD Billions



[69] HolonIQ. 2021.

mean it may provide competition to the existing traditional TVET institutional model. There is room for both, but at its core, TVET is about delivering employment outcomes. Traditional TVET models that do not integrate EdTech will likely not keep pace with the accelerating demand for digital skills and digitization of training methods, and thus may not be able to demonstrate good employment outcomes from training. In contrast, the inherently digital nature of EdTech also embeds data capture and analytics into business models and will be able to provide real-time outcomes statistics to learners. There is room to accommodate the growth of EdTech and there are substantial benefits from closer integration of EdTech solutions into existing national TVET systems. However, existing players that do not adapt and demonstrate outcomes may not survive.

These EdTech models also offer the potential for national TVET systems in low-capacity emerging markets to integrate with EdTech services in developed markets. The opportunities EdTech allows through dislocation outlined in Chapter 2, and the innovations and scalability of models described in this chapter, demonstrate that TVET development and opportunities for learners need not explicitly come from ground-up development in each emerging markets. Models using an integrated approach allow emerging market TVET to potentially overcome capacity constraints and leverage established high-quality EdTech products and services that are unavailable in the local market and, in turn, support skill diffusion through both training and employment opportunities.

The role of government in supporting EdTech business models

Growth in EdTech is being driven by private sector models; however, emerging market governments can play an important role in supporting private EdTech growth.

EdTech's unique scalability also offers government the ability to scale TVET delivery and meet unmet demand for skills development more rapidly than could be done through bricks and mortar TVET institutions. Through partnerships with EdTech providers, high-quality content can be made available to underserved populations and delivered simultaneously in unlimited locations—bringing content directly to the learner in their preferred location (provided the digital infrastructure is sufficient). This type of partnership could create

substantial efficiency within TVET systems by (i) reducing the capital expenditure burden from government to fund bricks-and-mortar infrastructure; (ii) harmonizing content quality and reducing the burden on institutions to develop and deliver unique content, freeing up resources from content delivery to be used in improving the learning experience; and (iii) potentially supporting a prospective learner's ability to pay for TVET via embedded finance models that are linked to employment outcomes, reducing the burden on government to fund TVET.

Government needs to work in partnership with private EdTech companies to support and facilitate EdTech investment. EdTech models cannot flourish if the digital infrastructure that underpins them does not support the necessary connectivity. This is particularly important to ensure that low-income and vulnerable populations are able to access EdTech products, otherwise it will constrain the ability of these products to reach underserved populations and potentially expand the digital divide. Additionally, government needs to provide accommodating policy and regulatory settings to promote a digital ecosystem that is supporting of EdTech offerings. Described in Chapter 2, there is currently a lack of a coherent digital strategy in emerging markets. Chapters 5 and 6 will further describe government procurement and policy settings.

Government may be able to play a role as facilitator or incubator to integrate effective EdTech into national TVET systems. In many emerging markets, particularly in Africa, private investment in emerging technology is perceived as high-risk and global investors are wary of committing capital. In addition to providing a supporting environment for EdTech investment, government may be able to provide financial capital or support to act as an incubator for locally grown EdTech solutions, or entry and piloting of global EdTech solutions. The challenge for governments is to ensure they support effective EdTech products that improve employment outcomes for learners. Government may be able to engage in constructive partnerships to access outcome data from EdTech companies to improve evidence-based policy making and integrate findings into national TVET system design. Chapter 4 will further describe evidence and outcomes.

Government also has a unique role in providing authority and accreditation of EdTech training. To overcome potential resistance from established players or industry views on digital credentials, government can leverage this role to encourage awareness and recognition of learner outcomes from EdTech products. For learners, there may also be a barrier to providing the upfront financial cost of EdTech products. Government may be able to support this through education-related grants, low-interest or income-contingent loan programs. Given the potential skill diffusion and income generation opportunities enabled by a dislocated model, the societal return on education facilitated through these EdTech models may be high.

CONCLUSION

This chapter highlights the role that emerging EdTech business models can play in supporting national TVET development in emerging markets. Private sector EdTech products have the potential to close skills gaps within emerging markets through different channels and business models, but will require government to work in partnership with private EdTech companies to truly unlock its potential. The emerging EdTech models offer significant potential to complement and augment existing national TVET offerings in emerging markets, however they also come with a challenge to established models. Companies that don't embrace EdTech will not attract the best talent. TVET institutions that do not integrate EdTech will not attract learners. Learners who do not use EdTech will miss out on the best education and employment outcomes.

BOX 3.1 The evolution of EdTech in emerging markets

EdTech companies have evolved from their roots selling services to K-12 schools in the United States, and developed new products, delivery channels, and business models selling to consumers, higher education, employers, and governments. The COVID-19 pandemic has further shown that online learning and skills platforms can create strong learning outcomes at low cost—and new technology, machine learning, and AI can increase their effectiveness. However, many EdTech companies in emerging markets have not been able to leverage these trends, as they are constrained by a lack of capital and guidance from knowledgeable EdTech investors.

The earliest education technology companies, dating from the 1980s, focused on computer programming applications to improve the management of public schools. Through the early 2000s, EdTech startups primarily focused on public education, although universities and corporations were starting to explore digital learning initiatives. In the 1990s, the internet boom and early email facilitated the development of integrated learning management systems (LMSs) for schools and companies and the first online degrees. With developments in cloud computing, followed by the rollout of inexpensive laptops and basic smartphones in the mid-2000s, EdTech evolved from programs running on separate local servers into scalable cloud-based platforms. New services for the consumer market began to emerge, including mostly free online K-12 learning programs and massive open online courses (MOOCs), broadening the EdTech landscape.

Prior to the COVID-19 pandemic, the EdTech market had already been scaling up and diversifying, driven by several factors. Demographic trends, the rising cost of traditional education, and the threat of labor market dislocations have all driven demand for better K-12 offerings, more relevant and flexible degree programs, and digital/vocations skills offerings linked to employability through certificates and other credentials. Meanwhile better internet and digital infrastructure has made data-heavy EdTech more accessible. Accordingly, a wide range of subsectors selling to multiple parties has evolved, spanning early childhood, K-12, higher education, workforce, and lifelong learning solutions. The COVID-19 pandemic has created even greater demand for remote learning and workforce/upskilling solutions, and at the same time has validated EdTech models. The result has been a flow of new investment into the sector, though much of it remains focused on companies in developed markets.

BOX 3.2 IFC investments in EdTech

IFC has invested in a number of education technology companies providing improved learning access and outcomes to post-secondary and adult learners, with a focus on employability-linked skills relevant to workforces worldwide. Examples include:

Coursera, a global education corporation, was IFC's first EdTech investment in 2013. Since then IFC has made three follow-on investments to support Coursera's expansion. It is now one of the largest online learning platforms in the world, with 77 million registered learners, with over half in emerging markets, delivering on its promise in 2013 to "empower people with education that will improve their lives, the lives of their families, and the communities they live in."

In the context of rapidly evolving markets, individuals urgently need knowledge and skills to be productive. Coursera works with over 200 international university and corporate partners to offer over 4,500 top-tier courses and 20 degrees—with demonstrated links to employability and career enhancement. More than 6,000 institutions have used Coursera to upskill and reskill their employees, citizens, and students, including in high-demand fields such as data science, technology, and business. The company recently converted into a public-benefit corporation (Certified B Corp) committed to serving all stakeholders and meeting international standards of environmental and social (E&S) sustainability, and also launched new initiatives to support emerging markets students to acquire digital skills, as well as to promote social justice and racial and gender equity.

Revelo is an online business-to-business (B2B) recruiting marketplace that uses machine learning to streamline the hiring process by efficiently connecting job candidates with employers that are hiring for open positions. The company does this through a technology-first approach in which it uses its data to power candidate sourcing and matching. This creates a higher rate of successful placements at a fraction of the cost, since little to no human interaction is needed in the curation process for candidates. The different marketplace players generate tens of millions of data points that drive the machine learning algorithm and help Revelo's matching capabilities (83 percent hiring success vs. 46 percent for offline recruiting agencies). Revelo uses a prepaid model whereby it sells credits to customers and then uses these credits on a rolling basis during the following 12-month period. This business model has proven to increase engagement from clients, compared to the traditional success-fee model used by offline recruiting agencies.

Crehana, which started as a B2C online education company, has transformed into a blended B2C and B2B model where the Company plays an integral role in upskilling the workforce of enterprises across Latin America. Through the B2B segment, which was launched in 2019 and now represents approximately 7 percent of revenue, Crehana offers software that integrates with businesses' internal HR systems to identify employees' skill gaps. It subsequently provides its proprietary online courses to employees in order to effectively develop skills important to their careers. Crehana's more than 500 courses span a range of different disciplines, including business, computer engineering, and digital design. The company is industry-agnostic and its courses are applicable to multiple industries including financial institutions, CPG, and industrials.

Other investments include those made in Andela, Brilliant, Byju, Sololearn, Springboard, UpGrad, and Zhangmen. A full list is available on IFC's website. These investments contribute to IFC's strategy for supporting the advancement of digital economies in emerging markets and contribute to achieving equitable education under Sustainable Development Goal #4.

CHAPTER 4

Evidence on the Effectiveness of EdTech Deployment on Skills Development and Access in TVET

Undoubtedly, the increasing integration of technologies in education systems has altered the educational production function. Beginning in the 1990s, hardware deployment and increasing connectivity featured prominently in many education interventions. In the 2000s, educational technology deployment shifted toward technological supplements such as learning software, facilitating online course management, and, increasingly, augmenting models of distance learning. Recently, progress has been made in leveraging frontier technologies such as virtual and augmented reality to facilitate learning.

The rapid pace at which education technologies have been deployed has come at a cost. Scholarship has not kept up in rigorously assessing what works and what does not, nor with how interventions interact with the contexts in which they take place. The scarce body of existing research comes together as a patchwork of differing technologies applied in different educational and occupational fields within different geographic and institutional contexts (see Figure 4). Scholarship assessing the impact of leveraging technologies for education is characterized by 'mixed evidence with a pattern of null results.'[70] As a consequence, the jury is still out regarding the extent to which, and through which channels, EdTech models in TVET can improve learning, skills acquisition, and thus ultimately, labor market outcomes of students. No consensus has crystallized among policymakers and academics as to the types of technologies that are worth investing in.[71]

The lack of generalizable evidence to date indicates the crucial need to combine the deployment of EdTech in TVET with rigorous monitoring and evaluation systems. Deploying new educational technologies is, by virtue of adopting frontier systems, experimental. Making better decisions requires an understanding of EdTech reform in TVET as both an attempt to solve existing problems and a learning experience to rigorously assess its success. A particular gap that remains is the lack of informative outcome metrics. Learner success in test results, while easy to measure, is less appropriate than evaluating the actual desired outcomes, such as job attainment post-degree,

[70] Bulman, George, and Robert Fairlie. 2016. "Technology and Education: Computers, Software, and the Internet." Cambridge, MA: National Bureau of Economic Research, May 2016. https://doi.org/10.3386/w22237 With respect to TVET interventions, the quality of the evidence base, especially in middle- and low-income countries, is an additional issue. A 2013 review of TVET interventions in low- and middle-income countries for instance identified 26 studies, only three of which were randomized controlled trials - Tripney, Janice S., and Jorge G. Hombrados. 2013. "Technical and Vocational Education and Training (TVET) for Young People in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis." *Empirical Research in Vocational Education and Training* 5 (3). https://doi.org/10.1186/1877-6345-5-3

[71] Escueta, Maya, Andre Joshua Nickow, Philip Oreopoulos, and Vincent Quan. 2020. "Upgrading Education with Technology: Insights from Experimental Research." *Journal of Economic Literature* 58 (4): 897–996. https://doi.org/10.1257/jel.20191507

salaries, (lifetime) income, satisfaction with job outcomes, and others. This gap in outcome metrics is disproportionately relevant for TVET, with its goals of equipping students with job-relevant technical skills and creating improved labor market matching.

EdTech deployments can help improve skills development and labor market outcomes through different channels, including i) improving the quality of education and/or labor market matching, ii) increasing the number of people able to access education and iii) increasing the relevance of education. MOOCs, for instance, may not lead to better student learning than classroom-based alternatives, but by being more cost-effective, scalable, and flexible, they can provide access to lower-income segments and populations that otherwise would not gain access to learning opportunities.

With respect to improving the **quality of education**, educational technologies can work through various channels. Software-based education can be adaptive to learners' skill levels, thus individualizing learning. Rapid assessments can improve learning via feedback; the gamification of education through technology can increase motivation; and simulations, for instance through virtual reality, can allow for the mastering of skills needed for costly and rare events (such as disaster control).

The **relevance of education** can increase if technologies allow for a tighter integration between on-the-job needs and education, or establish relationships of students with employers. For instance, micro-credentials or codesigned curricula administered online can help strengthen this link. And virtual reality can simulate real job environments.

While the literature increasingly suggests that EdTech deployment works, it often remains unclear through which channels, that is, how it works. The effectiveness of interventions needs to be measured against the goals they seek to achieve. Often EdTech is deployed to advance several goals simultaneously: In 2004, for instance, China launched what is often deemed the largest EdTech intervention to date. Satellite dishes, computer rooms, and other multimedia equipment were installed at rural schools. Simultaneously, the most accomplished teachers across the country were selected to record lectures, which were subsequently rolled out to 100 million students.[72] The intervention had positive impacts on several metrics, including education attainment and labor market performance. Yet it remains unclear whether and to what extent this was a function of granting access or leveraging higher teaching quality.[73]

Most research focuses on whether technology improves or augments the quality of education. However, to the extent that an intervention might improve access and/or lower costs, null effects might be a sign of success, as they may indicate that educational technologies are similarly effective to traditional models of education.

This chapter takes stock of what we know about the effectiveness of EdTech in TVET, focusing primarily on technologies used for content delivery; that is, teaching and learning. EdTech captures a broad array of instruments, all of which target different aspects of the education value chain. The body of research on content delivery, such as online learning or computer-assisted learning, is growing and increasingly methodologically sophisticated. Other areas with strong potential, such as data analytics for labor market information systems or the impact of EdTech use in admissions and registration, still lack rigorous evaluations in a coherent research agenda.

[72] Bianchi, Nicola, Yi Lu, and Hong Song. 2020. "The Effect of Computer-Assisted Learning on Students' Long-Term Development". https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3309169

[73] Bianchi, et al. 2020. Specifically, individuals who were exposed to CAL in middle school 10 years later were employed in occupations with 15.5 percent higher average earnings. More tellingly, the authors find a strong increase in productivity. Comparing those in the same occupation and migration status, those who received CAL in middle schools earn on average 29.5 percent more that those who did not, 10 years later in their life.

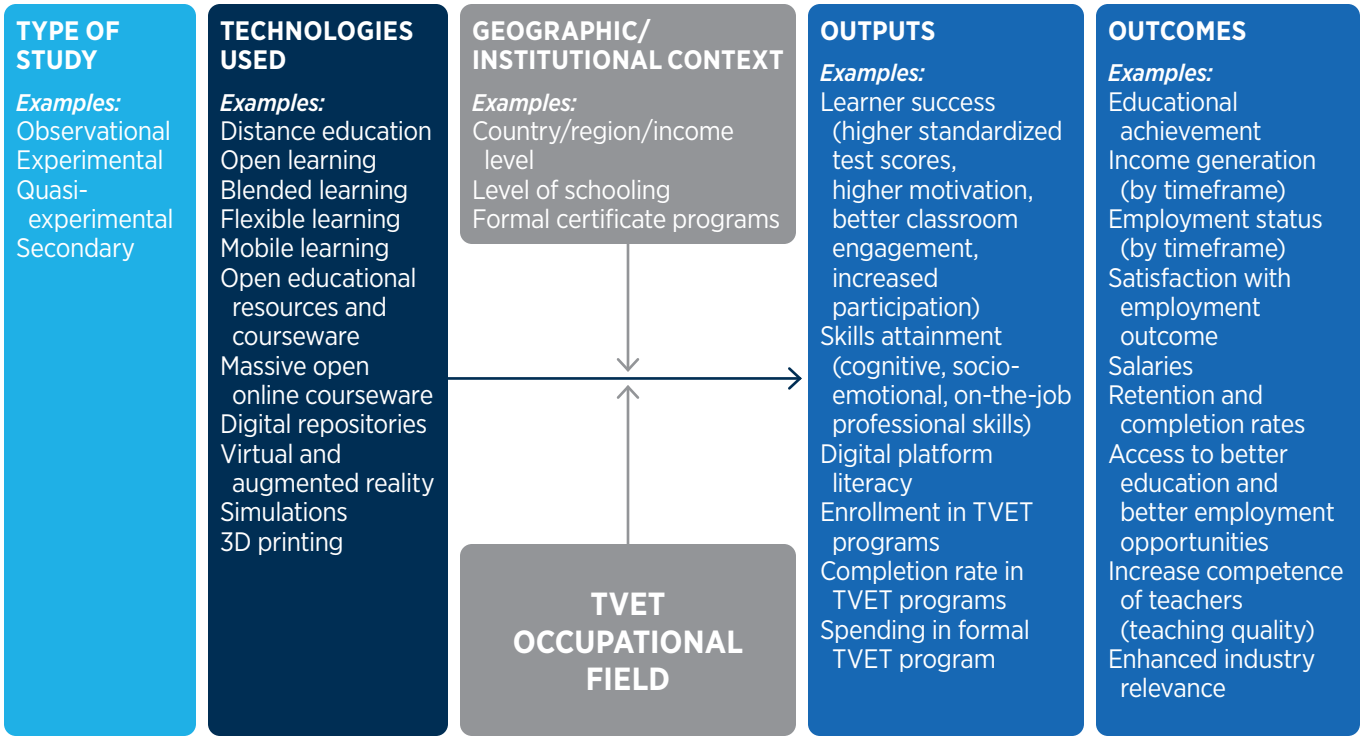
Thus, here we focus on rigorous experimental studies on the use of EdTech in content delivery; and to the extent that they have been assessed as part of content delivery, micro-credentialing and skills assessment. Such rigorous studies of specific interventions are crucial and can help understand the channels of influence, though it should be noted that the combination of different interventions may hold the biggest potential.

Interventions combining different elements of education technologies may hold the greatest potential with respect to revolutionizing TVET, yet they are the least amenable to evaluation. Promising interventions often combine reforms in different elements of the educational value chain to tackle shortcomings in education delivery holistically, often including systemic interventions to the institutional environment. Such interventions may be the most appropriate in many settings, but they are also often the most difficult to evaluate rigorously, if measurement and evaluation schemes metrics aren't embedded rigorously in the reform itself. In cases where evaluation metrics are not incorporated, it often becomes almost impossible to attribute outcomes ex-post to singular aspects of the intervention. This is disproportionately true for TVET. TVET is unique in that it spans the realms of cognitive skills formation and practical, technical skills. A particular opportunity in leveraging technologies is integrating these different aspects more closely by using multimedia environments that transcend the boundaries between theory and application.

Several practical and theoretical considerations limit both the scope of the literature assessed here as well as the generalizability of findings.

The literature on EdTech is small; the subset assessing EdTech in TVET is even smaller. Where it exists, it often lacks quality and rigor. Given this limitation, we include literature on EdTech in general, insofar as it is relevant to TVET contexts.

FIGURE 4.1 Stylized overview over exemplary inputs and outputs to be considered for conducting and aggregating research



This includes in particular:

- **Computer-assisted learning (CAL)**
  CAL programs are predominantly used for cognitive skill formation (e.g., mathematics and languages). They are of relevance for TVET contexts insofar as TVET curricula contain educational components. Moreover, dropout rates in TVET programs tend to be higher than in traditional programs, which is often attributed to the lack of foundational skills necessary to learn TVET content. As such, CAL could be a way to provide TVET students remedial education and improve their academic readiness to deal with TVET specific content, in particular since CAL can be designed to be adaptive to the learner's skill level. Moreover, gamification and improved design can increase student motivation.
- **Online learning (pure online learning, blended learning and MOOCs)**
  Online learning in TVET presents an opportunity to increase access for groups that otherwise could not seek education, while maintaining similar quality. Improvements in access can be driven by geographic challenges, income differences, or life situations, all of which may require flexibility in scheduling. Moreover, online learning has particular potential for TVET, as it can integrate the theoretical and practical components of TVET education. In addition, online learning can increase the relevance of content; online courses offered or co-developed by employers can help improve labor market matching.
- **VR applications**
  The use of VR is particularly promising for vocational settings, as it might help bridge the divide between the study of theory in classroom settings and the professional skills needed to perform the job (such as the assembly of parts or the servicing of machines).

The range of contexts in which EdTech is deployed warrants caution in generalizing findings. For example, training interventions that were, in principle, identical in several Latin American countries have produced widely diverging outcomes with respect to the incomes of graduates of the program.[74] Factors such as different labor market needs, pre-existing skills levels of the population, the technology readiness of instructors, and even the current phase of the business cycle can mediate the impact of leveraging technologies for the ultimate purpose of improving a match between labor market needs and the skills of the workforce. Such issues are disproportionately salient in vocational education. Differences between vocational fields—from nursing to mechanical engineering—are more pronounced than in non-vocational post-secondary learning.[75]

[74] Alzúa, María Laura, Paula Nahirñak, and Belisario Alvarez de Toledo. 2007. "Evaluation of Entra 21 Using Quantitative and Qualitative Data," Q-Squared Working Papers (41). https://www.trentu.ca/ids/sites/trentu.ca.ids/files/documents/Q2_WP41_Alzua_etal.pdf

[75] There are a number of additional concerns: To the extent that vocational interventions have been rigorously evaluated, they often focus on evaluating the development of skills, which are not specific to vocational settings, in particular the developing of cognitive and socioemotional skills. The hallmark goal of vocational training, improving practical skills which directly translate to on-the-job tasks, have been measured to a lesser extent. The same holds true with respect to impact metrics on labor market outcomes, such as incomes after graduation, whether graduates find formal employment, etc.—which are of key interest for vocational training but are rarely measured.

THREE DECADES OF TECHNOLOGY IN EDUCATION: AN ASSESSMENT OF THE LITERATURE

Experimental evidence suggests that the use of certain educational technologies can be effective in augmenting traditional teaching methods. A recent metastudy of the use of technology for educational purposes analyzes the existing body of high-quality experimental research on the effectiveness of leveraging technologies, including computer-assisted learning, conventional online courses, and MOOCs.[76] The authors summarize the universe of empirical assessments employing quasi-experimental methods; that is, randomized controlled trials and regression discontinuity designs. Their findings serve as the main backbone for this section.

Computer assisted learning

Computer assisted learning programs and tutoring software have been effective in supporting development of cognitive skills such as quantitative skills and language acquisition, though there is heterogeneity and little knowledge about why certain programs work and others do not. Computer assisted learning tools broadly refer to software programs, which are used to help develop specific skills, especially in mathematics and language acquisition. Across 31 experimental evaluations in developed countries, Escueta et al. (2020) found that 21 reported statistically significant positive effects on learning metrics, often of substantial magnitude; 16 of these focused on mathematics. In general, findings of positive impact on mathematics have been more consistent than in language acquisition.[77]

[76] Note that the most traditional form of EdTech deployment beginning in the 1990s has taken the form of providing access to computers and/or internet connectivity. While access certainly acts as a precondition for using EdTech in content delivery, there is little evidence that on its own it can improve student learning and skill formation. A synthesis of 13 experimental papers across access interventions in developed and developing countries concludes that on average there is no discernible improvement of academic performance of providing access alone. This is even though evaluations consistently find that the programs met the desired output targets with respect to features such as the number of computers distributed, time spent on computers, and so on. It should be noted that while, on average, academic performance did not improve, digital literacy did.

[77] **Studies finding positive effects (including those finding positive and null effects in different specifications):** Barrow et al. 2009. "Technology's Edge: The Educational Benefits of Computer-Aided Instruction." American Economic Journal: Economic Policy; Beal et al. 2013. "Randomized Controlled Trial (RCT) Evaluation of a Tutoring System for Algebra Readiness."; Borman et al. 2009. "A Randomized Field Trial of the Fast ForWord Language Computer-Based Training Program." Educational Evaluation and Policy Analysis; Ritter et al. 2007. "What Evidence Matters? A Randomized Field Trial of Cognitive Tutor Algebra I." In 15th International Conference on Computers in Education: Supporting Learning Flow through Integrative Technologies, ICCE 2007; Roschelle et al. 2010. "Integration of Technology, Curriculum, and Professional Development for Advancing Middle School Mathematics: Three Large-Scale Studies." American Educational Research Journal; Roschelle et al. 2016. "Online Mathematics Homework Increases Student Achievement."; Morgan, Pat and Steven Ritter. 2002. "An Experimental Study of the Effects of Cognitive Tutor® Algebra I on Student Knowledge and Attitude."; Pane et al. 2014. "Effectiveness of Cognitive Tutor Algebra I at Scale." Educational Evaluation and Policy Analysis; Ragosta, Marjorie, and Paul w. Holland. 1982. "Computer-Assisted Instruction and Compensatory Education: The ETS/LAUSD Study - the final report"; Deault et al. 2009. "Inattention and Response to the ABRACADABRA Web-Based Literacy Intervention." Journal of Research on Educational Effectiveness; Hegedus et al. 2015. "The Impact of Technology-Enhanced Curriculum on Learning Advanced Algebra in US High School Classrooms." Educational Technology Research and Development; Karam et al. 2017. "Examining the Implementation of Technology-Based Blended Algebra I Curriculum at Scale." Educational Technology Research and Development; Kelly et al. 2013. "Estimating the Effect of Web-Based Homework." In Artificial Intelligence in Education, edited by H. Chad Lane, Kalina Yacef, Jack Mostow, and Philip Pavlik; Mitchell, Mary Jane, and Barbara J. Fox. 2001. "The Effects of Computer Software for Developing Phonological Awareness in Low-progress Readers." Reading Research and Instruction; Wang, Haiwen, and Katrina Woodworth. 2011. "Evaluation of Rocketship Education's Use of DreamBox Learning's Online Mathematics Program."; Wijekumar et al. 2012. "Large-Scale Randomized Controlled Trial with 4th Graders Using Intelligent Tutoring of the Structure Strategy to Improve Nonfiction Reading Comprehension." Educational Technology Research and Development; Wijekumar et al. 2014. "Multisite Randomized Controlled Trial Examining Intelligent Tutoring of Structure Strategy for Fifth-Grade Readers." Journal of Research on Educational Effectiveness; Schenke et al. 2014,. "Alignment of Game Design Features and State Mathematics Standards: Do Results Reflect Intentions?" Computers & Education; Alzúa et al. 2007; Snipes et al. 2015. "The Effects of the Elevate Math Summer Program on Math Achievement and Algebra Readiness."; Tatar et al. 2008. "Scaling Up Innovative Technology-Based Mathematics." Journal of the Learning Sciences.
Studies finding null effects only: Cabalo et al. 2007. "Comparative Effectiveness of Carnegie Learning's Cognitive Tutor Bridge to Algebra Curriculum: A Report of a Randomized Experiment in the Maui."; Cavalluzzo et al. 2012. "Effects of the Kentucky Virtual Schools' Hybrid Program for Algebra I on Grade 9 Student Math Achievement."; Dynarski, Mark. 2007. "Effectiveness of Reading and Mathematics Software Products: Findings from the First Student Cohort Report to Congress March 2007."; Faber, Janke M., and Adrie J. Visscher. 2018. "The Effects of a Digital Formative Assessment Tool on Spelling Achievement: Results of a Randomized Experiment." Computers & Education; Rockoff, Jonah E. 2015. "Evaluation Report on the School of One I3 Expansion."; Rouse, Cecilia, and Alan Krueger. 2004. "Putting Computerized Instruction to the Test: A Randomized Evaluation of a 'Scientifically-Based' Reading Program."; Rutherford et al. 2014. "A Randomized Trial of an Elementary School Mathematics Software Intervention: Spatial-Temporal Math." Journal of Research on Educational Effectiveness; Klaveren et al. 2017. "The Effect of Adaptive versus Static Practicing on Student Learning—Evidence from a Randomized Field Experiment." Economics of Education Review.
Studies finding negative or mixed effects including negative: Pane et al. 2010. "An Experiment to Evaluate the Efficacy of Cognitive Tutor Geometry." Journal of Vocational Education & Training. For a summary of the literature including effect sizes see Escueta et al. 2020.

While these findings indicate substantial potential for software use, the precise mechanisms by which they facilitate improved learning are unclear. The programs assessed differ in design, including comparatively light-touch applications aiding in homework through providing direct feedback, as well as more substantive tools that provide entire curricula and lesson plans, combined with a large range of technical applications to administer course content.

Some evidence suggests that automatic adaptation and personalization of content for the specific skill level of learners play a crucial role for effectiveness.[78] A core benefit of software-enabled learning over traditional in-person teaching is that such programs can tailor content more specifically to different learners' skill levels. Rather than teaching the same content to a comparable group of students, software can pre-assess and cater to the appropriate level of difficulty. Programs featuring adaptivity tend to produce better results than purely pedagogy-focused programs that allow students to review material at their own pace.[79]

This feature can be of particular benefit in TVET systems. Dropout rates in TVET programs remain persistently high, and this has been attributed to lower prior academic achievement.[80] The use of CAL, especially when it is adaptive to learners' skill levels, can act as a tool for remedial education and help improve learners' academic readiness to deal with TVET specific content.

Computer-assisted learning programs appear to be particularly effective in developing countries and emerging economies. A growing body of evidence, mainly from China and India, finds positive impacts of interventions, typically of larger magnitudes than in developed countries.[81] This suggests that benefits of computer-assisted learning may be more profound where it alleviates binding constraints in existing capacities, such as teaching quality or class size. There are concerns of selection bias with respect to effects of larger magnitude. It might be that programs in the most promising developing country settings are disproportionately studied. However, the effectiveness of teaching technologies is likely to be contingent on technological infrastructure availability and the ICT readiness of teaching staff, both of which have been shown

[78] Muralidharan, Karthik, Abhijeet Singh, and Alejandro J. Ganimian. 2019. "Disrupting Education? Experimental Evidence on Technology-Aided Instruction in India." *American Economic Review* 109 (4): 1426–60. https://doi.org/10.1257/aer.20171112

[79] For pedagogy focused interventions see for example, Carillo et al. 2021., "Information Technology and Student Achievement: Evidence from a Randomized Experiment in Ecuador"; Lai et al. 2015, "Does Computer-Assisted Learning Improve Learning Outcomes? Evidence from a Randomized Experiment in Migrant Schools in Beijing." Economics of Education Review"; Linden, Leigh L. 2008. "Complement or Substitute? The Effect of Technology on Student Achievement in India"; Mo et al. 2014. "Integrating Computer-Assisted Learning into a Regular Curriculum: Evidence from a Randomised Experiment in Rural Schools in Shaanxi." Journal of Development Effectiveness; Barrow et al. 2009; Rouse and Krueger. 2004."

[80] Yi et al. 2015. "Exploring the Dropout Rates and Causes of Dropout in Upper-Secondary Technical and Vocational Education and Training (TVET) Schools in China"; European Centre for the Development of Vocational Training, Assuring the Quality of VET Systems by Defining Expected Outcomes; Janjua and Irfan, "Situation Analysis to Support the Programme Design Process for National Skills Strategy of the Islamic Republic of Pakistan."and Causes of Dropout in Upper-Secondary Technical and Vocational Education Training (TVET) Schools in China." International Journal of Educational Development; Jordan et al, 2009. "Dropout Rates in Vocational Education and Training: A Failure of the School-to-Work Transition?" In Innovative Apprenticeships: Promoting Successful School-to-Work Transitions, edited by Felix Rauner, Erica Smith, Ursel Hauschildt, and Helmuth Zelloth, 2. ed., 57–61; European Centre for the Development of Vocational Training. 2008. "Assuring the Quality of VET Systems by Defining Expected Outcomes: A Cross-Country Analysis in Seven Member States."; Janjua, Yasin, and Mohammad Irfan. 2008. "Situation Analysis to Support the Programme Design Process for National Skills Strategy of the Islamic Republic of Pakistan." MPRA.

[81] For studies in China see, Bianchi et al. 2020; Bai et al. 2016. "The Impact of Integrating ICT with Teaching: Evidence from a Randomized Controlled Trial in Rural Schools in China." Computers & Education; Lai et al. 2013. "Computer Assisted Learning as Extracurricular Tutor? Evidence from a Randomised Experiment in Rural Boarding Schools in Shaanxi." Journal of Development Effectiveness; Lai et al. 2016. "More Is Not Always Better: Evidence from a Randomised Experiment of Computer-Assisted Learning in Rural Minority Schools in Qinghai." Journal of Development Effectiveness; Lai et al. 2015; Mo et al. 2015 "Computer Technology in Education: Evidence from a Pooled Study of Computer Assisted Learning Programs among Rural Students in China." China Economic Review; Banerjee et al. 2007. "Remedying Education: Evidence from Two Randomized Experiments in India." The Quarterly Journal of Economics; Linden, Leigh L., and M. Macleod. 2007. "Helping Teach What Teachers Don't Know: An Assessment of the Pratham English Language Program 1."; Muralidharan et al. 2019; Naik et al. 2016. "Can Technology Overcome Social Disadvantage of School Children's Learning Outcomes? Evidence from a Large-Scale Experiment in India."

to mediate the impact of new technologies.[82] For example, Fancsali et al. (2016) assessed differences in implementing a software-based mathematics tutoring program and found that effectiveness in improving learning outcomes depended critically on the ability of teachers to keep students 'on task.'[83]

The use of computer assisted learning programs in TVET appears particularly promising for the formation of cognitive, theoretical skills, insofar as they are relevant to the occupation or needed to succeed in TVET training. A limited number of studies directly assessed comparable online tools in vocational settings. Zwart et al. (2020) performed a randomized experiment of providing digital learning materials, including structured content provision, automated assignments, domain specific clips, and online collaboration spaces to administer mathematics training in nursing schools in the Netherlands.[84] They found no significant differences in the learning of those in the treatment condition and those receiving traditional face-to-face education, which suggests equal learning successes of online learners. In an earlier analysis of using digital learning materials to administer the mathematics curriculum across the apprenticeship students in the fields 'Health and Welfare' and 'Economics and Services,' Zwart et al. (2017) found significant improvements for students in the 'Health and Welfare' but null effects in the other two fields.[85]

Fully online courses, blended learning, and MOOCs

Online courses have been heralded as a great opportunity to increase access to education; research suggests that if blended with face-to-face interaction, they can do so without lowering quality. The cost of access plays a key role in whether people seek education, particularly people from lower-income groups.[86] Balancing the deterrence impact of high costs with maintaining high quality has been a perennial challenge in

[82] See, for example, Pane et al. 2010; Pane et al. 2014; Morgan and Ritter. 2002.

[83] In addition, several studies found positive impacts only when software is used out-of-school in extracurricular tutoring programs, while they are ineffective if used during teaching (Lai et al. 2013). A recent study attempting to disentangle the impact of the 'tech component' in EdTech interventions from the beneficial impact of the added non-technology inputs, such as spending more time or receiving instructional support, still report positive impacts on the 'tech component,' though of substantially smaller magnitude than preexisting findings (Mo et al. 2015).

[84] Zwart, Diana P., Omid Noroozi, Johannes E.H. Van Luit, Sui Lin Goei, and Arjen Nieuwenhuis. 2020. "Effects of Digital Learning Materials on Nursing Students' Mathematics Learning, Self-Efficacy, and Task Value in Vocational Education." *Nurse Education in Practice* 44 (March 2020). https://doi.org/10.1016/j.nepr.2020.102755

[85] Zwart, Diana P., Johannes E. H. Van Luit, Omid Noroozi, and Sui Lin Goei. 2017. "The Effects of Digital Learning Material on Students' Mathematics Learning in Vocational Education." *Cogent Education* 4 (1) http://ezp-prod1.hul.harvard.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ1168474&site=ehost-live&scope=site

[86] Bhalotra, Sonia, Kenneth Harttgen, and Stephan Klasen. 2014. "The Impact of School Fees on Educational Attainment and the Intergenerational Transmission of Education - UNESCO Digital Library." https://unesdoc.unesco.org/ark:/48223/pf0000225956

educational development. Early initiatives in the mid-1990s to improve access by abolishing school tuition entirely, such as reforms in Malawi and Uganda, showcased the detrimental impact of such endeavors on quality if they are not complemented by additional reform.[87] Dramatic increases in class size and a loss of school-level funding disproportionately affected students in low-income segments, often leaving them no better off than before.[88]

Online learning can potentially solve this balancing act by bending the educational cost curve without adversely affecting quality, and thus lowering the marginal costs of education provision. In addition, online learning can alleviate binding geographical constraints, and by offering increased flexibility could allow people who assume work or family responsibilities to seek education. The central question, then, is whether online courses can provide access without adversely affecting quality in the TVET context.

In TVET contexts, online learning may be particularly promising in increasing access and administering off-the-job components of training, though questions remain regarding its effectiveness in teaching practical professional skills. Online learning has been successfully leveraged in many postsecondary settings, with research focusing mainly on statistics, economics, and mathematics courses. To the extent that TVET comprises off-the-job educational elements, online learning might be a cost-effective mode of delivery. Indeed, the fact that online learning transcends geographical boundaries might lead to a tighter integration of on-the-job and off-the-job learning, since key concepts can be reinforced theoretically while they are being applied practically. Traditional rotations between job placements and theoretic learning times might become obsolete. Few such models have been rigorously tested but early evidence indicates potential. Callan, Johnston, and Poulsen (2015) assessed the use of e-learning models in Australian trade apprenticeships across bakery, building and construction, plumbing, and stonemasonry industries based on interviews with TVET professionals, employers, and apprentices. E-learning models across these industries are different but are all characterized by more flexibly integrating content during the practical learning stages of the apprenticeship. In bakery, for instance, chats, photo-stories, email, SMS, and traditional self-paced packages were used to explain the correct process of breadmaking immediately as it was practiced. Evidence of workplace activities was recorded and sent to instructors, followed by virtual sessions with instructors to reinforce the learning. The authors found that such models were particularly useful in the pre-apprenticeship or initial stages of an apprenticeship, when the development of foundational theory was particularly important.

The success of such blended models based on observational evidence is in line with more robust experimental findings.

Existing research gives little confidence that online learning on its own can achieve similar quality to face-to face-learning, though blended learning models have achieved similar results in terms of quality in several settings. There was, to our knowledge, only one evaluation of the differences between purely face-to-face education, purely online education, and a blended version in a joint experimental setting. The findings of this study are paradigmatic of broader literature findings, which typically compare only two of the three models. In a microeconomics principles course, students who received online training only performed significantly worse in final tests than those receiving face-to-face instruction.

[87] Birger, Fredriksen, and Di Craissati, eds. 2009. *Abolishing School Fees in Africa: Lessons Learned in Ethiopia, Ghana, Kenya and Mozambique.* The World Bank, 2009. https://doi.org/10.1596/978-0-8213-7540-2

[88] Birger, F., and D. Craissati. 2009.

The performance of those who received blended learning—instructor time was cut in half and replaced by online instruction—was not statistically different from those who received only face-to-face education.[89] By and large, other experimental papers confirm this finding.[90]

A natural follow-up question is whether there are indications that online learning improves access.

There is some evidence that online learning leads to higher enrolments for groups that otherwise would not seek further education. Goodman et al. (2019) empirically assessed enrolments into a computer science degree, which was offered both online and face-to-face. They found that the applicant pool differed substantially, with little overlap. The online degree was disproportionately attended by older individuals, many of whom were employed; 'the average in-person applicant is a 24-year old non-American recently out of college, whereas the average online applicant is a 34-year old mid-career American.' In addition, the authors found compelling evidence that the option increased the overall number of enrolments, specifically for groups that otherwise would not seek education, indicating that online learning does not act as a substitute for other education modes but is a true means to increase access.[91]

MOOCs are a special form of online courses, and in many ways they hold the greatest promise for increasing access through massive scaling and by allowing learners to select coursework flexibly. MOOCs are online offerings, either free or for tuition fees, that typically set no enrolment criteria. In principle, they allow learners to select individual courses based on their needs, though recently certified sequences of course and nano-/micro-degrees have grown in numbers.

What makes MOOCS unique also makes them particularly hard to assess, both in terms of skills attainment and their impact on access. Completion of a MOOC lacks a clear counterfactual against which outcomes could be compared. It is unclear what a reasonable alternative to a MOOC could be against which the effects could be compared, as they enable learners to seek education that they likely would not have received otherwise. Moreover, MOOCs are likely to attract very different clienteles depending on the context. Whether people use MOOCs depends on the quality and structure of the existing national education systems. Survey evidence across the Philippines, Colombia, and South Africa for instance shows strikingly different user profiles: While in Colombia, for instance, 66 percent of the MOOC users surveyed hold a vocational degree, in the Philippines only 4 percent

[89] Alpert, William T., Kenneth A. Couch, and Oskar R. Harmon. 2016. "A Randomized Assessment of Online Learning." *The American Economic Review* 106 (5): 378–82.

[90] **Studies finding positive effects (incl. those finding positive and null effects in different specifications):** Esperanza, Peter, Khristin Fabian, and Criselda Toto. 2016. "Flipped Classroom Model: Effects on Performance, Attitudes and Perceptions in High School Algebra." In *Adaptive and adaptable learning*. Edited by Katrien Verbert, Mike Sharples, and Tomaž Klobučar, 85–97. Switzerland: Springer International Publishing. https://digitalcommons.chapman.edu/scs_books/27; Joyce, Ted, Sean Crockett, David A. Jaeger, Onur Altindag, and Stephen D. O'Connell. 2015 "Does Classroom Time Matter?" *Economics of Education Review* 46 (June 2015): 64–77. https://doi.org/10.1016/j.econedurev.2015.02.007; Wozny, Nathan, Cary Balser, and Drew Ives. "Evaluating the Flipped Classroom: A Randomized Controlled Trial." *The Journal of Economic Education* 49 (2): 115–29. https://doi.org/10.1080/00220485.2018.1438860
Studies finding null effects only: Bowen, William G., Matthew M. Chingos, Kelly A. Lack, and Thomas I. Nygren. "Interactive Learning Online at Public Universities: Evidence from a Six-Campus Randomized Trial: Interactive Learning Online at Public Universities." *Journal of Policy Analysis and Management* 33 (1): 94–111. https://doi.org/10.1002/pam.21728; Cavalluzzo et al. 2012; Harrington, Susan Ann, Melodee Vanden Bosch, Nancy Schoofs, Cynthia Beel-Bates, and Kirk Anderson. 2015. "Quantitative Outcomes for Nursing Students in a Flipped Classroom." *Nursing Education Perspectives* 36 (3): 179–81. https://doi.org/10.5480/13-1255
Studies finding negative or mixed effects including negative: Alpert et al. 2016.
For a summary of the literature including effect sizes see Escueta et al. 2020. p 928.

[91] Specifically, they use quasi-random variation in admissions among mostly identical applicants. During the first term of the program, admission was numerically limited, which led to a GPA threshold becoming binding. Those just above and just below this threshold were otherwise identical but faced a 20 percentage point difference in the probability of being admitted. Almost all of those just above the threshold eventually enrolled with very few enrolling in the face-to-face version of the degree. The applicants just below the GPA threshold had the same likelihood of enrolling elsewhere than the ones just above it.

hold such a degree, with a substantially higher rate of users holding college degrees.[92]

A common critique against MOOCs is the well-established finding of strikingly low completion rates. An assessment of edX, a MOOC platform run by Harvard University and the Massachusetts Institute of Technology (MIT), analyzed its performance over six years based on 12.7 million course registrations of 5.6 million learners.[93] The authors found that completion rates have consistently declined since inception of the platform. In 2017–18, the last year of the analysis, only 3.1 percent of enrollees completed their courses. Among the subset of those who purchased 'verified' certificates for their course, 46 percent completed their classes.

Survey evidence from Colombia, the Philippines, and South Africa indicate retention rates that by far supersede those in developed countries, indicating high potential in developing country settings.[94] In a survey of 1,400 MOOC users, 49 percent responded that they attained certification for at least one course; almost 80 percent said that they had completed at least one course.

MOOCs used for TVET purposes are less common, but the little evidence that exists points to slightly higher completion rates among those courses. An assessment of the Australian MOOC

ecosystem compared a sample of 263 national university, 27 transnational, and 72 TVET MOOCs.[95] The completion rates of the TVET MOOCs, both unconditional and conditioned on the subgroup having completed at least one significant piece of work, were comparatively higher and the difference was statistically significant. A potential reason for this difference might have been the differing cognitive intensity of the workload.[96] Insufficient foundational skills[97] and demanding workloads[98] have been found to adversely affect retention, which might make courses focused on practical skills more amenable to online learning. A caveat is that the TVET MOOCs assessed were provided by

[92] Garrido, Maria, Lucas Koepke, Scott Andersen, and Andres Felipe Mena. 2016. "The Advancing MOOCs for Development Initiative: An examination of MOOC usage for professional workforce development outcomes in Colombia, the Philippines, & South Africa". Seattle: Technology & Social Change Group, University of Washington Information School. https://digital.lib.washington.edu/researchworks/bitstream/handle/1773/35647/Advancing_MOOCs_for_Development_Final_Report_2016_Final.pdf?sequence=4&isAllowed=y

[93] Reich, Justin, and José A. Ruipérez-Valiente. 2019. "The MOOC Pivot." *Science* 363 (6423): 130–31. https://doi.org/10.1126/science.aav7958. For evaluations based on Coursera MOOCs see for instance de Freitas, Sara Isabella, John Morgan, and David Gibson. 2015. "Will MOOCs Transform Learning and Teaching in Higher Education? Engagement and Course Retention in Online Learning Provision." *British Journal of Educational Technology* 46(3): 455–71. https://doi.org/10.1111/bjet.12268; Greene, Jeffrey A., Christopher A. Oswald, and Jeffrey Pomerantz. 2015. "Predictors of Retention and Achievement in a Massive Open Online Course." *American Educational Research Journal* 52(5): 925–55. https://doi.org/10.3102/0002831215584621; Khalil, Hanan, and Martin Ebner. 2014. "MOOCs Completion Rates and Possible Methods to Improve Retention - A Literature Review." In Proceedings of EdMedia 2014--World Conference on Educational Media and Technology, edited by J Viteli and M Leikomaa, 1305–13. Tampere, Finland: Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/primary/p/147656/

[94] Garrido et al. 2016.

[95] Paton, Rachael, M., Joel .D. Scanlan, and Andrew. E. Fluck. 2018. "A Performance Profile of Learner Completion and Retention in Australian VET MOOCs." *Journal of Vocational Education & Training* 70 (4): 581–99. https://doi.org/10.1080/13636820.2018.1463278

[96] Paton et al. 2018. p 591.

[97] Khalil, H., and M. Ebner. 2014.

[98] Hew, Khe Foon. 2016. "Promoting Engagement in Online Courses: What Strategies Can We Learn from Three Highly Rated MOOCS: Engagement: Lessons from MOOCs." *British Journal of Educational Technology* 47 (2): 320–41. https://doi.org/10.1111/bjet.12235

reputable university institutions under a certification program. This additional incentive might have played a role in improving retention.

Completion rates, however, might not be the most telling metric. The question of what determines when a MOOC enrollee has actually 'commenced the course' for evaluation purposes is actively debated.[99] When the commencement date is set to students having completed a significant piece of learning, completion rates improve. Enrollees might often simply not start with the goal of completing the course and/or enroll to consume specific content only.

Similarly, starting a course to test whether the content fits one's purposes before enrolling for fees might be interpreted as positive,[100] though it reduces completion rates. Most important, to the extent that low completion rates reflect gaps in the educational model, there might be room for adjustments to rectify the shortcomings of the model. As Escueta et al. (2020) observed, 'low rates may, at least in part, reflect missed learning opportunities that could be avoided with modifications to the MOOC platform."[101]

The positive flipside of the lack of scholarship on MOOCs' effectiveness in skills development is that research has assessed factors that increase retention and completion rates. A growing strand of literature in the tradition of behavioral sciences assesses mostly low-cost design options to help overcome common barriers in self-directed learning, such as procrastination. Escueta et al. (2020) identified eleven random control trials that assessed interventions to reduce student attrition, seven of which found significant effects of at least one treatment arm.[102] Two studies found that social comparisons, such as informing the student of their performance against peers, yielded significant improvements on learning and completion.[103] Two other studies replicated the well-established impact of commitment and planning devices for the purpose of overcoming procrastination in the realm of learning: Patterson et al. (2018), for instance, tested three different tools:[104] a commitment device that allowed students to set limits on distracting internet time each day during a course; an alert system that triggered a reminder after each half-hour students spent on the distracting websites; and a distraction blocker, which received an option to block other websites when students went to the course website. The alert tool was found to have no significant impact on outcomes, while the distraction blocker only yielded modest improvements. Students who received the commitment device treatment, however, were 40 percent more likely to complete the course, spent 25 percent more time working on the course, and had course grades 0.29 standard deviations higher than those in the control group. Yeomans and Reich (2017) found in another study that planning prompts at the beginning of a MOOC improved course completion by 29 percent.[105]

[99] Jordan, Katy. 2015. "Massive Open Online Course Completion Rates Revisited: Assessment, Length and Attrition." *The International Review of Research in Open and Distributed Learning* 16 (3). https://doi.org/10.19173/irrodl.v16i3.2112

[100] Paton et al. 2018.

[101] Escueta et al. 2020.

[102] Escueta et al. 2020. p 939.

[103] Davis, Dan, Ioana Jivet, René F. Kizilcec, Guanliang Chen, Claudia Hauff, and Geert-Jan Houben. 2017. "Follow the Successful Crowd: Raising MOOC Completion Rates through Social Comparison at Scale." In Proceedings of the Seventh International Learning Analytics & Knowledge Conference, 454–63. Vancouver British Columbia Canada: ACM. https://doi.org/10.1145/3027385.3027411; Martinez, Ignacio. 2014. "The Effects of Nudges on Students' Effort and Performance: Lessons from a MOOC." EdPolicyWorks Working Paper. https://education.virginia.edu/sites/default/files/files/EdPolicyWorks_files/19_Martinez_Lessons_from_a_MOOC.pdf

[104] Patterson, Richard W. 2018. "Can behavioral tools improve online student outcomes? Experimental evidence from a massive open online course. *Journal of Economic Behavior & Organization* 153: 293-321. https://ideas.repec.org/a/eee/jeborg/v153y2018icp293-321.html

[105] Yeomans, Michael, and Justin Reich. 2017. "Planning Prompts Increase and Forecast Course Completion in Massive Open Online Courses." In Proceedings of the Seventh International Learning Analytics & Knowledge Conference, 464–73. Vancouver British Columbia Canada: ACM. https://doi.org/10.1145/3027385.3027416

Non-experimental research has identified additional factors that contribute to improved retention, including that the first weeks and early assessments are critical for engagement and commitment to the course.[106] Shorter courses and courses with more achievable workloads were associated with improved retention rates.[107] Rewards such as digital badges for the achievement of milestones can improve learner motivation.[108]

Such design interventions will also be crucial to ensure that MOOCs are applicable in developing country contexts. By and large, MOOCs appear to have predominantly attracted learners from affluent countries and neighborhoods, rather than bringing in new non-consumers of education.[109] More worryingly, socioeconomic status correlates with persistence in programs.[110] The structure of courses may exacerbate such differences. Learners who receive lower grades on early assignments, for instance, are less likely to continue on the course.[111]

These differences might reflect the interaction of learning outcomes with preexisting skills in self-directed learning, which are affected by the quality of primary education systems. Additionally, so-called social identity threats, such as the feeling of being unwelcome and not fitting into a community of learners, can impose additional cognitive burdens and affect learning. An experimental evaluation of several writing exercises designed to reduce such social identity threats showed that they can effectively close the achievement gap between participants from developing and developed countries.[112]

This evidence suggests that successful deployment of MOOC models for developing country settings warrants a particular focus on design elements that help overcome deficiencies in self-directed learning as well as perceived differences between the community of learners.

A central question relevant to online learning for TVET relates to the extent to which it improves labor market outcomes. By and large, the literature suggests that employers favor traditional degrees over online degrees. However, online learning is associated with improved labor market outcomes when compared to holding no degree.

Broadly, employers appear to prefer traditional degrees over online degrees. Deming et al. (2016) experimentally assessed the value of postsecondary credentials in the labor market by sending out fictitious resumes for real vacancies.[113] They found that applicants with degrees from online for-profit institutions were 22 percent, or two percentage points, less likely to receive a callback compared with applicants from nonselective public schools. In addition, applicants with degrees from 'local brick-and-mortar for-profits'[114] were penalized less strongly than applicants with degrees from large, online chain institutions. In a complementary set of experiments, they found that licensing examinations, as an independent proxy for student quality, can

[106] Skrypnyk, Oleksandra, Pieter De Vries, and Thieme Hennis. 2015. "Reconsidering Retention in MOOCs: The Relevance of Formal Assessment and Pedagogy," https://doi.org/10.13140/RG.2.1.1881.3286; Jordan, K. 2015.

[107] Jordan, K. 2015. Skrypnyk et al. 2015. de Freitas et al. 2015. Hew, K.F. 2016.

[108] Rosewell, Jon and Darco Jansen. 2004. "The OpenupEd Quality Label: Benchmarks for MOOCs". *INNOQUAL - International Journal for Innovation and Quality in Learning*. 2. https://www.researchgate.net/publication/286925442_The_OpenupEd_quality_label_Benchmarks_for_MOOCs; de Freitas et al. 2015.

[109] Hansen, John D., and Justin Reich. 2015. "Democratizing Education? Examining Access and Usage Patterns in Massive Open Online Courses." *Science* 350 (6265): 1245–48. https://doi.org/10.1126/science.aab3782

[110] Hansen, J.D. and J. Reich. 2015.

[111] Skrypnyk et al. 2015.

[112] Kizilcec, René F., Andrew J. Saltarelli, Justin Reich, and Geoffrey L. Cohen. 2017. "Closing Global Achievement Gaps in MOOCs." *Science* 355 (6): 251–52. https://doi.org/10.1126/science.aag2063.

[113] Deming, David J., Noam Yuchtman, Amira Abulafi, Claudia Goldin, and Lawrence F. Katz. 2016. "The Value of Postsecondary Credentials in the Labor Market: An Experimental Study." *American Economic Review* 106 (3): 778–806. https://doi.org/10.1257/aer.20141757

[114] Deming et al. 2016. p 803.

diminish differences between public and for-profit schools, which suggests that the addition of external certifications might help lift existing stigma effects.

Observational evidence suggests that in specific TVET settings, differences between traditional and online degrees may be less pronounced. An evaluation of TVET courses in the Australian system delivered online descriptively assessed employment outcomes of graduates of online courses compared to students receiving traditional training.[115] The authors reported that outcomes were broadly similar between the two groups. If anything, online students had more success in finding employment after graduation, though, given the much lower completion rates of online students, this might be attributable to a self-selection process for high performers.

Evidence suggests that online certifications are rewarded over having no formal certification in MOOCs focused on professional settings. Programs such as Coursera's Digital Marketing Specialization and Udacity's Nanodegree in Google AdWords reflect the strong and increasing professional orientation of MOOCs. The emergence of micro- and nano-degrees for professional skills, often directly offered by firms, might help improve labor market outcomes.[116] Rivas et al. (2020) experimentally assess the preferences for web developers with traditional certifications vs. MOOC certifications vs. no certifications.[117] Their findings suggests that managers prefer traditional credentials (bachelor's degrees, associate degrees, and community college degrees) over MOOC degrees. However, MOOC degrees are preferred over having no traditional credentials independent of professional experience. The authors estimate that the size of the preference of a MOOC certificate is similar to the effect of two years of professional experience. In a similar vein, an analysis comparing completers vs non-completers of a Coursera data science MOOC program found an average increase in salary for completers of $8,230, as well as an increase in the likelihood of changing jobs by 30 percentage points.[118] In addition, the authors find that average incomes increase per completed course (rather than only for those who complete the degree), indicating that the effect is not purely driven by signaling through credentials but by skills attainment.

Online and computer-assisted learning in vocational settings—open questions

How can these findings inform use of EdTech in TVET?

In principle, the lessons from evaluations focusing on postsecondary settings translate to the off-the-job portions of TVET, where foundational cognitive skills are developed. Indeed, the established limitations of MOOCs, for instance, with respect to retaining students in courses for very advanced and demanding content, may be less problematic for TVET, where the required level of foundational content tends to be comparatively lower than in tertiary education.

The biggest potential of leveraging the technologies described above in TVET, however, relates to integration of on-the-job and off-the-job training. In TVET, these stages are often separated and administered in different time-blocks and in different places. EdTech allows for reorganization and integration of these phases, for instance, by delivering content online as and when it is applied and by leveraging computer-assisted learning technologies to provide real-time feedback while

[115] Griffin, Tabatha, and Mandy Mihelic. 2019. Online Delivery of VET Qualifications: Current Use and Outcomes. National Centre for Vocational Education Research (Australia) (NCVER). https://www.ncver.edu.au/__data/assets/pdf_file/0040/7682296/Online-delivery-of-VET-qualifications.pdf

[116] Rivas, Mariela J., Rachel B. Baker, and Brent J. Evans. 2020."Do MOOCs Make You More Marketable? An Experimental Analysis of the Value of MOOCs Relative to Traditional Credentials and Experience." *AERA Open* 6(4). https://doi.org/10.1177/2332858420973577

[117] Rivas et al. 2020.

[118] Hadavand, Aboozar, Ira Gooding, and Jeffrey T. Leek. 2018. "Can MOOC Programs Improve Student Employment Prospects?" https://doi.org/10.2139/ssrn.3260695

performing tasks. The product offering in this realm is scarce, providing ample room for further research.

Making such models applicable to developing country contexts and relevant for the skills levels required for TVET requires careful design. Specifically, such courses will require features to help overcome motivational barriers, barriers in self-directed learning, and other barriers such as social-identity threats that might lower the participation and learning success of the most disadvantaged groups.

A review of literature indicates that it is imperative to collect data, especially on the labor market outcomes of graduates. Technologies have altered the way in which education is delivered, but there is still little systematic knowledge of what works and what does not. Where studies exist, they focus on skills rather than labor market outcomes. Given the goal of TVET to create matches between labor market needs and skills supply, this component is critical to measure success. Any reform of TVET systems or piloting of interventions should, from its inception, integrate strategies to measure labor market outcomes so as not to repeat prior mistakes in creating reform with unmeasurable outcomes.

However, it remains unclear to what extent online learning can be leveraged for building the hallmark goal of TVET: technical and practical skills that can be directly applied on the job. For this aim, a different realm of technology applications might hold greater potential: the use of virtual reality applications.

USING VIRTUAL REALITY FOR TVET

VR applications for education are a particularly promising avenue for cost-effectively developing skills in applied domains. They may bridge the divide between theoretical learning and practical application, as they offer students and teachers/trainers reproducible learning environments, allowing for unlimited repeated simulations of costly and/or rare real-life situations across geographical boundaries. Such contexts have been at the forefront of deploying VR applications. Emergency simulations have been used for training purposes in various domains, including public emergency management during natural disasters or pandemics,[119] decision making of police officers during critical incidents,[120] as well as emergency triage during disasters by medical personnel.[121] Other early applications include costly and high-risk applications such as surgeries.[122] Applications in TVET settings are rarer though environments such as welding[123] or food preparation,[124] where

[119] New York City Office of Emergency Management. "Biennial Report 2009." 2009. https://www1.nyc.gov/assets/em/downloads/pdf/biennial09_final.pdf.

[120] Government Technology. 2010. "L.A. Police Department's Hydra System Promotes Training for Command-Level Officers." GovTech. https://www.govtech.com/em/disaster/LA-Police-Department-Training-Hydra.html

[121] Andreatta, Pamela. B., Eric Maslowski, Sean Petty, Woojin Shim, Michael Marsh, Theodore Hall, Susan Stern, and Jen Frankel. 2010. "Virtual Reality Triage Training Provides a Viable Solution for Disaster-Preparedness." *Academic Emergency Medicine* 17 (8): 870–76. https://doi.org/10.1111/j.1553-2712.2010.00728.x; Vincent, Dale S., Andrei Sherstyuk, Lawrence Burgess, and Kathleen K. Connolly. 2008. "Teaching Mass Casualty Triage Skills Using Immersive Three-Dimensional Virtual Reality." *Academic Emergency Medicine* 15 (11): 1160–65. https://doi.org/10.1111/j.1553-2712.2008.00191.x

[122] Blumstein, Gideon, Brian Zukotynski, Nicolas Cevallos, Chad Ishmael, Steven Zoller, Zach Burke, Samuel Clarkson, Howard Park, Nicholas Bernthal, and Nelson F. SooHoo. 2020. "Randomized Trial of a Virtual Reality Tool to Teach Surgical Technique for Tibial Shaft Fracture Intramedullary Nailing." *Journal of Surgical Education* 77 (4): 969–77. https://doi.org/10.1016/j.jsurg.2020.01.002; Thomsen, Ann Sofia Skou, Daniella Bach-Holm, Hadi Kjærbo, Klavs Højgaard-Olsen, Yousif Subhi, George M. Saleh, Yoon Soo Park, Morten la Cour, and Lars Konge. 2016. "Operating Room Performance Improves after Proficiency-Based Virtual Reality Cataract Surgery Training." *Ophthalmology* 124 (4): 524–31. https://doi.org/10.1016/j.ophtha.2016.11.015; Kim, Youngjun, Hannah Kim, and Yong Oock Kim. 2017. "Virtual Reality and Augmented Reality in Plastic Surgery: A Review." *Archives of Plastic Surgery* 44 (3): 179–87. https://doi.org/10.5999/aps.2017.44.3.179

[123] McLaurin, Elease J., and Richard T. Stone. 2012. "Comparison of Virtual Reality Training vs. Integrated Training in the Development of Physical Skills." *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 56 (1): 2532–36. https://doi.org/10.1177/1071181312561526; Stone, Richard T, Kristopher Patrick Watts, and Peihan Zhong. 2011. "Virtual Reality Integrated Welder Training." *Welding Journal* 90 (7): 136–41

[124] Rose, F. D., B. M. Brooks, and E. A. Attree. 2000. "Virtual Reality in Vocational Training of People with Learning Disabilities." Conference paper presented at University of Reading.

repeated practice with (often expensive) physical objects is crucial to advance learning, are increasingly deployed. Other TVET settings take advantage of VR's potential to help students immerse themselves into the industrial realities they will face after completion of their degrees. A woodworking program in Taiwan, China, for instance deployed VR to allow students to immerse into an industrial scale production line.[125] The education facility itself is only equipped with a basic woodshop and traditionally uses theory-based training for understanding industrial production. Industrial batch manufacturing production requires operating complex machinery in disintegrated steps, which could be modeled virtually.

Another key advantage of VR-based learning can be that its interactive and often gamified nature might improve student motivation (see Box 4.1).

Angel-Urdinola et al. (2021) systematically assess the universe of peer-reviewed papers and doctoral theses on VR applications in educational settings between 2005 and 2020, focusing on their success in developing technical, cognitive, and socio-emotional skills.[126] Of the 31 studies (covering 92 experiments) they identified, nine (covering 29 experiments) were conducted in TVET settings. The studied applications in TVET settings differed, with experiments being conducted in the fields of health and safety (specifically, the emergency evacuations of neonates[127]), engineering, science and technical education (computer network administration,[128] welding,[129] and aircraft maintenance procedures[130]), and in general education settings (job interviews).[131] Given the small number of studies in TVET domains, we explore the study's results across all 31 studies.

[125] Lee, I-Jui. 2020. "Applying Virtual Reality for Learning Woodworking in the Vocational Training of Batch Wood Furniture Production." Interactive Learning Environments. https://doi.org/10.1080/10494820.2020.1841799

[126] Angel-Urdinola, Diego F, Catalina Castillo-Castro, and Angela Hoyos. 2021. "Meta-Analysis Assessing the Effects of Virtual Reality Training on Student Learning and Skills Development." Policy Research Working Paper March, no. 9587 https://openknowledge.worldbank.org/handle/10986/35299

[127] Farra, Sharon, Eric Hodgson, Elaine T. Miller, Nathan Timm, Whittney Brady, Matt Gneuhs, Jun Ying, et al. 2019. "Effects of Virtual Reality Simulation on Worker Emergency Evacuation of Neonates." *Disaster Medicine and Public Health Preparedness* 13(2): 301–8. https://doi.org/10.1017/dmp.2018.58

[128] Lampi, Evans. 2013. "The Effectiveness of Using Virtual Laboratories to Teach Computer Networking Skills in Zambia." Virginia Polytechnic Institute and State University. https://eric.ed.gov/?id=ED557800

[129] Stone, R.T. et al. 2011; McLaurin, E.J., and R.T. Stone. 2012.

[130] Buttussi, Fabio, and Luca Chittaro. 2018. "Effects of Different Types of Virtual Reality Display on Presence and Learning in a Safety Training Scenario." *IEEE Transactions on Visualization and Computer Graphics* 24 (2): 1063–76. https://doi.org/10.1109/TVCG.2017.2653117

[131] Smith, Matthew J., Emily J. Ginger, Katherine Wright, Michael A. Wright, Julie Lounds Taylor, Laura Boteler Humm, Dale E. Olsen, Morris D. Bell, and Michael F. Fleming. 2014. "Virtual Reality Job Interview Training in Adults with Autism Spectrum Disorder." *Journal of Autism and Developmental Disorders* 44 (10): 2450–63. https://doi.org/10.1007/s10803-014-2113-y

BOX 4.1 Virtual reality training

ActiVaR: Virtual reality training programs for technical education in Ecuador

The Government of Ecuador, with the support of the Korea-World Bank Partnership Facility, recently introduced the ActiVaR program through its Secretariat of Higher Education, Science, Technology, and Innovation (SENESCYT). The ActiVaR program supports the design, implementation, and evaluation of virtual labs using VR, to be delivered by Ecuador's state system of technical and technological institutes (TTIs). The training curriculum will combine traditional in-class and VR methodologies. The main objectives of the program are (a) to assess the performance and cost-effectiveness of using computer-based and VR technologies to deliver practical training in selected TTIs in Ecuador, and (b) to capitalize on the Republic of Korea's experience in technical vocational education and training to inform Ecuador's ongoing reform of higher technical and technological education.

In December 2018, the World Bank and SENESCYT launched a competitive selection process to identify two TTIs that would benefit from ActiVaR. A total of 16 proposals from TTIs across Ecuador were received and five were shortlisted. In February 2019, the finalists traveled to Quito to pitch their proposals to a selection panel of academics, representatives from the industrial sector, information technology experts, and SENESCYT and World Bank staff. Two TTIs were chosen: (a) Cotopaxi, to develop an immersive course on motor repair, and (b) Tsa Chila, to develop a course on industrial risk prevention. The ActiVaR program is being implemented in collaboration with Namseoul University's Advanced Digital Virtual and Augmented and Reality Center, one of the main designers and developers of VR content for learning and technical training in Korea.

Cotopaxi TTI: VR laboratory in auto-mechanics

The intervention will provide a group of students from Cotopaxi Technical Institute's Motor Engine Repair Program with training on generic V-6 gasoline engines using augmented and virtual reality (AVR) technology. The training includes eight learning modules developed in coordination with Namseoul University in Korea. The content is being delivered to second-year student cohort at Cotopaxi, one of the largest public technical universities in Ecuador. The pedagogical approach for the curriculum is based on blended learning models. The students' initial introduction to content will be through AVR-mediated experiences, allowing a customized and integrated approach to learning. The AVR simulations actively allow students to manipulate a virtual motor engine in order to make them proficient in understanding, manipulating, and repairing it.

Tsa Chila TTI: VR laboratory in prevention of industrial risks

The intervention will provide a group of students from Tsa Chila Technical Institute's Safety and Occupational Risk Prevention Program with training on industrial risk prevention using VR technology. The curriculum was developed by the Educate Foundation (an Ecuadorian nonprofit organization) in coordination with private sector stakeholders. The pedagogical approach for the proposed curriculum is based on blended learning models. The Tsa Chila Technical Institute will be equipped with an AVR lab (hardware and software). The experience transports students to a virtual factory, introduces them to industrial risk prevention; simulates work environments and risk factors; and provides them with practical experiences to control risks, to use machines safely, and to react correctly in case of an emergency.

The meta-assessment on 92 experiments found that VR instruction on average is more effective than traditional teaching in developing student skills across technical, cognitive, and socio-emotional domains. For technical skills, on average, each additional hour of VR teaching led to a three percent increase in learning assessments. For cognitive skills, each quarter hour led to an increase of similar magnitude. Reported socio-emotional skills were on average 30 percent higher after completing VR training. VR instruction for developing technical skills was particularly promising in the health and safety domain, notably in surgical performance, where post-training ability assessments were between 20 and 60 percent higher per additional hour of instruction.[132] In engineering, science, and technical education, such as welding or computer network configuration, the effects were less pronounced. Broadly, recipients of VR training showed similar skills improvements as those receiving traditional or blended forms of instruction, suggesting that VR training may act as an appropriate substitute in certain settings.

The latter is particularly promising for developing countries. Lampi's (2013) assessment of using VR laboratories to train computer networking configuration and troubleshooting skills in Zambia, for instance, was motivated by the fact that access to real laboratories is scarce and building such capacities is expensive. He found that there was a statistically significant outperformance by the group that received VR training in terms of time needed to perform tasks and no significant difference in accuracy, suggesting the potential of VR to be cost-effective.

In a sequence of studies on VR applications in the field of welding, the authors found that integrated learning environments, where traditional teaching was blended with VR, led to improvements in weld quality, higher certification rates, reduced training time, improved physical skill learning, and reduced costs for simpler welds.[133] In a follow-up study, they compared training entirely delivered via VR with blended models.[134] They found that performance levels between the two groups were indistinguishable for low and medium task difficulty. It was only for the highest level of difficulty that VR systems alone were not sufficient.

It is promising that the literature predominantly reports either zero or positive effects, though it remains unclear what drives the differences in magnitude. It may be a combination of the technology itself, the way in which it is applied, and the occupational field and specific skill itself. The body of literature is too small to determine which settings VR is particularly impactful in or the precise causal mechanisms by which VR applications improve skills attainments. This offers substantial room for additional research.

[132] Angel-Urdinola et al. 2021. p 18.

[133] Stone et al. 2011.

[134] McLaurin, E.J., and R.T. Stone. 2012.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CHAPTER 5

Procurement Models for Governments

As demonstrated in previous chapters, the accelerating use of EdTech within TVET and its increasing ability to be deployed at scale in emerging markets create burgeoning opportunities to strengthen the quality of education in this sector and the number of people that it reaches. However, this is largely dependent on a core set of capacities within the EdTech supply chain, chief among which is well-established and effective EdTech procurement processes. Strong procurement processes form the foundation of the supply of EdTech in the TVET system but are dependent on complex decisions on educational goals, staffing, models, and capacities.

Khan (2018) identifies four pillars of public procurement: legislative; institutional arrangement and management capacity; procurement operations and market; and integrity and transparency, as illustrated in Figure 5.1.

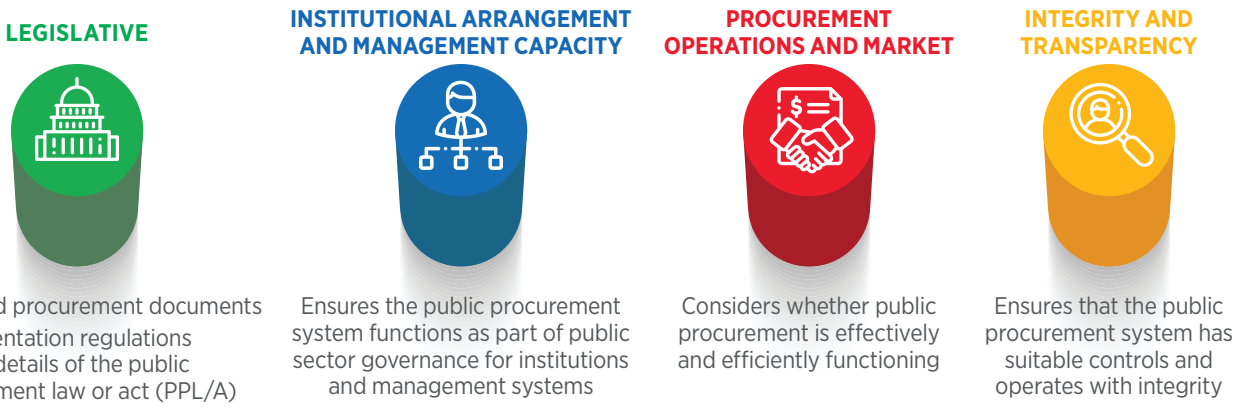
BOX 5.1 Public procurement

Public procurement is an essential government system for spending public money to acquire products and services required for public programs and projects. It is generally divided into three categories: goods (all manufactured items), works (construction and repair of infrastructure), and services (categorized into either advisory and consultancy services or technical services). Public procurement comprises three key facets that collectively aim to deliver quality and timely services to citizens. These are:

1. Preparation of an annual budget when government agencies have to estimate their needs;
2. Procurement planning following budgetary allocation; and
3. Implementation of procurement plans using a procurement cycle that includes tendering or bidding, contract award, and contract management.

Source:
Khan, Naushad. 2018. "Public Procurement Fundamentals: Lessons from and for the Field". https://books.emeraldinsight.com/resources/pdfs/chapters/9781787546080-TYPE23-NR2.pdf

FIGURE 5.1 The four pillars of procurement[135]



[135] Khan, Naushad. 2018. *Public Procurement Fundamentals: Lessons from and for the Field.* United Kingdom: Emerald Publishing Limited. https://books.emeraldinsight.com/resources/pdfs/chapters/9781787546080-TYPE23-NR2.pdf

TABLE 5.1 Procurement methods[136]

METHOD	TYPE	DESCRIPTION
Open tendering	**Goods, services, and works**	The process of acquiring goods, works, and services at the lowest price. The process aims to stimulate competition and minimize discrimination. It enables transparency, which allows fair play for competing contractors, suppliers, or vendors.[137]
Limited/restricted tendering	**Goods, services, and works**	A process where a limited number of bidders are shortlisted or invited to tender for goods, works or services. This can reduce the time and cost of the selection process.[138]
Low value (micro-purchasing)	**Goods, services, or simple works**	The simplified and often informal purchase of readily available goods, standardized services and small works.
Request for quotation (RFQ)	**Standardized goods or services**	A procurement method where the buyer sends a written request to a vendor, soliciting a written price quotation based on a requirement that is described in the request.
Request for proposal	**Services**	A procurement method used when inputs and/or outputs cannot be quantitatively and qualitatively expressed in sufficient detail; in this method, services could be designed according to the buyers' specific needs.
Direct contracting	**Services, goods, or works**	A process that involves direct rewarding of a contract to a vendor without any competition.

There are six broad procurement methods for goods, services, and works (collectively referred to as 'products and services' in this chapter). (See Table 5.1.)

Procurement is a simple concept that has far-reaching consequences for the TVET sector because it determines the efficiency of product and service supply in the sector, as well as the effectiveness of *what* is supplied. Despite this, there is a dearth of information on EdTech procurement in TVET and its implications for the TVET system. This chapter will explore how public procurement relates to EdTech in TVET, together with existing models and frameworks in EdTech. Given the dearth of information from the TVET sector, the latter are drawn predominantly from the K-12 sector. The chapter will use this information to develop a hybrid procurement framework and outline imperatives for operationalizing the framework.

HOW DOES PROCUREMENT RELATE TO EDTECH IN TVET?

As Chapter 3 has outlined, growth of the EdTech industry has led to various business models, EdTech products, and services. This started with a focus on computer programming applications to improve public school management in the 1980s. The evolution of the EdTech market has led to several channels (refer to Table 6 in Chapter 3). Thus, while government procurement may be applicable to any of the key customer segments through, for example, learning marketplaces or training tools, it most notably focuses on B2C EdTech solutions such as MOOCs and online content providers (where content development is outsourced to third parties with government covering costs). Governments have a significant role to play in expanding access to education and improving its relevance through procurement

[136] Adapted from UNFCCC. no date. "What is Public Procurement?" https://unfccc.int/files/secretariat/procurement/application/pdf/unfccc_procurement_process_2017.pdf

[137] Aavenir. no date. "What Is Open Tendering?- Definition." https://aavenir.com/glossary/what-is-open-tendering/

[138] Lynch, Jorge. no date. "Restricted Tendering. The Procurement Classroom". https://procurementclassroom.com/restricted-tendering

processes such as procuring teacher training services, EdTech, and data systems.[139]

Vocational EdTech is procured by different actors for different purposes. Generally, these are:

1. National or regional governments for their own use, i.e., to strengthen the governance and management of the TVET system.
2. National or regional government for distribution to and use by public (and sometimes private) training providers.
3. Public and private training providers for their own use.

The EdTech procurement cycle differs from procurement of other products and services. There are several reasons for this; not only does there need to be close alignment between EdTech supply and desired outcomes on the ground (i.e., in the classroom), but technology purchasing is also much more complex than for other learning tools, as explained below:

> *Hardware alone has several vendors with multiple models and thousands of possible combinations available for purchase, most of which are significantly different by the time a new purchase needs to be made. Software has hundreds of potential vendors with several products, which also rapidly evolve. So how does a single purchaser, or purchasing team, keep up with the thousands of possible options every year, all the while ensuring maximization of each technology dollar? Simply put: they don't.*[140]

There are also additional considerations that come into play in EdTech purchasing, such as the impact of institutional, provincial, or national budgets, parents' opinions, and the needs of teachers and students.[141]

Public procurement of EdTech in TVET is unique because it requires thorough evaluation of learner and teacher/trainer needs, balancing these requirements with policies and legislation relevant to the TVET sector, available resources, infrastructure, and EdTech product or service development. As Chapter 4 illustrated, the EdTech sector is a rapidly changing landscape, with new innovations and developers entering the market constantly. While this provides an advantage to the public sector by expeditiously improving the available technology and presenting new products, it also makes procurement processes more complex due to the constantly shifting functionality of EdTech solutions. Despite these complexities, innovation is crucial to EdTech procurement in TVET because it ensures that students are provided the solutions that are best suited to their requirements. Innovation also ensures that the procurement process evolves to become increasingly safe and is infused with integrity and efficiency.

INNOVATION AND THE IMPORTANCE OF PARTNERSHIPS

Public sector procurement has been conceptualized and implemented in innovative ways within the education sector and beyond, often relying on partnerships for successful implementation. Chapter 6 outlines a specific set of tools that government and its agencies can use to implement policies to support such partnerships, thereby managing and directing changes in public services. The concepts of public procurement and innovation converge in various ways to form useful policy levers. First, public procurement for innovative solutions (PPI) is a concept that offers novel solutions to the market. PPI occurs when the public sector exerts its purchasing power to become

[139] Caerus Capital. 2017. "The Business of Education in Africa." https://edafricareport.caeruscapital.co/thebusinessofeducationinafrica.pdf.

[140] Owens, Daniel. 2014. "21st Century EdTech Procurement. The Learning Accelerator." https://learningaccelerator.org/blog/21st-century-edtech-procurement

[141] Copadis, Amy. 2020. "EdTech Sales: The ultimate guide to selling to schools during COVID-19." https://blog.close.com/edtech-sales/

an early adopter of existing innovative solutions that are currently unavailable on a large-scale commercial basis. PPI supports more widespread diffusion of innovations by creating a large enough demand that incentivizes industry to invest in commercialization, creating products or services with the quality and price appropriate for mass market deployment.[142] PPI focuses on solutions that do not need additional research and development for large-scale deployment and may already exist in the market in small quantities. For example, the Learning Technology Accelerator (LEA) established LEA-Network, a partnership between European public procurers in the education domain. The network seeks to deploy personalized learning environment innovations and to prepare new future pre-commercial and PPI procurements. It does so by facilitating relationships between buyers and sellers and grouping demand.[143]

Pre-commercial procurement (PCP) can be used when there are no near-to-market solutions yet and new R&D is required. In this model, the public sector buys R&D to steer development of solutions to meet its needs, gather information about the benefits and potential pitfalls of alternative solutions, and use it to de-risk the most encouraging innovations through systematic solution design, prototyping, development, and product or service testing.[144] For example, Innovative Methods for Awards Procedures of ICT Learning in Europe (IMAILE) was the first PCP project in Europe in the field of Education and Technology Enhanced Learning. As the precursor to the LEA-Network, IMAILE facilitated dialogue between the demand and supply parties, enabling R&D to home in on the actual needs of the end users (schools, teachers, and students), providing them with Personal Learning Environments in primary and secondary education within the subjects of science, mathematics, and technology.[145]

The concept of innovative public procurement (IPP) focuses on innovation within the procurement process itself and includes solutions such as e-procurement services (the use of ICT in public procurement), framework agreements, or public-private partnerships (PPPs) as a means of procuring goods or services. Framework agreements vary by country, but they generally refer to agreements between procuring entities and one or more suppliers that establish specific terms and can enable the awarding of future contracts. They are often carried out in two stages, the first being to select one or more suppliers or contractors to participate in an agreement with the procuring entity. The second stage involves the awarding of a procurement contract under the framework agreement.[146] For example, the RM6103 framework was introduced by the Crown Commercial Service in England and offers vetted suppliers, standardized contracts, and prior agreements to simplify the procurement process. It established an agreement for spending on EdTech at schools so that colleges, universities, and local authorities could rapidly and securely procure hardware, software, services, and infrastructure to support education.[147]

[142] European Commission. 2021. "Public Procurement of Innovative Solutions." https://ec.europa.eu/digital-single-market/en/public-procurement-innovative-solutions.

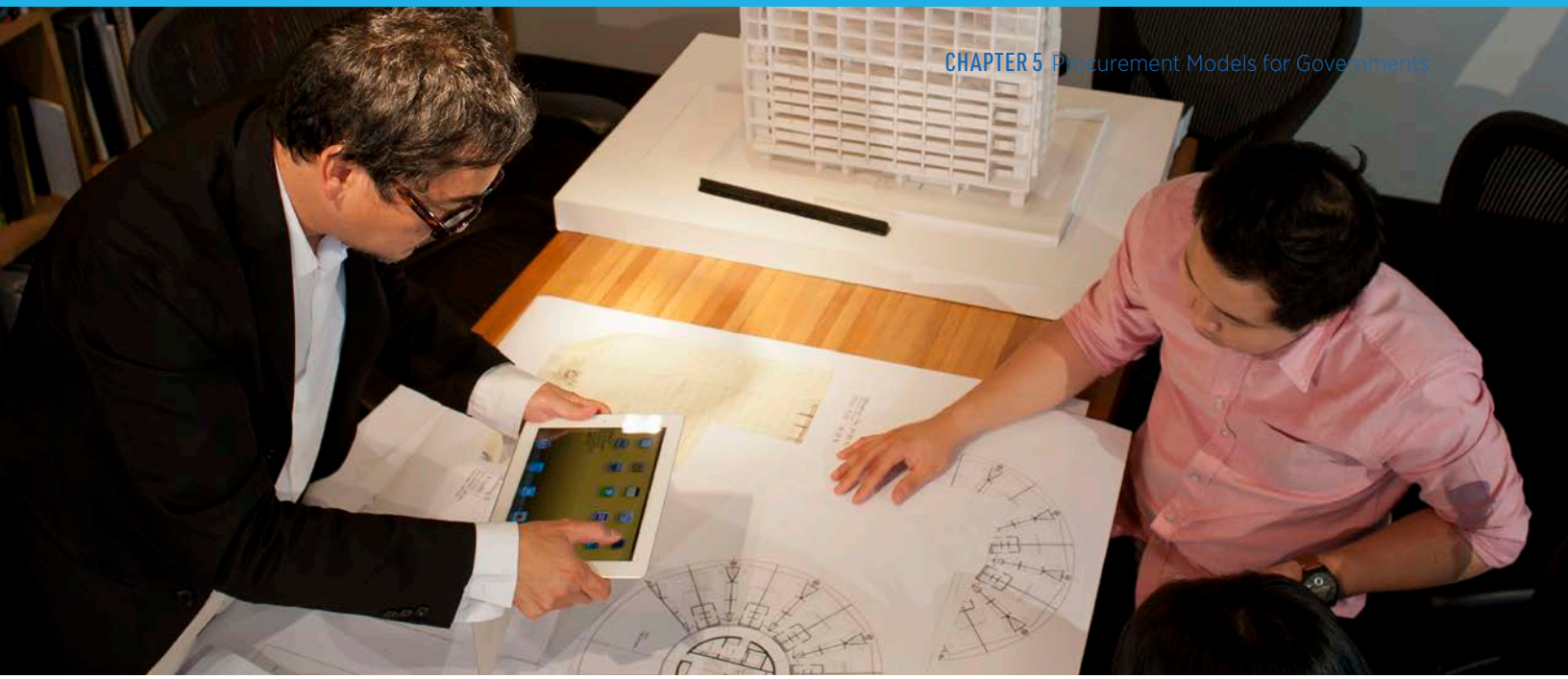
[143] European Commission. 2021. "EU funded projects implementing Pre-Commercial Procurements (PCP) or Public Procurement of Innovative Solutions (PPIs)." https://ec.europa.eu/digital-single-market/en/eu-funded-projects-implementing-pre-commercial-procurements-pcp-or-public-procurement-innovative.

[144] European Commission. no date. "Innovation Procurement." https://ec.europa.eu/digital-single-market/en/innovation-procurement

[145] Innovative Methods for Awards Procedures of ICT Learning in Europe (IMAILE). no date. Homepage. http://www.imaile.eu

[146] OECD. 2013. "Public procurement: Innovative tools in public procurement. Government at a Glance." https://www.oecd-ilibrary.org/docserver/gov_glance-2013-45-en.pdf?expires=1622010826&id=id&accname=guest&checksum=C75A38D410E2EFB9510FBC23F8889FFF.

[147] Rogers, Charley. 2019. "The Report: What is the CCS edtech procurement framework? Education Technology." https://edtechnology.co.uk/latest-news/the-report-what-is-the-ccs-edtech-procurement-framework/



PPPs can be an effective way of promoting innovation in EdTech procurement and supporting access to EdTech. As Chapter 3 notes, partnerships between the public and private sector are key to supporting EdTech investment and growth. The PPP Knowledge Lab (2018) defines a PPP as 'a long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance.'[148] However, PPPs have been conceptualized differently and used for different purposes to achieve varying outcomes in the education sector. Some argue that PPPs refer to equal sharing of risk and reward between private and public partners, while others categorize any contractual collaboration between private and public partners as a PPP. Because both risk and reward are generally shared, all partners are incentivized to contribute fully to the partnership. Governments may also use the concept to refer to 'an established procurement model that incorporates policy guidance, rules, and regulations.'[149] There are various types of PPPs in the education sector. These include institutional infrastructure partnerships, where the government leases a facility that is financed, built, and operated by a private party while the government continues to retain responsibility for delivery of the core educational service provision. Another example is government purchasing programs, in which a government contracts with private institutions to provide publicly funded education, often in the form of a subsidy per student enrolled.[150]

PPPs have provided a viable solution for large-scale EdTech provision and innovation, often involving PCP or PPI. This is because, due to the nature of PPP contracts, governments can procure products and services through open bidding, which allows them to define specific requirements for the quality of the product or service and the level of delivery.[151] The Finnish EdTech ecosystem emphasizes how governments, teachers, and innovators can build impactful products and services together. The five largest cities in Finland

[148] PPP Knowledge Lab. 2018. "PPP Reference Guide." https://pppknowledgelab.org/guide/sections/1-introduction.

[149] Valerio, Alexandria., Neil Butcher, Ji Liu., Viviana Venegas Roseth and Mohini Baijnath. 2019. "Europe Skills for Competitiveness: Leveraging Skills for Competitiveness in Europe." https://www.nba.co.za/resource/leveraging_skills_competitiveness_europe

[150] Taken verbatim from Valerio et al. 2019.

[151] Patrinos, Harry A., Felipe Barrera-Osorio, and Juliana Guáqueta. 2009. *The Role and Impact of Public-Private Partnerships in Education.* The World Bank. https://documents1.worldbank.org/curated/en/453461468314086643/pdf/479490PUB0Role101OFFICIAL0USE0ONLY1.pdf

are setting up a structure where cities and schools become innovation platforms for new EdTech development. This includes the following activities:

- Asking teachers/trainers what they need in the classroom;
- Challenging existing EdTech companies or new entrepreneurs to come up with solutions that address those needs; and
- Procuring the best solutions that meet these needs using a method called rapid experimentation—where companies co-create their offerings in collaboration with teachers and students, allowing them to iterate more quickly—to improve the effectiveness of EdTech products and services.

Products and services are evaluated by experts before and after the rapid experimentation process, after which a package of solutions that have been co-created by the schools and companies is given to each city's department of education.[152]

PPPs and innovative financing mechanisms have demonstrated significant effectiveness in rural areas, where supporting infrastructure is required for effective EdTech implementation. One such example was in the Samoa Schoolnet project, which was initiated by the Samoan government and supported through a grant from the Asian Development Bank (ADB). The private partner designed and built a virtual private network overlay on its existing network, operating the school network for three years, while providing repair and maintenance services for the products and network. The partnership allowed the network to operate at a significantly lower cost than normal business practice would allow. Moreover, the ADB grant allowed the project to support rural areas of Samoa where high-speed infrastructure is not present, by enabling Schoolnet to procure last-mile access technology that links schools to the private partner's network.[153]

One key principle for the use of PPPs is that all parties involved need a clear financing plan to avoid 'budget creep,' which may lead to disagreements and result in partners becoming reluctant to contribute resources, thus risking the sustainability of the partnership.[154] Clear designations between the roles each partner is expected to fulfil provide a strong foundation for successful PPPs, leading to effective implementation of EdTech.

[152] Singh, Ashmeet. 2018. "The Nordic EdTech Scene: Part 3 — The Finnish EdTech story." The EdTech World. https://medium.com/the-edtech-world/finnish-edtech-729e15fb37bc

[153] Sarvi, Jouko, Venkataraman. Balaji, and Hitendra Pillay. 2015. "Public-Private Partnerships in Information and Communication Technology for Education." *ADB Briefs* 49. https://www.adb.org/sites/default/files/publication/176953/ppp-ict-education.pdf

[154] Sarvi, J., V. Balaji, and H. Pillay. 2015.

BOX 5.2 Ruang Guru's use of partnerships with regional governments to scale products and aid the procurement process, Indonesia

Indonesia has used the latest global developments, including innovation in EdTech and the COVID-19 pandemic, to increase platform and content innovations in its education sector, which have been led by both government and the private sector. For example, during the COVID-19 pandemic, the Ministry of Education and Culture and the Ministry of Religious Affairs (MoRA) partnered with telecommunications companies to provide free internet quotas for teachers, students, university students, and lecturers with the aim of maintaining educational continuity during the pandemic. Internet quota packages include a study quota for access to EdTech apps and 5 GB of general quota for access to other online apps and social media. The quota provision ranges from 20 GB for early childhood education to 50 GB for university students.

Regional governments also hold a lot of influence in EdTech partnerships. Ruang Guru is a leading EdTech start-up in Indonesia that offers a range of products and services aimed at improving educational performance. It is one of the most frequently downloaded and used applications in Indonesia and has reached an estimated 10 million registered users.

Since 2014, Ruang Guru has used a strategy of B2G direct sales through government relations officers by negotiating with regional governments in 32 of Indonesia's 34 provinces. These partnerships have been profitable and have improved regional governments' capacity to provide EdTech companies with access to schools. In turn, this has allowed Ruang Guru to distribute vouchers sold to the government for their products. These voucher sales are within a legal direct procurement limit for 'small' purchases under IDR 200 million per transaction (approximately $17,000). Partnerships also include a package of educational content, virtual classes, the online-based test platform, and teacher training. Stemming from this strategy, Ruang Guru has a significant stronghold on the K–12 EdTech market. Other EdTech products are available through an e-catalogue of approved products (which is not limited to education or EdTech). If local governments purchase from the e-catalogue they can avoid a full tender process.

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Quicksand Design Studio Pvt. Ltd. 2021. "Situational Analysis on Digital Learning Landscape in Indonesia: Final Report." UNICEF. https://www.unicef.org/indonesia/media/8766/file/Digital%20Learning%20Landscape%20in%20Indonesia.pdf

Omidyar Network. 2019. "Scaling Access and Impact—Realising the Power of EdTech: Indonesia Country Report." https://assets.imaginablefutures.com/media/documents/Scaling_Access_and_Impact_Indonesia_Report_vFinal_r.pdf

EXISTING MODELS AND FRAMEWORKS FOR EDTECH PROCUREMENT

There are various models and frameworks that are relevant to the EdTech procurement process. Although there is limited information available on innovative EdTech procurement processes for TVET, below are five procurement frameworks and models—mostly from the K-12 sector—that are relevant to the exploration of innovative procurement practices for vocational EdTech. These frameworks are presented with the aim of identifying key elements of EdTech procurement and then developing a hybrid EdTech procurement framework suited specifically to TVET.

The International Society for Technology in Education (ISTE) and Project Unicorn's five pillars of EdTech procurement

The five pillars allow stakeholders to evaluate individual EdTech tools. They also provide a guide for redesigning procurement processes to become more efficient, inclusive, and aligned with teachers' and students' needs. The five pillars are:

1. **Data interoperability:** EdTech solutions should be integrated so that tools work together to achieve specific outcomes.
2. **Student privacy:** Key to effective student privacy is a data privacy policy that aligns with legal privacy standards and then ensuring that every tool an institution uses complies with it.
3. **Standards alignment:** Aligning EdTech tools with learning standards enables students to master a learning area as well as develop digital learning skills.
4. **Research and evidence:** EdTech tools should have robust research to prove their effectiveness in achieving learning outcomes within specific contexts.

5. **Implementation and ongoing support:** Implementation plans, support for teachers, policies, and training programs are all means of ensuring that EdTech is implemented effectively and sustainably.[155]

These five pillars provide a useful indication of the elements that an EdTech procurement system for TVET should prioritize and around which it should be designed. Data interoperability is crucial to ensure that EdTech products and services can exchange data and that system users derive optimal insight and usage from EdTech. A key opportunity that this framework highlights relates to micro-services architecture[156] that may allow increasingly modular and interoperable approaches to procurement systems, thereby de-risking large full-stack procurement decisions. Procurement and supply chain for EdTech in TVET are an ideal environment for deploying micro-services architecture because they have diverse functional requirements.[157]

The pillars also indicate that the procurement process should factor in requirements for ongoing support. This includes analyzing the total cost of ownership for a product or service, which should account for training and implementation costs, as well as subscription renewals.

A Theoretical Framework for Technology Decision-Making

Ribeiro (2016) employs a useful theoretical framework for technology decision-making within the context of Ontario's school districts.[158] The author highlights the difficulty of finding a comprehensive theory that includes all aspects of technology decision-making and includes the following framework to understand the interactions between technology spending, its academic impact, and data-driven decision-making to determine how senior leaders in school district make decisions.

The author provides the following key insights for each of the three elements in Figure 5.2:

- **Technology Procurement and Spending**
  - *Total Cost of Ownership (TCO):* Senior leaders should be aware of the TCO of a product over its lifespan. This includes amortizing or annualizing initial purchases, training, and implementation costs.
  - *Organizational vision:* Effective decision-making requires leaders to consider the overall organizational vision and goals.
  - *Efficacious funding:* Leaders should ensure that they have enough funding at their disposal to successfully purchase, deploy, and assess a new technological intervention.
- **Academic Impact of Technology on Student Learning**
  - *Teacher training:* To maximize the success rate of a technology, the teacher's role should be a central consideration. Crucially, this means providing professional learning and development for teachers/trainers.
  - *Increased student engagement:* Student engagement is one of the key measurements that leaders can use to assess the academic return on investment for a technology purchase.
  - *Collaboration:* Implementing a new technology can enable far greater collaboration in the classroom.

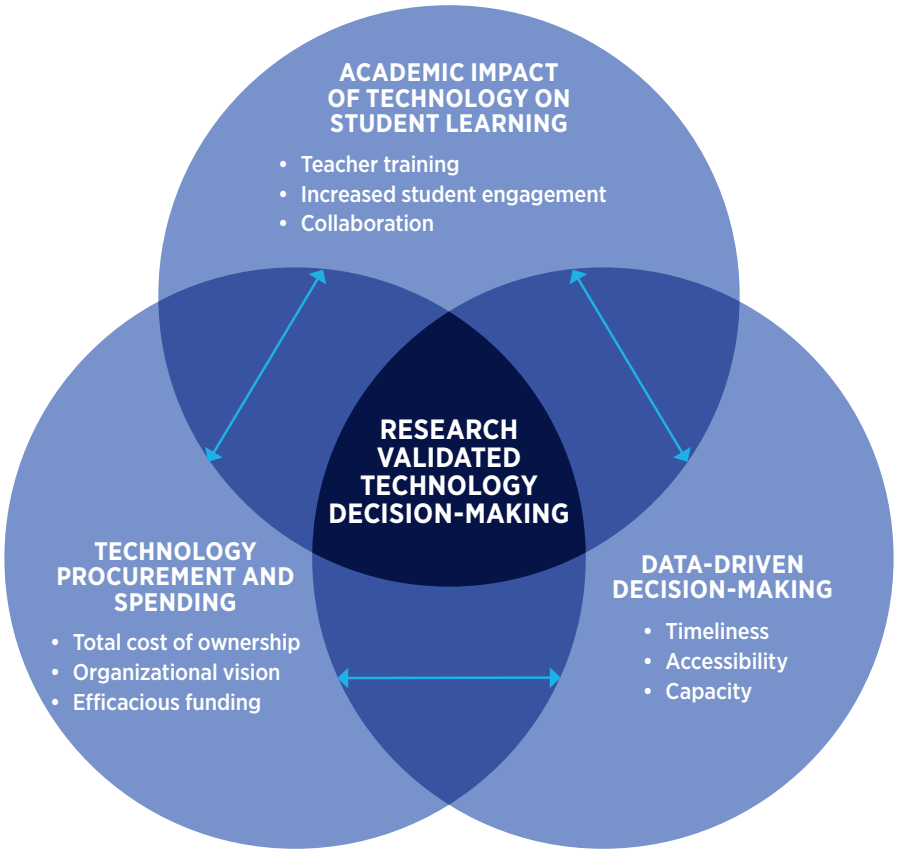
[155] Krueger, Nicole. 2019. "The Five Pillars of EdTech Procurement." ISTE. https://www.iste.org/explore/empowered-learner/five-pillars-edtech-procurement

[156] Microservices architecture is a collection of small, autonomous services that combine to create a larger platform or system.

[157] GEP. 2021. "Together Yet Independent: The Rise of Microservices in Procurement and Supply Chain Software." https://www.gep.com/blog/technology/rise-in-microservices-in-procurement-and-supply-chain-software.

[158] Ribeiro, Jason. 2016. "Educational Technology Decision-Making: Technology Acquisition for 746,000 Ontario Students." *Canadian Journal of Educational Administration and Policy*. 176. https://www.researchgate.net/publication/298252001_Educational_Technology_Decision-Making_Technology_Acquisition_for_746000_Ontario_Students

FIGURE 5.2 Theoretical framework of technology decision-making[159]



- **Data-Driven Decision-Making**
  - *Timeliness:* The internet and technological innovations can provide students real-time feedback in their personal lives, for example through text messaging and video games. With these technological capabilities, teachers should be equipped with the same capacities in the classroom.
  - *Accessibility:* Ensuring that technological tools are accessible is an important consideration for relevant stakeholders, particularly regarding data, as this improves the overall processes and systems.
  - *Capacity:* For quality data collection to occur, district leaders should either seek out technologies that build the district's technical capacity to analyze and use data for decision-making or ensure that personnel (such as teachers) are able to analyze data that classroom technologies are gathering.[160]

This framework provides insight into how requirements for useful data, academic impact, and procurement would intersect in an effective EdTech decision-making process for TVET. The framework also draws one's attention to important sub-elements within the broader elements that

[159] Ribeiro, J. 2016.

[160] Ribeiro, J. 2016.

the public sector should consider throughout the procurement process. When examining TCO, it is crucial for relevant stakeholders to factor in implementation, maintenance (including technical support), capacity building, and disposal of EdTech after use (in the case of tangible products) when budgeting. This involves looking at expenses at a systemic level and making allowance for unforeseen changes in, for example, how the technology operates.[161]

The center of the diagram shows that when these elements intersect, leaders achieve research-validated technology decision-making, which highlights how an informed approach can lead to a successful vocational EdTech procurement process.

The EdTech Pilot Framework

The EdTech Pilot Framework provides a step-by-step process to help education leaders and technology developers run successful EdTech pilots. Each step contains helpful tools, tips, and resources. The framework includes the following steps:

1. **Identify need:** Articulate the specific need or challenge the district is trying to solve to determine if the EdTech product meets that need.
2. **Discover and select:** Evaluate various products based on factors like existing research and pilot scope, with the aim of selecting a product that matches your need.
3. **Plan:** Create specific goals to ensure a shared vision, identify data that will be used to determine success, and create shared expectations.
4. **Train and implement:** Ensure teachers are provided training, technology support, and instructional coaching to enable a strong implementation of the new tool.
5. **Collect data:** Collect quantitative and qualitative data through surveys and interviews to determine whether the pilot goals are met.
6. **Analyze and decide:** Analyze data to evaluate if the piloted EdTech tool met your goals and to determine whether to purchase, continue piloting, or discontinue use of the tool.
7. **Negotiate and purchase:** Work with the EdTech provider to understand and negotiate the total cost of implementing the tool. Remember to consider ongoing costs.
8. **Summarize and share:** Share results with participants to foster transparency, build trust, and to support other schools and districts in their decision-making.[162]

The EdTech Pilot Framework demonstrates how pilots can be used as a tool to meet market demand and deliver tested products and services to stakeholders within a TVET system. It also highlights steps within the piloting process, which are designed with the purpose of addressing needs within the educational system through EdTech. This is a valuable takeaway, as it draws attention to purposeful EdTech planning, piloting, and selection, enabling a quicker turnaround for insights about specific products instead of relying on a full rollout to gain feedback on effectiveness. One example of effective EdTech piloting is bitmedia's Tec4Vet project in Austria, which ran from 2017-2018. Tec4Vet offers highly intuitive TVET-related e-learning content, including mathematics, electrical engineering, and mechanics. It uses well-known e-learning courses, builds on innovative e-learning standards that are geared toward an international market, and provides in-depth technical knowledge to improve training on a user-friendly platform. The web-based trainings with voice-over and videos can be integrated into curricula for technical apprenticeships. One of the main insights from

[161] Pusey, Stacey. 2019. "How to plan for your edtech's total costs." EdScoop. https://edscoop.com/how-to-plan-for-edtechs-total-cost/

[162] Taken verbatim from Digital Promise. no date. "EdTech Pilot Framework." https://edtech.digitalpromise.org

the rollout of the project was how important it is, in addition to the EdTech solution, to provide training on how to integrate pedagogical systems to add value, together with the importance of standardizing learning outcomes.[163]

An operational framework for relating results to key procurement needs

Focusing on procurement in K-12 school districts, Morrison et al (2014) present an operational framework for relating results to key procurement needs along the pathway from the allotment of funding to the acquisition of products. The framework presents five key *Action Points* of typical procurement processes in school districts, which are interactive and often overlapping.[164]

- **Action Point I: Allotment of funding for EdTech product acquisitions.** The amount of funding available to purchase EdTech products directly influences the degree of participant involvement in subsequent phases.
- **Action Point II: Assessment of needs for EdTech products.** By knowing where and how EdTech support is needed, school districts aptly put the horse before the cart, so that the search for products (Action Point III) has direction and purpose.
- **Action Point III: Discovery of EdTech products that address priority needs.** This phase exposes school districts to a variety of EdTech products that perform different educational functions, thus, creating opportunity to further investigate those appearing to offer the best fit.
- **Action Point IV: Evaluation of product quality and effectiveness.** Here, by examining evidence about the product, obtaining peer recommendations, observing demonstrations, and conducting 'pilots' (quick-turnaround try-outs), school districts obtain information to guide selection of the product(s) likely to most reliably and effectively support instructional needs and goals.
- **Action Point V: Acquisition of selected products.** In this culminating activity, the products selected are acquired through completed purchasing agreements with the vendors. The processes involved may be quite straightforward and rapidly completed, or complicated and slowed by district (e.g., school board) or external (state or municipal) policies.[165]

FIGURE 5.3 Operational framework for relating results to key procurement needs[166]

[163] Interview with representatives of bitmedia, 22 April 2021 and resources provided by representatives.

[164] Morrison, Jennifer R., Steven M. Ross, Roisin P. Corcoran, and A.J. Reid. 2014. "Fostering Market Efficiency in K-12 Ed-tech Procurement: A Report from Johns Hopkins University to Digital Promise in partnership with the Education Industry Association." https://digitalpromise.org/wp-content/uploads/2016/02/DP_ImprovingEdTechPurchasing_FullReport.pdf

[165] Taken verbatim from Morrison et al. 2014.

[166] Morrison et al. 2014.

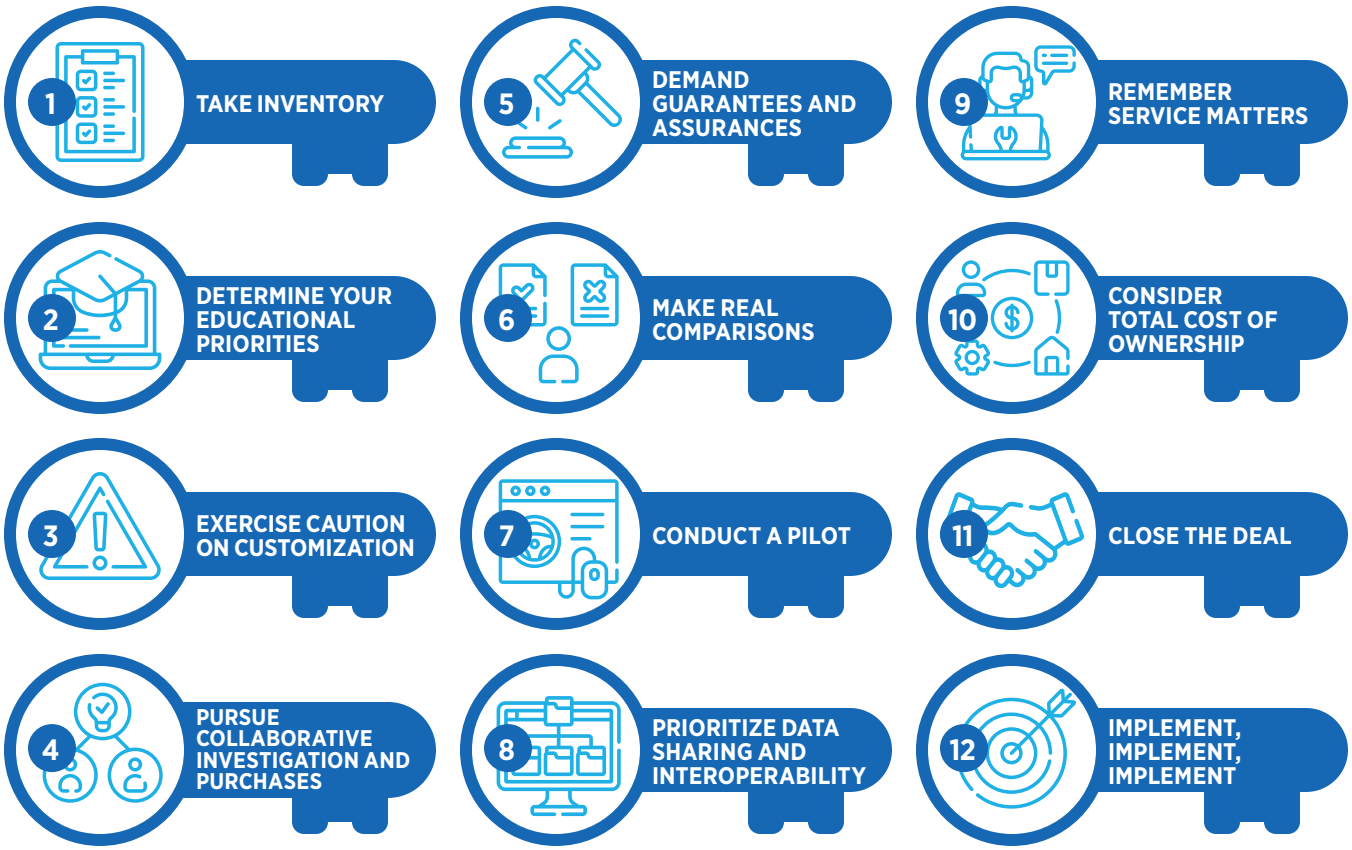
The operational framework outlines a useful high-level procurement process that is relevant to vocational EdTech products, highlighting that these action points often overlap or might not occur in a linear manner. The framework also suggests that each of the action points are interrelated, a key consideration for vocational EdTech procurement to ensure that the process is not siloed and instead that stakeholders are cognizant of the inputs into the whole process.

Twelve keys to smart EdTech procurement

Bailey et al (2015) provide 12 keys to smart EdTech procurement. These simplify the purchasing process for school districts and assist those involved in resource selection and implementation in avoiding pitfalls.[167]

The 12 keys foreground important considerations for EdTech procurement, starting with the importance of taking stock of what EdTech exists in the system through a comprehensive audit of hardware, software, services, and applications as well as the TCO associated with these products and services. Being aware of what solutions exist within the system, as well as prioritizing multi-functional solutions, can be extremely valuable. In India for example, PwC has been digitizing the student journey in over 200 government colleges based in rural areas of India through its Student Life Cycle Management (SLCM) Solution. SLCM is a one-stop solution to manage the entire life cycle of students, from registering for admission through graduation and as an alumnus. Key functions of SLCM include Admission

FIGURE 5.4 The 12 keys to smart EdTech procurement[168]



[167] Bailey, John, Daniel Owens, Carri Schneider, Tom Vander Ark, and Rob Waldron. 2015. "Smart Series Guide to EdTech Procurement." http://digitallearningnow.com/site/uploads/2014/01/Procurement-Guide-FINAL.pdf

[168] Bailey et al. 2015.

BOX 5.3 Prioritizing data interoperability in EdTech purchasing with Project Unicorn, United States

A key element that complicates EdTech demand is how fragmented the education market is. Procurement decisions about tools, features and functionalities often happen once-off, which means that vendors seldom adjust their offerings in a single direction. However, initiatives like Project Unicorn try to overcome this issue. While this case is not specific to the TVET sector, it highlights the importance of interoperability between EdTech products, as well as the implications of this for the vocational EdTech procurement process.

Realizing some of the existing impediments to procuring and using EdTech as a means of improving student outcomes, Project Unicorn was founded in 2016. The initiative was created as a response to the inability of schools to compare and contextualize their data across different platforms, as well as the time and cost of analyzing data so that it was useful to teachers, administrators, and students. The core issue was that, although some schools were procuring innovative EdTech, the data was housed on different applications, making it difficult to cross-analyze data and measure results.

Project Unicorn aims to improve data interoperability within K-12 education, thus enabling secure and controlled exchange of data between different applications. The initiative has created a community of innovators who collaborate with school systems and vendors to determine shared priorities and benefits, creating demand-side influence for interoperability through partnerships, and educating buyers to consider the TCO through informed comparison of vendors.

Ultimately, Project Unicorn focuses on 'improving the adoption of industry adopted data interoperability standards in the education technology space and empowering districts and states to be smart consumers in their procurement of technology.'

Among its activities, Project Unicorn developed a rubric focusing on data interoperability for all stakeholders. It also released a School Network Pledge and an EdTech Tools Pledge to consolidate which vendors and school systems can sign, committing them to following technology practices such as adopting data interoperability standards and educating their communities about data privacy.

Sources:
Project Unicorn. 2021. About. https://www.projectunicorn.org/about
Freeland Fisher, J. 2018. "5 Levers That Can Unlock Smarter Demand for Education Technology." EdSurge. https://www.edsurge.com/news/2018-03-28-5-levers-that-can-unlock-smarter-demand-for-education-technology

Management, Course Management, Academics Management, Fees Management and Examination Management. This system has been developed by PwC using Microsoft Dynamics; it has transformed the functioning of the colleges and is providing an efficient digital interface to more than 200,000 students in rural India. The potential for data analytics to improve the quality of education services is also being explored.[169]

One critique of this framework might be the difficulty of finding alignment between the 12 Keys and the reality of short government and donor timeframes for project implementation, particularly regarding expectations on time and outputs. Possible ways to overcome this could be through contract negotiation that favors extended timeframes for well-defined outputs.

The 12 Keys also recommend pursuing collaborative investigation and purposes. An emphasis on collaboration between public stakeholders can reduce the overall procurement costs because the vendor stands to sell more. A third important insight from this model is for the purchaser to determine a common standard of comparison so that different vocational EdTech solutions are evaluated using the same criteria. This will enable the public sector to select the most appropriate solution.

[169] PWC. 2019. "Changing minds in a changing world—The future of education in the Fourth Industrial Revolution." https://www.pwc.co.za/en/assets/pdf/changing-minds-in-a-changing-world.pdf.

A HYBRID EDTECH MODEL FOR TVET

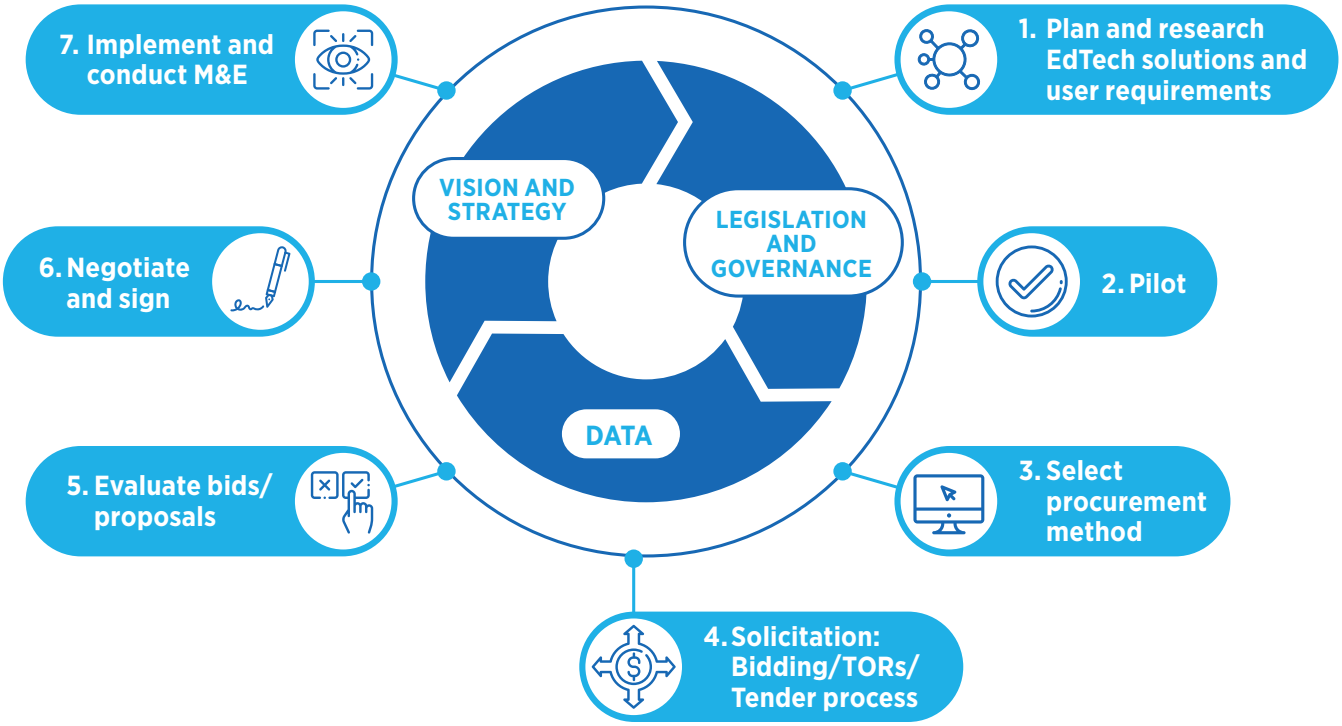
Drawing from the literature, models, and frameworks presented above, and the TVET system framework presented in the first chapter, it is possible to distill a hybrid EdTech procurement framework suited specifically to the TVET system. The framework is general, as it seeks to maintain its relevance to all LMICs and relate to the procurement of EdTech products and services.

Below is a description of the vocational EdTech framework. Note that these functions may not necessarily occur in the same sequence presented above and may exclude certain steps in the case of, for example, the establishment of framework agreements.

At the center of the system are three elements that feed into one another and pervade the procurement process. First, the **vision and strategy** for the government entity or institution inform procurement activities and determine how an EdTech product or service feeds into the overarching vision for the TVET system. Second, **legislation and governance** mechanisms influence the legal obligations to which the procurement process is subject. Last, **data** from training institutions and the LMIS determines what vocational EdTech is procured (by determining EdTech needs and data requirements), as well as how data from the EdTech that is procured feeds into the system and promotes data interoperability with existing vocational EdTech. Its core focus is to enable data-driven decision-making. These three elements are surrounded by the procurement process, which is outlined in Figure 5.5.

- **Plan and research EdTech solutions and user requirements:** The beginning of the process should include taking inventory of available EdTech in the TVET system, defining educational priorities, and mapping needs against those priorities. During needs assessment, the buyer—whether it is the government or a training institution—should factor in overarching requirements for any EdTech product or service, such as interoperability, as well as consider what funding is available to procure, deploy, and evaluate a new TVET EdTech product.

FIGURE 5.5 A proposed EdTech procurement process for TVET systems



Researching available EdTech solutions and vendors, as well as user requirements, provides the buyer with a sense of the range of solutions available to meet its needs and fulfil educational priorities. A user-centered approach is integral because it assures alignment between the functionality of the EdTech solution and requirements on the ground. The research process also provides insights into the costs, functionality, and providers in the market.

- **Pilot:** Piloting is crucial to bridging the gap between intended and actual outcomes so that implementers can test, analyze, and iterate implementation of the EdTech solution. This aspect of the process should include capacity-building measures to train the pilot group on how to use the solution. Piloting should be fundamentally data-driven, which will allow the buyer to make an informed decision about whether to purchase, continue piloting, or discontinue use of the solution.
- **Select procurement method:** Selecting a suitable procurement method depends on who is procuring the solution, what solution the entity is trying to procure, and how the entity wants to procure it.
- **Solicitation:** Bidding/Issuing Terms of Reference (ToRs)/Tender notice: Bidding/ToRs are central to the procurement process as they enable the organization to find a suitable provider for its requirements. Where applicable, the government entity would issue a tender notice that should be submitted in accordance with specific requirements.
- **Evaluate bids/proposals:** Once bids and proposals have been received, they are evaluated against the entity's educational priorities, needs assessment, and predetermined evaluation criteria (including budget and legal requirements). The buyer then selects the best service provider.
- **Contract negotiation, award, and signing:** When a provider has been selected, the parties negotiate and sign a contract, which may include a piloting clause and other relevant conditions to successfully complete the procurement process. Piloting the vocational EdTech solution provides an opportunity for the buyer to gain insight into the effectiveness of the solution for its purposes.
- **Implement and conduct monitoring and evaluation (M&E):** Key to this part of the process is ensuring that consistent M&E occurs so that the rollout process is successful, transparent, and provides insight into the suitability of the solution for its end users.

KEY CHALLENGES AND PROPOSED SOLUTIONS FOR TVET EDTECH PROCUREMENT

There are various challenges associated with EdTech procurement processes for TVET. These are complex and often have a knock-on effect. The previous section outlined how an ideal EdTech procurement process might function, but it is also important to understand challenges faced in the process of EdTech procurement with a view to avoiding pitfalls and optimizing effectiveness and efficiency in procurement. Some key challenges are highlighted below, along with a brief explanation.

- **Procurement can be lengthy and cumbersome, with some estimates of up to 12 months to plan, execute, and evaluate a bid for nationwide procurement of EdTech.** Procurement often demands a lot of resources and takes a long time because of the complexity of the products one is procuring, as well as the bureaucracy associated with procurement processes (which is linked to the fact that large amounts of money are being spent).[170] This can act as a deterrent for smaller EdTech providers, which often need to get their product to market at scale as fast as possible in order to recover the costs of development, or else risk business closure. This in turn has an impact on competition within the market. One way to overcome this may be through e-Procurement

BOX 5.4 The Mercado Público, Chile

Chile has a rapidly growing EdTech sector and its *Educarchile* initiative is leading to the use of a wide variety of digital resources by schools. For example, 200 municipalities purchased 325 different digital educational resources from 75 companies registered on the *Mercado Público* (MP) in 2018. The MP is a digital marketplace established by the Ministry of Economy to assist procurement process for products and services. It offers over 100,000 products, 500 of which are catalogued as digital educational solutions. At the core of the MP is a centralized procurement platform for digital educational solutions, which is aided by an EdTech Catalogue that provides technical, curricular, and methodological information about the solutions.

One of the main critiques of the MP is that while it assists municipalities in procuring EdTech relatively rapidly, it has not completely solved the issue of the slow pace of decision-making and bureaucracy in municipalities. As a result, it can still take two to six months from first contact with the buyer to purchase. Moreover, the MP does not set out to educate decision-makers and teachers/trainers on the features or impact of products and services. A third issue is that the platform is only updated every two to four years, which means that EdTech companies may need to wait a long time to be included on MP—lead-time that it not congruent with the pace at which many EdTech companies need to scale in order to survive.

Despite these challenges, the MP provides an impactful sales channel for municipal schools to procure EdTech products.

Source:
Omidyar Network. 2019. "Scaling Access and Impact—Realising the Power of EdTech: Chile Country Report." https://ierc-publicfiles.s3.amazonaws.com/public/resources/Scaling%20Access%20and%20Impact_Chile%20Report_.pdf.

services to reduce lead-time, while another could be to approach relevant bodies to fast-track the purchasing process, as was the case with the recent purchase of $65 million worth of ICT equipment for TVET institutions in Guyana.[171]

- **Many LMICs have limited funds to purchase EdTech.** This, along with institutions' insufficient spending power, are key issues in countries like Bangladesh, where some institutions cannot effectively disburse funds allocated to them. There are several reasons for this, including that operational funds are insufficient, budget flexibility is low as transfers between budget lines are not allowed, and institutions receive a limited share of their budgets to disburse at their discretion.[172] These challenges can be mitigated by providing institutions with more autonomy as to what type of EdTech is procured and how. Another approach could be to encourage private entities to deliver or manage training institutions, including by providing financial support.
- **Policies and regulations hinder discussion.** Policies and regulations seek to limit contact between the vendor and consumer with the aim of making the procurement process transparent and fair, thereby disadvantaging one vendor over another. However, the corollary of this is that there are limited opportunities for the buyer to interact with external experts to find out about new technology or innovative ways of providing a service.[173] An added challenge is that regulations and policies often take a lot of time to be updated and implemented. For example, in South Africa, the main guiding document for the use of technology in education has not been updated since 2004. The resulting lack of guidance about

[170] Global e-Schools and Communities Initiative (Gesci). 2009. "Buyers' Guide for ICTs for Education—A series of recommendations on how to compile and evaluate bids to acquire equipment and services for school systems." https://en.unesco.org/icted/sites/default/files/2019-04/buyers-guide-ict-equip.pdf.

[171] Carnegie School of Home Economics. 2021. "TVET goes online!—Over $65M in ICT equipment given to TVET institutions for online learning." https://carnegieguyana.com/news/tvet-goes-online/

[172] Asian Development Bank. 2014. "Technical and Vocational Education and Training for Accelerated Human Resource Development in South Asia." https://www.adb.org/sites/default/files/publication/41186/innovative-strategies-technical-vocational-education-training.pdf.

[173] Bailey et al. 2015.

which curriculum-aligned content and software schools can buy, and how to buy it, is an obstacle to effective EdTech provision.[174]

- **Many products and services are expensive to develop:** An EdTech product or service can cost millions of dollars to develop, which puts pressure on the developer to recover the investment by selling the product at scale. Because a lot of EdTech procurement is localized and fragmented, this can be a significant challenge. Countries like the United Kingdom, however, are testing regional buying hubs and pre-negotiating buying deals to mitigate these risks.[175] Moreover, through demand-driven funding models, governments can build the market by providing funding per student and rely on the private sector to create the market through, for example, private TVET providers.
- **Student privacy and data protection are not always priorities.** Exploratory research at Carnegie Mellon University suggests that technology start-ups are not prioritizing data protection for students who use their products.[176] Moreover, although Ruang Guru (see box on page 67) offered access to its e-learning platform at no cost during the COVID-19 pandemic, at the time of writing the app in Google Play includes eight separate trackers and 34 permissions, including nine marked 'Dangerous' or 'Special,' according to Google's protection levels.[177] While there is a paucity of data from the TVET sector, the unfortunate reality is that many countries do not have data privacy laws that explicitly protect students of varying ages.[178] Privacy International is part of a coalition that seeks to tackle this issue, providing recommendations on what measures stakeholders can take to protect students, including for policymakers to 'Publish any decisions about new national level product or service adoptions, and commit to review practices, and their impacts with civil society including the most affected and marginalized communities, once the emergency situation has ended.'[179]
- **There is no formal way to assess student and teacher/trainer needs.** This results in products being purchased that do not directly meet the needs of teachers/trainers or students, which in turn means that valuable resources are used inefficiently and ineffectively. While there is a lack of available data from the TVET sector, lessons from K-12 suggest that affording teacher and trainers formal opportunities to provide meaningful feedback on EdTech solutions and acting on their critiques of these solutions can be effective.[180]
- **Finding new EdTech products can be difficult.** The EdTech market is already large and continues to grow rapidly. Procurement practices do not generally facilitate communication between vendors and buyers, which can make it difficult to identify suitable EdTech to meet user needs. PPPs provide a promising solution to overcome this. EdTech France is an association of French companies that seeks to federate and structure the French EdTech ecosystem, with the aim of optimizing the impact of innovation and technology

[174] Mail and Guardian. 2018. "Edtech needs to bridge the divide." https://mg.co.za/article/2018-06-15-00-edtech-needs-to-bridge-the-divide/.

[175] Atlantis Group. no date. "Buying and selling EdTech is complicated, and costly." https://www.varkeyfoundation.org/what-we-do/atlantis-group/system-failure/edtech-today

[176] Schaffhauser, Dian. 2017. "Report: Ed Tech Startups Stink at Student Data Privacy." The Journal. https://thejournal.com/articles/2017/07/14/report-ed-tech-startups-stink-at-student-data-privacy.aspx

[177] Privacy International. 2020. "Schools and Covid-19." https://privacyinternational.org/news-analysis/3709/schools-and-covid-19.

[178] Cordeiro, Vanessa C. 2021. "Educational technology (EdTech) and children's right to privacy." *Humanium*. https://www.humanium.org/en/educational-technology-edtech-and-childrens-right-to-privacy/

[179] Privacy International. 2020.

[180] Klein, Alyson. 2019. "Ed-Tech Usage Levels Are Low: What Should Schools Do?" *Education Week*. https://www.edweek.org/technology/ed-tech-usage-levels-are-low-what-should-schools-do/2019/10

in education and professional training. By improving the visibility of private sector solutions, it facilitates exchanges and meetings with the various providers and seekers of EdTech solutions.[181]

- **EdTech products are not always evaluated effectively.** This can most likely be attributed to time constraints in product development and a lack of measurable outcome. This is compounded by the fact that buyers are often not the end-users of the products. As seen in the case study of Chile's MP above, some governments have resolved this by creating catalogues of vetted EdTech.
- **Procurement practices are not always appropriate for the digital age.** Many public institutions still use outdated procurement practices based on textbook adoption models, which have not been adapted to suit shifting EdTech market trends.[182] However, e-Procurement systems can expedite the procurement process and reduce inefficiencies.
- **Risks and challenges remain in using PPPs as a vehicle for EdTech procurement and implementation.** Conventional procurement contracts differ from PPP contracts in that the latter provide a long-term contractual agreement and involve risking private capital. However, it could be argued that the relative benefit of private financing tends to outweigh the risk as non-state actors can provide resources and infrastructure that governments might be unable to, while the public sector can provide opportunities to scale EdTech implementation more rapidly. Moreover, partners can use resources more efficiently by, for example, establishing a baseline and measuring costs or building the financial management capacity.[183]
- **Vendor lock-in remains a concern for those who purchase or use EdTech.**[184] A common issue is that buyers have sometimes found it expensive or disruptive to change suppliers. Adding to this is concern over how much control vendors have over clients' data. However, new tools and negotiation techniques are empowering buyers. 'Perhaps one of the biggest attempts to offset potential lock-in is the increased use of highly portable, open-source container-based solutions that theoretically work across different cloud vendors.'[185]

CONCLUSION

The EdTech procurement process for TVET may differ across countries, regions, and cities, but this chapter has sought to distill key functions within the procurement process, as well as the main takeaways from available literature to ensure that a government or training institution can procure optimal EdTech products or services as efficiently as possible. Below is a summary of the key takeaways from this chapter.

- **There are procurement models that can facilitate the growth of EdTech in TVET at scale in emerging markets.** Although there is a dearth of use cases available regarding EdTech in emerging markets' TVET sectors, the procurement models that are predominantly from K-12, together with information on EdTech use in developed countries, provide valuable insights into procuring EdTech for TVET in emerging markets.
- **Governments and training providers would likely gain significant benefits from analyzing available inventory before seeking out new**

[181] European Commission. 2020. "Innovation and Digitalisation: A report of the ET 2020 Working Group on Vocational Education and Training (VET)." https://ec.europa.eu/social/main.jsp?langId=en&catId=89&newsId=9861&furtherNews=yes#navItem-1.

[182] Smith, Andrew, J. 2019. "Guest Post: Challenges and Possible Solutions for Edtech Procurement: Part 1. Digital Promise." https://digitalpromise.org/2019/05/07/challenges-and-possible-solutions-for-edtech-procurement-part-1/

[183] Asian Development Bank. 2017. "Innovative Strategies for Accelerated Human Resource Development in South Asia: Public-Private Partnerships for Education and Training." https://www.adb.org/sites/default/files/publication/385661/ppp-education-sa.pdf.

[184] Vendor lock-in is a situation in which a customer using a product or service cannot easily transition to a competitor's product or service without incurring substantial switching costs or experiencing a disruption in services.

[185] Mok, Kimberley. 2020. "Should we really be worried about vendor lock-in in 2020?" https://www.protocol.com/manuals/new-enterprise/vendor-lockin-cloud-saas

solutions. This ensures interoperability between existing and newly purchased solutions and eliminating duplication in functionality.

- **At the national level, undertaking pilots of new EdTech provides an invaluable tool for testing out an EdTech solution's effectiveness before rolling it out at scale.**
- **Electronic procurement systems can expedite the purchasing process,** but key to this is ensuring that these systems do not replicate paper-based systems and instead prioritize efficiency and can effectively align requirements with available EdTech products and services.
- **When using procurement to drive innovation, procuring entities should avoid being too prescriptive in tender specifications.** Finding a balance between defining essential functionality and removing excessive details can enable greater innovation and creativity for a product or service instead of restricting it. To achieve maximum practicality, RFPs should focus on educational delivery requirements instead of product or service features.
- **Policy levers can be used strategically to enable more efficient, effective, and transparent procurement outcomes.** This chapter showed how policy levers can be used to drive innovation in procurement processes for TVET and in what kinds of EdTech is procured. The next chapter will demonstrate how government institutions and organizations can use policy levers in various other ways to operationalize policies and achieve specific outcomes. For example, finance levers can control the distribution of funding for procurement purposes; while service agreements enable government and public training providers to enter into agreements with private sector companies and technology service providers to fulfill specific services related to EdTech in the form of discrete solutions or more comprehensive service offerings.
- **A core competency for any procurement process should be prioritizing data-driven decision-making and data interoperability.** Data-driven decision-making enables buyers to make an informed decision about what EdTech products or services to procure for users. Data interoperability allows different EdTech solutions to work together and exchange data, which provides more comprehensive insight into different aspects of educational delivery, thus creating a holistic picture of education delivery instead of a segmented view that individual EdTech solutions provide.
- **Encouraging greater transparency in the interactions between public and private actors regarding EdTech issues is vital to ensuring that governments can implement practical, sustainable, scalable, equitable policies and governance mechanisms.** Transparency also promotes buyer confidence, greater innovation, and responsiveness in EdTech for TVET, and enables a more efficient procurement process.
- **Student privacy should be a non-negotiable priority throughout the procurement process.** This means that EdTech companies should clearly define the measures they take to protect student privacy. Governments should hold EdTech companies accountable by only procuring EdTech solutions from those that meet government-approved privacy standards.
- **Countries around the world have very different TVET systems, with some very centralized, others highly decentralized, and many somewhere in between the two.** Procurement processes for EdTech in any given country should have a set of standards that define central procurement guidelines and follow a common standard. This will ensure that, even if training providers in different regions buy different EdTech products for the same purpose, they still fulfill the required functions.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CHAPTER 6

Policy Levers to Support EdTech in TVET

Government policy and regulatory approaches to EdTech in TVET varies across countries. A commonly adopted approach emphasizes EdTech in TVET within a broader/general ICT in education policy (see for example, Botswana[186]). Notably, in many low- and middle-income countries, the policy changes required to incorporate EdTech in TVET are yet to be realized, although there is evidence of countries such as Zambia, Botswana, and Jordan drafting policy guidelines specific to TVET.[187] While countries may not have a specific EdTech in TVET policy, this does not necessarily mean a lack of TVET-related EdTech initiatives. However, it has been observed that countries with the most progress in EdTech in TVET (such as Australia, South Korea, and many European Union countries) are also those with the strongest national policy supported by funding resources and national programs.[188]

Good policies are essential but are only effective when the right policy levers are defined in the policies and then actively deployed throughout the system to ensure implementation.[189] Thus, in laying the foundation and conditions for the delivery and sustainability of good quality EdTech, a central goal is to formulate strong legal frameworks and effective policies and plans to achieve education goals and promote lifelong learning. Within systems, it is important to understand where the leverage points are, and when it will be possible to do/use them.[190]

Policy levers are the tools and mechanisms that government and its agencies have at their disposal to direct, manage, and shape changes to public services. Various policy levers can be applied by governments, with the choice of lever influenced by the political climate as well as constitutional and legal restrictions on government authority.[191] There is no commonly accepted typology of policy levers, with different researchers and disciplines proposing different typologies and categorizations. Policy levers are also mediated at different levels within a system.[192]

[186] Botswana IFAP Committee. 2016. "ICT Literacy Policy—BOTSWANA. 9th session of the Intergovernmental Council for the IFAP." 30 May 2016—31 May 2016. http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/CI/CI/pdf/ifap/meetings/council/ifap_botswana_ict_literacy_report_9thifapcouncil.pdf.

[187] As noted in Latchem, Colin. (ed). 2017. *Using ICTs and Blended Learning in Transforming TVET.* Commonwealth of Learning. http://oasis.col.org/bitstream/handle/11599/2718/2017_Latchem_Using-ICTs-and-Blended-Learning.pdf

[188] Herd, George, and Alison M. Richardson. 2015. "World Report on TVET – The promise and potential of ICT in TVET." http://oasis.col.org/bitstream/handle/11599/824/UNESCO%20World%20Report%20-%20ICT%20in%20TVET%20-%20Herd%20%2B%20Mead%20Richardson.pdf?sequence=1&isAllowed=y

[189] Unesco Education Sector. 2018. "Activating Policy Levers for Education 2030." https://teachertaskforce.org/knowledge-hub/activating-policy-levers-education-2030-untapped-potential-governance-school.

[190] Donaldson, David. 2018. "Policymaking amid complex systems: finding the levers of influence." https://www.themandarin.com.au/92653-policymaking-amid-complex-systems-finding-the-levers-of-influence/

[191] Grace, Francesca C., Carla S. Meurk, Brian W. Head, Wayne D. Hall, Georgia Carstensen, Meredith G. Harris & Harvey A. Whiteford. 2015. "An analysis of policy levers used to implement mental health reform in Australia 1992-2012." *BMC Health Services Research* 15 (479). https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-015-1142-3

[192] Grace et al. 2015.

The potential of EdTech can only be realized when it is embedded in a context that is open to innovation and supported by a favorable policy environment. This chapter illustrates, using practical examples wherever possible, how different policy levers can be applied to promote the effective use of EdTech in TVET, drawing on the trends and business models presented in Chapters 2 and 3, and the conceptual framework introduced in Chapter 1. It is important to note that some policy levers described below serve core roles while others permeate several core functions within the conceptual framework. In addition, not all risks identified in Chapter 1 are mitigated through 'policy levers' (which serve to influence the behavior of actors other than policymakers); for example, a public sector failure like buying ineffective platform software is prevented not through policy levers but through 'better government,' such as effective procurement systems described in Chapter 5. Further, as will be seen, several of the levers mentioned below require coordination between different government ministries, including those outside education and training, so effective coordination between government ministries is essential. Hence, the first lever focuses on governance.

KEY POLICY LEVERS

Strengthen and streamline governance

Governance systems play an important role in generating and guiding the relevance, access and participation, and quality/innovation components for effective EdTech delivery. As highlighted in the conceptual framework, governance serves a core role of setting out the vision for the TVET system, and how EdTech complements the system's functions. This is important to making strategic decisions regarding direction and roles, ensuring that all stakeholders' interests are addressed, and coordinating different governmental entities, as well as the public and private sectors. A good example of this is the Korea STEP initiative (see boxed case study), which demonstrates how government can coordinate between various stakeholders within the TVET system to achieve widespread impact. Moreover, governance usually includes finance (the rules and regulations whereby financial resources are collected, allocated, and managed—and is dependent on the economic situation and available resources, and the priority levels of decision makers), access and participation (promoting equity and inclusion), quality (the teaching and learning process, facilities and equipment), and relevance (the extent to which TVET is responsive to labor market needs and requirements).[193] Governance structures at the institutional, organizational, and national levels alike are important to ensure that there are frameworks and mechanisms in place so that learning is adequately facilitated, recognized, and validated.[194]

Governance structures depend on institutional arrangements and the roles of key stakeholders. Some governments have established ICT/education agencies or institutions such as KERIS in South Korea, Becta in the United Kingdom, and NCET in China to be responsible for the development and application of ICT in the field of education. In other countries, such functions are carried out by foundations and NGOs such as the Omar Dengo Foundation in Costa Rica and the Pilipinas Schoolnet at FIT-ED in the Philippines. Other countries assign such roles to a special division of the ministry of education or to universities.[195]

[193] European Training Foundation, International Labor Organization, and Unesco. 2012. "Proposed Indicators for Assessing Technical and Vocational Education and Training." https://www.etf.europa.eu/sites/default/files/m/E112211E42995263C12579EA002EF821_Report%20on%20indicators%20April%202012.pdf.

[194] Kanwar, Asha, K. Balasubramanian, and Alexis Carr. 2019. "Changing the TVET paradigm: new models for lifelong learning." *International Journal of Training Research* 17 (1): 54-78 https://www.tandfonline.com/doi/full/10.1080/14480220.2019.1629722

[195] Lee, Molly, N.N. and Soon Sen Thah. 2016. "Building and sustaining national ICT/education agencies: Lessons from Malaysia." World Bank Education, Technology & Innovation: SABER-ICT Technical Paper Series (#04). Washington, DC: The World Bank. https://openknowledge.worldbank.org/bitstream/handle/10986/26265/113112-NWP-Agencies-Malaysia-MSSI-SABER-ICTno04.pdf?sequence=1

BOX 6.1 Korea STEP

In the Republic of Korea, the Ministry of Employment and Labor together with KoreaTech Online Lifelong Education Institute identified the need for a new TVET paradigm and platform for supporting new training methods in response to the national demand for job skill development. Smart Training Education Platform (STEP) was thus created with the aim of building the job skill development infrastructure and filling gaps in job training.

STEP is an innovative training infrastructure that increases the accessibility of training by providing diverse e-learning content. STEP's objectives are to lay the foundation for lifelong job skills development system, and to reinforce customer-oriented personalized online TVET. It comprises:

- The 'Content Open Market' where educational content is gathered and arranged by field. Diverse types of e-learning content such as VR and micro-learning contents are freely traded. Learners can access free public e-learning content and purchase content developed by private companies, allowing them to take courses in their own time. Training institutions can upload content they developed, and sell or trade them for free. Purchased contents can be utilized to design training programs as well.
- The 'Learning Management System (LMS)' supports the operation of online training programs. It supports various learner management activities of training institutions such as online attendance check, assignment management, and evaluation data accumulation. Training institutions that use the LMS can operate remote (online) training programs by opening an online classroom more conveniently, and further utilize the LMS for vocational training focused on strengthening practical business capabilities.

STEP was launched in 2019. This initiative created an ecosystem and infrastructure for job skills development in line with 4IR. It also lays the foundation for lifelong job skills development by filling gaps in job training. The program provides theory courses online and practical classes offline. All curriculum lists and various e-learning contents in STEP can be found on its official website (step.go.kr). STEP improves user accessibility by reducing restrictions in time and space, provides new knowledge content, recommends training methods such as flipped learning and blended learning, and strengthens public training.

Various stakeholders benefit from STEP. These include:

- Content providers—STEP provided a marketplace for TVET content, built the system for distribution of TVET content, and procured and built systems to manage TVET content.
- Training institutes—STEP provided the LMS for 'SMART' TVET.
- Businesses—STEP provides knowledge sharing and community services, and a one-stop service for supporting customized employment.
- Related government agencies—STEP serves as a testbed as a future oriented TVET model. It studies and promotes cutting edge training media models, promotes online-based new teaching methods and provides consulting services.

The main accomplishments of STEP thus far are:

- It has secured diverse training content (1,387) from public and private content providers: (1,182 from public providers and 205 from private providers).
- It has provided online training to 626,591 learners.
- It has allocated STEP LMS infrastructure to 40 vocational training institutions.
  - » Provided online training infrastructure to 17 private training institutions conducting blended learning in a pilot project.
  - » Provided online infrastructure to 23 training institutions for their own training programs.
- It has developed 602 high level e-learning and VR training content (533 e-learning content based on NCS competency units, and 69 VR training content relevant to dangerous, high cost, and heavy-instrument courses).

Sources

Wang, Like. no date. "Policy Framework and Platform Development in China". Shanghai Jiao Tong University.

Jong-Kil Park. 2020. "Recent Trend of TVET in Korea". Slides provided courtesy of the author.

Ministry of Employment and Labor. 2019. "Take the first steps in vocational training with Smart Training Education Platform (STEP)." https://www.moel.go.kr/english/poli/poliNewsnews_view.jsp?idx=1526

Establish a strong investment climate

The economic, financial, and sociopolitical conditions of a country influence whether individuals, banks, and companies are willing to lend and invest in EdTech businesses operating within a country. With the COVID-19 pandemic and technological disruptions, data across the world suggests a surge of investment into educational technology.[196] For example, in South Africa online learning is growing rapidly with the market potential first noted in 2017 by the acquisition of South African online course provider GetSmarter for $100 million by U.S. company 2U. Since 2020, Naspers Foundry invested R45 million in an online vocational learning platform called The Student Hub, and Edge Growth invested R2.5 million into EdTech start-up Syafunda.[197] Thus a policy environment that encourages investments and partnerships has the potential to facilitate rapid growth in the TVET EdTech space.

Provide financing mechanisms

Finance levers involve control of the overall allocation and distribution of funding across government (national, provincial, and local) and cover private and not-for-profit sectors. Finance influences the degree of control and responsibility accorded to each type of service provider, as well as the overall sector's capacity and reach. Sustaining meaningful EdTech investment is a problem faced by many institutions and countries, particularly as it may not be afforded high priority compared to paying staff salaries or maintaining utilities. Governments may enter into partnerships with the business sector, particularly EdTech providers, to help maintain operation and financial viability of EdTech programs (Chapter 5). Further, financial incentives can help to stimulate demand for EdTech investments.

Financial incentives encourage rather than mandate TVET investments, and can take various forms, such as grants[198] that result in some monetary benefit to companies.

> *A financial incentive to engage companies in TVET is a policy instrument through which a monetary benefit is designed and offered to encourage behaviour or actions related to training, either on its own or as part of a group of measures.[199]*

Designing incentives depends on several factors such as policy objectives, existing institutional structures, and perceptions of companies' roles in TVET financing. Incentives can be used in various ways, for example, to support partnerships or stimulate training markets. Financial incentives can operate in place of formal regulation and can be used along with other existing policies aimed at improving resource allocation. Financial incentives have been used to target companies in countries such as Austria, Ireland, and France to increase their TVET expenditure; similar models could be used more specifically to support TVET delivery models underpinned by effective use of EdTech. In Austria and Ireland, the incentive is linked to companies pursuing training for their own benefit, whereas in France the incentive encourages companies to fulfill public policy targets.[200]

[196] Oxford Business Group. no date. "Investment in education technology surges around the world." https://oxfordbusinessgrop.com/overview/investment-education-technology-surges-markets-around-world-recognise-its-transformative-0

[197] Goldstuck, Arthur. 2021. "Educational technology booms in SA." https://www.businesslive.co.za/bt/business-and-economy/2021-01-24-educational-technology-booms-in-sa

[198] Grants involve a transfer of money or in-kind support from the state to companies.

[199] Jweiles, Ziad. 2019. "Enhancing Institutionalized Partnerships between TVET - Institutions and the World of Work in Palestine." UNESCO Regional Bureau for Education in the Arab States – Beirut. https://en.unesco.org/sites/default/files/palestine_study_on_enhancing_institutionalized_partnerships_between_tvet_institutions_and_the_world_of_work_in_palestine_september_2019.pdf

[200] Jweiles, Z. 2019.

BOX 6.2 China's online skills platforms

In China, following the outbreak of COVID1-19, the government issued several notices related to educational platforms including 'China Vocational Training Online' that provided free online skills courses. China has several online skills platforms related to TVET, for example:

- 'Online Learning Platform for Industrial and Information technology Talents' (www.tech-skills.org.cn) contains approximately 3,200 micro video course resources in 14 categories, including information technology, automobile, new energy, construction engineering, logistics, electromechanical, economic management, intelligent manufacturing, industrial robot, and enterprise information management, etc. The platform helps enterprises to establish electronic portfolios of learners in vocational training, and support to further improve the quality and skill level of workers.
- Technical Education Network (http://jg.class.com.cn) has more than 20,000 digital teaching resources, including courseware, teaching plans, micro videos, micro animations, assessments, and demonstration courses to meet the needs of teachers' online interactive teaching and students' online learning.
- China Vocational Training Online (www.chinanet.gov.cn) is a large-scale free online vocational training program provided by government as part of its efforts to improve workers' professional skills and facilitate poverty alleviation. By May 9, 2020, the total number of online skill training registrations nationwide exceeded 8.3 million.
- Shanghai craftsman college (http://gj.sou.edu.cn/7869/list.htm)—in 2017, Shanghai Federation of trade unions and Shanghai Open University jointly established Shanghai craftsman college. The purpose of the college is to improve capacity of craftsmen. It offers face-to-face and online craftsmen workshops.
- Shanghai Jiao Tong University developed a 'guidance platform' for online Teaching and Learning (http://ctld.sjtu.edu.cn/wp).

Source:
Wang, Like. "Policy Framework and Platform Development in China." Shanghai Jiao Tong University.

BOX 6.3 Skills Future in Singapore

Policymakers in Singapore are addressing skills imbalances and the impact of technological change on labor markets by pioneering an approach to the nation's education system to focus on lifelong skills and career training. They regard their approach as an 'investment in people' rather than simply 'financing.' The SkillsFuture scheme's dual focus on developmental and social policy goals can be explained as having four key thrusts:

- Help individuals make well-informed choices in education, training, and careers.
- Develop an integrated, high-quality system of education and training that responds to constantly evolving needs.
- Promote employer recognition and career development based on skills and mastery.
- Foster a culture that supports and celebrates lifelong learning.

One aspect of the initiative is Skills Future Credit, with a focus of strengthening individual ownership of skills development and lifelong learning. The government offers subsidies of up to 80 percent of the cost of training courses for between six and 18 months, with special arrangements in place for mature workers, the long-term unemployed, and low-income workers. Introduced in 2015, all Singaporeans over 25 years of age can access an opening credit of S$500. This credit can be used for Courses subsidised or approved by SkillsFuture Singapore (SSG) including online courses, selected courses offered by Ministry of Education (MOE)-funded institutions, courses supported by public agencies, and courses by associations.

The SkillsFuture Credit portal enables skills development and lifelong learning. Over 18,000 courses from 700 public, private, and online training providers are eligible for the SkillsFuture Credit of the government that 126,000 citizens used in 2016.

The SkillsFuture Enterprise Credit (SFEC) encourages employers to invest in enterprise transformation and capabilities of their employees. Eligible employers will receive a one-off S$10,000 credit to cover up to 90 percent of out-of-pocket expenses on qualifying costs for supportable initiatives, over and above the support levels of other schemes. Similarly, SkillsFuture offers an Enhanced Training Support Package, which aims to support sectors affected most due to the economic impact of the pandemic to better position them for the post-COVID-19 recovery. Companies like Dubai National Air Travel Agency used the package to undertake a three-month upskilling and multi-skilling of its workforce via virtual training.

A report notes that as of 2020, approximately 540,000 individuals and 14,000 enterprises have benefitted from SkillsFuture initiatives.

Sources:

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FU.SE. no date. "Policy action on skills is an investment in the future—Singapore minister." https://www.futureseriesfuse.com/insights/Skills%20policy

Enterprise Singapore. no date. "SkillsFuture Enterprise Credit (SFEC)." https://www.enterprisesg.gov.sg/financial-assistance/grants/for-local-companies/skillsfuture-enterprise-credit

Dnata. 2020. "dnata Embraces eLearning Across Asia-Pacific." Aviation pros. https://www.aviationpros.com/ground-handling/ground-handlers-service-providers/press-release/21150076/dnata-dnata-embraces-elearning-across-asiapacific

Citizens can receive financial incentives to participate in TVET skills development. This can take the form of a conditional cash transfer allowing learners to earn or learn if they would like benefits. For example, youth were invited to apply for the Vocational Training Voucher Program in Kenya. Those who were successful received a voucher to cover a cost of their training at 65 different public and private institutions in rural and urban areas across the country.[201] Governments can also provide student loans under an income-contingent loan scheme whereby learners can borrow what they need to complete a course/program and only repay loans once they earn sufficiently. Singapore's Skills Future initiative (see boxed case study) demonstrates a multipronged approach to skilling using technology, and provides financial incentives to encourage individuals to take ownership of their skills development and lifelong learning. The case study also highlights how companies can be financially incentivized to train their employees.

Loans, scholarships, and stipends can provide significant opportunities for B2C EdTech programs, as well as improving access to educational opportunities. In Lao People's Democratic Republic, for example, the state provides scholarships to the ten best students who are selected through a rigorous process, and offers stipends of KN200,000 per month per student to those taking courses that address skills shortages.[202] However, the literature indicates that 'while [these types of finance leavers] have some equity benefits, some lack alignment with labor market needs and can come with high actual and opportunity costs.'[203] These levers are also greatly dependent on strong administrative

systems, without which implementation suffers. For example, a Ministerial Committee of Inquiry found that South Africa's National Student Financial Aid Scheme IT system. which provides financial aid to students in TVET and higher education, to be inadequate. The system was intended to provide an improved IT platform for submitting and processing student applications. The government cited core issues with the system as being 'system and business process that are not fit-for-purpose and were designed without adequate consultation with and consideration of institutional systems.'[204]

Companies can be encouraged to embrace ways to upskill and reskill their workforces to keep pace with technological changes in a cost effective and socially responsible way, through the provision of tax relief. Governments can create regulatory environments that encourage the private sector to invest in lifelong training, including accounting and tax incentives.[205] A different tax treatment of

[201] Miguel, Edward, Michael Kremer, Isaac Mbiti and Joan Hicks. no date. "Vocational Training and Cash Transfers for Youth Employment and Entrepreneurship in Kenya." J-PAL Africa. https://www.povertyactionlab.org/evaluation/vocational-training-and-cash-transfers-youth-employment-and-entrepreneurship-kenya

[202] Gonçalves, Christine U. 2019. "Financing TVET: a comparative analysis in six Asian countries." https://issuu.com/objectif-developpement/docs/nt56_tvet_asian_countries_anahat_kaur

[203] Palmer, Robert. 2019. Financing Technical and Vocational Skills Development Reform. In *Handbook of Vocational Education and Training*. Edited by Simon McGrath, Martin Mulder, Joy Papier, and Rebecca Suart. Springer: Switzerland.

[204] Mzekandaba, Simnikiwe. 2020. "R100m student aid IT system found to be 'terribly wanting.'" IT Web. https://www.itweb.co.za/content/rW1xL759JlV7Rk6m

[205] FU.SE. no date. "Policy action on skills is an investment in the future–Singapore minister." https://www.futureseriesfuse.com/insights/Skills%20policy

dismissals and reskilling costs would encourage companies to reskill their workers rather than replacing them with new recruits. Another option is for companies to benefit from deductions in their taxable income through their Corporate Social Investment Initiatives (CSI) that focus on EdTech and reskilling. Importantly, the procedure for applying for tax incentives should be clear and simple. For example, in Canada, the Educational Technology Tax Incentive (ETTI) was available to Ontario businesses that supported Ontario's community colleges and universities in acquiring new teaching equipment and learning technologies until 2004. For corporations, the incentive was a 15 percent tax deduction in computing income.[206]

Improve ICT infrastructure

Infrastructure levers involve the deployment of ICT infrastructure and services such as networks, high performance computing facilities, cloud storage services, and access to equipment. Robust infrastructure is a foundation of EdTech, and, as a key component, requires strategic planning and implementation. However, significant challenges remain for countries without reliable electricity, digital devices, and internet connectivity, and where teachers are unable to use technology in their teaching either due to a lack of infrastructure access and/or insufficient digital skills. This poses a danger of ICT widening the digital divide and the gap between rural and urban learners and between the rich and poor.[207] Infrastructure also impacts on EdTech companies' growth as they rely on it to develop and grow their platforms and services.

This calls for reliable and regular funding mechanisms (at the institutional and national levels) to source, develop, maintain, and upgrade existing infrastructure and equipment. This is particularly important as rapid advances in technology tend to be much faster than changes in the education system. Many governments are turning to the private sector for the financing, design, construction, and operation of infrastructure projects. Initially limited to a few countries and infrastructure sectors, PPPs are emerging as an important procurement option for governments to close the infrastructure gap[208] particularly for large-scale infrastructure projects.

Some governments are supporting the development of broadband activity to training institutions, usually with assistance from the private sector. In Kenya, subsidized broadband is provided to TVET institutions and the higher education sector through the Kenya Education Network (KENET). KENET was endorsed by the Ministry of Education as the National Research and Education Network (NREN) of Kenya in 2009. It was licensed by the Communications Authority of Kenya since 2002 to build and operate the private national network that interconnects institutional campus networks, and to provide internet and community cloud services to member institutions. KENET works with internet service providers (ISPs) to facilitate last-mile connectivity of subsidized broadband. In total, 280 institutions including universities, TVET institutions, colleges, hospitals, and research institutions currently receive high-speed broadband via KENET, benefitting some 600,000 students. There are plans to expand KENET's coverage to more TVET institutions, which could provide faster and more reliable connectivity.[209]

[206] Ontario Ministry of Finance. no date. "Educational Technology Tax Incentive." https://www.fin.gov.on.ca/en/credit/etti/

[207] Veal, Karina, and Muriel Dunbar. 2017. "Preparing TVET for the Digital Age." Development Asia. https://development.asia/explainer/preparing-tvet-digital-age

[208] Deloitte. 2006. "Closing the Infrastructure Gap: The Role of Public-Private Partnerships." www.infrastructureaustralia.gov.au/publications/files/Closing_the_Infrastructure_Gap-The_role_of_PPPs_Deloitte_2006.pdf.

[209] World Bank Group. 2019. "Kenya Digital Economy Assessment." Background paper series: Digital Skills. Washington, DC: World Bank. License: Creative Commons Attribution CC BY 3.0 IGO.

Examples across the world highlight the challenge of training institutions having difficulty catching up with the latest technology that companies require their workers to be familiar with.[210] Improving learners' digital skills relies on their access to devices and technology-based learning materials (requiring affordably priced broadband data). For EdTech companies wishing to address this gap, there is a need to consider regulations around importing devices and necessary infrastructure materials.

Donors also play an important role in providing infrastructure to support training institutions. For example, in Kenya, a few TVET institutions have been fitted with smart classrooms that are helping to improve the quality of teaching. In 2015, a smart classroom concept for TVET was rolled-out in ten colleges as part of a bilateral TVET project between Kenya and the Netherlands. Several partners were involved in this initiative, including EdTech hardware and software providers. Learners were provided with computers and digital library resources, and trainers were provided with over 1,000 interactive presentations covering vocational, technical, and life skills. Classrooms were fitted with state-of-the-art technology and software, enabling simulations, experiments, and hands-on training. It was intended to enable incubation, student-centered learning, and competency-based and interdisciplinary training. Feedback from trainers indicates that the tools had significantly improved teaching, allowing teachers to use visual aids and simulations to convey complex concepts, and supported the development of digital specialist skills by enabling courses in robotics, 3D, and engineering design.[211]

Partners can also be encouraged to pool resources to create the necessary infrastructure. In Melbourne, Australia, a group of secondary schools, each unable to afford top-of-the-range science and technology equipment, joined together to create a high-tech learning lab (The Knox Innovation, Opportunity and Sustainability Centre—KIOSC) where students are exposed to the latest technology. It was set up with support from the Swinburne University of Technology, the Australian Commonwealth Government's Trade Training Centers in Schools Program, and the Knox City Council. The goal was to pool resources to create a modern high-technology learning center that all the participating schools could benefit from. The center provides classroom learning in 'real life' work skills that reflect the modern labor market. KIOSC provides hands-on training in industrial and other technological skills using high-quality equipment and with support from industry mentors. Its goal is to equip senior students with the knowledge and practical training to enable them to step into technical jobs in the future.[212] A second example is the East Africa Skills for Transformation and Regional Integration Project (EASTRIP), which aims to cultivate specialized TVET skills in the region by creating a cluster of regional TVET Centers of Excellence. Each center specializes in specific sectors and occupations. There are niche programs in highly specialized TVET diploma and degree programs, as well as industry-recognized short-term courses. Each center shares its standards, curriculum, and training facilities with the others, which reduces the costs of implementation.[213]

[210] Gonçalves, C.U. 2019.

[211] World Bank Group. 2019.

[212] Evans, Kate K. and Karina Veal. 2017. "Pulling Together Resources to Power Classrooms with Technology." Development Asia. https://development.asia/case-study/pulling-together-resources-power-classrooms-technology

[213] East Africa Skills for Transformation and Regional Integration Project (EASTRIP). no date. "ICT Overview." https://www.eastrip.iucea.org/overview/

Enhance digital skills

Digital skills are essential to support and leverage the opportunities provided by EdTech, and to bridge the digital divide. Digital skills are defined as a range of abilities necessary to use digital devices, communication applications, and networks that access and manage information.[214] These skills are regarded as a necessary component of 21st century education and employability, and are needed at all levels: at the basic level to help people connect and benefit from internet services and applications; at the intermediate level to help learners and job seekers get the necessary skills required by the digital economy; and at the advanced level to increase the pool of ICT experts and meet the demands of industry.[215] Countries that place a strong focus on developing citizens' digital skills are in a better position to adopt EdTech technologies, as citizens are likely to be more familiar with using digital devices and navigating digital resources. In TVET, such skills extend to all aspects of teaching and learning, and their use extends into citizenship, industrial uses, and e-safety. Trainers, learners, and government officials responsible for TVET require the necessary tools, understanding, and practice to recognize and then leverage the benefits of EdTech. Within TVET, the digital skills listed in Table 8 are required to take advantage of EdTech opportunities.

There have been several initiatives focused on developing digital skills within the TVET sector. For example:

- The African Development Bank, the government of Nigeria, and Microsoft launched the Digital Nigeria eLearning Platform to provide marketable digital skills to the country's youth.[216]
- The World Bank is financing the Regional TVET initiative, which aims to create highly specialized regional flagship institutes in 16 selected TVET institutions in Sub-Saharan Africa. Among other activities, these institutes will train technicians and faculty in regional priority sectors, including ICT.[217]

TABLE 6.1 Digital skills required

STAKEHOLDER	EXTENT OF DIGITAL SKILLS REQUIRED
Learners	This can include skills related to: accessing, collecting, organizing, engaging with and visualizing information, and producing digital artifacts (spreadsheets, word processing, presentations, etc.) to convey understanding and inform audiences; communicating information in a variety of online formats; curating and synthesizing resources; collaborating with others using digital mediums; and modelling safe, legal, and ethical behavior when using technology.
Trainers	This involves skills to teach concepts and techniques to allow learners to work with any digital device and adapt to new technology quickly using the skills and concepts they have been taught. This also requires trainers to have digital skills as noted for learners above.
TVET managers/ administrators	Same digital skills as trainers (noted above). The ability to identify digital skill areas of need, together with the advantages and disadvantages of digital technologies for instructional purposes, to build trainers' capacity for effective instructional delivery and assessment of instruction.

[214] UNESCO. 2018. "Digital skills critical for jobs and social inclusion." https://en.unesco.org/news/digital-skills-critical-jobs-and-social-inclusion.

[215] Teltscher, Susan. 2019. "Why digital skills training is so important if we are serious about closing the digital divide." *ITU News.* https://news.itu.int/why-digital-skills-training-is-so-important-if-we-are-serious-about-closing-the-digital-divide/

[216] African Development Bank. 2020. "Nigeria: African Development Bank partners with government and Microsoft to launch Digital Nigeria eLearning Platform." https://www.afdb.org/en/news-and-events/press-releases/nigeria-african-development-bank-partners-government-and-microsoft-launch-digital-nigeria-elearning-platform-38060.

[217] The World Bank. no date. "Regional TVET Initiative. Skills Development/TVET." https://www.worldbank.org/en/programs/paset/brief/skills-developmenttvet

- In South Africa, The Council for Scientific and Industrial Research (CSIR) and Siemens South Africa entered a partnership to empower the country's TVET students with digital skills.[218]
- Microsoft and the National Skills Development Council (NSDC) in India have a partnership focused on enhancing women's workforce participation by equipping underserved young women from rural communities with the skills required to thrive in a digital economy.[219]

In Serbia, initial TVET trainer education does not include digital skills and competences as a mandatory subject, and trainers mainly acquire digital skills through continuing professional development. These focus mainly on basic digital skills and are largely organized as in-service training only. The Ministry of Education thus embarked on several initiatives to improve the situation. It participated in the pilot of SELFIE, a self-assessment tool for schools' progress toward digital-age learning based on the European framework for digitally competent educational organizations; it intends to help schools reflect on their progress toward comprehensive integration and effective deployment of digital and online learning. It adopted the Digital Competence Framework, which intends to help trainers in the process of self-assessing and developing their own digital skills and digital learning practices, as well as to identify the next steps for their professional development. For trainers, this document can help improve the quality and relevance of professional programs, while decision makers can use it to assess and revise existing regulation and design specific policy measures. In addition, the Serbian Moodle Network (a nongovernmental, nonprofit organization) was established to create a collaborative network of digitally competent teachers. The objective is to enhance the quality of digital and online learning for education and training in Serbia by (i) promoting, supporting, and improving its use in education; and (ii) implementing education development programs in the online environment. In addition, Serbia participated in Share—a joint project of UNICEF, the Institute for Education Quality and Evaluation, and the Centre for Education Policy—and started with the creation of an online platform for training trainers and external associates to improve the quality of education in primary and secondary schools, including vocational schools. This serves as an example of how ICT resources can be used in networking and training trainers, and raising the overall quality of education.[220]

Develop capacity of teachers/trainers to use EdTech effectively

Developing the capacity of teachers/trainers to use EdTech effectively is a critical lever for successful EdTech implementation. Early adopters of online education provide important insights for delivering education through online learning. The most often cited lesson from these programs is the importance of securing buy-in and capacity building of teachers/trainers to adapt to new pedagogies and methods of delivery. This requires pre-service and in-service training on the basics of online course development, instructional design, content production, content delivery, and online learning operational management.[221] Consequently, in addition to digital skills, teachers/trainers should have the pedagogical capacity so that they are equipped to align instruction to the modality

[218] ITWeb. 2021. "CSIR, Siemens unlock digital skills for college students." https://www.itweb.co.za/content/KzQenqjVDOeqZd2r.

[219] Microsoft News Centre India. 2020. "Microsoft and NSDC collaborate to empower 1 lakh underserved young women across India with digital skills." https://news.microsoft.com/en-in/microsoft-and-nsdc-collaborate-to-empower-1-lakh-underserved-young-women-across-india-with-digital-skills/.

[220] European Training Foundation. 2017. "Digital Skills and Online Learning in Serbia." https://www.etf.europa.eu/sites/default/files/m/0A2814EFC7BF6440C125822E00573883_Digital%20factsheet_Serbia.pdf

[221] Garcia, M. 2019. "Indonesia Online Learning Strategy Report on the Recommendations of the Workshops in Jakarta and Surabaya." Indonesia.

being used. These skills need to be promoted in pre-service training so that new teachers/trainers have a good understanding of why and how digital information should be used. They should also be updated during in-service training so that they keep abreast of the latest EdTech innovations.

Skilled teachers/trainers are crucial to ensuring quality and maintaining training standards, and thereby enhancing the employability of learners. Importantly, they need to understand the impact of technologies on future jobs that require new skills set, and the consequent need for trainers to be well informed about new developments. Governments and training institutions can promote professional development, helping trainers update their knowledge and skills by giving them opportunities to work with businesses on industry projects and participate in training opportunities related to the design and delivery of tech-supported lessons. Teachers can be trained in courses via online training. For example, in Namibia, the Namibian College of Open Learning (NAMCOL) partnered with the Commonwealth of Learning for financial support to conduct Assessor, Facilitator, and Moderator training for all TVET trainers and facilitators for the International Computer Driving License (ICDL) and Professional Programs.[222]

Develop effective institutional leadership and management

Effective institutional leadership and management directly influences and changes the culture (values, norms, vision, skills, and practices) of training systems. As a result, institutional leaders should be able to develop a clear vision for the institution, which includes a vision for EdTech adoption and integration. They should also have a comprehensive sense of the TVET sector and how EdTech solutions can address the sector's demands, as well as of the labor market and its changing needs. Moreover, leaders are required to manage sophisticated business operations, including innovating and dynamically changing staff configurations to keep pace with technological development and changing labor market needs.[223] Key to this is being able to identify areas of need to build trainers' capacity for effective instructional delivery and assessment. Further, it is important to build institutional leaders' capacity in planning for and managing ICT investments. This also involves appropriately allocating budgets for renewal, maintenance, and upgrades of ICT infrastructure.

[222] Nitschke, Jan J. 2013. "Capacity Building in Trainers of Technical Vocational Education and Training at the Namibian College of Open Learning (NAMCOL)" http://oasis.col.org/bitstream/handle/11599/1877/2013_Nitschke_TrainersTVET.pdf?sequence=1&isAllowed=y.

[223] OECD. 2021. "Strengthening leadership in vocational education and training, in Teachers and Leaders in Vocational Education and Training." OECD Publishing: Paris. https://www.oecd-ilibrary.org/docserver/8764e86c-en.pdf?expires=1623413250&id=id&accname=guest&checksum=564EBD4DDAD1FF856F76A5E58E87160D.

Support development and sharing of relevant technology-enabled educational content

While the potential of new technologies to transform skills development and TVET is unprecedented, actual benefits can only be realized if digital education content is locally contextually relevant or based on local curriculum frameworks. Digital learning resources need to be directly related to the curriculum and to the assessment methods used to evaluate educational outcomes, in order to have positive educational impacts. In addition, digital technology (such as simulators and augmented and virtual reality) can diversify training methods and increase training effectiveness in high-cost and high-risk education and training courses. Governments can define educational content standards to which institutions need to adhere, or create policies on using open licenses for educational content and resources that facilitates the reuse of content to ensure scaling. Open licensing allows users to share and, under some licenses, translate or otherwise adapt the work of others without requesting written permission. Creative Commons (CC) licenses[224] are the most widely used open licenses in education and publishing.

In Korea, the Online Lifelong Education Institute (OLEI) within the Korea University of Technology and Education is a hub for online vocational training specializing in technology and engineering. The institute relies largely on interactive and experiential e-learning practices by incorporating new technologies into its online learning environment. Funded by the Korean Ministry of Employment and Labor, OLEI developed and offers more than 200 free online courses free of charge to industrial workers and jobseekers on mechanics, electronics, mechatronics, ICT, design, materials, architecture, and chemistry.

In recognizing the need for more hands-on learning with industrial equipment, OLEI administrators developed virtual training content using simulators, emulators, and virtual reality (and augmented reality) software. Through specialized ICT, learners can learn about various types of equipment, including macro-sized tools, ultra-mini tools, and highly expensive equipment that institutions cannot afford to buy. They also learn how to stay safe in dangerous work situations. Through the online platform[225], students log in to access the learning content at any time. Since 2007, OLEI developed 31 virtual training courses in subject areas such as mechanics, electronics, mechatronics, architecture, design, and new energy, and offers them in 141 training centers, both public and private. Deploying these courses, the centers have so far trained 24,418 students. While the virtual training content allows students to work with expensive equipment or learn a machine in a dangerous work situation, developing the software is also expensive. Hence, OLEI had to choose wisely and think carefully about how long the content would be relevant before the technology became obsolete. OLEI also realized that providing virtual training content freely over time to its training centers reduced overall vocational training costs.[226]

In another example, TVET Academy[227] equipped eight vocational training centers across Cambodia with a bank of video recordings of TVET instructors explaining theory and practice in their native language. This initiative occurred in partnership with the Ministry of Education. This is an example of how problems related to access

[224] Creative Commons. no date. "About the Licenses". https://creativecommons.org/licenses/

[225] http://vt.e-koreatech.ac.kr

[226] Yian, Theresa Thang Tze, and Jonghwi Park. 2018. "Chapter 9: Technology-enhanced TVET delivery for improving access, relevance and inclusion in Asia and the Pacific." In *Skills and the Future of Work. Strategies for inclusive growth in Asia and the Pacific.* Edited by Akiko Sakamoto, A. and Johnny Sung. http://apskills.ilo.org/downloads/chapter-9-technology-enhanced-tvet-delivery-for-improving-access-relevance-and-inclusion-in-asia-and-the-pacific-1/view

[227] http://www.tvetacademy.org/en/

to in-service training and access to materials for teachers in remote areas can be overcome using low-tech solutions and local expertise.[228]

Technology companies have a role to play in supporting the development of the ecosystem and aligning public and private sector digital skills with the latest industry standards by reviewing and adopting these standards. They can also play a role as direct digital skills providers through expansion of online courses and certification opportunities.

Strengthen verification and certification processes

TVET systems and credentialing authorities need to provide quality assurance systems that are responsive to the changing landscape in order to make credentialing information from multiple sources more accessible, provide the methodologies for comparing credentials, and understand how these combine meaningfully. Systems of quality assurance thus need to adapt to allow them to be streamlined, agile, and responsive to changing needs and to accommodate new ways of teaching and learning, assessment, as well as processes such as RPL, and recognition and validation of micro-credentials. Some countries' credentialing authorities are developing quality assurance and governance systems that are responsive to the changing landscape. For example, in some countries, the government's strategic response to economic recovery during the COVID-19 pandemic has been to invest in the rapid development and deployment of micro-credentials. Australia has invested US$4.3 million to support the growth of micro-credentials and to create a marketplace for them.[229]

Digital credentials are becoming sufficiently substantive to be included in national qualifications frameworks, with some micro-credentials being credit-bearing if they are aligned with a specific qualification.[230] A current review of the Australian Qualifications Framework (AQF) is considering the role of micro-credentials in Australia's formal credential architecture. It is understood that current thinking supports the role of micro-credentials in the broader Australian education landscape, but to minimize complexity, the mechanism for RPL (the AQF Qualifications Pathways Policy) needs to be elevated and reinvigorated.[231] In some countries, micro-credentials can be 'stacked' to create a credit course, which is then transferable from the college system to the university system. For example, in Canada, micro-credentials can be recognized and transferred into a degree or diploma.[232] Governments are also working toward creating equitability in the TVET system by allowing students

[228] Veal, K. and M. Dunbar. 2017.

[229] Jean-Loius, Maxim. 2020. "Micro-credentials and the Skills Agenda." https://www.linkedin.com/pulse/micro-credentials-skills-agenda-maxim-jean-louis

[230] Harris, Lynette. 2019. "Micro-credentials – measuring the value of soft skills." https://insights.navitas.com/micro-credentials-measuring-the-value-of-soft-skills/

[231] Harris, L. 2019.

[232] Jean-Loius, M. 2020.

to accumulate credits and apply them to credentials. This creates upward mobility in the sector, promotes access, and allows any student to compete on a level playing field. For example, in China in 2020, the government passed regulations for the construction of a National Credit Bank of Vocational Education. This included the recognition and accreditation of online skill learning achievements. It will record individual vocational education credits to enable the transfer and conversion of those credits toward other certifications. The National Credit Bank System (NACBS) is a central agency and mechanism through which credit can be accumulated and applied to credentials and provide students with greater access to mobility and progression within education, and training and career paths, thus fostering a lifelong learning society.

Credentials obtained from informal training opportunities can support students to find jobs, particularly if they can gain credit for the skills they develop. An example of this is the recent development of Sri Lanka's National Skills Passport (NSP), which provides recognition of skilled workmanship and the verified work experience through a central web-based online database. The ultimate objective is to ensure that every citizen entering the workforce, at least by 2035, will be certified in their skills and registered in the database. The NSP is a smart card issued to a skilled person who possesses a National Vocational Qualification (NVQ) and at least one year of confirmed and verified related-employment experience. This card is connected to a fully online system[233] that links different stakeholders such as employees, employers, qualification bodies, and labor market intermediaries by collating the passport holder's skills, expertise, and experience. It provides recognition of skilled workmanship and the verified work experience through a central web-based online database. Importantly the NSP provides pathways to employment. The NSP can be directly linked with the RPL system that helps recognize informally acquired knowledge, skills, and competencies through formal assessments and certification. While students who already have an NVQ can directly apply for a NSP, other workers need to first obtain a NVQ through the RPL pathway. Such candidates can apply for related NVQs from a basket of around 500 National Competency Standards (NCS) listed on TVEC website[234] through the RPL pathway. When they obtain the NVQs they can then apply for the NSP through the TVEC online portal, allowing them to apply for better jobs locally or abroad for a better salary with recognized qualifications.

Establish and sustain monitoring systems and ongoing evaluation processes

Monitoring and evaluation allow for lessons to be learned and helps inform changes in relevant TVET policy, programs, and practices. As highlighted in Chapter 4, in order to guide public policies and inform private efforts, more evidence is needed about the effectiveness of various initiatives and approaches in EdTech that foster youth employment and smooth transitions from education and training to work. Education Management Information Systems can incorporate and support this data collection.

There are some examples of countries formalizing such efforts. In Germany, the Federal Institute for Vocational Education and Training (BIBB) operates as a center for vocational research and the progressive development of TVET.

> *BIBB works to identify future challenges in VET, stimulate innovation in national and international vocational systems, and develop new, practice oriented solutions for both initial and continuing vocational education and training.*[235]

[233] www.nsp.gov.lk

[234] www.nvq.gov.lk

[235] The Federal Institute for Vocational Education and Training (BIBB). https://www.bibb.de/en/461.php.

BIBB monitors and evaluates these projects which, if shown to be effective, are then adopted in the national system.

In another example, the Korea Research Institute for Vocational Education and Training (KRIVET) is a public national research institute affiliated with the Prime Minister's Office. KRIVET conducts policy research and development in the field of education and employment, with a focus on the vitalization of VET and enhancement of the public's vocational competencies. It spearheads the creation of linkages between education and training with employment, provides effective policy options, and supports the strengthening of the Korean public's lifelong career competencies.[236]

The availability of accurate and timely information on labor markets, employment, and skills development metrics will enhance decision making by anticipating labor market trends and revising programs and trainings offered by TVET providers.[237] Accurate data and information help the continuous formulation of improved evidence-based policies following monitoring and evaluation. One of the major problems in education is the mismatch in the labor market—employers complain that graduates do not have the skills for the jobs, whereas the training providers believe they are providing the best education to their students. This is partly a problem of missing information—data on labor market demand is not readily available from existing labor force surveys, which are not transmitted to training providers resulting in the delivery of courses which tend to be supply driven.[238]

Governments can set and recommend standards for accurate data and proper data management. This involves developing appropriate procedures and mechanisms for collecting, processing, storing, analyzing, and disseminating labor market data and insights, thus facilitating action and value creation toward the improvement of the labor market. Such information can help with skill development, inequality and discrimination reduction, investment promotion, migration flow management, productivity enhancement, policy evaluation, etc.

Successful LMISs tend to rely on partnerships between multiple stakeholders from the public and private sectors. Thus, governments need to foster partnerships between multiple stakeholders such as training agencies, private employment centers, online job portals, and employer associations (in both the public and private sector), which play an important role in shaping and developing an LMIS, both sharing data and informing the public administration about their needs, which can make an important difference to the success of the LMIS. The involvement of the national statistical agency in monitoring the quality of the data should also be stressed, given its typical nature as a public body of greater independence.[239] Mozambique is setting up an LMIS that provides data on the different dimensions of its labor market. The Labor Market Observatory plays a critical role in this area as it compiles, processes, and disseminates a considerable amount of information originally produced by different agencies of the Ministry of Employment and by other bodies, in particular the Statistical Agency. The Labor Market Observatory

[236] UNESCO UNEVOC. no date. "Korea Research Institute for Vocational Education and Training (KRIVET)." https://unevoc.unesco.org/home/Explore+the+UNEVOC+Network/centre=389.

[237] Sulaiman, Norlisa, and Kahirol M. Salleh. 2019. "The development of technical and vocational education and training (TVET) profiling for workforce management in Malaysia: Ensuring the validity and reliability of TVET data." *Man In India* 96 (9) : 2825-2835. https://www.researchgate.net/publication/309403104_The_development_of_technical_and_vocational_education_and_training_tvet_profiling_for_workforce_management_in_Malaysia_Ensuring_the_validity_and_reliability_of_tvet_data

[238] Garcia, M. 2019.

[239] Askitas, Nikos, Rafik Mahjoubi, Pedro S. Martins, and Koffi Zougbede. 2018. "Labor Market Data Sources towards digital Technical and Vocational Education and Training (TVET)." PARIS21 Discussion Paper, No. 13. http://www.paris21.org/sites/default/files/2018-09/Labour-Market-Data-Sources-TVET_WEB.pdf

BOX 6.4 Malaysia's Critical Occupations List (COL)

Malaysia developed a Critical Occupations List (COL) that shows occupations that are skilled, sought-after, and strategic across 18 sectors in Malaysia. The COL identifies shortages in occupations that are high in demand by employers. It aims to be the primary instrument to promote better coordination of human-capital policies aimed at attracting, nurturing, and retaining talent. The data is collated on an annual basis by the Critical Skills Monitoring Committee (CSC), which is a partnership led by TalentCorp and the Institute of Labor market Information and Analysis (ILMIA) under the Ministry of Human Resources (MOHR). Because the COL is developed with the data from employers, it provides a big picture of the skills and occupations that are in demand within the industries. It also provides an idea of the occupations that will be prioritized by policymakers, especially in the aspects of immigration, education, and upskilling opportunities.

It seeks to identify and draw stakeholder attention to a set of occupations that are critical to the continued growth and development of the Malaysian economy but are currently difficult to fill. The occupations that are skilled, sought-after, and strategic in the list span a range of fields and professions. The COL still faces several challenges that are useful for other countries to consider. These include the challenge of classifying job titles and occupations into standardized occupations, which is the backbone of the Critical Occupations List and similar shortage lists—and the creation of shortage lists that reflect subnational labor market dynamics.

Sources:

StudyMalaysia.com. 2019. "The most difficult jobs to fill according to Malaysia's Critical Occupations List 2018/2019." https://studymalaysia.com/education/top-stories/the-most-difficult-jobs-to-fill-according-to-malaysia-critical-occupations-list-2018-2019

TalentCorp. no date. "Critical Occupations List—Identifying Malaysia's Talent Shortages." https://www.talentcorp.com.my/initiatives/critical-occupations-list

Moroz, Harry E. 2019. "Malaysia's most wanted: The critical occupations list." https://blogs.worldbank.org/eastasiapacific/malaysias-most-wanted-critical-occupations-list

publishes quarterly and annual reports that present several statistics. The reports cover developments in the labor market and comparisons with previous periods, including breakdowns by industries and regions (provinces, municipalities, and districts), and by employment and training dimensions.[240]

Facilitate partnerships

Well-functioning partnerships and networks can accelerate innovation and help deliver EdTech solutions across all of the above policy levers. They are outlined here as a separate policy lever, as implementation of effective partnerships often requires additional measures to be implemented to enable the partnerships to be operationalized. Within EdTech, there can be a range of different types of partnerships at different levels of the education system (local or national)—for example, there can be PPPs between the private sector and government, between industry and training institutions, between governments and donors/NGOs, and between government and companies.

Legislative frameworks, particularly those that have advocated—and succeeded in enforcing—e-rates[241] for social services from telecommunications and technology companies, are useful for governments looking for ways to reduce costs associated with accessing the internet.[242] During the COVID-19 pandemic, many governments partnered with telecommunications companies to enhance internet provision to learners. For example, in South Africa, mobile

[240] Askitas, N, and P.S. Martins. 2018.

[241] The e-Rate program, facilitated by the Universal Service Fund, provides discounts to assist schools and libraries in the United States to obtain affordable telecommunications and internet access.

[242] Butcher, Neil. 2010. "ICT, Education, Development and the Knowledge Society." http://www.gesci.org/assets/files/ICT,%20Education,%20Development,%20and%20the%20Knowledge%20Society(1).pdf

network operators agreed to zero-rate access to a range of educational and public service resources online.[243] In the Philippines, Globe Telecom partnered with the Technical Education and Skills Development Authority (Tesda) to offer all subscribers free data to access the Tesda Online Program (TOP)[244], which is the government's online skills training program.[245] TOP is an open-educational resource that aims to make technical education more accessible to Filipino citizens. Launched in 2012, it generated more than 755,745 users in the Philippines and abroad for thirty courses in its first three years.[246] By May 2020, TOP had over 554,000 users. Free online courses include Tourism, Computer Systems Servicing National Certificate (NC) II, Food Processing NC II, Bread and Pastry NC II, Housekeeping NC II, and other courses from sectors such as automotive, agriculture, entrepreneurship, and health care.

Partnerships between governments and private companies can also enhance quality and access to training opportunities for TVET learners. For example, in Egypt, the government is working with the private sector to provide training opportunities for TVET learners via Applied Technology Schools that connect the education system with the tech industry in order to provide specialized educational opportunities in the field of technology.[247] Introduced in 2018 using a PPP model, private sector companies are responsible for funding the upgrading of school facilities, educational resources, and equipment, as well as for funding the running costs of the schools (including bonuses and incentives for the existing teaching staff, and salaries for new teaching personnel). Companies have three agreement options depending on the level of responsibility they can and/or want to undertake: Full Partnership Agreement, Consortium Partnership, and Associate Partnership. Full Partnership is suitable for large and labor-intensive companies as well as with mega national projects, Consortium Partnership is suitable for medium size enterprises, and Associate Partnership allows small and micro enterprises to participate in the apprenticeship programs.[248]

Training providers also partner with private companies to enhance their training provision, a process that can be supported by clearly defined government vision and policies. For example, in South Africa, Huawei and the South African College Principals Organization (SACPO) partnered to cultivate ICT talent in 23 TVET colleges across South Africa's nine provinces. These colleges are enrolled to the Huawei ICT Academy Program, making them certified ICT academies. This is a nonprofit partnership program that allows colleges to deliver Huawei certification courses to their students with the aim of building a 'talent ecosystem for the ICT industry.' The partnerships also involve training more than 200 instructors to offer Huawei-accredited courses. It is hoped that the courses offered by the academy will prepare students with the latest technologies and practical skills to work in the ICT industry, making them more employable and helping to kick-start their careers. The partnership feeds into the government vision of building links between post-school education and the world of

[243] Goldstuck, A. 2021.

[244] https://www.e-tesda.gov.ph/

[245] Camus, Miguel, R. 2020. "Globe makes accessible Tesda's online skills training program." https://business.inquirer.net/305727/globe-makes-accessible-tesdas-online-skills-training-program

[246] Gonçalves, C.U. 2019.

[247] Egypt Independent. 2019. "Egypt cooperates with IBM to launch the country's first IT school." https://egyptindependent.com/egypt-cooperates-with-imb-to-launch-its-first-it-school/.

[248] European Training Foundation. 2020. "Torino Process 2018–2020—Egypt National Report." https://openspace.etf.europa.eu/sites/default/files/2020-04/TRPreport_2020_Egypt_EN.pdf.

work, to ensure that young people have better opportunities and that the system produces the skills required by the economy.[249]

Governments and training providers may also enter into agreements with private sector companies and technology service providers to fulfil specific services related to EdTech. Companies may offer discrete solutions or a more complete package including an online learning platform, learning resources, interaction, and assessment mechanisms.[250] TVET training providers adopt these packages as part of their online programs, or to provide supplementary academic support to students. In China, the focus areas for technology in TVET are smart campus applications and IT-based teaching and learning, with the current trend being integrated applications from a service provider.[251] Establishment of such partnerships can be accelerated if they are foreshadowed in clear policy directives that steer the processes of procurement and solicitation that are needed to put the partnerships in place.

Summary

Policies are important to foster the development of EdTech within the TVET sector, but initiatives run the risk of being irrelevant and unsustainable unless the right policy levers are used. Significantly, almost all of the policy levers highlight the importance of building partner networks to ensure that initiatives and solutions are tailored appropriately. To successfully leverage policies, it may be useful for governments to establish accountable agencies to lead the development, regulation, and implementation of relevant policies/strategies related to EdTech in TVET.

Although it is tempting to seek to classify recommendations in reports of this nature by country type (for example, by income level), this kind of grouping is unhelpful as it masks important contextual differences between individual countries and does not recognize that some supposedly less developed countries may be significantly more advanced in EdTech implementation in TVET than their more developed counterparts. For example, in considering partnerships, it is not possible to differentiate between LICs and MICs as this depends on many factors including the legislative and political environment.

Table 6.2 summarizes some of the key levers and their potential effect/impact on stimulating private sector growth of EdTech in TVET.

[249] Mzekandaba, Simnikiwe. 2020. "Huawei ICT Academy attracts 23 local TVET colleges." https://www.itweb.co.za/content/P3gQ2MGxGbOqnRD1

[250] Zawacki-Richter, Olaf, and Adnan Qayyum. 2019. *Open and Distance Education in Asia, Africa and the Middle East.* Springer. https://www.researchgate.net/publication/331299194_Open_and_Distance_Education_in_Asia_Africa_and_the_Middle_East

[251] Hui, Luo. no date. "Quality and Equitable Training Delivery by Education Technology - The Situation, Trends and Cases of Vocational Institutions."

TABLE 6.2 Summary of policy levers

POLICY LEVER	POTENTIAL IMPACT	EFFECT ON PRIVATE SECTOR GROWTH	EXPENSE
FINANCES AND PROCUREMENT			
Develop procurement standards that outline central procurement guidelines	HIGH	Highlights requirements for EdTech products and services, thereby promoting quality, competition, and innovation.	LOW
Implement the use of e-procurement systems	HIGH	Expedites the procurement process and allows the private sector to get its products to market (and scaled) faster.	MEDIUM
Provide financial incentives including tax incentives	MEDIUM	Attracts more investors and private sector partners as the tax relief/financial incentive may be a more attractive proposition.	LOW
Incentivize innovative practices in EdTech and innovative solutions through, for example, tax incentives for PPPs	MEDIUM	Encourages innovation at scale, impacting sector competitiveness by encouraging all players in the EdTech field to innovate and improve their offerings.	LOW-MEDIUM
Subsidize broadband to education institutions	HIGH	Allows service providers to extend their reach beyond urban areas, attracting more subscribers.	HIGH
Establish zero-rated access to education websites	HIGH	For telecommunications providers, users are likely to use a telecommunication network if they zero-rate educational content, and providers can still charge for uploads (when assignments are submitted), communications, and social networking apps (learning communities usually also have networks outside the platforms or content, for example, on Facebook, WhatsApp, Signal etc.). Provides a massive opportunity to grow customer/subscriber base.	LOW
Create incentives for citizens to engage in lifelong learning	HIGH	Stimulates online training markets to meet training needs. Encourages employers to invest in company transformation to keep up with latest trends and developments.	LOW-MEDIUM
POLICY AND REGULATORY ENVIRONMENT			
Establish governance structures and strategies to coordinate the work of different governmental entities, as well as the public and private sectors	HIGH	Creates a common decision-making structure across government ministries, consolidates spending on TVET, and prevents fragmentation and duplication of efforts.	LOW
Create enabling regulations for importing digital infrastructure	MEDIUM	Allows for increasing access to digital devices and hardware to grow businesses, thereby widening their offerings in the EdTech space.	LOW
Open access to business opportunities for nontraditional TVET global service providers	MEDIUM	Increases sector competitiveness by pushing all players to innovate and improve their offerings (though this may carry risks if local players are unable to rise to this challenge).	LOW-MEDIUM

POLICY LEVER	POTENTIAL IMPACT	EFFECT ON PRIVATE SECTOR GROWTH	EXPENSE
PARTNERSHIPS			
Establish partnerships to test infrastructure models before scaling	MEDIUM	Provides opportunities to showcase and market EdTech solutions to government, diversify offerings, and grow businesses.	LOW
Coordinate public agencies and leverage multi-stakeholder partnerships and collaborative teams to develop digital skills	HIGH	Fosters the development of digital economy and meets the needs of workplaces and employers. Allows for continuity and scaling of effective programs.	LOW-MEDIUM
Harness PPPs for infrastructure procurement	HIGH	Provides opportunities to develop private sector capabilities in the short and medium term.	HIGH
Establish collaborative taskforce teams, which include training providers, industry players, and EdTech providers to enhance the development and provision of curricula and programs	MEDIUM	Drawing on industry-specific and education sector expertise allows EdTech providers to develop and tailor context-appropriate technology solutions.	LOW
GENERAL			
Promote the use of piloting for EdTech products before rollout at the national level	MEDIUM	Enhances the value-add of the final product and creates opportunities for the private sector to measure the impact of EdTech solutions before they are rolled out at scale.	MEDIUM
Promote online educational content platforms (including virtual training content) and the use of open licenses for educational resources	HIGH	Private companies can market and sell their content and provide customized content that is aligned with latest industry standards, are part of learning pathways that lead to accreditation, or directly address the skills needs of local employer. It also opens certification opportunities.	LOW-MEDIUM
Strengthen digital skills and EdTech use in trainer capacity development	HIGH	Provides opportunities to promote platforms and develop marketing and distribution channels.	LOW-MEDIUM
Promote openly licensed content for trainers and learners	HIGH	Creates the potential for new players in the content development market, reducing the duplication of investments. For example, businesses can offer two levels of service—basic, which provides free access to a set of openly licensed resources and tools, and premium, which gives users additional services for a fee.	LOW
Implement rigorous evaluation to reinforce EdTech evidence of impact	HIGH	Utilizes trends and evidence-based data to improve products and offerings.	LOW

CONCLUSION

EdTech is now an essential feature of a well-developed national TVET system, put into the spotlight by the COVID-19 pandemic. It is transforming how people engage with learning, enabling people to access—and companies to seek—both learning and work opportunities removed from the physical location of the institution or company. Private sector and government have an incentive to work together to deliver EdTech solutions, as EdTech models cannot flourish if the digital infrastructure and enabling environment that underpins a digital ecosystem doesn't exist, meaning there is common cause for private sector and government to pursue EdTech solutions that solve substantial societal problems. While this report highlights several efforts that governments have made, it is unfortunate that there is a lack of evidence-based research analyzing the effectiveness of the approaches. There is thus significant scope for additional research on this topic, particularly with regard to the implications of EdTech implementation. Potential areas for future research are outlined below.

- The scarce body of existing research comes together as a patchwork of differing technologies applied in very different educational and occupational fields in different geographic and institutional contexts. Further research is needed to consolidate these findings into a coherent set of lessons that LMICs can use in practice.
- For policy application, the question of how the impact of EdTech deployment interacts with the institutional environment in which it takes place is crucial. Yet it remains insufficiently answered. Identical interventions in different setting have led to widely differing outcomes.
- While technologies such as computer assisted learning have demonstrated positive impacts on learning, it remains unclear why some applications work and others do not. Research assessing specific advantages of technology design is needed.
- Existing research largely focuses on cognitive and socioemotional skills while use of technologies for attainment of practical on-the-job skills remains understudied. Some of the most exciting frontier technologies such as VR are, in principle, well-suited to advance education in applied settings such as assembly, machine maintenance, and network configuration. Yet, more research is needed to understand specifically which settings work.
- Evidence tends to focus on proximate outcomes such as program completion or, if more advanced, learning and skills acquisition. Evidence on labor market outcomes of students over time remains scarce.
- Further consideration is needed to understand how effective EdTech is in closing disparities between educational outcomes by gender or other underserved groups.
- Evaluation is needed of the gaps between policy intentions and implementation.
- There is merit in undertaking research on how best to align procurement processes with intended learner outcomes and available resourcing in LMICs.
- Evaluation is needed of procurement systems in LMICs and research on how to make procurement processes for EdTech in TVET more efficient and effective.

APPENDIX 1

Examples of the Scope of EdTech Opportunities

AREA OF OPPORTUNITY	DESCRIPTION	OPPORTUNITIES	RISKS
ADMISSIONS AND REGISTRATION			
Online admissions and registration systems	The process of entering or being allowed to enter a training course/ program, which is increasingly being implemented using online systems.	• Admissions systems can steer learners in the direction of the growing range of flexible and informal opportunities within and beyond national borders and the formal TVET sector. • Application clearing house systems that are linked to LMIS data allow prospective learners to be directed toward areas of scarce skills. This could be done nationally or regionally. The application system would also guide students toward institutions most suited to what they wish to study and/or institutions that have places available. • Artificial Intelligence (AI) enables institutions to quickly assess applications and improve student fit while AI Chatbots can boost admissions and registrations by allowing institutions to communicate with students and field student queries about the admissions process or requirements.	• Not all learners may have online access to register and to continually check their application status. • Capacity development in data management is required to use these technologies effectively. • Breaches of data privacy might occur as databases are vulnerable to hacking.
DESIGN AND DEVELOP COURSES			
Technology-enabled materials design and development	The process of creating teaching and learning materials using various media forms such as audio, video, print (both digital and physical), computer-based multimedia, simulations, and virtual reality.	• There is massive innovation in the private sector in terms of software applications and online platforms that have increasingly become standard tools for use in content creation. Particularly, there has been an explosion in cloud-based content creation services. • Virtual design spaces can provide a focal point for discussion and a storage space for documentation and assets. These can be easily accessed by all stakeholders enabling institutions to procure services from highly skilled curriculum developers anywhere in the world. • Online reviewing systems can support scalable development of online courses, saving time and increasing efficiency by eliminating lost paper forms.	• Technological tools are making cheap content creation increasingly easy, but sometimes at the expense of proper instructional design. • There are challenges of vendor lock-in in business models, as most content formats in these systems are not yet standardized and/or open. • Capacity/training is required to understand and use the systems.

AREA OF OPPORTUNITY	DESCRIPTION	OPPORTUNITIES	RISKS
PROGRAM/COURSE DELIVERY			
Online and blended learning	Online learning refers to any form of learning that takes place over the internet (web or app-based). Blended learning involves a combination of traditional face-to-face instruction and web-based online learning, including watching videos, gaming, virtual reality, text messaging, and social networking sites. Online technology is not just used to supplement, but also to transform and improve the learning process. It usually includes some element of asynchronous learning that gives the student control over time, place, path, or pace.	• Management and administration software provides support to the learning process. • Collaboration technologies enables interaction between learners and teachers/trainers. This assists the learning process by allowing students greater access to teachers/trainers and fellow students as resources. • Apps, simulations, and games using augmented reality (AR) and virtual reality (VR) technologies to practice techniques reduces training costs. They allow learners to apply theory to practice in a realistic, safe, and controlled way to facilitate the learning process and equip learners with easily transferable skills in real-life situations. • E-books and textbooks can be more affordable, are convenient, can be delivered instantly, and can accommodate more learning styles.	• Not all learners have good internet connectivity or are able to meet the costs of connectivity. • Asynchronous independent learning can lead to reduced engagement and lower completion rates • The availability of technologies, skills levels of learners, capacity of teachers/ trainers. • Forfeiting control of data by using third party tools. • For e-books, publishers may implement Digital Rights Management (DRM)[252] on e-books formats.
Assessment of learning	The process and activities of measuring the progress of a learners' learning. Information gathered during this process helps better understand the strengths and weaknesses of learners' learning. It usually encompasses both summative and formative assessment. Summative assessment is the evaluation of student learning by comparing it against intended learning outcomes to quantify achievement, usually at the end of a learning program. Formative assessment covers the methods used to gather feedback on student academic progress and learning needs during the learning process to inform and modify in-process teaching and learning activities to improve student learning.	• There has been growth in e-assessment services using technology for assessment activity, such as the design and delivery of assessments, recording responses, marking, reporting, and storing data. • Customized online assessment and evaluations software streamline and secure test and examination delivery. • Learning management Systems (LMSs) and software facilitate online and continuous assessments (e.g., quizzes, reflections). • Artificial intelligence-based assessment makes it easy to grade bulk assignments within a short deadline. This allows teachers to focus more on in-class activities and learner interaction than grading, improving learner outcomes and saving time. • Formative and summative assessment tools and applications allow teachers and institutions to track learner progress and encourage collaboration or discussion between learners. This allows students to receive feedback in real-time, saves time, reduces costs, and can motivate learners to invest in their learning.	• There are risks of vendor lock-in. • Technological assessment tools might not be an optimal way to assess learners for specific hands-on subjects (for example, woodworking). • It may be easier for learners to cheat in online assessments. • Learners need to be computer literate and have access to devices and connectivity. • Subscription costs associated with cloud-based assessment software.

[252] This is a technical approach to copyright protection for digital media to prevent its unauthorized redistribution and restrict the ways in which consumers can copy content that they have purchased.

AREA OF OPPORTUNITY	DESCRIPTION	OPPORTUNITIES	RISKS
Assessment of learning *(continued)*		• Assessment software enables teachers/trainers to create and administer tests to learners via digital devices, grade learner answers, and analyze results. This streamlines the process of delivering tests/exams, allows teachers to gain a holistic view of a student's performance, provides information to facilitate instructional decisions, and gives teachers the opportunity to provide continuous feedback to learners. • Automated certification for short courses can provide evidence of completion that could be used in RPL ePortfolios. This saves time, is cost effective, and is easy to manage and share.	• Security and hacking risks, particularly with regard to issuing digital certificates. • Privacy risks and discrimination associated with digital proctoring.
PROGRAM/COURSE DELIVERY			
WORK			
Work Integrated Learning (WIL)	An educational approach that aligns academic and workplace practices for the mutual benefit of students and workplaces. It is an intentional experiential learning process that combines academic studies with professional work experience to integrate theoretical, conceptual knowledge with practice in the workplace through directed or supported educational activities.	• Virtual/remote/online WIL refers to placements that are undertaken remotely, rather than physically in the workplace or where in-person contact is impossible, for example due to the COVID-19 pandemic or individual circumstances. This allows learners to gain work experience while experiencing agile work environments and new ways of working, as well as learning about new collaborative technologies. These provide a means of accessing WIL for those who are unable to complete a required number of hours in a workplace due to difficulties with travel, childcare costs, or other reasons. • A central WIL portal/platform that permits learners registration, placement, and progress to be recorded centrally can maintain learner records and assign learners to specific programs or activities with a particular industry partner to provide better matches between a learner's aptitude and industry partners. • Portal and websites that record relevant information related to WIL programs such as sharing and listing available WIL opportunities and storing and registering CVs and resumes enhances access to WIL opportunities. • AI can improve accuracy and success of matching learners with job openings/opportunities both within workplaces and through online recruiters.	• Not all learners have good internet connectivity or are able to meet the costs of connectivity. • Providers will need to formalize structures to ensure that learners receive adequate supervision and guidance in virtual WIL.

AREA OF OPPORTUNITY	DESCRIPTION	OPPORTUNITIES	RISKS
RECOGNITION OF PRIOR LEARNING			
ADMISSIONS AND REGISTRATION			
ACCREDITATION AND QUALITY ASSURANCE			
Recognition of Prior Learning (RPL)	RPL is an assessment process that involves assessment of an individual's relevant prior learning (including formal, informal, and nonformal learning) to determine the credit outcomes of an individual application for credit.[253]	• Electronic RPL e-Portfolio systems that help individuals build their e-Portfolios and align them with a competency framework can save time and avert cumbersome paperwork. • Management Information Systems (MIS) or Learning Management Systems can track and verify learning that takes place on the job, during the apprenticeship period, and throughout an individual's career. In applications for RPL, it can allow learners and institutions to easily track performance and achievement over time. • Blockchain technology can provide a single secure record of educational attainment that is accessible and distributed across many institutions. Certificates can be delivered in blockchain, thereby simplifying the verification process by employers, and countering forged certificates and false résumés. • Systems to enable RPL assessments to take place up-front allows students to progress faster through programs without repeating work where they already have skills. • Automated certification for short courses to provide evidence of completion that could be used in RPL ePortfolios, saves time, is cost effective, and easy to manage and share.	• Security and hacking risks (digital certificates). • Learning analytics software is expensive and requires trainers to be able to use it effectively. • Blockchain is a relatively new technology, and it will take time to establish its use widely and assess its impacts, and how it could complement and develop within approaches to digital repositories and credentials.
ACCREDITATION AND QUALITY ASSURANCE			
Micro-credentialing and certification	A micro-credential is a short, competency-based recognition demonstrating mastery (skills, knowledge and/or experience) in a particular subject area. Examples are open digital badges, e-portfolios, verified certificates, and nanodegrees. They provide a pathway to personalize and recognize professional learning.	• Micro-credentials are flexible and cost effective to implement, have the potential to train learners quickly to fill new, emerging skill gaps, and help businesses fill specialized skill gaps that might not be addressed with traditional credentials. Micro-credentials are also nimble enough to support rapid changes in industry. • Blockchain technologies that allow for the issuing of academic and professional micro-credentials can improve data verifiability, availability, and reliability for the evidence of learning.	• There is a need to create awareness and develop knowledge of micro-credentials and consistent definition of skills requirements. • Formal institutions and employers may not recognize micro-credentials and the process of recognition may be time consuming and laborious.

[253] Australian Qualifications Framework. 2012. "Recognition of Prior Learning: An Explanation." https://www.aqf.edu.au/sites/aqf/files/rpl-explanation.pdf.

AREA OF OPPORTUNITY	DESCRIPTION	OPPORTUNITIES	RISKS
LABOR MARKET INFORMATION SYSTEM (LMIS)			
PLANNING, POLICY, REGULATION, AND LEGISLATION			
GOVERNANCE			
DEVELOP STANDARDS			
DESIGN AND DEVELOP COURSES			
Data analytics	Data analytics is the science of analyzing raw data to make conclusions about that information. Data analytics techniques can reveal trends and metrics that would otherwise be lost in the mass of information. This information can then be used to optimize processes to increase the overall efficiency of a system.[254]	• Can identify at-risk students and automate processes of pointing students to specific support interventions. When these assessments are done in a digital environment, the data can be used to identify and support at-risk students in a more personalized manner. • Data analytics drawing on LMIS data and TVET providers data plays an important role in revealing labor market trends and metrics that would otherwise be lost in the mass of information.	• Developing economies may experience data limitations and related constraints such as resource scarcity and limited analytical capacity, resulting in poor or outdated data (and hence being unable to accurately analyze supply and demand trends).

[254] Frankenfield, J. 2020. "Data Analytics." Investopedia. https://www.investopedia.com/terms/d/data-analytics.asp.

APPENDIX 2

Mapping Roles for Educational Technology in TVET

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
1 NATIONAL/REGIONAL STRATEGIC DIRECTION AND SYSTEM GOVERNANCE			
1.1 Establish laws and policies, combined with a supportive regulatory environment and relevant government/regional bodies/councils, to support the Skills Development Sector	• Regional TVET bodies • Ministries responsible for economic growth and development • Skills Councils	» Websites that provide access to laws, policies, and relevant archived materials through repositories, which improve access to information, provide easier searchability, and stimulate compliance with regulations.	• Websites require ongoing updates to ensure information is current and relevant. • Websites and repositories incur hosting costs.
1.2 Manage education and training providers (or independent bodies overseeing the licensing, accreditation, and quality assurance of training providers)	• Regional TVET bodies • Ministries responsible for education and training • Ministries responsible for ICT • Training institutions/ providers	» Management information systems that process operational information at national and institutional levels allow for monitoring of activities, assessment and planning of new services, and monitoring of trends, enhancing strategic planning. » Virtual meetings improve efficiency and reduce travel costs.	• Systems need to be intuitive and easy to use. • Systems must be updated regularly to mitigate security risks. • Software is cumbersome and often acts solely as a data repository. • Educational institutions need technical IT and information management skills capacity. • Users have varying access to reliable internet.
1.3 Manage a national admission system	• Ministries responsible for education and training • Ministries responsible for ICT • Training institutions/ providers	» Online admissions, enrollment, and registration saves time, allows translations of forms in multiple languages, streamlines paperwork, decreases chances of 'lost' applications, and increases efficiency. » Application clearing house systems that are linked to LMIS data allow prospective learners to be directed toward areas of scarce skills. This could be done nationally or regionally. The application system would also guide students toward institutions most suited to what they wish to study and/or institutions that have places available. » AI Chatbots that boost admissions and registrations allow for easy communication with learners and fields learner queries about the admissions process or requirements.	• Not all learners may have online access to register and to continually check their application status. • Requires learners and teachers/trainers to have reliable access to ICT infrastructure and digital devices. • Capacity development in data management is required to use these technologies effectively. • Breaches of data privacy might occur, as databases are vulnerable to hacking.

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
1 NATIONAL/REGIONAL STRATEGIC DIRECTION AND SYSTEM GOVERNANCE			
1.4 Assess the delivery and quality of education and training offerings (Quality assurance and Accreditation system that sets and monitors standards for education and training providers/ institutions, programs, and delivery)	• Ministries responsible for education and training • Quality agencies and bodies	» Virtual meetings and electronic communication allow for faster assessment of quality assurance processes without requiring assessors to be in the same location, thereby saving time and reducing travel expenses. » Accreditation systems that allow training providers to submit applications online and track progress in applications, results of applications, and at which stage of approval they are in the system allows for national oversight of the qualification mix across training providers, better accountability for programs offered and transparency and standardization of accreditation processes.	• Systems are typically complex and difficult to use, resulting in the process being time consuming. • Requires reliable internet and possibly some training to use systems.
1.5 Secure, mobilize, and channel funding to support skills development: • **Provide and maintain infrastructure** • **Create incentives for private sector involvement** • **Support the implementation of Active Labor Market Policies (ALMPs) aimed at upskilling/ reskilling job seekers**	• Ministries responsible for education and training • Ministry responsible for labor • Ministries responsible for ICT • Ministry responsible for finance	» Electronic bids enable an open and competitive hiring process. » Cloud accounting and financial management platforms improve accuracy and record payment or transfers of financial resources, allowing for improved cross-checking of accounting information and greater access for personnel, regardless of location. » Supplier management software helps retain quality, safety, and risk management processes, allowing users to remotely monitor vendor compliance, thereby increasing efficiency, saving costs, and reducing the risk of fraud. » Distributed ledger technology/blockchain technology can automate transactions when certain eligibility criteria are met and verified by the blockchain network, helping simplify processes, reduce settlement times, errors, fraud and disputes, and alleviating cumbersome administrative processes. » eProcurement systems enable greater flexibility and control over the content purchasing process, automating procurement, reducing human error and providing a reliable audit trail.	• Administrative processes can be cumbersome. • Electronic bids limit contact between personnel for identity verification, but this can be bypassed through stringent security procedures. • Cloud-based software is susceptible to hacking or downtime due to upgrades, which is a particular concern for financial processes that contain confidential information and require frequent/daily use. • Requires good data management system.
1.6 Engage employers and collaborate with industry to keep abreast of demands for skills in labor market and ensure that skills system is responsive to labor market needs	• Ministry responsible for labor • Ministries responsible for education and training • Employers	» Virtual meetings enable structured consultations between employers, industry, and government representatives, reducing the cost of travel for stakeholders. » Online survey tools allow large numbers of representatives to provide input, which can be easily analyzed and collated through AI-enabled content analysis tools. » Online surveys to conduct tracer studies to assess whether training is relevant to labor market demands allows for tracking per learner to obtain accurate information on the responsiveness of skills to labor market needs.	• Development of AI-enabled content analysis is still in the early stages. • Participation in online surveys may be low.

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
1 NATIONAL/REGIONAL STRATEGIC DIRECTION AND SYSTEM GOVERNANCE			
1.7 Provide incentives for employers and employees to engage in upskilling/reskilling opportunities	• Ministries responsible for education and training • Ministry responsible for labor • Employers	» A national database, hosted by the relevant ministry, that allows employers to log their skilling efforts, can track whether and how employers are engaging in upskilling or reskilling programs. Based on employer performance in these areas, government can provide rewards through recognition and reward schemes. This creates accountability for skilling efforts, incentivizes companies to prioritize these activities, and creates wider impact in upskilling and reskilling. The database could also recognize employers' achievements in this regard, allow employers to see their progress over time, and act as motivation for prospective employees to join the company because of the skilling opportunities it offers.	• Database systems are complex and can be difficult to design. • High hardware and software costs. • Varying levels of digital fluency.
1.8 Produce and share learning materials aligned to curricula/ standards for use by providers and learners	• Ministries responsible for education and training • Professional associations • Training institutions/ providers • Company in-house training units • Corporate social responsibility units • Learners	» Knowledge management systems can store, curate, and share education content, and can include national repositories of learning materials with information on licensing of curriculum materials. This can significantly reduce the cost of access to learning materials. » eProcurement systems that enable greater flexibility and control over the content purchasing process, automating procurement, reducing human error, and providing a reliable audit trail for learning materials » Print on Demand is a book distribution system or process made possible by digital printing, whereby individual copies or a small number of books are printed in response to orders, printing the exact number required. This system brings books closer to learners, eliminates the need to keep books in an inventory, allows books without substantial sales to stay in print, vastly reduces the investment needed to maintain a large backlist, and eliminates the waste and expense of pulping thousands of unsold books. » Monitoring systems (including track-and-trace systems) for book distribution, ensuring consistent movement through distribution chain, eliminating delays, avoiding loss/theft of items within supply chain, and verifying delivery to final point of distribution. » Online content creation tools to create content, facilitate translation/adaptation, and foster collaborative content creation, allows content creation teams (authors, illustrators, editors, and language experts, etc.) to be geographically dispersed (drawing experts in multiple locations). It also allows new players to enter the content creation field. » CPD systems that allocate professional development points to activities and tracks CPD points earned develop capacity to use and implement the learning materials created.	• Some learners do not have access to reliable bandwidth, potentially reinforcing the digital divide. • The integration process for e-procurement systems, without effective training, can lead to incorrect implementation. • For POD, digitally printed books cost more per unit than books printed offset, digital printing is not efficient for books that will sell in volume, and digital printing's quality and flexibility of formats is not as good as offset printing.

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
1 NATIONAL/REGIONAL STRATEGIC DIRECTION AND SYSTEM GOVERNANCE			

1.9 Establish a national Management Information System (MIS) to aid Monitoring and Evaluation (M&E) of the system and feed into a national Labor Market Information System (LMIS)	• Ministry responsible for labor
	• Ministries responsible for education and training
		» Data management tools that improve data sharing between departments, promote integration between systems, reduce data inconsistency, and improve data access for users, assists in accurate decision-making.
		» A standalone suite of applications that provides several services, or an integrated solution that integrates into an existing technology stack expedites administrative tasks.
		» Cloud-based government budgeting and planning software that allows users to integrate and synchronize financial and nonfinancial data with other data sources promotes internal and external collaboration and sharing, improve decision making, and allow governments to build public trust by sharing plans, budgets, and processes.
			• Data silos can inhibit productivity and effectiveness.
			• Standalone software may be difficult to integrate into existing systems and requirements to export data, for example, may be time- consuming and leaves a gap for human error.
			• MIS systems require capacity and skills to set up and manage.
			• Cloud-based systems are susceptible to security breaches, and need to establish partnerships to secure data. Issues related to security to consider are:
			  • Protections from theft by a cyber-attack or data breach,
			  • business continuity and service level commitments,
			  • intellectual property (IP) rights protections that prevent the transfer of data to an unauthorized user,
			  • guarantees that anonymized data will remain confidential,
			  • limitations on further sharing of data, and
			  • restrictions on the ability to reverse engineer data to derive valuable source algorithms.

1.10 Oversee M&E of the skills development system	• Regional TVET bodies • Ministries responsible for education and training • Training institutions/ providers • Research agencies	» Indicators, dashboards, and performance tools that focus on high-level performance-related data and methods to collect this data (either by directly entering indicator values or via surveys), can help with visualizing performance data and are easy to interpret. » Online survey tools that help stakeholders to obtain feedback on the skills development system from a diverse group of people provide a cost-effective means of conducting M&E, promote a strong feedback loop, and therefore encourage program success.	• If indicators are entered manually into the system, there is room for human error. • Requires reliable internet access.

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
1 NATIONAL/REGIONAL STRATEGIC DIRECTION AND SYSTEM GOVERNANCE			
1.11 Raise awareness of education and training opportunities and resources via public relations and media	• Regional TVET bodies • Ministries responsible for education and training • Professional associations • Digital marketing companies	» Websites and submission management systems provide access to education and training opportunities, which allows larger numbers of people to apply for these opportunities and reduces the administrative process of collating applications. » Online communications (e.g., newsletters, website posts) promote training opportunities and inform individuals on the mailing list about relevant opportunities, reducing the cost of advertising and providing a broader sample of applicants (increasing access). » Social media platforms (Twitter, Facebook, LinkedIn, etc.) allow communications to be distributed at scale, and for the public to act as secondary disseminators through sharing, retweeting, and tagging. » Data visualization web tools such as infographics that communicate information quickly and clearly can be used in external communications and improve accessibility of information. » Reporting dashboards track performance and allow users to communicate both internally and externally, making data easier to understand.	• Effective social media requires a large following, and can be open to misinterpretation and abuse. • There is a large skills development component in learning to use new software and tools effectively, so stakeholders will require resources and capacity to do so.
1.12 Establish an inter-ministerial task team to oversee governance of the skills development system that includes representation from education, labor, and other key governmental role players in skills development	• Ministries responsible for education and training • Ministry responsible for labor • Ministries responsible for economic growth and development • Skills councils • Quality agencies and bodies • Professional associations • Development partners and economic development agencies	» Communication and collaboration tools allow task team members to jointly participate in strategic and governance sessions, regardless of where they are located. » Indicators, dashboards, and performance tools that focus on high-level performance-related data and methods to collect this data (either by directly entering indicator values or via surveys), can help with visualizing performance data and are easy to interpret. » Online survey tools that help stakeholders to obtain feedback on the skills development system from a diverse group of people provide a cost effective way of gathering data to inform the task team	• Collaboration tools that are not managed properly can lead to cluttered mailboxes and a proliferation of notifications, impacting collaborative processes.

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
2 ACCREDITATION AND QUALITY ASSURANCE			
2.1 Create/sustain quality assurance agency(ies), certification and recognition agencies, and frameworks	• Quality agencies and bodies (national, regional, international) • Ministries responsible for education and training	» Quality assurance portals that provide access to multiple resources regarding quality assurance, regulatory documents, frameworks, and quality assurance agencies enhance access to relevant information and resources.	• Portals incur hosting costs and need to be updated with relevant information regularly.
2.2 Develop standards to inform qualifications frameworks/ skills recognition framework, accreditation standards, Recognition of Prior Learning (RPL), etc.	• Quality agencies and bodies	» Integrated business planning platforms that enable distributed and continuous planning by using analytic technologies and interactive planning, allow stakeholders to centralize planning and effectively collaborate from anywhere to drive year-round planning for qualifications frameworks and accreditation standards. Stakeholders can also collaborate across departments by sending and receiving documents, tracking performance on strategic objectives, commenting on key reports, and sharing outcomes internally and with the public. This leads to more efficient, real-time collaboration with shorter turnaround time and greater accuracy in tracking progress on achieving strategic objectives.	• Introducing new systems requires institutional-level buy-in and there will be a process of adoption, to which some employees might be resistant. • Necessary skills are required to use the systems.
2.3 Develop internal and external approval processes (of achievement or quality standards), conduct audits, and monitor processes	• Training institutions/ providers • Quality agencies and bodies	» Websites/blogs/wikis provide information to pathways and RPL inform learners about their career options and give them the tools to make choices that better suit their contexts. » Interactive career pathways toolkits guide training providers and learners on access and pathways of qualifications, result in more informed, goal-oriented learners, and provide training providers with a clear sense of how to tailor their offerings. » Electronic RPL e-Portfolio systems that help individuals build their e-Portfolios and align them with a competency framework can save time and avert cumbersome paperwork.	• Toolkits and information sources do not account for individual learner aptitudes and performance.
2.4 Provide access and pathways of qualifications, and the extent of RPL and credit transfer	• Training institutions/ providers • Quality agencies and bodies	» Virtual meetings and electronic communication allow for faster assessment of quality assurance processes without requiring assessors to be in the same location, thereby saving time and reducing travel expenses. » Accreditation systems that allow training providers to submit applications online and track progress in applications, results of applications, and at which stage of approval they are in the system allows for national oversight of the qualification mix across training providers, better accountability for programs offered and transparency and standardization of accreditation processes.	• Systems are typically complex and difficult to use, resulting in the process being time consuming. • Requires reliable internet and possibly some training to use systems.

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
2 ACCREDITATION AND QUALITY ASSURANCE			
2.5 Build capacity of personnel in QA agencies and accreditation bodies (e.g., capacity of assessors)	• Ministries responsible for education and training • Quality agencies and bodies	» e-Learning that delivers standardized high-quality content at scale (via pre-recorded lessons, distance education, pre-loaded hardware, computer assisted learning, video tutorials, and games) upskill QA personnel and assessors, enabling them to do their jobs more efficiently and effectively. » Simulations (modelling of work environments in digital worlds) that provide QA personnel and assessors more opportunities to practice techniques and manipulate different parameters can improve confidence and mastery, allowing personnel to get up to speed on new tools faster, and can reduce training costs.	• Lack of digital fluency among QA personnel and assessors. • Some personnel might be resistant to using new technology. • Requires ICT infrastructure and access to devices.
2.6 Ensure that standards and accreditation are aligned with data from LMIS	• Ministry responsible for labor • Ministries responsible for education and training • Training institutions/ providers • Quality agencies and bodies	» Knowledge management systems that classify and categorize classification/standards documents and cross-check them against LMIS improve alignment between the two and promote transparency in labor market data.	• The effect of the system is dependent on input of accurate data. • Need to ensure interoperability of systems for maximum efficiency.
2.7 Develop systems for RPL assessments, and issue certificates and credentials	• Ministries responsible for education and training • Training institutions/ providers • EdTech companies	» Blockchain technology can provide a single secure record of educational attainment accessible and distributed across many institutions. This can allow certificates to be delivered in blockchain, thereby simplifying the verification process by employers, and countering forged certificates and false résumés. » MIS that tracks and verifies learning that takes place on the job during the apprenticeship period, and throughout an individual's career, in applications for RPL, allows learners and institutions to easily track performance and achievement over time.	• Blockchain is a relatively new technology and it will take time to establish its use widely and assess its impacts and how it could complement and develop within approaches to digital repositories and credentials.
2.8 Develop a micro-credentialing system	• Training institutions/ providers • Employers • EdTech companies	» Micro-credentials (such as open digital badges, e-portfolios, verified certificates, and nanodegrees) that demonstrate skills, knowledge, and/or experience in a given subject area or capability provide a pathway to personalize and recognize professional learning, are flexible and cost effective to implement, have the potential to train staff quickly to fill new, emerging skill gaps, and help businesses fill specialized skill gaps that might not be addressed with traditional credentials. » Blockchain technologies that allow for the issuing of academic and professional micro-credentials can improve data verifiability, availability, and reliability for the evidence of learning.	• Need to create awareness and develop knowledge of micro-credentials. • Formal institutions may not recognize micro-credentials and the process of recognition may be time consuming and laborious.

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
3 INSTITUTIONAL/TRAINING PROVIDER MANAGEMENT AND GOVERNANCE (INCLUDING IN-HOUSE COMPANY TRAINING UNITS)			
3.1 Implement laws and policies, and ensure compliance with the regulatory environment created by relevant government bodies/ councils in the Skills Development Sector	• Ministries responsible for education and training • Employers • Training institutions/ providers • Company in-house training units	» Websites and repositories provide increased access to relevant laws, policies, documents, and forms, increasing access to key documents and creating opportunities for improved compliance. » Electronic document management systems that provide a centralized cloud-based repository accessible from anywhere reduces lost or duplicated information and promotes compliance.	• Websites require ongoing updates to ensure information is current and relevant. • Websites and repositories incur hosting costs. • Cloud-based systems are susceptible to security breaches, and need to establish partnerships to secure data.
3.2 Conduct internal and external quality measures as stipulated by designated quality assurance bodies, ensuring compliance with relevant institutional and program standards	• Ministries responsible for education and training • Training institutions/ providers	» Interactive self-assessment toolkits for institutions that provide accessible benchmarks against which institutions can measure themselves can assist the QA process by highlighting strengths and areas for improvement for institutions. » Online survey tools that gather feedback from key stakeholders on data needed to measure indicators allows users to modify existing forms, link survey data to indicators, collect survey data using tablets or smartphones, and includes options to collect data without an internet connection and later synchronize back to an online system. This expedites data collection, saves costs, and reduces transcription errors thereby improving the quality of data. » Statistical and Qualitative Data Analysis Software that can analyze unstructured text, audio, video, and image data, such as interviews, focus groups, surveys, social media, and journal articles saves time during the QA process and allows data to be collected from multiple sources. » Quality assurance management software can deliver features such as organization performance, and evaluation of educational programs and research outputs that are relevant to the needs of the society allowing for monitoring and improvements to be made. » Systems can set reminders to ensure accountability and task completion, track performance, and identify areas for improvement. » Online database that includes provision for uploads of program information and supporting documentation together with checks and balances can identify data anomalies.	• Systems need to be intuitive and easy to use. • Systems must be updated regularly to mitigate security risks. • Software is cumbersome and often acts solely as a data repository. • Users have varying access to reliable internet.
3.3 Use allocated budgets appropriately	• Ministries responsible for education and training • Training institutions/ providers	» Web-based financial information systems that enable flexible reporting, dashboards, and analytics provide more accurate financial records and analytics, which can be compared over time and consolidated into a single system. » Budgeting and planning software for budget process automation, personnel cost forecasting, managerial reporting, and public transparency, drives more effective planning and projections, and strengthens stakeholder trust.	• Cloud accounting and financial management software is managed externally, with the attendant risk of security breaches and leaked sensitive information.

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3 INSTITUTIONAL/TRAINING PROVIDER MANAGEMENT AND GOVERNANCE (INCLUDING IN-HOUSE COMPANY TRAINING UNITS)			
3.4 Engage employers and collaborate with industry to keep abreast of demands for skills in the labor market and be responsive to needs	• Employers • Training institutions/ providers • Teachers/ Trainers • Professional associations • EdTech companies	» Virtual meetings enable structured consultations between employers, industry, and training institution representatives, reducing the cost of travel for stakeholders. » Online survey tools allow employers and industry to share knowledge on demands, enabling greater responsiveness to labor market needs. » Appointment scheduling software that streamlines the process of scheduling training provider visits to employers/industry promotes frequent engagement between stakeholders, thereby supporting alignment between them on skills demand and supply.	• Both employers and training providers need to agree to use the appointment scheduling software.
3.5 Align course offerings/ specialization areas with labor market needs	• Training institutions/ providers • Company in-house training units	» Knowledge management systems that classify and categorize classification/standards documents and cross-check them against LMISs improve alignment between the two.	• Course design takes time, so may not always be possible to be responsive where courses don't currently exist.
3.6 Manage, curate, and share learning materials aligned to curricula/standards for use by learners	• Training institutions/ providers • Company in-house training units	» Knowledge management systems that store, curate, and share education content, including possible creation of institutional repositories of learning materials with information on licensing of curriculum materials, provide easier access to curriculum-aligned education content for learners. » Document management/content management systems that store, manage, and track electronic documents and manage version control enable learners and teachers to have access to the latest documents in real time and to provide input on these materials when necessary.	• The effect of the system is dependent on input of accurate data. • Need to ensure interoperability of systems for maximum efficiency.
3.7 Administration of the learning process (deliver content, registration, course administration, assessment, tracking, and reporting) and enable institutional advancement	• Training institutions/ providers • Company in-house training units • Teachers/ Trainers • Learners	» Online enrolment and registration saves time, allows translations of forms in multiple languages, streamlines paperwork and decreases chances of 'lost' applications, and increases efficiency. » AI Chatbots that boost admissions and registrations allow for easy communication with learners and fields learner queries about the admissions process or requirements. » Institutional management information system that automates the administrative functions of training providers, enables planning, support, and monitoring of training provision and the effectiveness thereof, tracks Work Integrated Learning (WIL) placements and tracks student progress, creating a more integrated system that is easier to use and saves on administrative costs. » Data analytics that identify at-risk students can direct students to specific support interventions.	• Not all learners may have online access to register. • Requires learners and teachers/trainers to have reliable access to ICT infrastructure and digital devices.

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3 INSTITUTIONAL/TRAINING PROVIDER MANAGEMENT AND GOVERNANCE (INCLUDING IN-HOUSE COMPANY TRAINING UNITS)			
3.8 Implement RPL assessments, and issue certificates and credentials	• Training institutions/ providers • Company in-house training units • Teachers/ Trainers • Learners • EdTech companies	» Blockchain technology that can provide a single secure record of educational attainment accessible and distributed across many institutions, allowing certificates to be delivered in blockchain, thereby simplifying the verification process by employers, and countering forged certificates and false résumés. » MIS that tracks and verifies learning that takes place on the job, during the apprenticeship period, and throughout an individual's career, in applications for RPL allows learners and institutions to easily track performance and achievement over time. » E-Portfolios that showcase learning over time can create social learning environments within organizations, enabling learners to track their progress, learn from one another, and provide evidence of learning.	• Blockchain is a relatively new technology and it will take time to establish its use widely and assess its impacts, and how it could complement and develop within approaches to digital repositories and credentials.
3.9 Raise awareness of education and training opportunities via public relations and media	• Training institutions/ providers • Company in-house training units • Digital marketing companies	» Websites that publicizes education and training opportunities together with submission management systems provide access to education and training opportunities, which allows larger numbers of people to apply for these opportunities and reduces the administrative process of collating applications. » Online communications (e.g., newsletters, website posts) that promote training opportunities and inform individuals on the mailing list about opportunities that are relevant to them, reduce the cost of advertising and provides a broader sample of applicants, thereby increasing access. » Social media platforms (Twitter, Facebook etc.) allow communications to be distributed at scale, and for the public to act as secondary disseminators through sharing, retweeting, and tagging. » Data visualization web tools such as infographics that communicate information quickly and clearly can be used in external communications and can improve accessibility of information. » Reporting dashboards track performance and allow users to communicate both internally and externally, making data easier to understand.	• Effective social media requires a large following, and can be open to misinterpretation and abuse. • There is a large skills development component in learning to use new software and tools effectively, so stakeholders will require resources and capacity to do so.

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4 CURRICULUM DESIGN AND DEVELOPMENT			
Define occupations and learning outcomes/competencies and pedagogical strategies (a systems-level function linked to credentialing, and institutional-level functions to operationalize)			
SYSTEMS-LEVEL FUNCTIONS			
4.1 Integrate information on needs assessment and labor market trends from LMIS to identify demand-gaps that will inform supply needs	• Ministries responsible for education and training • Training institutions/ providers	» Collaboration platforms (including file storage and synchronization services to store and collaborate on shared documents) allow multiple people to provide input on the same document in real-time, enabling faster collaboration and identification of demand gaps. » Data management tools that improve data sharing between stakeholders, promote integration between systems, reduce data inconsistency, and improve data access for users, assist in accurate decision-making.	• Collaboration tools that are not managed properly can lead to cluttered mailboxes and a proliferation of notifications, impacting collaborative processes. • Data silos can inhibit productivity and effectiveness.
4.2 Conduct subject/ sector-specific needs assessments in consultation with subject experts and representatives from the labor market to ensure alignment with labor market needs and relevant national needs, skills development requirements (e.g., digital and soft skills), policies, and strategies	• Ministries responsible for education and training • Training institutions/ providers	» Virtual meetings to discuss needs that enable structured consultations between employers, industry, and government representatives, are convenient and reduce costs associated with travel. » Online survey tools that allow large numbers of representatives to provide input, enable quick data collection (particularly if done via AI-enabled content analysis tools), saving time. » File storage and synchronization services (cloud computing) that store assessment files, allowing subject experts and labor market representatives to provide remote input, and allow the creation of archives of key documentation over time.	• Too many virtual meetings run the risk of preventing the interaction and personal contact that allows for the development of these relationships. • Participants need the necessary infrastructure and digital security, and need to be comfortable with virtual meetings. • Participation in online surveys may be low.
INSTITUTIONAL-LEVEL FUNCTIONS			
4.3 Incorporate National Occupational Standards and/ or (Inter)national Occupational Classifications into the curriculum	• Ministries responsible for education and training • Training institutions/ providers	» Knowledge-based systems that classify and categorize classification/standards documents and cross-check them during curriculum development enable more focused alignment between inter/ national standards and curricula.	• Cloud accounting and financial management software is managed externally, with the attendant risk of security breaches and leaked sensitive information.
4.4 Work within the available standards for curriculum development/ curriculum framework (model/approach to curriculum development) and align outcomes to recognized benchmarks (if applicable)	• Ministries responsible for education and training • Training institutions/ providers	» Knowledge-based systems that classify and categorize relevant documents (e.g., benchmarking) and cross-check them with curriculum outcomes enable development of internal and external approval processes (of achievement or quality standards), audits, and monitoring processes. » Word processing software that allows users to make comments, highlight overlaps, and take note of alignments within the document promotes detailed record keeping of outcome alignment processes and facilitates collaborative processes between departments.	• Systems are not well-aligned. • Requires reliable internet access.

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4 CURRICULUM DESIGN AND DEVELOPMENT			
4.5 Determine the approach to learning, key purpose, and outcomes	• Ministries responsible for education and training • Training institutions/ providers	» Virtual communication tools allow stakeholders to engage with one other (e.g., through email, voice call, video call, and instant messaging), enabling more efficient, cost effective interactions that are not reliant on all stakeholders to be at the same location.	• Too many virtual meetings run the risk of preventing the interaction and personal contact that allows for the development of these relationships. • Participants need the necessary infrastructure and digital security, and need to be comfortable with virtual meetings.
4.6 Define the assessment strategy (e.g., formative and summative assessments, including work-based), feedback to learners, recording and reporting, and how credentialing will be determined (e.g., creating a micro-credentialing framework for credit accumulation and RPL).	• Ministries responsible for education and training • Training institutions/ providers • EdTech companies	» Learning analytics software that processes learner log data generated by the MIS, allowing the institution to customize learning paths that are unique to learners' learning needs, style, strengths, and weaknesses, rather than forcing learners to go through a standard curriculum and path, promotes individualized learning, thereby improving the learning experience for learners and allowing teachers to address learning gaps more effectively. » Data from continuous assessments that automatically syncs with the MIS, enables more efficient and accurate learning analytics. » Systems to enable RPL assessments to take place up front so that students can progress faster through programs without repeating work where they already have skills	• Learning analytics software is expensive and requires teachers/ trainers to be able to use it effectively.
Design and develop curricula, teaching and learning materials, practical activities, and assessments			
4.7 Access and engage skilled curriculum developers/subject experts/instructional designers, including from training providers, relevant skills councils, and the private sector	• Training institutions/ providers • Content creation companies	» Virtual design spaces that provide a focal point for discussion and a storage space for documentation and assets that can be easily accessed by all stakeholders enable institutions to procure services from highly skilled curriculum developers anywhere in the world.	• Remote work entails a great dependence on cloud technology, might pose a security risk.
4.8 Determine which national and international standards to align to for program design	• Training institutions/ providers	» Knowledge-based systems that classify and categorize classification/standards documents and cross-check them during curriculum development enable more focused alignment between inter/ national standards and curricula.	• Systems are not well aligned resulting in gaps.

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4 CURRICULUM DESIGN AND DEVELOPMENT			
4.9 Create content outlining learning activities and assessments • **Identify the learning design approach, outcomes, assessment strategy, technologies required, and monitoring and evaluation plan** • **Develop a curriculum map that describes how the curriculum standards will be converted into lesson plans.** • **Determine the teaching and learning methods to be adopted (e.g., independent study, group activities such as lectures, tutorials, practical sessions, work-based activities, and individual support such as telephone, email, or tutoring support.** • **Integrate opportunities to build digital skills and cross-cutting/ soft skills in curricula**	• Training institutions/ providers • Content creation companies	» Virtual design spaces that allow instructional designers/ curriculum developers to collaborate remotely, conduct structured meetings and live collaboration sessions where designers can share screens or engage and distribute key documents promote more rapid curriculum design processes. » Presentation software that enables curriculum designers to undertake a virtual storyboarding process during course design and share storyboards with one another for comment creates opportunities for easier review of course content by larger numbers of people using widely available software. » Websites and repositories that provide access to existing teaching and learning material (e.g., Open Educational Resources, Open Access repositories, Open textbooks, and MOOCs) significantly reduces the cost of digital learning materials for learners. » Wikis that allow discussion on evolving and complex issues and involve the different stakeholders in ongoing processes of creation and collaboration using a simple mark-up language and a Web browser support many forms of media and provide easy access to content regardless of where the user is located. » Personal learning platforms use a subscriber-based model so that institutions can deliver course texts to learners around an aggregated, single bookshelf, which dramatically decreases the cost of textbooks for learners, provides valuable data to institutions on achievement of learner outcomes, and centralizes access to core texts.	• Wikis allow anyone to edit their content, which may lead to false or unreliable information. • Personal learning platforms put the onus on institutions to take on the expense of service provision for textbooks and learning analytics. • Use of vendors may encourage the creation of monopolies (vendor lock-in).
4.10 Ensure adherence to internal and external quality assurance and accreditation standards (including alignment of learning outcomes with relevant National Qualifications Framework (NQF)/ skills recognition framework)	• Training institutions/ providers • Content creation companies • Publishers	» Online reviewing systems that can address the scalable development of online courses save time and increase efficiency by eliminating lost paper forms.	• Capacity/training is required to understand and use the system.
4.11 Adopt copyright licensing conditions for materials to determine how materials can be used	• Training institutions/ providers • Content creation companies • Publishers	» Open licenses such as Creative Commons licenses enable wider sharing of materials and promote accessibility.	• Requires knowledge of different licensing schemes and how to apply them.

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4 CURRICULUM DESIGN AND DEVELOPMENT			
4.12 Select the most appropriate modes of delivery (online, face to face, blended, distance, etc.) for the curriculum	• Training institutions/ providers • Content creation companies • Publishers • EdTech companies	» Digital tools that allow instructional designers to experiment with new tools during the content development process and gauge their suitability for integration into the learning design provide a wider range of options to implement effective learning design.	• Reviewing too many tools may make the process cumbersome and may not be productive.
4.13 Design formative and summative assessment opportunities	• Training institutions/ providers • Content creation companies • EdTech companies	» Formative and summative assessment tools and applications allow teachers and institutions to track learner progress and encourage collaboration or discussion between learners. This allows learners to receive feedback in real-time, saves time, reduces costs, and can motivate learners to invest in their learning. » Data analytics can identify at-risk students and automate processes of pointing students to specific support interventions. When these assessments are done in a digital environment, the data can be used to identify and support at risk students in a more personalized manner.	• Technological assessment tools might not be an optimal way to assess learners for specific subjects.
4.14 Review and quality assure materials by subject experts	• Training institutions/ providers • Content creation companies • Publishers	» Collaboration tools and Word processing software that allow subject experts to review materials permit multiple collaborators to provide comprehensive feedback simultaneously.	• Incorporating QA feedback in different formats (video calls, email, chats) can be confusing and inefficient
4.15 Create schedules for developing materials	• Training institutions/ providers • Content creation companies • Publishers	» Spreadsheet software that creates plans for materials development contributes to a more structured planning process and therefore more efficient content development. » File storage capabilities that ensure that instructional designers receive the plan in real time and can make adjustments or provide input as necessary contribute to more rapid planning processes and allow multiple people to provide input on schedules.	• Spreadsheets carry security risks, where mismanagement might lead to data corruption or mismanaged information.

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4 CURRICULUM DESIGN AND DEVELOPMENT			
4.16 Design monitoring and evaluation strategies, and set key monitoring indicators (e.g., enrolment figures, dropout rate, pass rate, teaching and learning outcomes)	• Training institutions/ providers • Research agencies	» Word Processing tools that allow institutions to design comprehensive M&E strategies and create lists of indicators aid in a smoother design process and allow stakeholders to receive feedback and implement it more rapidly. » Analysis and visualization tools to cross-tab data; charts, maps and other options to visualize data, allow training institutions to compare data across years and indicators, providing a comprehensive view of key indicators and relationships between them, thereby giving a clearer picture of progress and development areas. These tools also allow users to share data intra-institutionally, so that M&E informs peoples' work in real time. » Project management software designed for managing specific activities that are open-ended in their functionality make it easy to add tasks, events, documents and share notes with team members, allowing them to collaborate efficiently from any location.	• Project management software can be costly, time-consuming to learn how to use effectively. • Multi-user access allows several users to access potentially sensitive information if one has not set strict access control measures.
5 PROGRAM/COURSE/TRAINING DELIVERY			
5.1 Ensure computer literacy/digital skills of learners	• Training institutions/ providers • Company in-house training units • Learners • EdTech companies	» Digital tools such as mobile phones, laptops, tablets, or desktops that are necessary tools to develop digital skills prepare learners for careers that are increasingly reliant on technology. » Digital literacy training (knowing how to use digital tools) using various ICT facilitates a digital culture at institutions while equipping learners with the tools and approaches to optimize their education and harness the principles of lifelong learning. » Digital class calendars that outline key training activities allow learners to plan their availability for specific lessons and impart valuable planning skills. » Email or online methods of communication (including bulk SMS or WhatsApp) to communicate efficiently with learners during and outside of class time complement the learning process by reinforcing digital skills in students. » Student digital portfolios that curate and collect student work for viewing and sharing provide a sense of progress over time for both learners and teachers, highlight areas of improvement, and instill digital competencies in students.	• This is a prerequisite to allow learners to engage in more blended/flexible learning environments. • Requires access to digital devices.

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5 PROGRAM/COURSE/TRAINING DELIVERY			
5.2 Distribute/provide access to teaching and learning materials	• Training institutions/ providers • Company in-house training units • Publishers • EdTech companies	» Ubiquitous computing (broadband, mobile broadband, cloud computing) allows learners to have access to practically unlimited information and computing resources, even from low-cost devices such as mobile phones, thereby reducing the digital divide among learners from varying socioeconomic backgrounds. » Devices that make communicating easier, for example, through feedback systems for accepting messages via SMS, calls, or interactive voice response, in which prerecorded messages are used to provide or gather information, are becoming cheaper and easier to use, making it easier for training institutions to gather data regarding rollout of teaching and learning materials and implement changes that support learners optimally. » Websites and repositories provide access to existing teaching and learning material, (e.g., OER, online repositories including Open Access repositories, Open textbooks, and MOOCs), significantly reduce the cost of digital learning materials for learners. They also enable greater access to material without the impediment of sufficient data for learners through functions such as zero-rated URLs for educational content sharing. » e-Learning that can deliver standardized high-quality content at scale (via prerecorded lessons, distance education, pre-loaded hardware, computer assisted learning, video tutorials, and games) provides greater diversity in how educational content is delivered and caters to different students' learning styles. » Simulations (modelling of work environments in digital worlds), which provide learners more opportunities to practice techniques, reduce training costs. » Games using augmented reality and virtual reality technologies that allow learners to apply theory to practice in a realistic, safe, and controlled way facilitate the learning process and equip learners with easily transferable skills in real-life situations. » Collaboration technologies that enable interaction between learners and teachers assist the learning process by allowing students greater access to teachers and fellow students as resources. » Infographics that use imagery to highlight, explain, or enhance text-based information promote content absorption and learning, particularly for visual learners. » E-Books and textbooks can be more affordable, are convenient, can be delivered instantly, and can accommodate more learning styles.	• Learners connectivity and the costs of connectivity. • The availability of technologies, skills levels of learners, capacity of teachers/ trainers. • Forfeiting control of data by using third party tools. • For e-books, publishers may implement Digital Rights Management (DRM)[255] on e-books formats.

[255] This is a technical approach to copyright protection for digital media to prevent its unauthorized redistribution and restrict the ways in which consumers can copy content that they have purchased.

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5 PROGRAM/COURSE/TRAINING DELIVERY			
5.3 Design, implement, and maintain staff administrative systems and functions that meet the needs of program delivery	• Training Institutions/ providers • Company in-house training units • EdTech companies	» Administrative systems that enable reliable filing and record keeping; internal communication; financial management, IT support and workflow processing create the conditions for more effective program delivery.	• Administrative systems need to be easy to use and not add extra layers of bureaucracy, otherwise they will be resisted and/or not used.
5.4 Ensure that efficient and effective support (including administration, digital skills, and technical support) is provided to teachers/trainers and learners	• Training Institutions/ providers • Company in-house training units • EdTech companies	» Remote desktop services (for example, helpdesks that allow organizations to provide technical support to teachers and learners remotely) improve the quality of service and support by increasing response times across any geographical location. They also reduce costs associated with support as travel expenses are reduced, improve efficiency, and allow for adjustments to be made to the system. » Online communication tools promote faster interaction between staff and learners, and between teachers and administrative staff, saving time and increasing efficiency. » Bots that automate tasks such as responding to student registration related queries or gathering content for teachers by automatically visiting websites to retrieve information that meets specific criteria, can significantly decrease demand on administrative personnel and time required to perform tasks.	• Varying internet connectivity. • Communication tools that are not encrypted are vulnerable to being intercepted.
5.5 Conduct audits and implement feedback (this can include QA processes, reporting lines, staffing, financial management) allowing for effective administrative support and performance monitoring	• Training Institutions/ providers • Company in-house training units • EdTech companies • Research agencies	» Online surveys and interviews via videotelephony tools such as Zoom or Skype that solicit feedback from learners and training staff save time and increases efficiency. » Databases, file storage and synchronization services (cloud computing) that maintain records on programs, staffing, and financial statements and provisions allows for easy access to relevant data for audits, enabling faster auditing processes and improved compliance for training institutions. » Research software that can help manage triangulation of data for analysis enables users to process large amounts of research data quickly and improves the validity and auditability of qualitative research. » Audit management software that can simplify, unify, and automate the auditing process, which streamlines processes and saves time. » Natural language generation technology uses AI to write narratives about data, which saves time, facilitates the reporting process, and improves accuracy. » Feedback Management Software allows institutions to solicit feedback from learners and teachers through surveys, and transform it into actionable information, enabling an effective feedback loop and ensuring that feedback is implemented by the relevant department.	• Poorly managed distribution channels and systems can lead to low response rates and incomplete or biased datasets.

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5 PROGRAM/COURSE/TRAINING DELIVERY			
5.6 Monitor program/ course delivery to ensure that objectives are met, and adjust the approach as necessary. This will include frequent engagement with teachers/trainers and learners to elicit feedback	• Training Institutions/ providers • Company in-house training units	» Digital technologies that assist program administrators to collect data more effectively and in real time (for example via the MIS) can produce analytics which can be used to extract accurate and detailed data that can be used for evaluation purposes. » Integrating quality assurance data with learner analytics can personalize education and provide granular performance data for learners and teachers.	• Systems need to allow for integrations.
5.7 Ensure that record-keeping and data collection processes are efficient and that issues are fed back into the system for continuous improvement	• Training Institutions/ providers • Company in-house training units	» Feedback loops through adaptive learning programs (which uses computer algorithms to tailor resources and learning activities according to how a learner interacts with the system) and digital assessment tools.	• MIS needs to be current and up to date.
5.8 Assess learners	• Training Institutions/ providers • Teachers/ Trainers • Company in-house training units • EdTech companies	» LMS and software that facilitate online and continuous assessments (e.g., quizzes, reflections). » Artificial intelligence-based assessment that makes it easy to grade bulk assignments within a short deadline allows teachers to focus more on in-class activities and learner interaction than grading, which improves learner outcomes and saves time. » Formative and summative assessment tools and applications that allow teachers and institutions to track learner progress and encourage collaboration or discussion between learners, which allows students to receive feedback in real-time, saves time, saves time, reduces costs, and can motivate learners to invest in their learning. » Assessment software that enables teachers/ trainers to create and administer tests to learners via digital devices, grading learner answers, and analyzing results streamlines the process of delivering tests/exams, allows teachers to gain a holistic view of a student's performance, provides information to facilitate instructional decisions, and gives teachers the opportunity to provide continuous feedback to learners. » Automated certification for short courses to provide evidence of completion that could be used in RPL ePortfolios, saves time, is cost effective and easy to manage and share.	• Cheating. • Learners need to be computer literate and have access to devices and connectivity. • Costs associated with online assessment software. • Security and hacking risks (digital certificates).

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
6 WORK-INTEGRATED LEARNING (WIL)			
6.1 Foster close collaboration and formalize relationships between institutions, training providers, and industry to facilitate WIL	• Ministries responsible for education and training • Employers • Training institutions/ providers	» Collaboration platforms (including file storage and synchronization services) that store and collaborate on shared documents, agreements, and contracts saves time. » Virtual communication tools allow stakeholders to engage with one other (e.g., through email, voice call, video call, and instant messaging), enabling more efficient, cost effective interactions that are not reliant on all stakeholders to be at the same location.	• Security risks as cloud computing could be hacked. • Too many virtual meetings run the risk of preventing the interaction and personal contact that allows for the development of these relationships. • Participants need the necessary infrastructure and digital security, and need to be comfortable with virtual meetings.
6.2 Facilitate the placement of learners in apprenticeships and internships within industries	• Employers • Training institutions/ providers	» A central WIL portal/platform/MIS that permits learners registration, placement, and progress to be recorded centrally can maintain learner records and assign learners to specific programs or activities with a particular industry partner to provide better matches between a learner's aptitude and industry partner. » Portal and websites that record relevant information related to WIL programs such as sharing and listing available WIL opportunities and storing and registering CVs and resumes enhances access to WIL opportunities.	• MIS' require capacity and skills to set up and manage. • Websites require ongoing updates to ensure information is current and relevant.
6.3 Supervise learners in their WIL placements and provide necessary support	• Employers • Training institutions/ providers • Teachers/Trainers • EdTech companies	» MIS for record-keeping/training records management to track metrics such as attendance, retention, learner performance, and learner and supervisor feedback that can be read by teachers/trainers provides feedback on gaps and support required. » Learning analytics tools that predict learner performance and intervene if they are underperforming can also provide opportunities for personalized learning and for distinguishing between levels of learning (understanding content versus guessing the answer).	• Comprehensive data collection can be time consuming, depending on the type of WIL program. • Not all educational data is relevant, so there should be a clear sense of what data is used and why, in order to avoid confusion.

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6 WORK-INTEGRATED LEARNING (WIL)			
6.4 Monitor and manage the quality of WIL (provided by education and training provider/ private sector collaboration, as well as independent, and in-house training providers)	• Ministries responsible for education and training • Employers • Training institutions/ providers • EdTech companies	» A central WIL portal/platform that permits learners registration, placement, and progress to be recorded centrally allows all data related to WIL to be stored in one space and offers employers the opportunity to liaise with learners as well as the training provider in order to achieve the desired outcomes of the WIL process. » Records management systems (student placement and management software) that streamline the process of placing, tracking, and monitoring learners in WIL programs, allowing for a centralized solution, increased transparency, and better reporting. » File storage and synchronization services (cloud computing) that maintain records on WIL programs, partnerships and training providers creates tighter feedback loops between educational institutions and the workplace, which allows quicker detection of emerging skills needs. » Collaboration platforms that facilitate interaction between employers, learners (or employees), and educational institutions, can provide real-time monitoring of apprenticeship placements.	• A centrally controlled WIL system which monitors student progress and performance requires dedicated and trained staff to populate and manage the system.
6.5 Evaluate WIL programs	• Ministries responsible for education and training • Employers • Training institutions/ providers • EdTech companies	» Online surveys, electronic forms, and videotelephony tools such as Zoom or Skype that can assist in soliciting feedback from learners, training providers, and industry partners. » Online course review systems can allow for expert reviews, improving the quality of WIL programs. » Videos and pictures can be taken to provide evidence of learning or products developed as part of WIL. » File storage and synchronization services that store evaluation instruments and reports can standardize WIL evaluation procedures.	• Requires good internet connectivity.
6.6 Develop organizational WIL policies and guidelines	• Ministries responsible for education and training • Employers • Training institutions/ providers	» Word processing tools to develop documentation such as policies and guidelines. » File storage and synchronization services to store policies and guidelines, allowing users to collaborate during drafting. » Websites that share policies and guidelines enable easier access to these documents and act as a source of information for learners.	• Websites require ongoing updates to ensure information is current and relevant.

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6 WORK-INTEGRATED LEARNING (WIL)			
6.7 Maintain a WIL program structure that is most appropriate to the type of work the organization undertakes, content, and required learner outcomes	• Employers • Training institutions/ providers • EdTech companies	» MIS systems align WIL program curricula with online content and learner outcomes. » Survey tools that solicit feedback from learners and their WIL supervisors regarding appropriateness of content. » Virtual/remote/online WIL opportunities can require learners to solve problems and manage a virtual environment that simulates the real world. These provide a means of accessing WIL for those who are unable to complete a required number of hours in a workplace due to difficulties with travel or childcare costs.	• Virtual WIL requires reliable internet access. • Providers will need to formalize structures to ensure that learners receive adequate supervision and guidance in virtual WIL.
6.8 Monitor learner proficiency in tools that the WIL program uses and offer training where necessary	• Employers • Training institutions/ providers • Teachers/Trainers	» Learning analytics that provide feedback on learner proficiency, provide opportunities to support learners better and inform learning interventions.	• Ethics and privacy issues (differing treatment of learners).
6.9 Conduct regular quality assurance on WIL program/s and manage relationships with professional/ accreditation bodies to ensure WIL program/s are aligned to norms and standards	• Ministries responsible for education and training • Employers • Training institutions/ providers	» Communication tools that allow users to interact with professional accreditation bodies. » File storage and synchronization services that store quality assurance documentation and enable collaboration across different functions of quality assurance (program delivery, program administration, etc.) » Indicators, dashboards, and performance tools that focus on high-level performance-related data can help with visualizing performance data and are easy to interpret.	
6.10 Maintain a database with comprehensive information about WIL program attendance, processes, and evaluation	• Employers • Training institutions/ providers	» Central WIL portal/records management system. (mentioned under 6.2). » MIS, along with file storage and synchronization services that store documentation and qualitative/ quantitative data. » Clock card systems that tracks learners attendance to understand how much time learners are spending at the workplace.	
6.11 Monitor internal resource allocation to WIL programs including staff, financial, and infrastructural resources	• Employers • Training institutions/ providers • EdTech companies	» AI-enabled MIS that cross-checks available resources against allocations and actual use. » Cloud accounting and financial management platforms that improve accuracy and record payment or transfers of financial resources allowing for improved cross-checking of accounting information and greater access for personnel, regardless of location.	• Willingness of employers/training providers to use a common accounting and financial management platform and be willing to share this data outside of the organization. • Cloud accounting and financial management software is managed externally, with the attendant risk of security breaches and leaked sensitive information.

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6 WORK-INTEGRATED LEARNING (WIL)			
6.12 Oversee certification procedures for learners who complete WIL	• Ministries responsible for education and training • Employers • Training institutions/ providers • EdTech companies	» MIS that evaluates eligibility for certification (for example, by checking attendance requirements have been met). » Auto-generated certificates to create automated certificates and digital badges once eligibility for certification is verified saves time.	
7 STAFF CAPACITY-BUILDING			
7.1 Provide pre-service training for teachers/ trainers	• Ministries responsible for education and training • Training institutions/ providers • Teachers/Trainers • EdTech companies	» e-Learning that can deliver standardized high-quality content at scale (via pre-recorded lessons, distance education, pre-loaded hardware, computer assisted learning, video tutorials, and games) provides greater diversity in how educational content is delivered and caters to different learning styles. » Simulations (modelling of work environments in digital worlds) provides teachers more opportunities to practice techniques, reducing training costs. » Games using augmented reality and virtual reality allow teachers to apply theory to practice in a realistic, safe, and controlled way, facilitating the learning process and equipping teachers with easily transferable skills in real-life situations. » Collaboration technologies that enable interaction between teachers and teacher trainers assist the learning process by allowing teachers greater access to trainers and fellow teachers as resources. » Videos aimed at helping new teachers build professional skills while linking it to actual classroom work allow teachers to see how to practically apply what they learn in their training with learners.	• Teachers will need to be digitally literate—i.e., have some digital literacy training to participate in training. • Teachers will need to be interested to participate.
7.2 Develop a capacity building/professional development framework and conduct in-service training/ CPD programs for institutional leaders and teaching staff	• Ministries responsible for education and training • Training institutions/ providers • Donors • Development partners and economic development agencies	» Tools such as simulations, 3D-immersive virtual reality, videos, videoconferencing, and collaboration software can make teacher training more engaging, and can help trainees stay better focused and learn faster. » CPD systems that allocate professional development points to activities and track CPD points earned provide recognition for capacity building efforts.	• Lack of digital fluency. • Resistance to change (teachers and institutional leaders). • Need to foster a culture of using technology. • Time to participate.

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
7 STAFF CAPACITY-BUILDING			
7.3 Ensure that requisite equipment and infrastructure is available to conduct in-house staff capacity building, where relevant	• Training institutions/ providers	» An asset register of equipment and infrastructure needed that ensures that the required hardware, software, and internet is available, helps in estimating the repairs and maintenance costs, assists in conducting an audit of assets and asset verification to constantly upgrade technology and infrastructure to keep up with technological advances.	• Lack of asset IDs and difficulty locating assets, which impacts on financial accounting.
7.4 Facilitate access to information and resources	• Ministries responsible for education and training • Training institutions/ providers • Development partners and economic development agencies	» Websites and repositories that provide access to existing teaching and learning material (e.g., Open Educational Resources, Open Access repositories, Open textbooks, and MOOCs) significantly reduces the cost of digital learning materials for trainers/teachers. » Online communications (e.g., newsletters, website posts) promote training opportunities and inform individuals on the mailing list about relevant opportunities, reducing the cost of advertising. » Self-paced online courses allow staff to access content and participate in training at their own pace. » OER and OCW can foster pedagogical innovation, avoid unnecessary duplication, reduce the costs of producing and distributing course material.	• Lack of digital fluency. • Reluctance to participate and resistance to change (teachers and institutional leaders). • Need to foster a culture of using technology. • Time to participate. • Connectivity and cost of connectivity challenges. • Security and maintenance of hardware. • Inadequate e-skills and operational skills among management.
7.5 Provide support and supervision during/ following capacity building and training	• Training institutions/ providers • Development partners and economic development agencies	» Email and videoconferencing tools to reach teachers. » Remote helpdesks to respond to queries that allow training providers to provide technical support to teachers remotely), improve the quality of service and support by increasing response times across any geographical location, reduce costs associated with support as travel expenses are reduced, improve efficiency, and allow for adjustments to be made to the system.	• Connectivity and cost of connectivity challenges. • Requires competent staff to run helpdesks and route teachers to appropriate support.
7.6 Provide support for staff on adapting assessment questions and tasks for virtual and blended environments	• Training institutions/ providers	» Online support and training modules allow staff to seek assistance when they require it. » Online assessment system /Question Repository populated with standard questions that a trainer could select as relevant, and add their own as needed can provide ideas and guidance on how to ask assessment questions.	• Connectivity and cost of connectivity challenges. • Online systems must be easy to navigate.

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
7 STAFF CAPACITY-BUILDING			
7.7 Facilitate the development of Communities of Practice to enable teachers/trainers to benefit from exposure to quality teaching and learning methodologies, professional dialogue with peers, and ongoing open sharing of information, ideas, and resources	• Ministries responsible for education and training • Training institutions/ providers • Professional associations • Development partners and economic development agencies	» Wikis, blogs, email lists, and closed Facebook groups that allow teachers to share their ideas and experiences and are not constrained by time and can be accessed according to member needs. » Online communication and mentoring creates spaces where teachers/trainers can experiment with, test, discuss, and exchange experiences regarding teaching methods and content providing access to authentic, relevant, and flexible learning. » National publicly accessible portals allow knowledge sharing by TVET teachers.	• It may be difficult to motivate trainers to engage in the content (trainers are typically very busy).
7.8 Provide a recognition/ incentives/reward scheme linked to CPD	• Training institutions/ providers • EdTech companies	» A company/institutional blog and other social media tools such as peer-to-peer employee recognition platforms that highlight key individual achievements that provide instant appreciation and social recognition (peer-to-peer recognition) as well as redeemable for real-world rewards that may motivate others to engage in CPD activities. » An online recognition platform that recognizes achievements and provides rewards can highlight CPD achievements, allow employees to see all of their accomplishments over time, and motivate staff to continue with CPD efforts. » An online newsletter shared via email and/or the company/institution website can provide recognition. » Sharing digital stories with local media outlets can provide recognition. » Blockchain technology that can be used to make rewards and recognition more meaningful to the individual while significantly reducing the overall administrative labor required through the use of smart contracts.	• High administrative costs. • Lack of real-world value to employees.

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7 STAFF CAPACITY-BUILDING			
7.9 Implement performance evaluations for staff to establish and promote career pathways	• Training institutions/ providers • Professional associations	» MIS tools that record and track CPD participation to ensure that staff have knowledge that is current. » Accredited ODL courses, electronic portfolios, etc., support assessment and recordkeeping. » Performance management systems that track how employees complete their jobs, set goals, and receive feedback allow for a tangible way to rate performance on the job to be used in performance reviews and promotion processes, and make staff accountable for their performance, thereby increasing motivation (and gaining rewards in the form of promotions, raises, or bonuses). » An e-performance competency-based system that allows employees to be assessed on competencies required for their job (and an associated competency library with rating in the profiles of each staff member), identify employees for promotion/transfer and identify which staff have the required competencies and which staff may need training.	• Lack of personal interaction/impersonal, particularly if staff receive the results online with no face-to-face explanation from the employer—a critical rating can seem much worse than the reviewer intended, or a serious problem might be overlooked by the staff member. • Electronic performance appraisals leave a paper trail that can be subpoenaed if there's a lawsuit, and if company files are hacked, the possible resultant data-sharing could lead to an invasion of privacy and create liability for the company that administered and kept them.

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
8 LMIS IMPLEMENTATION			
8.1 Identify key indicators that would inform the supply-demand chain (e.g., access and participation rates, retention and completion rates, transition or pathway rates, level of investment in continuing professional development, share of companies providing apprenticeship and other types of workplace training, placement data, employer satisfaction surveys, learner feedback, and destination analyses of graduates)	• International and regional labor bodies • Ministries responsible for education and training • Ministry responsible for labor • Statistical agencies • Training institutions/ providers	» Online survey tools that gather data from key stakeholders enable quicker data collection, up-to-date data, reduce margins of error as stakeholders enter their responses directly into the system, reduce costs, and enable decision makers to identify current trends and indicators more quickly. » Computer-assisted qualitative data analysis software (CAQDAS) allows for qualitative data analysis in team-based projects, including coding tools, writing and annotation tools, visualization tools, and mapping or networking tools that can save time. » Online reporting tools that take in data from various sources, create online reports and dashboards or visual presentations of all data requirements, facilitating analyses of data and transforming the data quickly into strategic insights that will support the decision-making process.	• Participation in online surveys may be low (i.e., low response rates) so there is a need to consider motivations and incentives of key stakeholders to participate (compulsory vs. voluntary participation). • It is difficult to reach those without internet access.
8.2 Set up infrastructure to enable synthesis of databases in a data warehouse (a central storage for all data)	• International and regional labor bodies • Ministries responsible for economic growth and development • Ministries responsible for ICT • Donors	» Data mining software that finds correlations or patterns among dozens of fields in large relational databases allows users to analyze data from many different dimensions or angles, categorize it, and summarize the relationships between indicators. » Metadata computer application servers that ensure that data are accurate, well-defined, and clean can help facilitate and speed up searches and allow metadata to be controlled in a centralized source. » Multiplatform data warehouse infrastructure that provide more options from which technical users can pick and choose per use case or data type can allow more flexibility of use.	• The more data being processed and maintained, the more powerful the system required. • The more complex the queries and the greater the number of queries being processed, the more powerful the system required. • Need to establish a proper data governance strategy to identify data silos before implementing the data warehouse.

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8 LMIS IMPLEMENTATION			
8.3 Draw data from warehouse to analyze supply and demand trends	• International and regional labor bodies • Ministries responsible for education and training • Ministry responsible for labor • Ministries responsible for economic growth and development • Training institutions/ providers • Statistical agencies • Research agencies • Workers and employer organizations	» Processing data inside the data platform allows data to be processed where it is stored, supporting a wide range of exploratory analytics and reporting without the need to move or copy the data. » Business Intelligence Tools utilize a set of methodologies and technologies to prepare, present and help analyze data, turning it into actionable business information that helps decision makers and end users to make more effective data-driven decisions. » Software packages and tools that allow for data analyses and visualization of quantitative and qualitative data, thereby freeing users from manual and clerical tasks, saving time, being able to deal with large amounts of qualitative data, having increased flexibility, and having improved validity and auditability of qualitative research. » Statistical Analysis tools allow users to manipulate, explore, and generate insights, enabling more useful reporting of data and increasingly accurate projections. » Predictive Analytics tools that combine data mining, machine learning, predictive modelling, and artificial intelligence to predict future events, allowing analysts to simplify their predictive analytics processes and identify trends.	• Increased pressure on researchers to focus on volume and breadth rather than on depth and meaning. • Time and energy need to be spent to learn how to use computer packages. • Developing economies may experience data limitations and related constraints such as resource scarcity and limited analytical capacity, resulting in poor or outdated data (and hence be unable to accurately analyze supply and demand trends). • Labor market institutions, including workers' and employers' organizations, are weak in many economies, which hampers the development and use of mechanisms to feed information and analysis into decision-making. Such problems may lead to ill-informed policy formulation and inadequate monitoring, hindering efforts to achieve labor market and development objectives. • Ensuring common data definitions at the international level.

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
8 LMIS IMPLEMENTATION			
8.4 Conduct primary research (labor market surveys, tracer studies, employer skill needs, etc.)	• International and regional labor bodies • Ministries responsible for education and training • Ministry responsible for labor • Ministries responsible for economic growth and development • Training institutions/ providers • Statistical agencies • Research agencies • Workers and employer organizations	» Online survey tools that gather data from key stakeholders enable quicker data collection, up-to-date data, reduce margins of error as stakeholders enter their responses directly into the system, reduce costs, and enable decision makers to identify current trends and indicators more quickly. » Digital form creation and digital data entry linked to electronic databases facilitates automatic data analysis and visualization. » Computer-Assisted Qualitative Data Analysis Software (CAQDAS) allows for qualitative data analysis in team-based projects, including coding tools, writing and annotation tools, visualization tools, and mapping or networking tools that can save time. » Cloud-based analysis software that allow multiple users to access their data-related work on an analysis project simultaneously from any computer with internet access, facilitating team-based coding and analysis in qualitative research. » Software that helps researchers to visually represent linkages between concepts and data such as mind mapping software, allowing researchers to organize patterns and themes that emerge from data analysis into a conceptual framework. » Online reporting tools that take in data from various sources, create online reports and dashboards or visual presentations of all data requirements (and customize for difference audiences with minimal effort), facilitating analyses of data, and transforming the data quickly into strategic insights that will support the decision-making process.	• Time and energy are required to learn to use new computer packages. • Ensure that all data gathered is sufficiently anonymized to provide individuals with privacy.
8.5 Use primary research and data warehouse analyses to inform and update national occupational standards and classifications of occupations	• Ministries responsible for education and training	» Software packages and tools that allow for data collation, data analyses, visualization of quantitative and qualitative data provides the ability to manage large amounts of qualitative data, synthesize this data, and use it to inform standards and classifications.	• Limited analytical capacity in some countries.
8.6 Ensure that data capturing and sharing of individual-level data corresponds with national and/or international privacy of information legislation	• Ministries responsible for ICT	» Data security filters that determine the subset of data available to the user (when they log in) can restrict access to the specific subsets of information ensuring that privacy is maintained and data is secure. » Field-level encryption that allows developers to select the individual field(s) to be encrypted protects sensitive information and provides greater control and flexibility on information that is accessed. » Rules-based encryption/decryption that allows users to see data only if predefined conditions are met provides increased flexibility and control, allowing developers to be very specific about what users can and can't see.	• Protections from theft by a cyber-attack or data breach. • Need to strike a right balance of addressing privacy concerns and inputting sufficient data. • Capacity development in data management and process standardization.

KEY FUNCTIONS	STAKEHOLDERS	KEY ROLES FOR EDTECH IN HELPING TO IMPLEMENT CORE FUNCTIONS OF TVET MORE EFFICIENTLY AND/OR MORE EFFECTIVELY	KEY RISKS
8 LMIS IMPLEMENTATION			
8.7 Determine specialty training areas linked to labor market data	• Regional TVET bodies • Ministry responsible for labor • Ministries responsible for economic growth and development • Ministries responsible for education and training • Employers • Training institutions/ providers	» Online survey tools that assist stakeholders in obtaining feedback on specialty training areas from greater numbers of people can reach stakeholders quicker and more cost effectively (without needing to deploy field researchers). » AI-enabled survey analysis tools that collate large amounts of information rapidly can reduce costs associated with time-intensive manual analysis.	• Poorly selected distribution channels for online surveys could lead to biased data. • Participants are likely to spend less time on an online survey that in-person research methods.
8.8 Assess existing skills shortages and use modelling or predictive analytics to anticipate skills changes or future skill needs	• International and regional labor bodies • Ministry responsible for labor	» Predictive Analytics tools combine data mining, machine learning, predictive modelling, and AI to predict future events, allowing analysts to simplify their predictive analytics processes and identify trends.	• Requires access to substantial and relevant data (big data) to utilize, which may be lacking in contexts where information is not gathered systematically on a regular basis.
8.9 Develop a dissemination strategy that considers the audience (decision-makers, the public, employers, employees), the platform (e.g., reports, dashboards, websites, workshops) and the relevant content	• International and regional labor bodies • Ministries responsible for education and training • Digital marketing companies	» Balance scorecard software can map strategic objectives of the dissemination strategy together with measures and targets and strategic initiatives to reach a target, which promotes a goal-oriented approach within the ministry, eliminates the need for complex spreadsheets, and enables better decision-making. » Strategic planning software to formulate strategy then properly structure and share it using strategy maps and strategic frameworks; and manage and track the results of different components of the plan, saving costs and improving efficiency.	• Time and financial investment are required to implement and maintain the software for the institution.
8.10 Engage decision makers in capacity building exercises to enable optimal use of information	• International and regional labor bodies • Ministries responsible for education and training • Training institutions/ providers • Development partners and economic development agencies	» Cloud-based platforms for video and audio conferencing that can accommodate large number of participants in webinars can raise awareness of key trends arising from LMIS data to multiple stakeholders in a short period of time.	• Requires decision makers to have access to reliable computer infrastructure and bandwidth. • Need to promote webinars and conferences. • Organizers require competencies to work through technical issues.

APPENDIX 3

Stakeholders and Their Roles Within the TVET Sector

KEY STAKEHOLDERS	DESCRIPTION OF ACTIVITIES RELATED TO TVET
Government ministries and departments	Several ministries and government departments are typically involved in TVET at both the national and the provincial/state level. These could include: • Ministries responsible for education and training—usually responsible for governance, overseeing the implementation and funding of TVET at the country level, creating a supportive regulatory environment for TVET, overseeing the management of training providers, ensuring that QA agencies function well, overseeing monitoring and evaluation of the TVET system, and raising awareness of skills development issues and opportunities. • Ministries responsible for economic growth and development—usually play a key role in identifying priority economic sectors and skills gaps, establishing laws and policies to support the skills development sector, provide key input into skills development, and play a key role in LMIS. • Ministries responsible for labor—usually implement Active Labor Market Policies (ALMPs) aimed at upskilling/reskilling job seekers, encourage private sector involvement in upskilling/reskilling opportunities, and implement the LMIS. • Ministries responsible for ICT—usually play an important role in ensuring that requisite ICT infrastructure is developed and maintained to support the use of EdTech. • Ministries responsible for finance—usually responsible for securing and channeling funds for the TVET sector.
International and regional TVET bodies	These bodies/groups focus on several issues relating to TVET, including a focus on policy, regulations, and strategic development of the TVET sector, QA, capacity building, and mobility of qualifications. They can also focus on sharing knowledge and fostering dialogue for good practice in skills development.
Quality assurance and accreditation agencies and bodies	QA and accreditation agencies are present at the national, regional, and international levels. Typically, QA bodies oversee the development and implementation of qualification frameworks and are responsible for safeguarding and improving the quality of the delivery of activities within TVET such as teaching, learning, infrastructure, and the entire academic process. Accreditation bodies generally have legislative and professional authority and focus on accrediting a training institution/provider, a program of study, or a service, by having met predetermined standards.
Training institutions/providers	These institutions and providers ensure that learners receive all the required training and practical education for the field of study. There are for-profit and nonprofit training providers operating at local and national levels and across multiple national systems. These can be private or public providers; at the national level these are usually formal training institutions/colleges.
Learners	Learners participate in teaching and learning activities and assessments. They are mainly young people, but they increasingly include people with differing levels of qualifications and work experience (encompassing the notion of lifelong learning).

KEY STAKEHOLDERS	DESCRIPTION OF ACTIVITIES RELATED TO TVET
Teachers/Trainers	Teachers/trainers plan, organize, and deliver training and workshops to learners to increase their proficiency in the required skills. They typically monitor and assess learning progress and skills development and interact with employers to ensure alignment of the training they provide and the workplace. They also update their own knowledge, skills, and competence in their professional fields.
Employers	This can include any organization/company/entity where TVET skills are required and learners could gain employment. Within TVET, employers usually provide opportunities for work-based learning or WIL and provide feedback to training providers on the types of skills needed and how well prepared learners are for the workplace.
Company in-house training units	Training units within a company/organization that teaches and coordinates work-related skills or knowledge to employees with the aim of increasing the quality and efficiency of their position and the company as a whole. This training is usually conducted by internal staff and employees. These units usually are responsible for the development of training materials, courses, assessment, and supervision.
Skills councils	These usually operate at a national and international level, adopting a sector approach and thereby contributing a sectoral 'voice' to education and training arrangements. These bodies typically specify the nature of the skills that an industry sector needs.
Professional associations	These associations/organizations may be part of national systems, regional bodies, or may set international standards for specific professions. They often guide curriculum content that is needed for professional designations. They may also regulate CPD requirements.
Worker and employer organizations	These organizations represent workers and employers respectively in collective bargaining negotiations. Worker organizations include trade unions and can operate on national, regional, and international levels. These organizations represent employees and deal with employers on issues such as labor grievances and disputes. Employer organizations usually comprise employers and companies and engage with governments, trade unions, and the public in policymaking on labor and social issues to allow enterprises to operate efficiently and competitively.
International and regional labor bodies	These bodies typically promote rights at work, encourage decent employment opportunities, enhance social protection, and strengthen dialogue on work-related issues.
Development partners and economic development agencies	These bodies typically focus on strengthening vocational education and training at the country level – for example, they can provide advisory services, technical support, or focus on developing the capacities of the responsible ministries and TVET authorities to manage and implement TVET. They may also provide funding.
Donors	Donors in the TVET space typically include national agencies dedicated to international cooperation, intergovernmental agencies, and development banks. Different agencies have different thematic approaches and priority countries, communication levels, financial regulations, and submission and reporting procedures for TVET funding.

KEY STAKEHOLDERS	DESCRIPTION OF ACTIVITIES RELATED TO TVET
Corporate social responsibility (CSR) units	National and multinational corporations implement diverse economic and social development projects through their CSR programs as a way of contributing to economic development and improving the quality of life of the local community and society at large. Within TVET, this may take a variety of approaches such as developing TVET infrastructure, companies adopting a TVET institution to help with skills development and job creation, or companies developing their own training programs.
Content creation companies	These companies include curriculum developers or instructional designers who are skilled in developing teaching and learnings materials, and within TVET they usually include subject-specific experts.
EdTech companies	These companies provide ICT tools aimed at facilitating and enhancing learning and educational outcomes. These companies serve different market segments including public and private schools, corporations, and government organizations. They provide products and solutions related to facilitating student learning through online and computer-based training to create a more engaging, inclusive, and individualized learning experience. These include virtual classrooms, e-learning materials, learning management systems, computer-aided assessment systems, classroom assessment tools for teachers, education-specific fundraising sites, and e-books.
Digital marketing companies	These companies focus on increasing online presence. They evaluate website traffic, determine the best online platforms to invest in, and continually maintain the balance between marketing activities and the results they provide.
Publishers	For-profit and nonprofit publishers produce books and learning and support materials and guides in hard copy and electronic formats for public and the private training providers.
Research agencies	These agencies typically offer market research services, offering qualitative and quantitative research, increasingly supplemented by consultancy services and workshop facilitation. This can be done at multiple levels within the TVET system (international, regional, national, local, institutional, etc.), depending on the purpose of the research. It can include research spanning multiple issues within TVET, for example, best practice in TVET education and assessing learning to inform QA. They can also provide monitoring and evaluation services using various methodologies and tools to training providers and other stakeholders including government, donors, and employers to ensure accountability and improve education and training implementation and outcomes.
Statistical agencies	These agencies collect, compile, process, and analyze relevant data pertaining to the TVET sector directly from providers, or from other sources, for statistical purposes, and share this data with relevant stakeholders including the public.
Employment agencies	Employment agencies can provide job seekers career guidance, employability support and counselling, as well as facilitate employment promotion and recruitment services.

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