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MOLDOVA – DIGITAL EDUCATION READINESS ASSESSMENT 2021-22

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Abbreviations

ApTI	Association for Technology and Internet
ANCRETI	National Regulatory Agency in Electronic Communications and Information Technology
BYOD	Bring your own device
CAPEX	Capital expenditure
CIS	Commonwealth of Independent states
CNTM	National Youth Council of Moldova
COVID-19	Coronavirus
CSO	Civil society organization
CTICE	Center for Information and Communication Technologies in Education
DLR	Digital learning resource
DPM	Deputy Prime Minister
ECA	Europe and Central Asia
eGA	e-Governance Agency
EHIS	Estonia education information system
EMIS	Education management information system
EU	European Union
GB	Gigabyte
GBps	Gigabyte per second
GDP	Gross domestic product
GNI	Gross national income
GoM	Government of Moldova
GSMA	Global System for Mobile Communications
HD	Human Development
HCI	Human capital index
HEI	Higher education institution
ICT	Information and communication technology
ISP	Internet service provider
IT	Information technology
LAYS	Learning Adjusted Years of Schooling
LPA	Local Public Administration
MoER	Ministry of Education and Research
MoLSP	Ministry of Labor and Social Protection
MoF	Ministry of Finance
ANACEC	National Agency for Quality Assurance in Education and Research
LMO	Labor Market Observatory
NBS	National Bureau of Statistics
NEA	National Employment Agency
NEET	Not in education, employment, or training
NGO	Nongovernmental organization
OECD	Organization for Economic Cooperation and Development
OER	Open educational resources
OLSDI	Local Specialty Bodies in the Education Sector of the Republic of Moldova
OPEX	Operational expenses
PISA	Programme for International Student Assessment
PPP	Public-private partnership
SAPD	Automated Data Processing System
SD	Standard deviation
SES	Socioeconomic Status
SIPAS	Information System for Personalized Education Certificates/Diplomas

STEM	Science, technology, engineering, and mathematics
STEAM	Science, technology, engineering, art, mathematics
STISC	Information Technology Service and Cyber Security
TEC	Temporary education center
UNDP	United Nations Development Programme
UNESCO UIS	United Nations Educational, Scientific and Cultural Organization Institute for Statistics
UNICEF	United Nations Childrens's Fund
USAID	United States Agency for International Development
VET	Vocational education and training
YOBIS	Education management information system for foreign students

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Executive Summary

1. **The Republic of Moldova is facing an unprecedented period of socioeconomic turmoil with profound adverse impacts on human capital formation.** Just as the country was battling a bumpy recovery from the coronavirus (COVID-19) pandemic and the energy crisis, the ensuing refugee influx from the war in Ukraine has further put its short-term economic recovery and long-term social and economic prospects at risk. Increasing inflationary pressures are affecting consumption, trade, and jobs. Moreover, the challenges of rapid demographic decline and aging combined with increasing digitalization, misinformation, and cybersecurity risks, inhibit the country from competing effectively in the information economy—especially since many graduates lack digital skills.

2. **Yet, Moldova intends to pivot these multiple crises into positive opportunities for short-term learning recovery and resilience, paving the way for an equitable and efficient growth path.** There is an ongoing effort to use the crises as a springboard to launch some of the most ambitious educational reforms in the country, including the digital transformation of education service delivery, both for teaching and learning, as well as for pedagogic and administrative management.

3. **Education plays an important role in human capital formation and economic growth in Moldova.** Substantial evidence indicates that more and better education leads to higher rates of return to the individual and society, creating a skilled workforce for the rapidly evolving workplace rests on the growing demand for advanced cognitive skills, socioemotional skills, and digital skills. However, a child born in Moldova today can expect to achieve only 58 percent of their human capital potential than if they enjoyed complete education and full health. Low learning outcomes reveal an opportunity to improve the human capital base in the country (Human Capital Index, World Bank 2020a).

4. **Despite progress made over the past decade, the quality of general education in Moldova lags international peers.** Education enrollment at all levels of education has been declining with a shrinking school-age population. The adjustment of the network of preuniversity education institutions to the decreasing flow of students has not been able to keep pace with the rate of decline in enrollment. Skills gaps and mismatches represent a major obstacle for employers and graduates from vocational education and training (VET) and higher education institutions (HEIs). A significant number of young Moldovans (ages 15–34) are not in education, formal employment, or training (NEET). Public expenditures in education have been declining due to a contracting education sector over the last decade but have been further reduced due to fiscal constraints in a pandemic environment.

5. **The pandemic revealed the fragility of Moldova's education system in terms of equity, efficiency, quality, and relevance.** Before the pandemic, the education system was already facing these challenges. Assuming average school closures of four months, learning is estimated to drop by approximately 8 PISA points, that is, from 424 to 416. As one year of learning is associated with gains of 40 PISA points, an 8-point drop represents 20 percent of the expected learning gain, eroding improvements made over the past six years. Although after the pandemic, the range of digital access points and tools have expanded, these have largely been fragmented efforts in response to an emergency. Estimates indicate that the gap in learning adjusted years of schooling (LAYS) between the richest and poorest households has increased.

6. **Learning losses are likely to have been experienced in Moldova, hence learning recovery is paramount.** Estimates show that about 20 percent of the student population, largely from disadvantaged groups, was disengaged from the educational process during the pandemic. The most vulnerable students may experience the largest losses and drop out altogether, as pre-existing risks are compounded leaving them further behind. While schools were opened from September 2020 with short intermittent closures of two weeks or less applied on some classes or groups as needed, the public health emergency restrictions were lifted in April 2022, enabling a stable and full-scale reopening of all schools. At this time, it is critical

to conduct rapid learning assessments to determine the learning gaps and provide targeted and compensatory learning recovery programs to minimize the losses. Simultaneously, measures are needed to strengthen the effectiveness, inclusion, and resilience of the education system to improve learning, reduce future earning losses, and better respond to future crisis.

7. **To address these pressing needs, education must digitally transform itself while also building a well-endowed and competitive labor force.** Hence, the digital transformation of education in Moldova involves advancing the system's capability to deliver effective and quality services for its students, parents, teachers, and administrative staff, both for teaching and learning as well as for pedagogic and administrative management. There are four strategic areas that are ripe for digitalization in the country's education system: (a) *supporting learning recovery* including targeted remediation services; (b) *improving effectiveness* by strengthening the management, monitoring and evaluation of the system and digital pedagogic practices as well as enhancing information and communication technology (ICT)-related science, technology, engineering, and mathematics (STEM) training; (c) *improving equity and inclusion* by improving access to digital learning environments at home and at school for the vulnerable and disadvantaged; (d) *improving resilience* by strengthening the digital readiness of the education system to absorb and pivot quickly in the face of future shocks. Reform efforts should be prioritized based on urgency and importance to address the above goals while considering the related risks and returns carefully.

8. **While school closures amplified and widened the learning inequities in Moldova, it has also presented a unique opportunity to transform education fit for 21st century purposes.** To harness this opportunity, the country would need to develop and embrace systemic changes in education that make digitalization practices habitual (in other words, adopt a 'digitally inclusive' and a 'digital first' approach) so these become part of the daily lived experience of student life in schools. Recognizing that integration is key to drive synergies through digitalization and minimize fragmentation and related inefficiencies, several actions have been taken by the Government of Moldova (GoM), along with development partners. In the education sector, digitalization efforts have been ongoing with productive strides made in some areas. At the same time, the GoM views the ICT sector as a priority for the country, both as a productive sector and as an enabler for economic and social development. But many challenges remain.

9. **This Digital Readiness Assessment of the education system aims to provide the Republic of Moldova a systematic and holistic view of the current level of readiness for achieving its digitalization objectives in the education system, identifying key barriers, opportunities, and potential risks that need to be managed.** The findings and recommendations from this assessment are intended to support a deeper and informed policy dialogue with the GoM to realize the digital transformation of its education system, with a substantial focus on general education. The assessment findings will inform policies for (a) recovery of learning losses from COVID-19 and (b) increasing effectiveness, inclusion, and resilience of the system.

10. **The Digital Education Readiness Assessment roots the analysis in a cross-cutting digital readiness framework for human development.** This framework (Figure ES.1.) has been adapted for education and covers five pillars: (a) leadership and governance, (b) enabling infrastructure, (c) human capacity, (d) education service delivery and analytics, and (e) EdTech market and business models. A comprehensive, evidence-based, yet flexible approach was taken to better understand the current state of play. This assessment triangulates existing analysis, administrative and open access data with new data collected using a Digital Readiness in Education survey instrument and interviews to get a wholesome picture, comparing, wherever possible, the de jure policies against the de facto practices. Institutions and organizations that are mandated, interested, and/or considered relevant in playing a role in education digitalization activities were identified for this system-level assessment as part of a stakeholder mapping exercise.

11. **The current level of readiness in the education system for digital transformation is determined to be at an *emerging stage* (Table ES.1. and Figure ES.2.).** This is so despite the enabling environment at

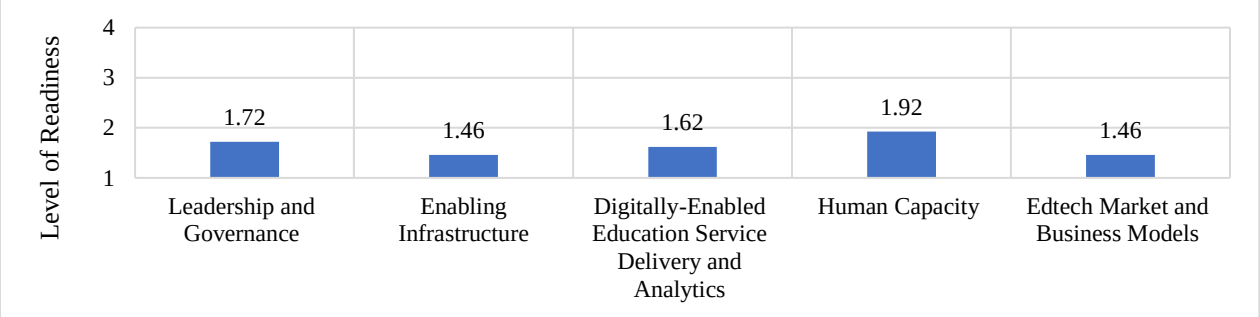
the level of the economy being at a 'differentiating' stage of digital readiness, that is, "the country has clear strengths in digital transformation and foundational elements in place." (UNDP 2021). Moldova has made massive strides in its digital transformation in the past decade by ensuring that it has many of the right ingredients in place for a strong digital backbone that can be leveraged to offer more and better services to its people, strengthen decision-making in public administration, and strengthen the capacity and skills base in the country to participate in an increasingly digital social and economic life.

Table ES.1: Moldova's overall Digital Education Readiness Assessment results

Level 1 - Latent	Level 2 - Emerging	Level 3 - Established	Level 4 - Advanced
Foundational investments that are required for technology solutions to be adopted are lacking and impede further progress.	Foundational investments have progressed, but many issues remain. Functional investments are growing opportunistically.	Foundational investments have taken root and stabilized. Functional investments are used to build evidence to scale systematically. There are marginal opportunities for frontier investments.	Foundational and functional investments are scaled up and continue to be managed and updated for decision making. Skills available to test new technologies within a framework of evidence.

Source: Elaborated by authors.

Figure ES.1: Distribution of average score for five domains of digital education assessment



Source: Elaborated by authors based on survey results.

12. **Based on the systemic assessment that shows an *emerging level* of digital readiness of the education system in Moldova, detailed recommendations for each of the five pillars (and their sub-areas) are prioritized to encourage dialogue and stimulate action to move to a more *established level* of readiness.** This involves advancing the system's foundational and functional digital capabilities.

13. **The assessment identified four strategic goals for the country's education system and related areas that will benefit from greater digital readiness**:

A) *Supporting learning recovery* including targeted remediation services, assessment and regular review, simplification and adjustments to the curriculum, as needed;

B) Improving effectiveness of management and teaching and learning

B1) *Improving effectiveness of administrative management* by strengthening the management, monitoring and evaluation of the system through data management and analytics;

B2) *Improving effectiveness of pedagogic management* by advancing digital pedagogy skills and data literacy competencies;

B3) *Improving effectiveness of teaching and learning* by advancing learning outcomes in all subject areas, with a special focus on ICT-related STEM subjects;

C) *Improving equity and inclusion* by improving access to digital learning environments at home and at school for the vulnerable and disadvantaged;

D) *Improving resilience* by strengthening the digital readiness of the education system to absorb and pivot quickly in face of future shocks.

14. The following recommendations aim to support a prioritized set of actions for achieving the above goals based on urgency and importance while considering the related risks and returns.

A) Supporting learning recovery including targeted remediation services using digitally enabled solutions. In the immediate term, the urgent and critical focus for education needs to be on supporting learning recovery, leveraging technology-enabled tools and services. This should include using rapid assessments across all grades, recognizing that a loss of foundational skills in any grade level has a compounding negative effect on future learning and hence earning potential. With ongoing multifold crises including increasing inflation and tightening fiscal space, technology can be used to reach the most vulnerable students at scale, effectively and at relatively lower marginal costs. Digitally enabled assessments and learning solutions can allow greater degree of personalization to teach at the right level to support students' learning recovery.

Prioritized actions

- **Conduct internet-based rapid assessments implemented at scale** to determine the current learning levels of students and target interventions accordingly.
- **Review and simplify the curricular content** as needed to ensure the core foundational skills are well supported based on assessment findings.
- **Provide supplementary, high-dosage small-group tutoring, especially for the most vulnerable students.** Tutoring also allows a greater degree of personalization to address academic learning gaps and support social emotional needs. It can be adapted to several languages, and is therefore, applicable to refugees, Roma, and other marginalized groups.

B1) Improving effectiveness of administrative management by strengthening the management, monitoring, and evaluation of the system through data management and analytics. This includes strengthening implementation and monitoring mechanisms through better governance of education data and by enhancing digital capacity. Governance of education data should be considered an area of highest priority and the specific gaps identified should be addressed.

Prioritized actions

- Diagnose the current management systems in education (including EMIS, open educational resources, Learning Management Systems, Human Resource management systems, Open Data portal, National Bureau of Statistics databases, among others) and develop a data management and data use strategy.
- Strengthen the data governance ecosystem in education, including through strengthening the institutional capacity for implementing a digitalization vision for education and developing the data and technology foundations to support better analytics and decision-making.
- Design and implement an education enterprise architecture that can support implementation and monitoring at district and local levels, in addition to the national level.

B2) Improving effectiveness of pedagogic management by advancing digital pedagogy skills and data literacy competencies. Ensure this by systematically developing and implementing an efficient human resource and performance management system to promote innovations, pedagogic excellence, and meritocracy.

Prioritized actions

- Strengthen institutional capacity for digital pedagogy skills in education by systematic training provision and qualification certification mechanisms, linked to incentive mechanisms.
- Set up automated assessment feedback reports and dashboards that can deliver school-/classroom-level reports on student work and a management dashboard for school directors on learning indicators and other school performance indicators.
- Encourage public-private partnerships (PPPs) and innovative education technology business models to strengthen pedagogic management.

B3) Improving effectiveness of teaching and learning process to advance learning outcomes in all subject areas, with a special focus on ICT-related STEM subjects. Ensure that pedagogical practices—both in person and remote—are observed in classroom to provide timely feedback and support to teachers to strengthen their professional practice.

Prioritized actions

- Strengthen the quality and access to digital learning experiences and incentivize the use of digital learning resources.
- Develop a system for yearly continuous professional development in digitalization of teacher practices, using professional trainers, classroom observation tools, and coaching.
- Design and implement a mechanism to identify and incentivize effective young teachers to teach remotely to students in rural areas in several subject areas, including in *Informatica*, and in the application traversal digital skills.

C) Improving equity and inclusion by improving access to digital learning environments at home and at school for the vulnerable and disadvantaged. Target support to vulnerable students through greater institutional coordination and improved access to technology infrastructure, especially at home (see Annex 6 for details) and improve capacity for data management and analytics.

Prioritized actions

- Develop or appropriately adapt a vulnerability index and mapping for identification of students and families including NEETs using the social benefits registry database—here data exchange and interoperability regulations and functions should be leveraged.
- Provision of devices, connectivity, and licensed software packages at home for students, especially those from low socioeconomic status (SES) groups, girls, and disadvantaged Roma and refugees and those living in remote rural and disconnected areas.
- Adopt a collaborative capability-based approach on data management and analytics for the MoER entities and departments such as Center for Information and Technologies in Education (CTICE), ANACEC, and the IT department, while leveraging the wider agencies, such as the e-Governance Agency (eGA), for their capacity and platform resources effectively.

D) Improving resilience by strengthening the digital readiness of the education system to absorb and pivot quickly in the face of future shocks. Most prioritized actions above would undoubtedly contribute to increasing resilience, but there are specific steps outside the purview of general education.

Prioritized actions

- Develop advanced digital skills programs in pedagogical universities to affect changes in education and in the economy over the medium to long term.

15. **Table ES.2. provides a simplified matrix of recommendations aligned with education system goals and indicatively identifies key actors.** It summarizes the priority recommendations and actions across the five assessment pillars and maps these against the relevant sections of the assessment, including clickable cross-referencing links in the report. These sections are further detailed out in the analysis in Chapter V along with specific actions to support that recommendation. An indicative list of key stakeholders and relevant actors are identified to catalyze and influence a dialogue that goes beyond the education system to the wider net of decision-makers, influencers, and broader stakeholders to affect change.

16. **The skills, knowledge, and mindsets acquired by Moldovan youth today need to be of value as they become ready to live and work in a digitally enhanced future. Thus, the role of digitalization in the coming decades must not be underestimated.** Moldova's ability to leverage technological advances to engage competitively in the global economy is only possible by advancing the human capital base in the country through equitable, high-quality, and technology enabled education. Recursively, advancing the human capital base fit for the digital age requires catalytic actions *now to* transform the education system's digital capability to meet the needs of a rapidly changing future. This is critical for Moldova's economic growth path in the context of its declining and aging population, high number of NEETs, impact of the pandemic and war, and economic contractions.

Table ES.2: Matrix of recommendations

Goals	Actions
A. Recover learning losses. Provide targeted remediation services using digitally enabled solutions.	**Action 1:** Conduct internet-based rapid assessments at scale. **Action 2:** Review, simplify, and adjust the curriculum based on assessment findings. **Action 3:** Provide supplementary, high dosage, small group tutoring, especially for the most vulnerable students.
B1. Effectiveness (efficiency, quality, relevance) of administrative management. Strengthen management, monitoring, and evaluation through data management and analytics.	**Action 1:** Diagnose the current management systems in education. **Action 2:** Strengthen data governance ecosystem and institutional capacity in education. **Action 3:** Design and implement education enterprise architecture to support implementation and monitoring at all levels.
B2. Effectiveness (efficiency, quality, relevance) of pedagogic management. Advance digital pedagogy skills and data literacy competencies. Improve parent-school interactions.	**Action 1:** Systematic training provision and qualification certification mechanisms, linked to incentive mechanisms. **Action 2:** Set up automated assessment feedback reports. **Action 3:** Encourage public-private partnerships and innovative education technology business models.
B3. Effectiveness (efficiency, quality, relevance) of teaching and learning. Focus on all subject areas, with a special focus on ICT-related STEM subjects especially for girls' education	**Action 1:** Strengthen quality and access to digital learning resources, especially for Girls. **Action 2:** Implement continuous professional development on digital pedagogical practices. **Action 3:** Incentivize effective young teachers to teach remotely.
C. Equity and inclusion. Target support to vulnerable students through greater institutional coordination, improved access to technology, and capacity for data management and analytics.	**Action 1:** Develop/adapt vulnerability index and identification mechanism. **Action 2:** Provide necessary technology infrastructure - devices, connectivity, licensed software packages at home. **Action 3:** Adopt a collaborative capability-based approach on data management and analytics.
D. Resilience. Strengthen the digital readiness of education to absorb and pivot quickly in face of future shocks.	**Action 1**: Develop advanced digital skills programs in pedagogical universities to affect changes in education and in the economy

I. Introduction

1. **The Republic of Moldova is facing an unprecedented period of socioeconomic turmoil with profound adverse impacts on human capital formation.** Just as the small, landlocked country was battling a bumpy recovery from the coronavirus (COVID-19) pandemic and the energy crisis, the ensuing refugee crisis from the war in Ukraine has further put its short-term economic recovery and long-term social and economic prospects at risk. Increasing inflationary pressures are affecting consumption, trade, and jobs. Moreover, the challenges of rapid demographic decline, and aging combined with increasing digitalization, misinformation, and cybersecurity threats, inhibit the country from competing effectively in the information economy—especially since many graduates may lack relevant digital skills.

2. **Yet Moldova intends to pivot these multiple crises into positive opportunities for short-term learning recovery and resilience, paving the way for an equitable and efficient growth path.** There is an ongoing effort to use the situation as a springboard to launch some of the most ambitious educational reforms in the country, including a serious consideration given to digital transformation of education service delivery, both for teaching and learning as well as for pedagogic and administrative management.

3. **Education plays an important role in human capital formation and economic growth in Moldova.** Substantial evidence indicates that more and better education leads to higher rates of return to the individual and society (Psacharopoulos and Patrinos 2018). In other words, creating a skilled workforce for the rapidly evolving workplace rests on the growing demand for advanced cognitive skills, socioemotional skills, and digital skills. However, a child born in Moldova today can expect to achieve only 58 percent of their human capital potential[1] than if they enjoyed complete education and full health. Low learning outcomes reveal an opportunity to improve the human capital base in the country.

4. **This Digital Readiness Assessment of the education system aims to provide the Republic of Moldova a systematic and holistic view of the current level of readiness for achieving its digitalization objectives in the education system, identifying key barriers, opportunities, and potential risks that need to be managed.** The findings and recommendations from this assessment are intended to support a deeper and informed policy dialogue with the government of the Republic of Moldova to realize the digital transformation of its education system, with a substantial focus on general education. The assessment findings will inform policies for (a) recovery of learning losses from COVID-19 and (b) increasing effectiveness,[2] inclusion, and resilience of the system.

5. **The Digital Education Readiness Assessment roots the analysis in a cross-cutting digital readiness framework for human development.** This framework has been adapted for education[3] and covers five pillars: (a) leadership and governance, (b) enabling infrastructure, (c) human capacity, (d) education service delivery and analytics, and (e) EdTech market and business models. A comprehensive, evidence-based, yet flexible approach was taken to better understand the current state of play. This assessment triangulates existing analysis, administrative and open access data with new data collected using a Digital Readiness in Education survey instrument and interviews to get a wholesome picture, comparing, wherever possible, the de jure policies against the de facto practices. Institutions and organizations that are mandated, interested, and/or considered relevant in playing a role in education digitalization activities were identified for this system-level assessment as part of a stakeholder mapping exercise.

[1] Human Capital Project estimates which adopts a comparable methodology and details of this analysis can be found at https://www.worldbank.org/en/publication/human-capital and https://openknowledge.worldbank.org/handle/10986/34432?cid=GGH_e_hcpexternal_en_ext

[2] Effectiveness as defined in this analysis includes quality, relevance, and efficiency of the general education system.

[3] This framework was initially developed after an in-depth review of and harmonization from digital capability maturity models and frameworks developed by think tanks and the foresight and intelligence units of international corporations, intergovernmental and international organizations, and private sector actors. These include widely used and cited models by Gartner, IBM, Deloitte as well as related outputs by USAID, Broadband Commission, ITU, Omidyar Network, WHO Digital Health Platform Handbook, WEF Digital Culture Guidebook, World Bank Digital Economy for Africa Diagnostic, World Bank Digital Government Readiness Assessment, and Global Digital Health Index Maturity model.

6. The assessment report is structured as follows: Chapter 2 provides an overview of the current education context. Chapter 3 envisages the next horizon for Moldova, discussing the potential role of digitalization for supporting learning recovery and resilience in a digital era. Chapter 4 provides an overview of the assessment approach, framework and methodology used, building on existing international and World Bank research, collection of survey data as well as leveraging existing administrative and assessment data. It describes the stakeholder mapping exercise and analysis. Chapter 5 provides the detailed findings and recommendations for each of the five assessment pillars. Curated international case studies from UK, Netherlands, Estonia, and others are referenced to provide relevant examples of best practices. Chapter 6 provides a summary of the assessment including key insights and overall recommendations. It also provides a draft action plan and discusses the related opportunities and risks. Chapter 7 offers a conclusion statement.

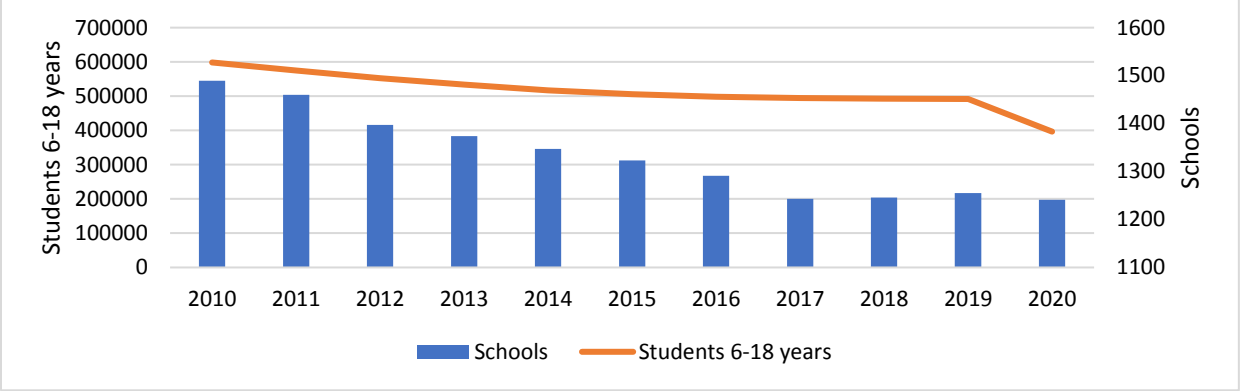
II. Education context

Education progress and challenges

7. **Enrollment at all levels of education have been declining[4] in line with the shrinking school-age population.** Over the last decades, Moldova's school-age population (ages 6 to 18) has been steadily declining. Since 2010, the school-age population fell by over a third. In 2020, there were less than half a million students enrolled in the education system, with approximately 58 percent of students enrolled in primary and general secondary education. According to data from Moldova's National Bureau of Statistics (NBS), the net enrollment rate in higher education institutions (HEIs) decreased by 22.8 percent between 2011 and 2022.

8. **The adjustment of the network of primary and general secondary education institutions to the decreasing flow of students has not been able to keep pace with the rate of decline in enrollment.** The network of schools in primary and general secondary education consisted of 1,241 institutions in 2020/21, including 1,239 full-time institutions and two part-time high school institutions (Figure 1). During 2010–2017, school closures have been advancing constantly, after which the network adjustments have largely stagnated. Although students' numbers have been mostly stable since 2014, this fell dramatically by 20 percent in 2020. Yet, the national average student to teacher ratio has been maintained at a steady state of 12:1 since 2015 (NBS 2020) and is lower than the European Union (EU) average of approximately 14:1 (Eurostat 2021). Similarly, the dramatic decline in university enrollment has led to oversized and ineffective institutional infrastructure, poor teaching and research capacities, and inefficient allocation of funding.

Figure 1: School network and student population (6–18 years old)



Source: NBS, Republic of Moldova 2021.

9. **Despite progress made over the past decade, Moldova's quality of general education lags international peers.** Since 2009, Moldova has improved in all three subjects measured in the Program for International Student Assessment (PISA). Yet, compared to the average in countries of the Organization for Economic Cooperation and Development (OECD), the Moldovan student score for reading is over 20 points less—for example, 487 versus 463 in PISA 2018 reading score (World Bank 2019b). Further, socioeconomically advantaged students outperformed disadvantaged students in reading, mathematics, science, and socioemotional learning (World Bank 2019a). In 2020, a child in Moldova starting school[5] at

[4] The total number of students is decreasing due to the decreasing flow of students through the education system owing largely to stagnant fertility rates and negative population growth rates (−1.7 percent in 2020) as well as increasing outmigration.

[5] While it is acknowledged that in the Republic of Moldova, according to the Education Code law, a child enters the preschool group at the age of 6 years, and primary schooling becomes compulsory after the child turns 7 years old, this measurement is based on PISA 2018 and the Human Capital Index (HCI) calculations, normalizing the starting age to 4 years for global measurements. For the HCI and Learning Adjusted Years of

age 4 could expect to complete 11.8 years of school by the age of 18 years, but after factoring in what the child will learn, the expected learning-adjusted years of school is only 8.3 years. This is an estimated loss of 3.5 years of learning,[6] a wasted opportunity for students (World Bank 2020a).

10. **Skills gaps and mismatches represent a major obstacle for employers and graduates from vocational education and training (VET) and HEIs.** Some crucial reasons for skill gaps are related to the slow development of the National Qualifications Framework and outdated teaching materials, irrelevant for the labor market. The skills gained are also not relevant and adequate for the needs of employers. For example, information and communication technology (ICT) is one of the most promising economic sectors in Moldova, but there is a shortage of advanced digital and data skills among graduates due to an overall decline in students and in those entering ICT.

11. **A significant number of young Moldovans (ages 15–34)[7] are not in education, formal employment, or training (NEET).** In 2015, this proportion reached 35.7 percent, which was more than double the EU average of 16.6 percent. The situation has improved in recent years and, currently, the proportion of NEET Moldovans[8] (ages 15–34) has decreased to 30.8 percent (NBS 2020). However, it is still too high relative to the EU average of 15 percent in 2020 (Eurostat 2020). Technology-enabled early warning and targeting mechanisms for identifying and supporting NEETs in Moldova to re-engage with education and work would be crucial. This is particularly important given that the working-age population able to contribute to economic productivity and competitiveness is shrinking due to Moldova's rapidly aging population, increasing out-migration, and labor market mismatches.

12. **Due to inadequate monitoring mechanisms at the national and regional level, there is little information available on the extent to which various national education agencies, local public administration authorities, and school directors perform their mandated tasks.** Systematic monitoring information is scant. Various mechanisms and tools are applied to generate educational data, such as the Education Monitoring and Information System (EMIS), regular 4th and 9th grade national student assessments, national baccalaureate exam at the graduation of high school (grades IX–XII), and Moldova's participation in PISA (World Bank 2018). However, these exercises do not provide information that is required and relevant for decision-making at various levels of education service delivery—from policy making to implementation. For example, while these sources provide data on aspects, such as student performance and school inputs, they do not generate information on regulatory compliance. Furthermore, these channels are often one-way with no feedback loops to the schools and teachers to take actions that support learning. After the pandemic, the range of digital access points and tools have expanded, but these have largely been fragmented efforts in response to an emergency.

13. **Public expenditures in education have been declining due to a contracting education sector over the last decade but have been further reduced due to fiscal constraints in a pandemic environment.** In 2022, the planned share of public spending on education is 5.8 percent of the gross domestic product (GDP), a decrease from 5.9 percent in 2021 and 7.0 percent in 2014 but compares favorably with the average in the Europe and Central Asia (ECA) region of 4.6 percent of GDP. Education spending as a share of total public expenditures is 15.4 percent, a decrease from 17.6 percent in 2014 (Figure 2). This decade-long trend is largely attributable to falling enrollments, a smaller infrastructure network, and a smaller

Schooling (LAYS) to be comparable, a harmonization methodology is used. Refer https://www.worldbank.org/en/publication/human-capital/brief/the-human-capital-project-frequently-asked-questions#HCI11 and https://blogs.worldbank.org/education/how-improve-human-capital-need-cost-effective-education-investments. The main insight from this methodology is that schooling is not equal to learning and there is tremendous room for improvement in learning outcomes for Moldovan students already attending school, to the extent of 3.5 years on average, based on harmonization of international assessment data.

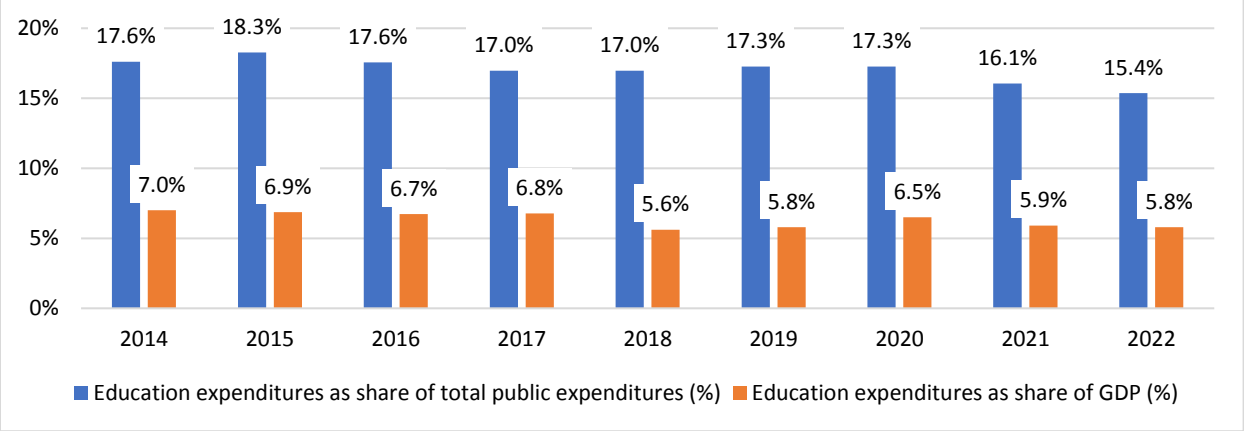
[6] This is based on a comparable summary measure Learning Adjusted Years of Schooling.

[7] The NEET phenomenon is most prevalent in the 20–34 age group as the vast majority of the 15–19-year age group both in the EU and in Moldova tend to remain within education and training but maybe taking a gap year or are in transition.

[8] NEETs are particularly at risk of not only labor market exclusion, but also social exclusion. The longer they remain NEET, the less employable they become.

teaching cohort, indicating that both capital and operating expenditures are declining. After the pandemic,[9] budget allocations for 2021–2022 were directly affected by fiscal constraints.

Figure 2: Education expenditures as share of GDP and total public expenditures



Source: Ministry of Finance (MoF).

Pandemic and learning losses

14. **From March 2020 to June 2021, the Ministry of Education and Research (MoER) developed a COVID-19 response action plan and a set of new regulatory provisions to adapt the education system at all levels to the epidemiological situation.** Approximately 586,000 students at all levels were asked to stay at home as of March 11, 2020, when Moldovan authorities closed institutions in response to the COVID-19 outbreak. Schools were mandated to provide distance learning opportunities using all available means, including computers, tablets, phones, and TV. The MoER adopted the Action Plan describing activities, responsible units, and funds to manage continuity during the emergency. Some regulatory provisions were adopted including (a) organization of the education process in different ways: distance learning, blended education; (b) rules and recommendations on providing blended education; (c) information on information technology (IT) tools, platforms, open sources for education purpose; (d) security and safety measures for online learning; (e) organization of the academic year: exams, promotions, grading (MoER 2020a). At the same time, for disadvantaged populations, including students from needy families who did not have internet connections at home, public libraries in villages were equipped with computers and internet through the NOVATECA project.

15. **The MoER actively leveraged partnerships to ensure continuity of the educational processes.** Toward this goal, the MoER took on several initiatives such as (a) signing a memorandum with the telecom companies to provide specific categories of teachers and students with 80 GB free internet traffic per individual; (b) launching a national campaign 'Donate a laptop to a student'; (c) redirecting funds and procuring from public resources 3,180 laptops ; (d) with the support of development partners, equipping teachers and students from disadvantaged groups, including (i) 10,000 laptops for teachers and students under the Moldova Education Reform Project funded by the Bank; (ii) 295 web cameras to selected schools that were provided by the United Nations Children's Fund (UNICEF); (iii) smart boards, laptops, projectors, and equipment for-rent by the United Nations Development Programme (UNDP) in future potential lockdown periods to the Gagauzia region. Online platforms with recorded or online lessons for students, such as www.studii.md, www.educatieonline.md were also developed. The admissions processes in VET and HEIs were switched to blended mode to offer students the option to apply online. National exams at all levels were also organized in 2021. Overall, in academic years 2020–2021 and 2021–2022, education was

[9] In 2020, the economy contracted by 7 percent but bounced back by 13.9 percent in 2021. Notably, in 2021, health and social protection were the main drivers of the spending increase (+11.9 percent, year-on-year) https://www.worldbank.org/en/country/moldova/overview#3

largely delivered in person, but a local, partial, or total switch to remote learning was applied whenever the epidemiological situation required.

16. **Despite these efforts, many teachers, parents, and students were severely affected.** Depending on the number of students and the infection rates, local authorities were able to choose from seven different education models proposed by the MoER. The models included face-to-face education, remote, blended, in shifts, and so on. Yet, remote learning during the pandemic proved to be a challenge for about 16,000 students who still did not have access to ICT (laptops, tablets, or access to internet) and represent 18 percent of those who needed support. The most affected school-aged children were the ones living in rural areas, from families with lower levels of education attainment and households with low income.

17. **The pandemic revealed the fragility of Moldova's education system in terms of equity, efficiency, quality, and relevance.** Before the pandemic, the education system was already facing these challenges. Assuming that a student gains 40 PISA points of learning in a year, and that schools were closed for around four months on average, if emergency remote learning was half as effective as face-to-face learning, it is estimated[10] that learning in Moldova will have dropped by the equivalent of 8 PISA points, that is, from 424 to 416, which represents 20 percent of the expected learning gain, eroding some of the improvements made over the past six years (Figure 3). Since the pandemic, the gap in learning-adjusted years of schooling between the richest and poorest households is estimated to have increased from 2.875 years to 3.075 years, deepening and widening further existing inequalities because of differential access to effective emergency remote teaching (Figure 4).

Figure 3: Estimated impact on PISA scores

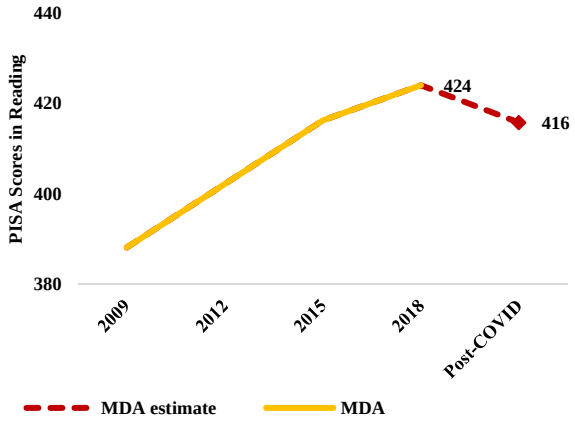
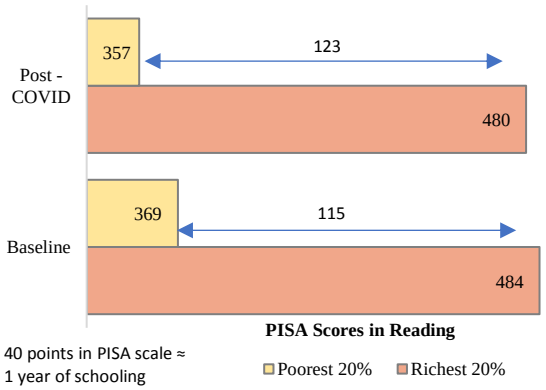


Figure 4: Estimated impact of COVID-19 on socioeconomic achievement gap due to COVID-19



Source: Azevedo et al. 2022.

18. **Learning losses likely to have been experienced and will lead to losses in earnings for individuals and households and limit economic growth over the medium and long term (Donnelly and Patrinos 2021).** These would likely stem from new learning not taking place when schools were closed for extended periods of time and past learning forgotten or lost due to school disengagement and dropouts. This would lead to greater exacerbation of inequalities in education and could cost Moldova 0.8 percent of its GDP annually (Psacharopoulos et al. 2020). Earnings losses are also being caused by reduced household incomes for families due to job losses (often faced disproportionately by women who tend to be primary caregivers), a less-skilled labor force, and lower economic growth. Failing to recall and apply past learning and acquire

[10] Please see the report by Azevedo et al. 2020 for global simulation of estimated impacts at https://openknowledge.worldbank.org/handle/10986/33945.

new academic skills and knowledge is likely to reduce aggregate lifetime earnings in Moldova by USD 2.1 billion in present value terms.

19. **For Moldova, learning recovery and strengthening effectiveness, inclusion and resilience of the education system is paramount.** Estimates show that about 20 percent of the student population, largely from disadvantaged groups, was disengaged partially from the educational process during the pandemic. The most vulnerable students may experience the largest losses and drop out altogether, as pre-existing risks are compounded leaving them further behind. While schools were opened from September 2020 with short intermittent closures of two weeks or less applied on some classes or groups as needed, the public health emergency restrictions were lifted in April 2022, enabling a stable and full-scale reopening of all schools. It is now critical to conduct rapid learning assessments to determine the learning gaps and provide targeted and compensatory learning recovery programs to minimize them, especially for the disadvantaged. Simultaneously, measures are needed to strengthen the effectiveness, inclusion, and resilience of the education system, to improve learning, reduce future earning losses and better respond to future crisis.

War in the region and refugee situation

20. **Unfortunately, a new shock affected Moldova just as it was recovering from the pandemic as well as an energy crisis that started in the fall of 2021.** The war in Ukraine has affected over 5 million people since February 24, 2022 (World Bank 2022d). As of April 29, 2022, more than 403,885 refugees crossed the Moldovan border and more than 90,000 remained in the country. Of these, over 48,000 are children. Thus, every eighth child in Moldova is now a refugee from Ukraine. To address this new challenge, the Government of Moldova (GoM) launched a new online information source (dopomoga.gov.md), which consolidates all relevant information to support refugees. On March 15, 2022, the MoER issued orders and guidance allowing all Ukrainian students to access all education levels in Moldova. From the data presented by Local Specialty Bodies in the Education Sector of the Republic of Moldova (OLSDI), between February 24, 2022 and May 31, 2022, there were 1,433 refugee children from Ukraine enrolled in studies in general education institutions and 879 children in preschool education institutions of Moldova.

21. **The influx of refugee children, primarily to Chisinau, can create additional capacity challenges for local institutions to deliver basic services, which are already stretched due to the pandemic.** According to NBS data for 2021–2022, there are 98,635 students in primary, gymnasium, and high school education institutions in the Municipality of Chisinau, of which 40,170 are in grades 1–4, 43,386 in grades 5–9, and 10,260 students in grades 10–12. Since this municipality has the most concentration of refugee children in the country. Therefore, addressing learning recovery programs, while also delivering main educational services to all local and refugee children may not be possible without additional support, including increased digital capacity for teaching and learning and socioemotional support for these students.

22. **Diverse solutions will be required to meet the distinct educational needs of all children.** It would be important to consider carefully among a variety[11] of service delivery modalities that can reach, re-engage, and deliver learning effectively and efficiently for refugee children. It is in this complex context that we discuss the relevance and role of digital transformation of education for Moldova in the following chapter.

[11] Traditional face-to-face instruction, use of digital devices and online learning platforms, use of SMS, phone and internet, as well as blended learning opportunities, temporary learning centers, catch-up classes and tutoring, learning circles, among others.

III. Moldova's next horizon: Role of digitalization in education for supporting learning recovery and strengthening effectiveness, inclusion, and resilience

23. **Moldova's digital transformation rests on its ability to develop and continuously strengthen its human capital base, especially for the most marginalized, to be competitive in the global economy.** Globally, digital transformation is now characterized by almost universal connectivity, but also by ubiquitous computing, generation and use of vast amounts of data, and widespread digital skills, and data literacy. Although Moldova provides one of the best—and cheapest—internet connections[12] in the world, quality of access is inequitable.[13] On the supply side, goods and services are being distributed digitally and communication and information availability is easy. On the demand side, there is growing need for *personalized, transparent, and secure* access to goods and services.[14] However, in the context of a shrinking school-age population, education service delivery to the poorest remains weak, leading to exacerbation of inequities[15], limiting the ability to effectively compete in the global economy.

24. **The role of digital technologies to transform education to be fit for the 21st century is critical to hasten learning recovery and drastically increase the effectiveness, inclusion, and resilience of the system for *all* students.** Digital technology is not a panacea and not all education problems can be resolved using technology-based solutions, however, strategic use of technology can have a transformative effect on learning due to its potential to rapidly scale for impact on several identifiable and seemingly intractable challenges. For example, governments—at the local, regional, and national levels—have an opportunity to use digital technologies to improve school network efficiency using geospatial mapping and optimization; improve learning through personalized, differentiated instruction based on learning needs, such as through adaptive learning; enable innovative policy design, monitoring and rigorous evaluation using learning analytics; develop digital skills and online credentialing programs for the workplace; and expand citizen and stakeholder engagement through participatory design tools.

25. **To address these pressing needs, education must digitally transform itself while also building a well-endowed and competitive labor force.** Hence, the digital transformation of education in Moldova involves advancing the system's capability to deliver effective and quality services for its students, parents, teachers, and administrative staff**,** both for teaching and learning as well as for pedagogic and administrative management. There are several areas that are ripe for digitalization in the country's education system: *supporting learning recovery*, including targeted remediation services; *improving effectiveness* by strengthening the management, monitoring, and evaluation of the system and digital pedagogic practices as well as enhancing ICT-related training in science, technology, engineering, and mathematics (STEM); *improving inclusion* by increasing access to digital learning environments at home and at school for the vulnerable and disadvantaged; and *improving resilience* by strengthening the digital readiness of the education system to absorb and pivot quickly in the face of future shocks. Efforts should be prioritized based on urgency and importance while considering the related risks and returns carefully.

26. **The pandemic demonstrated how digital technologies can help education systems remain interconnected and interdependent despite school closures, although paradoxically, a sudden switch to remote learning proved to be a challenge.** Remote learning strategies adopted during the pandemic were an emergency response to urgently mitigate the impact of school closures. Despite the challenges, the

[12] Moldova has 100 percent population coverage of mobile cellular network and close to 100 percent population coverage of 3G and 4G mobile networks. Fixed broadband household subscriptions is 25 per 100 inhabitants, estimating a 75 percent coverage at home (ANRCETI 2019).
[13] About 51 percent rural households in Moldova had access to the internet compared to urban households which only had 75 percent access (ITU 2019)
[14] In the OECD in 2016, 83 percent of adults accessed the internet and 95 percent of firms in OECD countries had a high-speed internet connection. Relatively, only 71 percent of adults in Moldova accessed the internet in the same year.
[15] According to the data presented in 2021 by the OLSDI, 16,575 students from primary, gymnasium, and high school education institutions (about 5 percent of the total number of students in the country) do not have internet.

use of technology did enable students, parents, teachers, and governments to cope with social distancing, reduce service interruptions, and support learning continuity. The ability to make this switch quickly and efficiently with minimum disruptions during a potential future crisis would be an indicator of resilience for Moldova's education system. To do so, the country would need to develop and embrace systemic changes in education that make digitalization practices habitual (in other words, adopt a 'digitally inclusive' and a 'digital first' approach) so these become part of the daily lived experience of student life in schools.

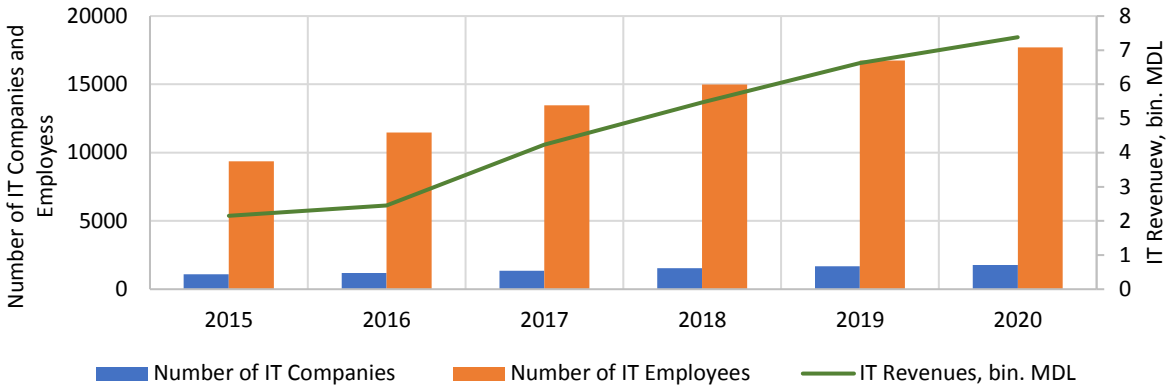
27. **While school closures amplified and widened the learning inequities in Moldova, it has also presented an incredibly unique opportunity to transform education to be fit for 21st century purposes.** Prior to the crisis, serious limitations entrenched in education structures of the industrial era were well-recognized and often criticized, but the cost of inaction was perceived as low, and designing and implementing innovations at scale too difficult. The crisis has provided a new impetus and call to action to reimagine and transform traditional models of education delivery to be fit for 21st century purposes. The pandemic has accelerated the need for many long-overdue shifts in education by fueling innovations that ease their implementation, while greatly multiplying the cost of inaction. Before the pandemic, the horizon for any system-level transformation was into the future. However, with COVID-19, the future is *now*. Reimagined education service delivery can leapfrog current siloed and fragmented, provider-focused, one-size-fits-all systems into more integrated, personalized, high-quality, learner and learning-centered systems.

28. **The government's digitalization efforts in education have been ongoing with productive strides made in some areas, such as education data management, IT equipment, digital content development, and connectivity.** Within the last decade, the MoER has made continuous efforts to develop and upgrade the EMIS, starting with general education, and recently expanding to VET institutions, HEIs, and preschools. Specifically, the module for Early Childhood Education Institutions was created and an electronic catalog was developed in EMIS. IT and STEM lab equipment have been provided to schools. Efforts have been made to digitalize learning content with video libraries to ensure free and unrestricted access for all students. Finally, the MoER has also sought to provide more schools with high-speed broadband internet.

29. **At the same time, the GoM sees the ICT sector as a priority for the country, both as a productive sector and as an enabler for economic and social development.** The ICT sector has grown considerably since 2015 and contributed 7.1 percent annually to Moldova's GDP—MDL 7.4 billion in 2020 (Figure 5). The number of employees in the sector has also nearly doubled during this time. Since 2010, the GoM has engaged in digital transformation to streamline governance[16] through intensive use of IT. Recently, the GoM has decided to develop a National Strategy on Digital Transformation for the next decade (MoER 2021). This will contribute to fostering transformational changes related to organization and innovation in the public and private sectors. The pandemic and its consequences have prompted the government to focus even more on the implementation of a digital economy, an eCommerce roadmap, and digital education and promotion of digital services to businesses and educational institutions.

[16] Over the last decade, the Republic of Moldova has developed several national strategies, programs, and policies for the development of the information society at the national level. The main document—the National Strategy for the Development of the Information Society 'Digital Moldova 2020' contained a range of policies aimed at increasing the population's access to ICT, including increasing access to high-speed internet, the transition to digital terrestrial television, digitization of public services, strengthening the capacity of the population to use ICT, and so on.

Figure 5: Number of IT companies and IT sector employees, and IT Revenue in Moldova



Source: Ministry of Economy, Republic of Moldova.

30. **Recognizing that integration is key to drive synergies through digitalization and minimize fragmentation and related inefficiencies, several actions have been taken by the government appointed in August 2021, along with development partners.** To elevate the digitalization goals, the government appointed a Deputy Prime Minister for Digitalization who set the following priorities to be implemented via the e-Governance Agency (eGA): (a) client-oriented service delivery, (b) digitally enabled entrepreneurship, (c) further digitization of public administration, (d) implementation of e-Democracy; (e) development of information society. At the same time, the MoER shared its nuanced vision for the use of technology for education services and helped identify educational problems facing general education in Moldova, particularly (a) curriculum modernization and ensuring high-quality digital learning content; (b) improved education management including better data exchange and interoperability; (c) upskilling of educators for technology-supported learning; (d) flexible and remote learning, including to support lifelong learning; (e) improving last mile connectivity. Based on this well-defined scope, the following chapters will clarify the assessment method, present a detailed analysis as well as a summary of results, recommendations, and actions.

IV. Methodology

31. **The first step to enable the digital transformation of any education system is to assess its current level of digital readiness to address sectoral challenges.** This would help determine the barriers, opportunities, and risks for adoption and scale-up of digitally enabled solutions for teaching and learning, as well as for pedagogic and administrative management. A recent report by the Broadband Commission on the potential for hybrid learning highlights the importance of assessing the digital maturity level to help governments and organizations determine the state and the capabilities of education systems in effectively managing and guiding digital transformation efforts (Broadband Commission et al. 2020). Digital maturity of an economy (and by extension, the digital maturity of its various sectors) is highly correlated with per capita income: the more mature and diversified an economy is, the likelier it is to have suitable infrastructure, institutions, regulations, and human capital.

32. **This Digital Readiness Assessment aims to better understand the key binding constraints to build greater resilience in Moldova's education system in times of crisis, and have quality, efficiency, and equity in times of peace.** Therefore, it is essential to identify the level of digital capability maturity and readiness in the education sector to systematically adopt, implement, evaluate, scale up, and maintain large-scale implementations of standards-based, interoperable, technology-enabled solutions to education problems. Furthermore, policy making would require a consideration of relevant international best practices and experiences to ensure that education policies put in place today consider and integrate a digitalization lens to remain resilient to a range of potential shocks, including climate change, conflict, and fragility. The purpose of this assessment is to determine gaps and provide recommendations for digitalization progress in the education system.

Assessment Approach

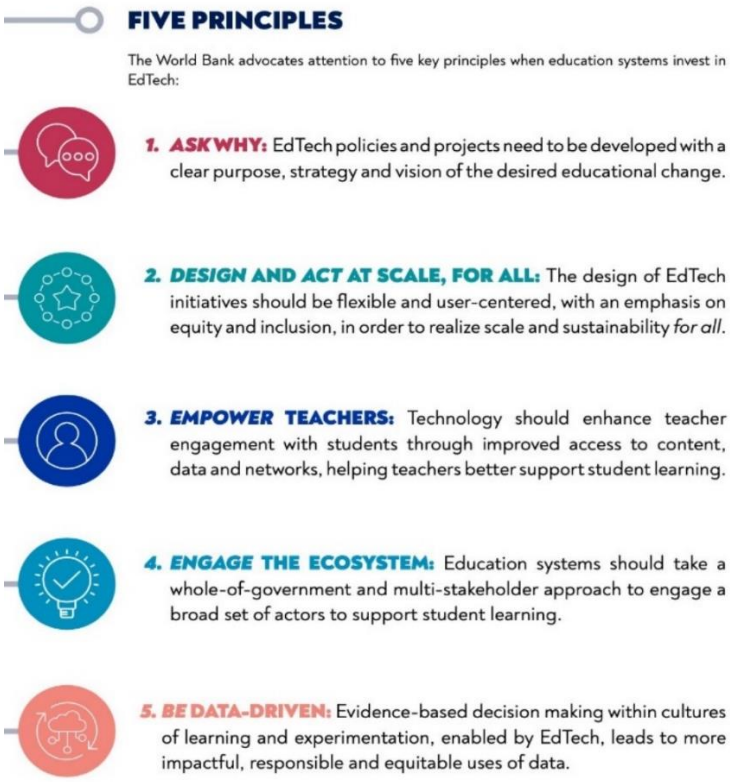
33. **The assessment follows a comprehensive, evidence-based, yet flexible approach to better understand the current state of play and the key barriers to uptake and scale-up of technology-based solutions in the education system.** Existing instruments, indicators, and available data along with a survey instrument and interviews were leveraged to get a wholesome picture. The assessment considers the nine principles of digital development adopted by international development organizations, to which the World Bank is a signatory, and the five World Bank principles for investing in EdTech, which incorporate lessons learned through the use of ICT for development (Figure 6a and 6b). Additionally, it incorporates and builds on existing analysis, guidelines, and resources[17] to support a deeper and informed policy dialogue and offer specific recommendations and actions.

[17] The technical assessment instrument draft consists of items adapted and/or incorporated from the Education Technology Readiness Assessment (World Bank 2021a) and from the EdTech Effectiveness Assessment available here and attributable to LearnPlatform, USA.

Figure 6a: Principles for digital development

Source: digitalprinciples.org.
Note: https://digitalprinciples.org/wp-content/uploads/2015/05/Principles-Overview.pdf

Figure 6b: World Bank EdTech Approach Paper[18]



Source: World Bank 2020b.
Note: https://digitalprinciples.org/wp-content/uploads/2015/05/Principles-Overview.pdf

18

Assessment Framework

34. **The Digital Readiness Assessment for Education roots the analysis in a cross-cutting digital readiness framework for human development.** This framework[19] has been adapted for education and covers five pillars: (a) leadership and governance, (b) enabling infrastructure, (c) human capacity, (d) education service delivery and analytics, and (e) EdTech market and business models (Figure 7). For each pillar, readiness is defined at four levels—latent, emerging, established, and advanced. Each of these levels corresponds to a score between 1 and 4, with 1 representing latent and 4 representing advanced. The readiness level in each of the five pillars is then aggregated to indicate the mix of investments needed, as defined by the three horizons of digital investments for human development programs[20]—foundational, functional, and frontier investments (World Bank 2022a) (see Box 1 for definitions). The definitions for the four readiness levels for each pillar as well as the overall assessment rubric for investments are elaborated in Annex 2: Detailed Approach, Methodology, and Framework: Assessment rubric.

Box 1: Three horizons of digital investments for human development programs

Foundational investments start with the data and data platforms, such as investments in technology infrastructure, data collection and management, cybersecurity, identification systems, and data governance for individuals, families, and households. The most urgent and important task is to distinguish among the data that pertain to human capital service delivery, such as by conducting an inventory and analysis across the human development space.

Functional investments would need to be made in scaling processes and technology platforms that have proven to work and synergistically help meet human capital needs, while supporting proof of concept technologies. These platforms represent a wide range of investment decisions in integrated information systems, such as integrated social information systems, social registries, payment systems, education management information systems, and health management information systems.

Frontier investments test new technologies within a framework of evidence as part of a systemwide transformation. Frontier investments include new and creative policies, processes, and technologies that together enable leapfrogging over current ways of working, with an eye toward solving intractable challenges or 'wicked problems' that have hitherto eluded obvious solutions. These are the most ambitious investment decisions. There should be a technology and service delivery transformation blueprint that is tied into government-wide digitization strategies and plans, and significant investments in highly skilled human resources.

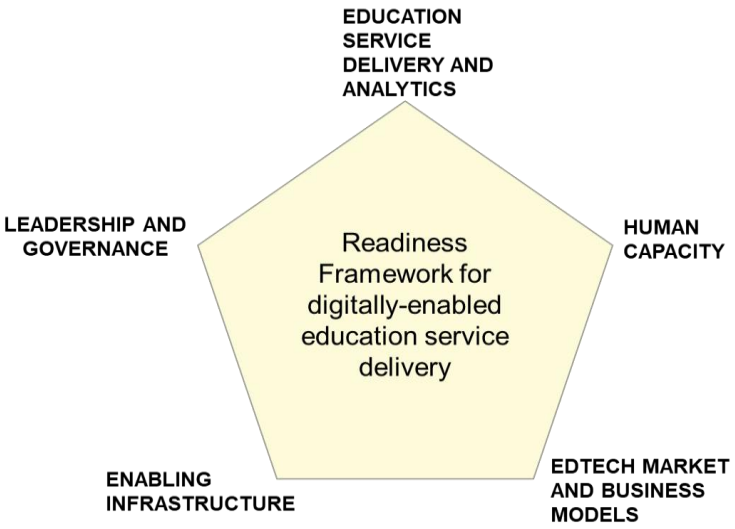
Source: World Bank 2021 Annual Meeting Human Capital Project Conclave paper (forthcoming)

35. **Such a digital readiness framework enables a critical and systematic analysis of the barriers to digitally enabled education, including opportunities and risks.** Analysis of barriers can be done from the perspectives of different stakeholders, including students, parents, school leaders, and teachers who stand on the front line of digital transformation, and national and sub-national governments as administrators, middle-managers and program implementers, and other key players in the system, such as EdTech and telecom partners, sector experts, technologists, teacher colleges, innovation hubs, and civil society. Each pillar includes sub-areas that can be analyzed based on government needs and priorities (see Table 1).

[19] This framework is developed after an in-depth review of and harmonization from digital maturity models and frameworks developed by think tanks and the foresight and intelligence units of international corporations, intergovernmental and international organizations, and private sector actors. These include widely used and cited models by Gartner, IBM, Deloitte as well as related outputs by USAID, Broadband Commission, ITU, Omidyar Network, WHO Digital Health Platform Handbook, WEF Digital Culture Guidebook, World Bank Digital Economy for Africa Diagnostic, World Bank Digital Government Readiness Assessment, Global Digital Health Index Maturity model, to name a few.

[20] World Bank 2021 Annual Meeting Human Capital Project Conclave paper, forthcoming.

Figure 7: Digital Readiness Framework for Education



Source: Elaborated by authors.

Pillar 1 - Leadership and Governance. This pillar focuses on the development of a clear vision and strategy for digitally enabled education systems. It is articulated at the highest level of government and is backed by durable legislation; adequate, equitable, and sustainable financing and procurement mechanisms to incentivize adoption and scale-up of technology-enabled solutions for education service delivery. This includes identifying champions at different levels of government, strengthening institutional capacity, and setting performance standards for key business processes to clearly establish accountability.

Pillar 2 - Enabling Infrastructure. This pillar recognizes the fundamental building blocks of electricity, telecommunications infrastructure, and broadband internet provision as the ICT backbone. Simultaneously, a digitally enabled education system requires an enterprise architecture, that is, a coherent, integrated 'blueprint' that aligns business, data, technology, and applications to deliver outcomes. It also recognizes that data governance and technology management infrastructure and oversight, as well as standards and interoperability across applications, devices, and equipment are critical prerequisites.

Pillar 3 - Digitally Enabled Education Service Delivery and Analytics. When digitalization is embedded in education service delivery, it can enable personalization and a dynamic response to improve teaching and learning for all students and teachers as well as augment analytics, school management, and decision-making. The focus here is on the teacher, learner, administrator, curriculum, pedagogy, teaching learning materials, assessments, analytics, and school management.

Pillar 4 - Human Capacity. This pillar covers the knowledge, skills, and capacity of a variety of stakeholders to collectively bring the vision of digitally enabled education to life via an environment that fosters a focus on the service users, incentivizes collaboration and inclusion, and uses evidence to manage change. Foundational literacy, data literacy, digital skills, and socioemotional skills are needed for successful technology uptake, adoption, and use. Fostering an environment that focuses on the user, develops a calculated risk appetite for innovation, incentivizes collaboration, attempts to increase trust in governance and data, and takes an evidence-based approach for managing change and disruption.

Pillar 5 - EdTech Market and Business Models. This pillar focuses on the appropriate selection and procurement of relevant EdTech products and services in the market and objective ways of matching these to identified needs. It also briefly covers the support for innovation and equitable distribution of education

technology products and services including access to capital and viable business models for the private sector (for profit and non- profit) to produce consistent revenues, particularly in the early stages. These business models could be sustained in a variety of ways—through direct consumer purchasing power, government procurement, grant programs, private investment, or some combination thereof.

Table 1: Sub-areas covered under each assessment pillar	
Pillar 1 - Leadership and Governance	• Vision and strategy • Institutional capacity • Legislation, policy, and compliance • Funding and procurement
Pillar 2 - Enabling Infrastructure	• Education enterprise architecture • Data governance • Connectivity • Technology infrastructure • Standards and interoperability across applications, devices, equipment
Pillar 3 - Digitally Enabled Education Service Delivery and Analytics	• Learners • Teachers • Education administrators • Digital learning resources (DLRs) • Curriculum and pedagogy • School management and analytics
Pillar 4 - Human Capacity	• Digital skills • Data literacy • Culture
Pillar 5 - EdTech Market and Business Models	• Management of EdTech products and services • Managing implementation and communication across the system • Support for innovative business models • Public-private partnerships (PPPs)

Source: Elaborated by authors.

36. **The five steps outlined below describe the methodology undertaken to conduct the assessment in Moldova.** First, an in-depth literature review and compilation of indicators helped develop a landscape profile. Second, a detailed stakeholder mapping exercise was conducted considering the influence and interest of the wider ecosystem, based on the Digital Development Principle of 'understanding the ecosystem' and the World Bank EdTech principle of 'engaging the ecosystem' (Figure 6a and 6b). This recognizes that digital initiatives maybe impacted by stakeholders who operate outside the education system. This enabled the purposeful selection of participants identified as senior technical experts by the GoM and its entities, in its education digitalization efforts. This was followed by an online survey and interviews with such purposefully selected and non-representative sample of senior technical experts, identified by the GoM from the relevant agencies, ministries, civil society organizations (CSOs), and donor entities, including but not limited to the MoER. As part of this exercise, related instruments and tools were developed. The survey results also helped analyze the perceptions, information, and data provided by the technical experts and aggregated these to generate overall scores. This provided a general view of perceived levels of readiness Finally, this top-down survey and interviews were complemented with administrative data analysis and PISA 2018 data analysis focusing on the digital aspects of education to provide a bottom-up view. This comprehensive approach helped (a) identify the relevant reports, analysis, and key indicators on digitalization of the economy and of education; (b) identify the key decision-makers and influencers in the system; (c) triangulate and validate the survey and interview findings against the data analysis to determine the likely level of readiness; (d) compare de jure policies against de facto practices, where possible; (e) determine gaps in awareness, track progress, and develop a holistic picture of the current state

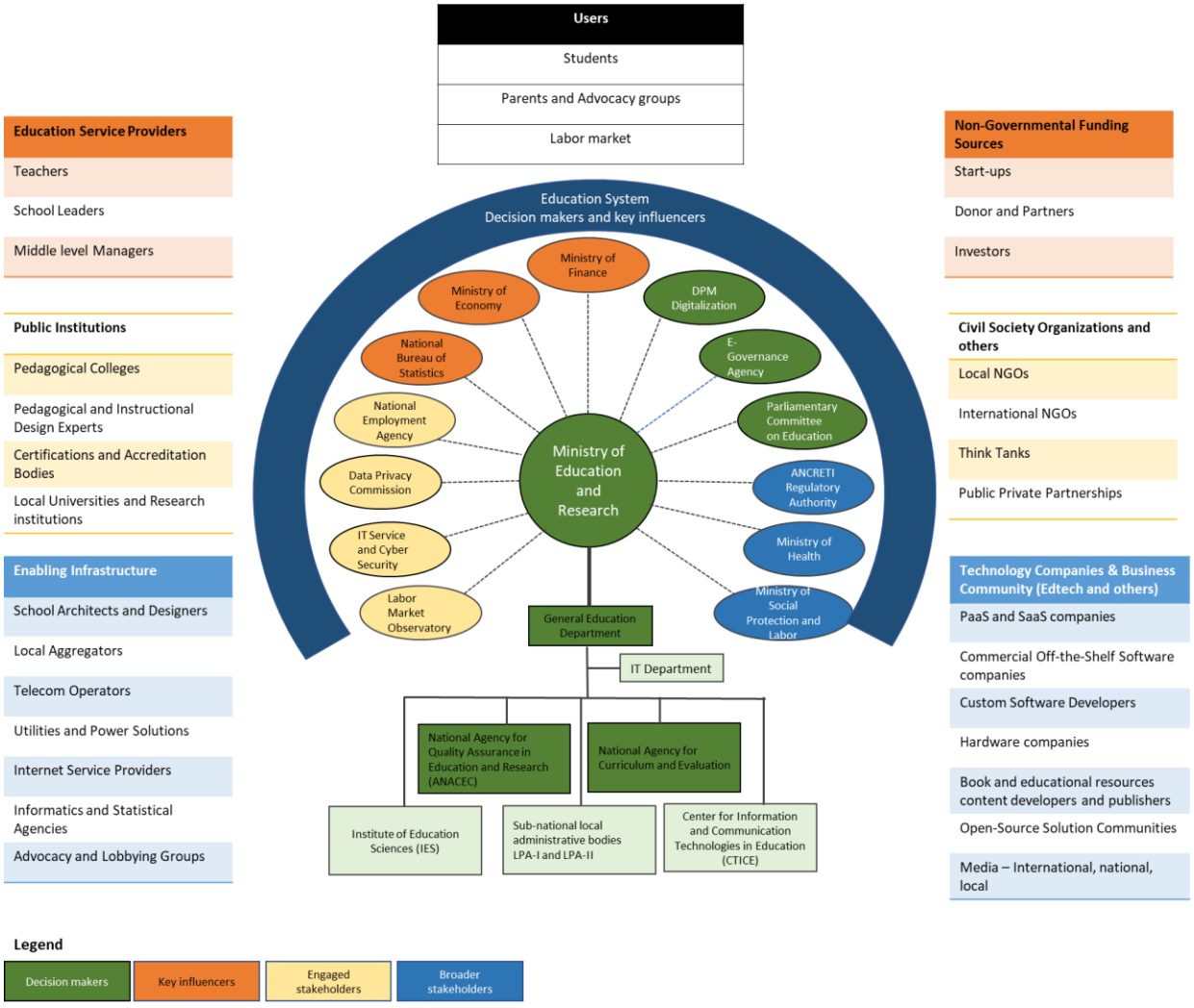
of play. Each pillar, and within that each sub-area, can be in a different readiness stage. The detailed methodology, scoring measurements, scale, and definitions of readiness levels are elaborated in Annex 2.

Stakeholder mapping and profile analysis

37. **Moldova has a stakeholder engagement legislation in place, which ensures the right to access information for policy development and decision-making.** The right to information is guaranteed by the Constitution of the Republic of Moldova in Article 34, while the Access to Information Law has been granting access to public data since 2000. Article 5 of the Law on Access to Information stipulates that the direct subjects of this Law are both Central and Local Public Administration Authorities. The Law on Access to Information (adopted in 2000) restricts public access to state secrets, confidential business information submitted to public institutions under conditions of confidentiality, and personal data, the disclosure of which may be considered interference in one's private life.

38. **Institutions and organizations that are mandated, interested and/or considered relevant in playing a role in education digitalization activities were identified for this system-level assessment (Figure 8).** These stakeholders were identified as Decision-Makers, Key Influencers, Engaged Stakeholders, and Broader Stakeholders (Ackerman and Eden 2011). The decision-making institutions with a high level of interest and influence on digitalization processes in education were identified as the MoER, eGA, National Agency for Quality Assurance in Education and Research (ANACEC), National Agency for Curriculum and Evaluation, and Parliamentary Committee on 'Culture, Education, Research, Youth, Sport and the Media'. Meanwhile, six ministries and agencies, including the MoF were identified as Key Influencers with high interest and indirect influence on the decisions and actions affecting implementation of digitalization solutions and instruments in education. Eight institutions that include institutes, universities, and other CSOs were identified as Engaged Stakeholders who may directly or indirectly affect implementation and need to be aware of the actions and decisions being made. Finally, there are a range of Broader Stakeholders, including the private sector, schools, students, parents, and national-level institutions, such as the National Center for Personal Data Protection, National Agency for Regulation in Electronic Communications and Information Technology and Cyber Security Service were selected to participate. It is important to note, the private sector role was not sufficiently represented given time constraints and the relatively nascent level of the EdTech sector as determined by the landscape review (Annex 3). However, the role of the private sector must be carefully considered in future follow-up readiness assessments. A detailed stakeholder mapping and analysis that informed this assessment can be found in Annex 4.

Figure 8: Stakeholder mapping



Source: Elaborated by authors, adapted from World Health Organization Handbook on Digital Health.

39. **Twenty-five purposefully identified technical experts participated in the Moldova Digital Readiness Assessment for Education.** These included six representatives from MoER, nine representatives from public education institutions including pedagogical universities and regional level public entities, five public non-education institutions and five representatives from CSOs (Figure 9). Over half of the participants had extensive experience (15–45 years) and self-identified their areas of expertise (Figure 10). All participants were identified as technical experts with substantial institutional memory and held decision-making positions. Most respondents identified Pillar 3 *Digitally enabled education service delivery and analytics* as their self-assessed area of expertise whereas Pillar 5 *EdTech market and business models* was determined as the pillar least familiar to them.

Figure 9: Distribution by institution

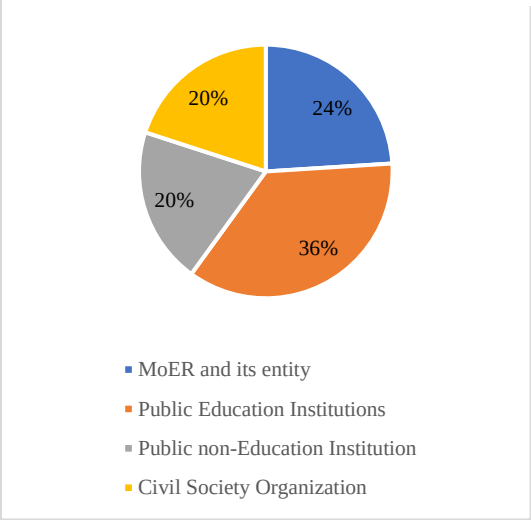
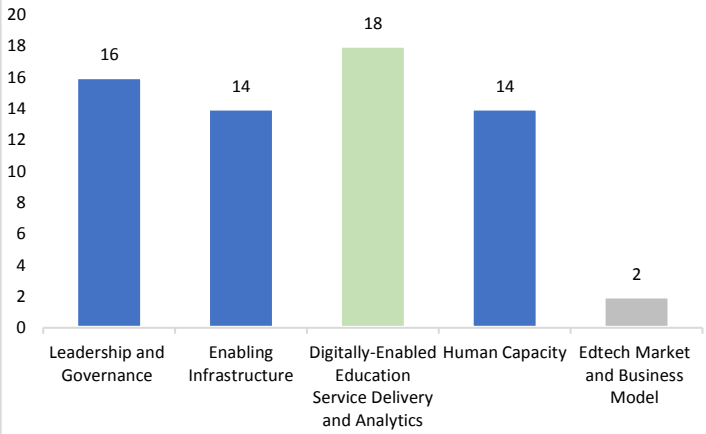


Figure 10: Respondents identified areas of expertise



Source: Survey respondent profile analysis.

V. Detailed findings and recommendations by pillar

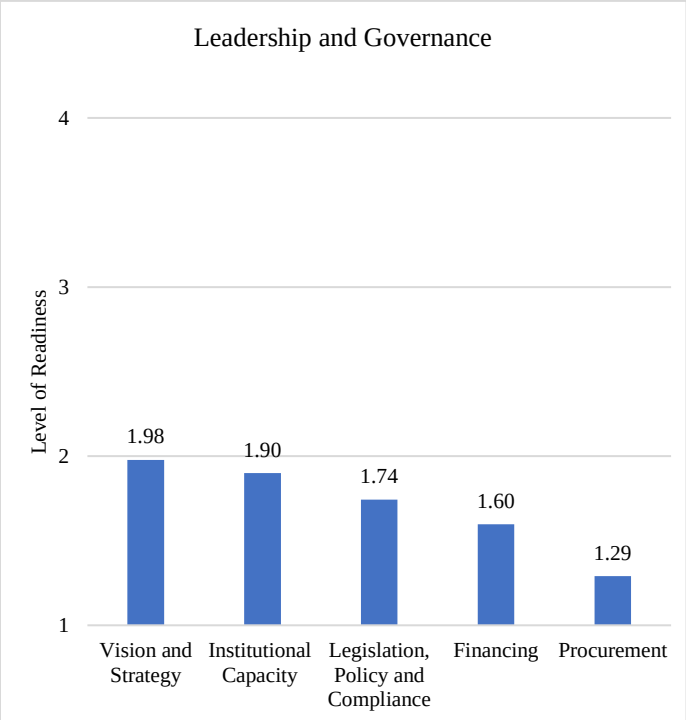
Pillar 1 - Leadership and Governance

40. *This pillar focuses on the development of a clear vision and strategy for digitally enabled education systems articulated at the highest level of government and is backed by durable legislation; adequate, equitable, and sustainable financing; and procurement mechanisms to incentivize adoption and scale-up of technology-enabled solutions for education service delivery. This includes identifying champions at different levels of government, strengthening institutional capacity, and setting performance standards for key business processes and key result areas to clearly establish accountability.*

41. Moldova was assessed on this pillar against five sub-areas: vision and strategy, institutional capacity, legislation policy and compliance, funding, and procurement. **The readiness level for this pillar is determined as emerging (Table 2).**

Table 2: Moldova's Pillar 1 - Leadership and Governance score

Level 1 - Latent	Level 2 - Emerging	Level 3 - Established	Level 4 - Advanced
Low or no governing structures, vision, and plan and low institutional capacity with scarce resources and weak policy and mechanisms for implementing digitally enabled education services.	There is a governing structure with a vision that may/may not be articulated and basic institutional capacity with some resources and mechanisms for implementing digitally enabled education services.	There is a well-defined governing structure with a clearly articulated vision, implementation plan and budgets, and sufficient institutional capacity including resources, talent, and mechanisms for implementing digitally enabled education services.	There is a well-defined governing structure with a clearly articulated collective vision and roadmap, and advanced institutional capacity including champions, experts, earmarked resources, and mechanisms for implementing digitally enabled education services.



Level 2 - EMERGING

Standardized average score 1.72/4

Vision and strategy are not articulated fully, but there is some expressed interest

Basic *institutional capacity* to implement digitally enabled education services with transactional coordination mechanisms

Legislation, policy and compliance for education-related data standards, data governance and cybersecurity, procurement standards, vendor management, interoperability, financing, among others, are in early stages

Financial allocation to education information systems management, analytics, and digital service provision are ad hoc and not consistently costed

A national digital *procurement* system is being planned and will include education sector digital procurement needs

Vision and Strategy

42. **Although there is expressed government interest in developing a digitally enabled education system, a widely shared vision and strategy have not currently been adopted.** The main strategic documents on digitalization expired in 2020 (that is, Digital Moldova 2020; Strategic Program for Governance Technological Modernization, 2011–2020) and development of the new strategies has been significantly delayed due to political instability from the past years and ongoing crises. Hence, an implementation strategy or other policy document has not yet been adopted to support digitalization of education services.

43. **Only one-third of survey respondents say that there is a concerted effort to understand and align the digitalization of education services to the whole-of-government digital transformation agenda**. The GoM is currently developing several long-term strategic documents that express political commitment to support a digitally enabled education system. At the national level, a new Moldova Digital Transformation Strategy (2022–2030) is being developed. This strategic document will set up objectives and implementation action plans country-wide, but also in sectors, including education. At the sector level, an 'Education Strategy 2030' is being developed. After its approval, this is expected to set the vision and implementation strategy for education including on digitalization.

44. **There is significant risk regarding the relevance and longevity of a digitalization of education strategy.** While the Education Strategy 2030 is being developed after extensive consultations with various government and non-government stakeholders, including with key development partners, national agencies, and ministries, such as the eGA, Center for Information and Communication Technologies in Education (CTICE), and ANACEC, respondents widely acknowledged that this work has been under development for over a decade and has been shelved several times under a changing political climate. Further, as technological change and advancements are rapid, a strategy or action plan adopted today may not be relevant even in the medium term since policy implementation on digital solutions has a much longer cycle relative to the dynamic pace of technological change. This makes the development and implementation of such a strategy particularly challenging as it needs to be clear, concise, and adaptable to change.

45. **Ongoing efforts are noteworthy but fragmented and do not effectively consolidate the potential benefits of digitalization by adopting a collective, comprehensive, and coherent approach for human capital development**. Selected activities related to digitalization in the education sector have been included in the Government Activity Program and in the MoER's Action Plan for fiscal year 2021–22, which expressed a high level of commitment for digitalization and defined some of the activities to be completed this fiscal year. For example, the Government Activity Program 'Moldova vremurilor bune', includes actions, such as reducing bureaucracy through extensive use of EMIS; development and implementation of digital platforms to support applications for educational institutions; increasing digital literacy of the public through implementation of education programs based on age categories. Also, the MoER's Action Plan for 2022 includes multiple actions, such as enhancing digital skills of teachers, increasing the number of school participants in 'Clasa Viitorului' (Future Classroom), 'Tekwill in each school', 'Support to connectivity and use of digital technologies in education' projects. Unfortunately, these siloed activities do not build on a cohesive digitalization vision or strategy for education.

Institutional Capacity

46. **Around 58 percent of respondents indicate a low to basic level of institutional capacity to deliver a national vision and associated work program for enhancing digital capabilities in educational institutions and related agencies.** Overall, there is a gap in terms of the champions, experts, earmarked resources, and mechanisms available to leverage the national level digital platforms and resources to modernize the education system. Specifically, there are several relevant standards and regulations related to technology access, competencies, and training, among others, but there is a clear lack of capabilities and capacities to ensure actual implementation and monitoring at scale at all levels.

47. **While national coordination is undertaken by the MoER for drafting policies, strategy, budgets, and action plans, there is no mechanism to monitor, analyze, and provide timely support where needed to ensure compliance.** This is likely the most critical barrier for progress on any reform effort in education. There is substantial variation in responses on extent of coordination between the national, regional, and local education levels to allow integration of strategy and planning with effective implementation and monitoring. This highlights a deeper problem of institutional capacity to enhance decision-making across all levels in education. For example, there is a lack of clarity in the decentralization strategy, the roles, and responsibilities of the local public administrations (LPAs I and II) and a lack of functional monitoring and accountability mechanisms across the system. Enhancing the institutional capacity of the public education actors for digitalization at the national and rayonal levels can significantly enhance the ability to deliver, monitor, and support effective implementation of reforms and regulations at scale and with efficiency, take corrective measures, and evaluate the impact on learning outcomes.

48. **There is a need to professionalize the system of education management with business enterprise and analytics capabilities using technology in such a way that it is used 'in service of' educational and learning objectives and related challenges facing the country and not vice versa.** It would be important for Moldova to avoid being part of the numerous global examples of ineffective yet expensive technology procurements for education due to the limited capacity to ensure their relevance and effectiveness for students, teachers, and administrators. This requires multidisciplinary education experts and champions who have the technical knowledge, skills, and collaborative networks to be 'translators' of the pedagogic objectives, technological needs, and related data requirements of the system to communicate with non-education ICT experts on issues such as data governance and interoperability, data and technology architecture for ensuring inclusive education services, knowledge of education financing and budgetary flows, among other areas. This is critical to ensure that the change management activities are led by education problems that are solvable with technology, and not led by the technology tools, devices, and products in and of itself.

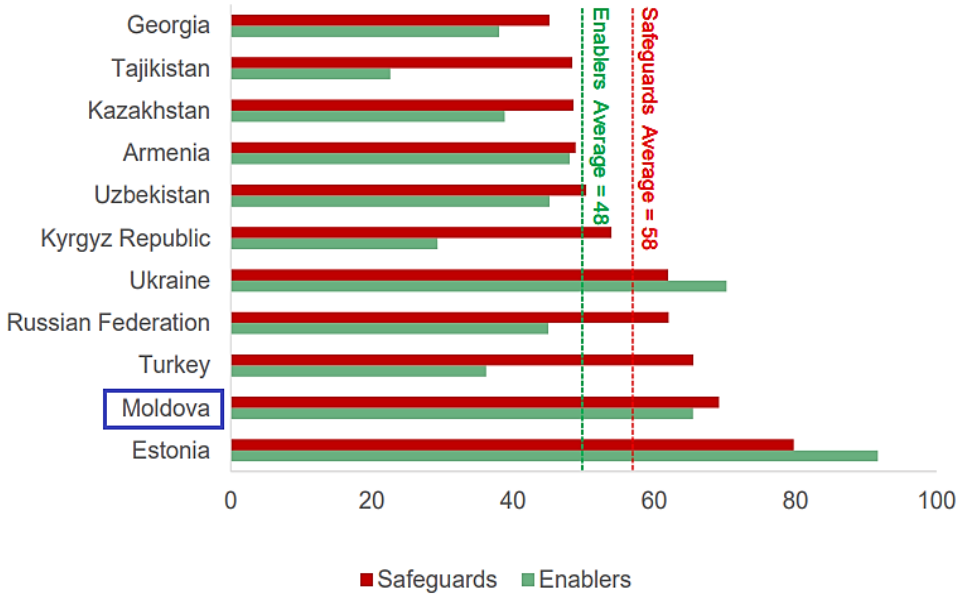
49. **To derive value from digitally enabled solutions for education systems, it is important to engage the ecosystem of stakeholders, while taking a whole-of-government approach, especially for addressing learning inequities.** Although the MoER tightly collaborates with many stakeholders at the national level such as the eGA, and IT and Cybersecurity Services, this engagement should be extended to non-traditional players that can both complement and enhance the government's capacity and may include education building architects, telecom operators, IT system and data engineers, architects, and designers, geospatial experts, e-publishers, social registries and labor market information systems, among others. Regional collaboration and exchange must be actively sought and utilized to derive possible efficiencies from economies of scale.

50. **There is a need for a functional review of the network of educational institutions that have a mandate for educational digitalization, technology, and data management and for undertaking enhancements to the current education governance structure, capabilities, processes, and resources**. This will not only ensure the efficient use, maintenance, and sustainability of existing information systems, but help education take advantage of the national level platforms to use, reuse and re-purpose existing data (both inside and outside Education), add relevant functionalities to support policy makers and teachers. The development, maintenance, and use of offline and paper-based data systems have been a shared responsibility in the past. This responsibility has now been consolidated under the MoER under an IT Department, but this unit is severely understaffed with just one or two personnel in charge of collaboration with all education departments at national and rayonal levels, eGA, CTICE, and several other agencies for running the national education information system smoothly. This is a complex technical area which requires advanced capabilities and institutional support to ensure that Moldova can effectively implement, monitor, and support the various reforms envisaged under the new Education Strategy 2030.

Legislation, Policy and Compliance

51. **Moldova has an evolved and comprehensive legal and regulatory framework in digital transformation on core building blocks such as e-ID, interoperability, privacy, cybersecurity, open data principles and standards, data protection, among others**. The country has a data regulatory environment of safeguards and enablers that match or exceed the average of high-income countries (Figure 11). These legislations have been subject to numerous modifications in the last decade, indicating that there is a constant need for adjustments with new developments. For example, some policies may benefit from alignment with European standards, such as the General Data Protection Regulations and global data protection and cybersecurity standards. The areas of development where regulatory frameworks are still catching up with international experience are around new technologies, such as artificial intelligence, blockchain, and Internet of Things.

Figure 11: Scores for quality of data regulation environment in ECA, 2020



Source: Joliffe 2021.

52. **The survey responses demonstrated a high level of awareness of the existence of the above-mentioned regulations on digital governance and data protection.** The implications and relevance of these laws for strengthening the education system information flows and unlocking the value of education data through governance are emerging. These reflect a critical barrier for advancing digitalization in education in Moldova and can be overcome by raising interest, understanding, and capability among leadership at all levels including central, district and local authorities, school managers and teachers, identifying champions for making advancements, managing risks, supporting relevant innovations, and providing adequate resources.

53. **Although the MoER has developed specific ICT-related standards for education, there is lack of awareness and low levels of adoption, and as such, there is no monitoring, support, and incentive system to ensure compliance, measure effectiveness, and perform quality assurance.** Some of these include the standards for ICT endowment of educational institutions, standards for digital competences of professors and students, and methodological guidelines on online safety and security of students in the distance learning process. These standards do not have the power of the law and are held as guidelines and norms which education institutions are expected to follow.

54. **There is an attempt to develop a policy/legislation to govern the integration of ICT use into schools' strategic plans.** According to the Education Code, educational institutions are responsible for ensuring implementation of sectoral policies, regulatory requirements, and standards related to use of ICT. To achieve this, the strategic plans for the development of educational institutions include actions regarding the development of ICT infrastructure, the training of teachers, implementation of ICT in the teaching-learning-evaluation process. However, the extent of compliance to the plans is unknown and is not monitored.

55. **According to Moldova's Public Services Portal, limited information is available on public services related to education and training whereas a recently approved Law on Public Services requires compliance to specific requirements for public service provision including digital service delivery**. According to the Education Code 2014, the MoER must develop the Standard Package of Educational Services.[21] This package of services has been elaborated by the Ministry and is undergoing review and approval. Such a package would aim to define the term 'educational service' using normative-legal acts in force. It is recognized that there may be possible cultural barriers as many teachers and managers may not accept the use of the term 'service' in the education sector.

56. **Most respondents expressed a lack of awareness or an emerging attempt in the areas of policy and legislation development related to technology adoption and uptake in education indicating that this area is at a nascent to emergent stage of readiness**. For example, there is no clear consensus on policies to stimulate and support education change management, innovation, and related risks; to evaluate EdTech applications and products for their appropriateness, feasibility, utility, and effectiveness; to determine the effectiveness and efficiency of digitalization interventions on education using impact evaluation and research. MoER is currently developing a set of quality criteria pertaining to digital education resources. The evaluation of the impact of digitalization in education is done sporadically, through research projects usually supported by development partners.

Financing and Procurement

57. **There is very low awareness about the areas of government financing and procurement on technology for education.** On average, a quarter of participants indicate an *emerging level of readiness* on the issues of budgetary allocations for activities related to digitalization in education whereas over one-third to half of the participants consistently indicated a lack of awareness. Whether related to availability of funds, practice of costed and consistent investments, standard procedures, and mechanisms to ringfence, as well as information and access to innovative government schemes—these two areas had among the lowest response rates in the entire survey.

58. **The structure of the State Budget for 2022 does not allow to assess if there are funds allocated to digital interventions for education in support of implementation of the MoER Action Plan for 2022**. In *general education*, at least 95 percent of the budget that is available for schools is allocated based on the per-student financing formula. These transfers are carried out by the MoF in line with the allocation formula developed by the MoER and approved by the government. Schools may receive additional funding (from the remaining 5 percent of the total budget) from the *inclusive education fund* and from resources that are allocated to the *LPA component*.[22] A fourth possible source of funds is *project-based financing*—funds provided by development partners to which schools can gain access through a competitive application, either in collaboration with a nongovernmental organization (NGO) or via their parents-teachers

[21] Education Code (EC) defines a *Standard package of educational services* as a package of educational programs, aimed at achieving concrete goals and acquiring a volume of knowledge, training, and skills in accordance with educational standards. Also, the EC states that the state would provide funding for the standard package of educational services for preschool, primary, secondary, and high school education, regardless of the type of property of the educational institution. Such a standard package of educational services for general education would have to be approved by the GoM.

[22] In addition to funds received from the state, LPAs may supplement these funds from their own means.

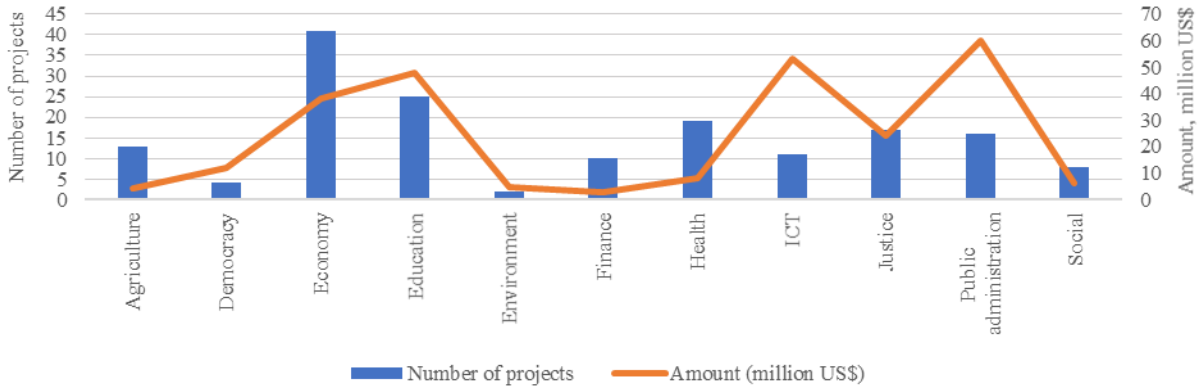
association. This last form of financing reportedly rarely materializes, due to schools' low capacity to develop proposals, initiate partnerships, write in English, and so on.

59. **As part of the general education budget preparation process, heads of the educational institutions are responsible for preparing and presenting budget proposals.** These are consolidated by the rayons whereas the LPA (II) authorities estimate and present the volume of expenses to the MoF and MoER. Monitoring the implementation of the current methodology is done at the central level by the MoER together with the MoF, and locally by the rayon education and finance departments. Budgets of educational institutions and reports on budget execution are required to be posted on the official webpage of the institutions and/or of the local body specialized in the education area. However, it is not clear if and to what extent this is implemented and how this information is coherently cross-validated from other local or central data systems on financial flows, if any.

60. **Standard procedures or guidelines for budgeting investments on digitally enabled education activities need to be developed.** While these maybe developed as part of the implementation of 'Education 2030' Strategy, over the last decade, information on consistent and costed investments for enabling digitalization of education services was absent and most of investments in digital education were supported from grants and investment projects by development partners.

61. **Digitalization efforts of Moldova for all sectors are greatly supported by external development partners.** As per a mapping exercise of all digitalization efforts through development assistance conducted by eGA in 2021, there were 189 active or planned projects amounting to USD 260.9 million through donor support. Of these, 25 projects in the amount of USD 48 million (approximately 18 percent) were in the education sector (Figure 12).

Figure 12: Number of digital projects and their amount per sector



Source: Zaharia 2022.

62. **Spending analysis of digital investments in education including review of budgets, expenditures, efficiency, and education effectiveness are likely conducted only on ad hoc basis, mainly for budgetary purposes.** There are some government programs or schemes through which funding is available for private sector to invest in ICT for education services, applications, infrastructure, but they are not easy to find or access. Government agencies such as eGA, development partners, and NGOs that invest in development of national IT infrastructure collaborate quite often with the ministry and key stakeholders to determine the needs and demands of the education system.

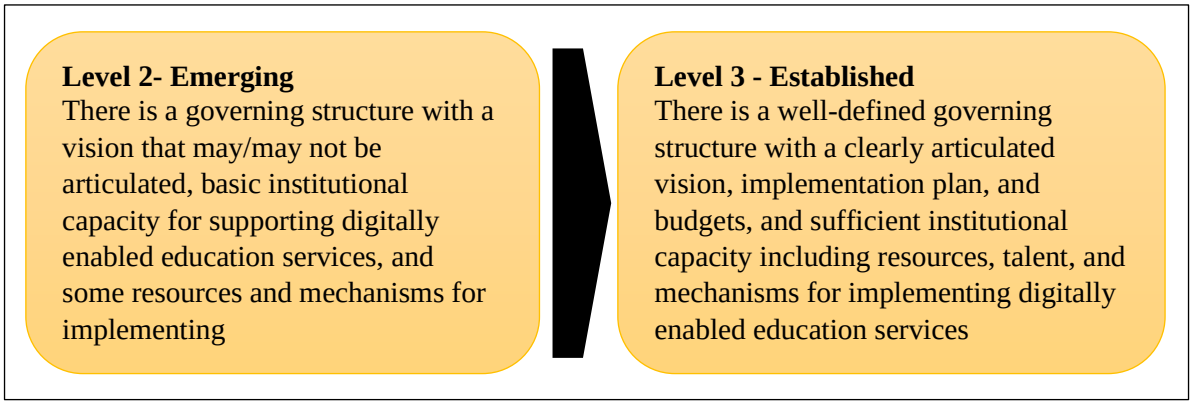
63. **Public procurements in education, including all education technology-related procurements, are conducted in compliance with the Law on Public Procurement using a centralized procurement information system MTender**. This is run by the Agency for Public Procurements (MoER 2015b). The MTender platform serves as a single window for all public procurements. The MoER and subordinated

educational institutions follow national procurement rules for all the procurements in education. Aside from the use of MTender, digital procurements for all IT procurements, both hardware and software, are cleared by the eGA through its Smart IT Investment Department. This is certainly a step in the right direction as technology procurement standards can be consistently applied, fragmentation is avoided and actively managed, and there are economic efficiency gains. At the same time, financing and procurement for specific education-related products and services including hardware, software, applications and other maintenance activities need to be closely linked to both the demand side through needs and gap assessments and the supply side through an effective mechanism to monitor the usage, impact, and cost-effectiveness of these procurements.

Recommendations and Actions

64. The below recommendations and actions have been identified to advance *leadership and governance* from current Emerging level to Established level of digital readiness of the education system (Figure 13).

Figure 13: Emerging to Established Digital Readiness on Leadership and Governance



65. ***Vision and Strategy.*** **Articulate and collectively agree on a clear and succinct vision and strategic direction for digitalization in education and its link to the socioeconomic aspirations for the country with key performance indicators to ensure continuity and support for the overarching educational aims for the Republic of Moldova.** The place of digitalization in the continuum of government priorities should be clarified—from 'core' such that all management actions consider the 'digital first' lens to 'peripheral' such that only specific areas are expected to be affected and in a limited way. There must be a recognition of the long lifecycle of digital efforts and hence a commitment to a phased but adaptable approach—which should be reflected in the implementation plans. Ensure that these aspirations for modernization are aligned with the educational goals and priorities of the upcoming Education 2030 strategy.

Proposed Actions

- Identify development goals relevant for general education from the MoER Education Strategy that will benefit greatly from digitalization: Select goals and challenges with high likely impact.
- Engage with a wide range of relevant stakeholders (see stakeholder map for reference);
- Define a vision and strategy for digitalizing education in Moldova, along with a costed implementation action plan/digital readiness roadmap.
- Develop and implement a communication plan of a Vison and Action Plan for digitalization of the education system for all stakeholders.
- Conduct a digital ecosystem stakeholder network mapping and analysis using a systems theory and network analytics approach.
- Identify leaders/champions across ecosystem to implement first phase of the strategy.

- Establish clear oversight and coordination mechanisms such as through a Steering Committee to implement action plans.

66. ***Institutional capacity.*** **Strengthen the overall institutional capacity in the country to deliver a national vision and associated work program of a digitally enabled education system.** This can be done via training, day-to-day support, hiring qualified IT specialists, smart use of the opportunities offered by technical assistance projects. This should focus on data governance, management, and regulatory compliance and consider innovative models for enhancing this capacity by leveraging the private sector, donors and development partners, and CSOs. A set of rapid assessments and reviews in a number of areas are required to inform the specific implementation and action plan for digitalization in education.

Proposed Actions

- Conduct a functional review of the education monitoring mechanisms for service delivery at all levels; this should include a review of the institutional capacity for delivering on the vision and identification of gaps including human and financial resources.
- Conduct a review of standards related to digital competencies, connectivity standards, and determination of legislation needs.
- Conduct a rapid needs assessment of schools with students, teachers, and school managers as end users from a digitalization perspective.
- Conduct a spending effectiveness and efficiency analysis and establish a systematic review process of budgets and expenditures on effectiveness and efficiency of digital investments and procurements in education. This should be undertaken periodically, for example, every three to five years.
- Develop an implementation action plan for institutional capacity development in digitalization.

67. ***Legislation, Policy and Compliance.*** **Develop and disseminate the policies/legislation that could stimulate and support change management and innovation.** This will help manage related risks for technology adoption and uptake in education.

Proposed actions

- Adopt assessment tools for establishing the level of schools' digitalization. Based on the results, schools must develop internal action plans for raising the level of digitalization, stimulating a bottom-up approach.
- Develop and implement innovative government programs or schemes through which funding is available for the private sector to invest in education ICT or digitalization of education services, applications, infrastructure. Elaborate clear technical and programmatic specifications on such digital initiatives in education.
- Develop and implement mechanisms to evaluate digital applications and products in the education system for their appropriateness, feasibility, utility, and effectiveness.

68. ***Financing and procurement.*** **Enhance financing and procurement mechanisms for supporting digitally enabled education services.** This implies developing affordable and sustainable financial models and procurement mechanisms that enable the system to provide up-to-date devices, connectivity options, content development, as well as technical goods and services.

Proposed actions

- Develop and implement standard procedures and guidelines for budgeting investments on digitally enabled education activities.

- Develop an affordable and sustainable financing model for school connectivity and equipment. This would likely mean identifying a PPP model that would allow schools across the country to finance upfront and ongoing expenditures, ensuring that they are affordable, sustainable, and tailored to the characteristics of the school system in Moldova.
- Consider total cost of ownership. Hence, include both capital expenditures (CAPEX) and operational expenditures (OPEX) rather than only upfront capital expenditures in technology related budgeting and spending reviews in education. Technology procurement for education should be based on operational rather than capital expenditures. EdTech procurement is complex and often requires high upfront capital expenditures but must consider the total cost of ownership and hence, the related risks. For example, it is important to consider issues related to vendor lock-in, obsolescence management, bulk pricing, and the rapidly changing technology landscape.
- Consider multiple sources of funding and centralize 'core' technology functions for economies of scale, coherence, and longer-term efficiency and value.

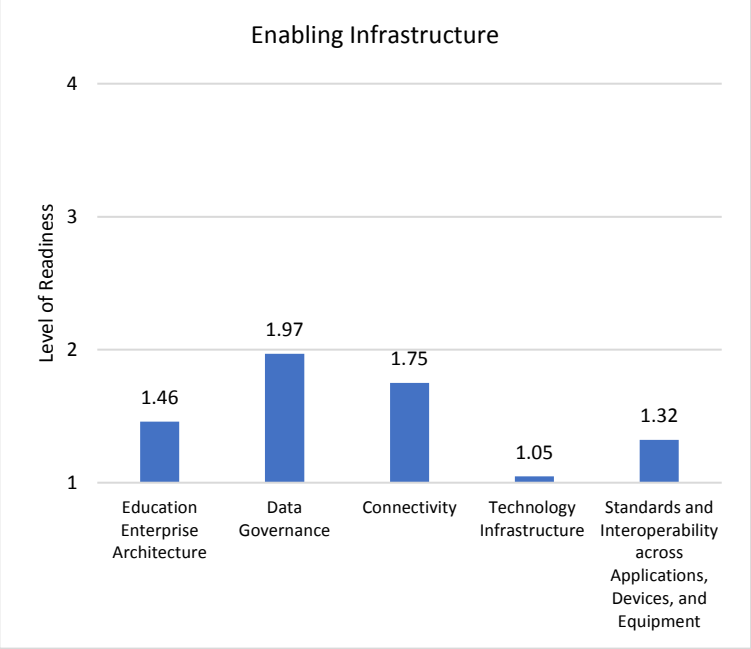
Pillar 2 - Enabling Infrastructure

69. *This pillar recognizes that aside from the fundamental building blocks of electricity, telecommunications infrastructure, and broadband internet access, which form the ICT backbone, digitally enabled education systems require an enterprise architecture, that is, a coherent, integrated 'blueprint' that aligns business, data, technology, and applications to deliver outcomes, data and technology management infrastructure and oversight, and standards and interoperability across applications, devices, and equipment. This pillar covers the supply side of ICT provision, penetration (affordability, quality).*

70. Moldova was assessed on this pillar against five sub-areas: Infrastructure design and management; Data governance; Connectivity; Technology infrastructure; Standards and interoperability across applications, devices, and equipment. **The readiness level for this pillar is determined as emerging (Table 3).**

Table 3: Moldova's Pillar 2 - Enabling Infrastructure score

Level 1 - Latent	Level 2 - Emerging	Level 3 - Established	Level 4 - Advanced
Digital technology infrastructure is not well developed outside key urban areas; mobile broadband coverage is limited; digital enabling environment is less advanced, including data governance, telecom, ID systems, and payments.	Mobile broadband coverage is ubiquitous and extends to rural areas; broadband adoption, quality, and affordability is low especially in rural; ID and payment systems emerging; no education enterprise architecture and interoperability; data governance, cybersecurity and data protection and privacy frameworks in early stages; technology infrastructure for learning is slowly catching up.	Modern broadband infrastructure for rural and urban; broadband adoption, quality, and affordability is growing, with demand for higher service quality (speed); ID and payment systems largely in line with good practices and up to date; education interoperability and enterprise architecture emerging; cybersecurity, data governance, data protection and privacy are developing; tech infra in education is adequate.	Penetration of modern broadband infra is ubiquitous; broadband adoption, quality, and affordability is widespread; ID and payment systems in line with good practices and up to date; cybersecurity, data governance, data protection and privacy are mature; education interoperability and enterprise architecture mature; tech infra in education is adequate and up to date.



Level 2 - EMERGING

Standardized average score = 1.46/4

Education enterprise architecture is not well-developed

Data governance is in early stages

Connectivity to mobile broadband is ubiquitous and extends to rural areas; Broadband adoption, quality, and affordability is low especially in rural areas

Technology infrastructure for learning is slowly catching up

Standards and interoperability across applications, devices, and equipment is emerging, cybersecurity and data protection and privacy frameworks in early stages

Education enterprise architecture

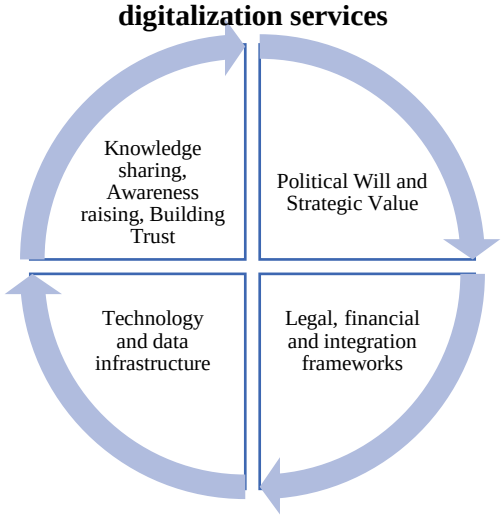
71. **This sub-area focuses on enterprise architecture and electronic data infrastructure management for education service delivery and is determined to be at *a latent to emerging level.***

Box 2. Definitions: Education enterprise architecture

Enterprise architecture can be defined as a coherent, integrated 'blueprint' to optimize the often-fragmented legacy of processes (both manual and automated) into an integrated environment that supports service delivery, while being responsive to changes. It provides a common vocabulary to discuss implementation across entities, such as model use cases including development of indicators, ICT workflow descriptions, and ICT building block attributes.

Electronic data infrastructure refers to the structure and interaction of the major types and sources of data including logical and physical data assets and related data management resources. Data quality (adequacy, accuracy, relevance, explanatory capacity), data flows, storage, protection, standards, interoperability, foundational data such as IDs, birth registries, and so on are often important enabling factors. Electronic education records or any other data assets would capture information regarding a child/teacher/parent's engagement with the education system.

Figure 14: Enablers of education digitalization services



Source: Srivastava and Teo (2004).

72. **Overall, it is critical to increase the level of awareness among stakeholders on the relevance and scope of benefits from an interoperable design and implementation of an enterprise architecture for education.** An interoperability framework carefully considers the strategic educational goals for the socioeconomic growth goals including equity, quality, and access. It also considers the necessary data, applications, and technology architecture needed to implement, monitor, and support the achievement of these goals. Finally, it carefully considers the redesign of service delivery processes that put students and parents first, that is, it is first and foremost citizen centered. Such an approach is increasingly undertaken by high-income and middle-income countries in public service delivery and is a best practice among large multinational conglomerates. This approach forces careful deliberation and design to meet strategic policy objectives and is significantly more concerned with organizational change management than with technological changes. One example is the effective use of MCloud,[23] the common government information infrastructure platform that operates based on cloud computing technology hosted in a consolidated data center, and potentially provides the platform for developing an effective data pipeline for education services. Hence, it is important to assign adequate technical and sectoral skills and financial resources for implementation.

73. **With regard to electronic data infrastructure, the most referred to application is the EMIS[24] system that captures and aggregates education data from school level to the national level.** Although there have been several advancements to this information system managed by the More and is expected to be the single source of valid and reliable data, in practice it is found to have several inconsistencies with the data from the NBS. There is no sufficiently developed mechanism for data entry and data validation as it is manually entered thrice a year by an IT or other subject teacher assigned to this task. Moreover, at the

[23] According to the Government Decision no. 128/2014, the ministries, the State Chancellery, other central administrative authorities subordinated to the government and the public authorities/institutions within their sphere of competence are obliged to host the existing and new information systems on the MCloud platform, except for the cases expressly provided in the normative acts; reuse the MCloud platform and not allow the creation of new centralized server and hardware infrastructure, including the licensing of newly created infrastructure components.
[24] The EMIS has an open data interface https://www.sime.md for dissemination and interactive visualization of educational data.

rayonal and national level, there is extremely limited capacity for management of the day-to-day operations and maintenance for EMIS components and data assets, hardware, and applications. Electronic data sources relevant for education are also produced by the MoER and its agencies, such as through a gamut of digital learning resources at www.educatieonline.md and teacher manuals at www.ctice.md. Information on students from vulnerable households as well as information about NEETs maybe held in other ministry agencies such as those related to the labor market and social benefits.

Box 3. Enterprise Architecture in (Estonia)

Estonia uses an Interoperability Framework that plays a role similar to an enterprise architecture. The Estonian IT Interoperability Framework is a set of standards and guidelines to ensure communication between the information systems of central and local government agencies. The IT Interoperability Framework employs three perspectives, including organizational, technical, and semantic interoperability. This allows decentralized public and private databases that are interoperable at a national level. For example, when the birth of a child is registered on the Estonian State Portal eesti.ee, the child is automatically registered for benefits and enrolled in school. This is possible only because of interoperability between the Population Registry, the IT system of the education department, and the IT system of the Social Insurance Board. This Interoperability Framework is not written in the law. However, its obligatory nature is regulated by the legal agreements among government agencies, the private sector, third sector organizations, and private persons who can submit proposals for data access.

The IT Interoperability Framework aims to ensure that state information systems are citizen-focused and service-based. To ensure interoperability, Estonia applies open standards and open-source-based solutions in information systems. Over 150 public sector institutions are connected to X-road, and it is used daily by more than 1,000 organizations and is calculated to save more than 820 years of working time for the state and citizens annually. However, these savings are the result of only 5 percent of queries done via the X-Road, as it does not consider all the savings that occur because of the automatic machine-to-machine data exchange, which amounts to 95 percent of the queries. In all, the Estonian government estimates that its digital infrastructure has led to annual savings of about 2 percent of GDP.

Source: BCG, n.d.; e-Estonia, n.d.

74. **Although Moldova has many relevant approved education standards and policies such as on curriculum, infrastructure, teaching learning materials, teacher training, recruitment, the biggest challenge in the country is consistently recognized to be that of effective implementation, compliance, and monitoring mechanisms.** Thus, although the various elements of the data infrastructure that maybe relevant to affect educational outcomes of students can be 'digitized', the overall data infrastructure is hugely fragmented, has data integrity challenges,[25] and does not allow fully capturing real value from the data to serve its students, teachers, and parents, equitably and with quality. In this regard, the MoER has developed an 'Electronic catalogue' module within the EMIS. During the 2020–2021 academic year, the process of piloting the system in 180 general education institutions was initiated. A few survey participants recognize these limitations of the current data systems in use for education management, monitoring, and decision-making. Furthermore, a standalone, single system of truth to the country's education data significantly reduces the necessary redundancies needed to safeguard the system against cyberattacks and data breaches. This can be potentially managed through consistent use of authentication modules such as

[25] Data integrity must not be confused with data integration or with data security. Here, data integrity refers to consistency of data on the same variables collected from different sources whereas data integration refers to the joining, combining, and reusing of different datasets usually using a common variable. Data security refers to the protection and safety of the data and related ICT systems.

MPass across the education ecosystem. Such efforts are ongoing and are intended to be used by school directors and by heads of OLSDI.

Box 4. Data Storage and Management in Education (Estonia)

The Estonian Education Information System (EHIS) is a state-run, web-based database that stores live data on education and is accessible to different public groups to a varied extent. All schools and institutions following a curriculum are obligated to enter up-to-date data by law, including kindergarten, primary schools, secondary schools, vocational training, universities, and adult education. EHIS performs automatic logical consistency checks to ensure the uploaded data are reliable and accurate. Each school owns individual online access to EHIS through the user interface to enter data in three ways. *First,* the digital tools and digital management software that schools use are connected to EHIS—data can be automatically transferred from the school management system to EHIS without additional action. *Second,* schools can generate Excel sheets and upload XML files to EHIS. *Third,* the school data can be manually entered into the EHIS user interface. The E-Service Department of the MoER is responsible for solving the issues encountered by schools in data entry. Schools can monitor students' and teachers' data through the EHIS user interface. Besides, an online platform in EHIS named Educational Eye offers publicly available school statistical data. In addition, about 50 specific service providers can access a broader range of contract-specified data in EHIS following strict legal agreements when they need to certify students' identities for the public service provision. Furthermore, over 20 other state-run information systems are connected to EHIS for data exchange among different state-run information systems. A variety of digital online tools supporting education delivery and progression are connected to EHIS via X-Road to complement the data in EHIS.

Source: OECD 2020a, b.

Data governance

75. This sub-area pertains to data identity, data quality and integrity, data privacy and protection, and openness of data, and was overall determined to be at *an emerging level of readiness* whereas data and evidence validation indicates *a latent to emerging level*.

76. **In general, the identity of schools is uniquely managed by the MoER across all assets of the education system, while the individual unique IDs are based on those assigned by the National Population registry.** However, there are cases when different education information systems, specifically, SAPD (Automated Data Processing System) and SIPAS (Information System for Personalized Education Certificates/Diploma) users have different identification (ID) registries. It is not clear how these different information systems reconcile and integrate the data coherently. In case of refugee children enrolled in schools, they can be incorporated into the school level data information systems, using an online or offline ID which is issued based on data from the Public Services Agency. In the case of refugees from Ukraine, these IDs are generated immediately on processing of border crossing into the Republic of Moldova (eGA n.d.).

77. **Survey responses were equally divided on the issue of data quality and integrity with one-third indicating sub-optimal quality, one-third indicating average to good quality, and another one-third indicating a lack of awareness**. In theory, data entry into the EMIS must be carried out by a school-level staff member thrice in the academic year. Nevertheless, in practice, this task is neither sufficiently institutionalized, nor compensated. Hence, it remains an ad hoc process subject to staff turnovers and other school- and system-level dynamics. At the national level, the MoER's IT department is extremely under-resourced. Further, the EMIS data extracts do not always correspond to the data presented on paper, thus,

revealing data quality issues. In parallel with EMIS, economists collect data equivalent to that included in EMIS at the beginning of the school year, hinting at low trust in the reliability of the EMIS data for macroeconomic analysis.

78. **One-third of respondents indicate a low or no adherence whereas one-third indicate high adherence to data privacy and protection policies put in place in 2013 (MoER 2013)**. Another one-third indicate no awareness on this. Legislative and regulatory requirements and standards pertaining to implementation of digital solutions, cybersecurity, and data protection are required to be applied to all education information systems and databases. To achieve this, until recently, each educational institution was required to be individually compliant with the Confidential and Personal Data Policy and obligated to register as a personal data operator with the National Center for Personal Data Protection to assure fulfilment of specific security requirements pertaining to access and administration of personal data. However, several respondents indicated low adherence or inconsistent application as registration was difficult and implied increased responsibility and scrutiny, making education institutions reluctant to get this status. Considering these challenges, this policy has been recently abolished, thus institutions are no longer required to register in the National Center for Personal Data Protection Registry.

79. **On openness of education data, almost 50 percent of respondents were aware of the open government data portal but were equally divided in the maturity of processes and management of education datasets on this portal.** Further, the Government Decision on the approval of the methodology for publishing open government data, sets up the 'open by default' principle, meaning that government data which does not contain personal or sensitive information is considered open by default and should be published on the Open Data Portal (https://date.gov.md/). This provision supports sharing education information across geographical and sectoral boundaries. Currently, Open Data Portal hosts 128 datasets published by the MoER since its launch. The MoER is one of the leaders in opening its data compared with other government agencies and holds the second place after the NBS with 129 datasets opened, followed by the Ministry of Health with 125 datasets opened. Based on open government data published by the MoER, an open data application 'Scoala Mea' https://scoalamea.md/ was developed in 2014 by the NGO 'Expert Group' with a World Bank Global Partnership for Social Accountability (GPSA) grant covering only 100 schools. The application provides information on schools, including geographical location, school budget, number of students, success rates, and so on. Such a use case can be reviewed and explored for scale-up under the MoER, with relevance for a variety of stakeholders for different purposes (for example, by parents when deciding which schools to choose for their children).

Connectivity

80. This sub-area covers the availability, quality, and affordability of access to mobile and broadband internet and was determined to be at an 'emergent' level of readiness by the survey responses. However, data analysis suggests a higher level and would be rated as 'established'. See Annex 6 for detailed analysis of usage of devices, connectivity, and software by gender and socioeconomic status (SES).

81. **Overall, broadband infrastructure in Moldova is adequate, but usage is low among rural households.** The country is almost fully covered with the latest 4th generation (4G) technologies (Figure 15). However, 4G market penetration in 2021 stood at 59 percent of the population, a level much lower than the high performers in the region, like Poland and Romania, 82 and 81 percent respectively (Figure 16). Usage of fixed broadband is even lower, standing at 18 percent of the population (ITU 2021). The digital divide is more prominent at the level of fixed broadband services, which are more reliable, and provide higher bandwidth and higher speed when accessing digital content for education and when multiple devices are connected at the same time, which was the case during lockdown periods. The gap between urban and rural households is significant: 77 percent of households have access to internet in urban areas versus only 56 percent in rural area (ITU 2021). Performance indicators in the telecommunications sector, especially the internet market, have been continually growing, though weaknesses remain with regard to

incentivizing demand, especially for closing the remaining digital divide, and increasing affordability of high-speed fiber connectivity (ANRCETI 2021).

Figure 15: Distribution of mobile and fixed broadband subscriptions

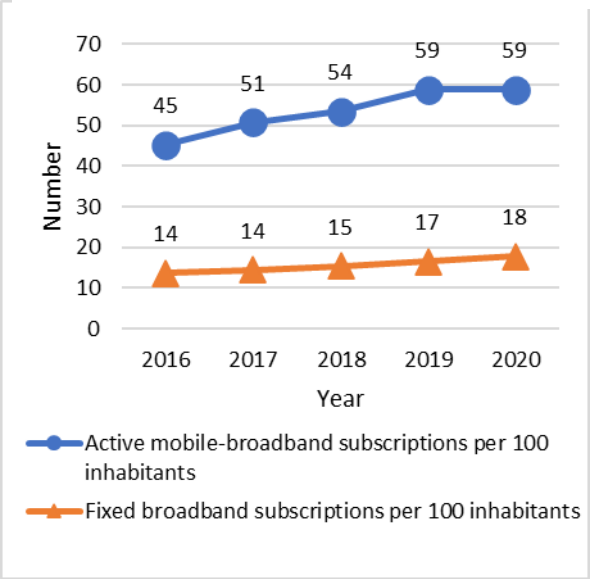
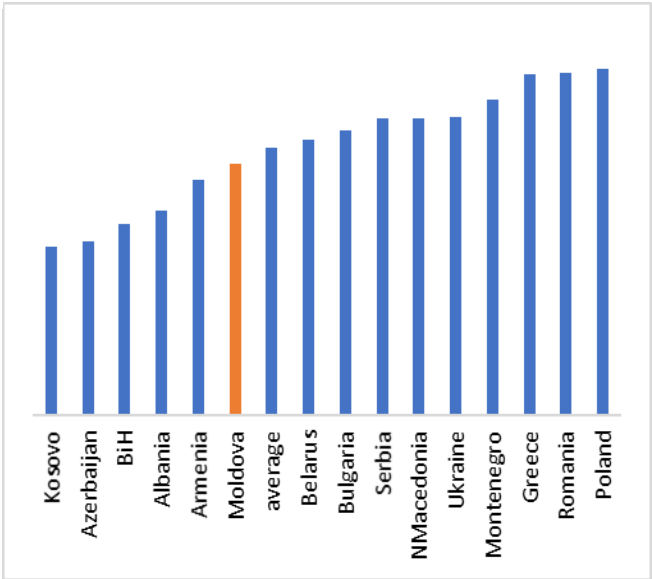


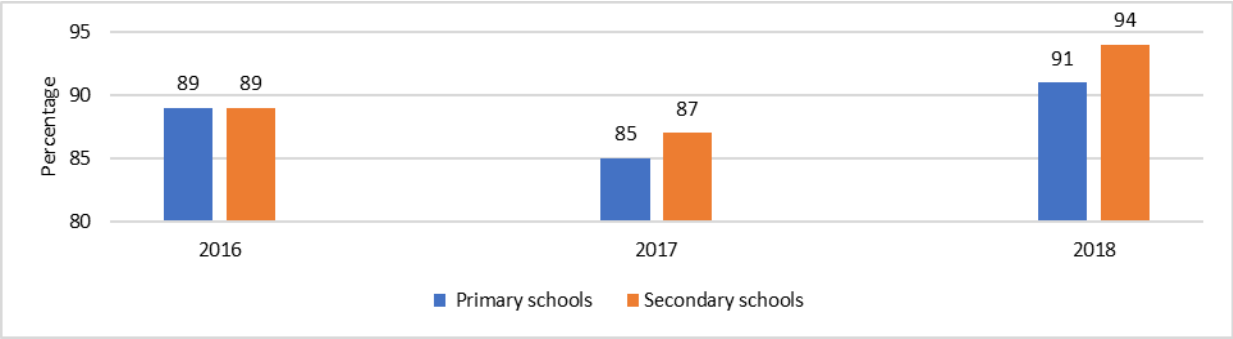
Figure 16: Mobile internet market penetration



Source: GSMA 2022.

82. **Most schools seem to be connected to the internet but connecting the remaining schools and ensuring good quality connectivity to all schools is an important next step**. In 2020–2021, Moldova had 1,241 registered education institutions, the majority of which are public. Private schools are mostly located in the urban areas. While in 2018, around 91 percent of primary schools and 94 percent of secondary schools were connected to the internet (Figure 17), currently, all primary and secondary general education institutions have this provision. Ubiquitous access to high-speed, high bandwidth connections and devices is critical to ensure that students and teachers have uninterrupted access to content and applications, especially under a hybrid learning mode. The impact of limited access to broadband and to computers for both teachers and students became prominent at the onset of the pandemic. The National Youth Council reported that the quality internet access and connection devices left 12 percent of young people in general education out of education and made teaching challenging for around 3,000 teachers (10.6 percent of the total), based on student surveys (CNTM 2021). Also, notably, a small number of schools are not connected to mobile internet in remote and rural areas (ANCRETI 2021).

Figure 17: Proportion of schools with access to the internet by education level



Source: United Nations Educational, Scientific and Cultural Organization Institute for Statistics (UNESCO UIS) 2020.

83. **The overall cost of broadband services is a determinant of the available opportunities to students and teachers to leverage digital content whether at home or at school. In Moldova, data show that the cost of fixed broadband connections is high relative to the purchasing power of people**. The cost of broadband services has decreased sharply in 2019 (Figure 18). The cost of a mobile data bundle providing download capacity up to 1.5 GB decreased from USD 2.15 as percentage of gross national income (GNI) per capita to less than half reaching USD 0.7 per GNI per capita (ITU 2021). This is among the lowest among regional peers and is considered at an affordable level according to international industry standards such as the ITU broadband commission (Figure 19). The cost of a fixed broadband connection is, however, much higher and although it decreased by half in 2019, the cost of a 5 Gbps (gigabyte per second) fixed broadband is around USD 2.1 per GNI per capita; contrary to mobile connection cost, fixed connection cost is among the highest among regional peers.

Figure 18: ICT prices by types of ICT services

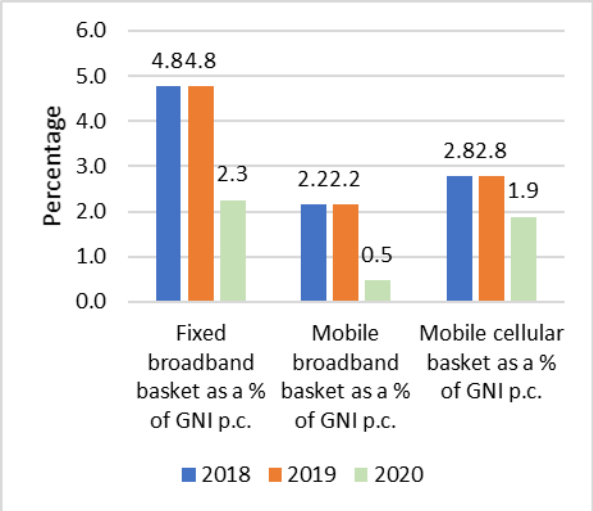
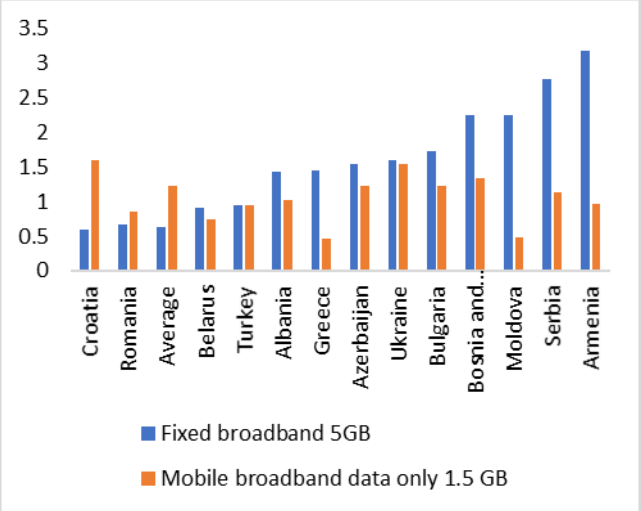


Figure 19: Cost of broadband services



84. **Government, donor partners, and the private sector have improved connectivity to schools and upgraded school equipment, however, challenges exist in providing quality and affordable access at home**. Although the average bandwidth for broadband connectivity is between 10 and 20 megabits per second, this is inaccessible for most vulnerable students for reviewing learning modules and classes from home as they may use slower but cheaper Digital Subscriber Lines (DSL) or 4G networks. To address this, during the pandemic, the MoER negotiated with the national internet service providers (ISPs) for additional databit capacity on the accounts (SIM card) for the students and teachers. Beyond that the government has started scaling up its interventions in this area: for instance, at the request of the MoER, the telecommunication companies have offered 50 GB of free internet access per month for the period March to May 2020 and 80 GB free Internet access per month for the period April to May 2021, to all teachers and students who expressed a need. In 2020, the government allocated MDL 20 million to purchase 3,180 laptops to ensure high-quality distance learning in general education institutions. Most recently, 55 schools were connected to the internet at a high speed of 1 GB during the period February to March 2022 by the *Connect your school to high-speed internet* with the National Center for Digital Innovation in Education and StarNet. Furthermore, in May 2022, another 35 schools have been equipped with internet by Orange Moldova, within the same project, with the same conditions of free use for 24 months. Connecting schools and equipping them with suitable ICT equipment has been a priority for the GoM as expressed in the Moldova 2020 strategy.

Technology infrastructure

85. **This sub-area covers digital devices, digitally enabled and digitally inclusive school facilities, and digitally connected school districts.** This is not only focused on individual or school-level computers, projectors, and whiteboards, but also includes components such as server farms, data centers, technical support personnel, as well as related monitoring and support mechanisms for implementation. This area was identified to be at *a latent level*.

86. **More and better devices are needed for students, teachers, and administrators in general education schools.** Students' familiarity with ICTs is limited by insufficient provision of computers and their use at a later age. Computers at schools are important to train students on programming and other important software applications across subjects and are increasingly required as a minimum proficiency level in the job market. Schools around the country had about 40,121 computers during the 2021/22 school year, of which 23,516 were used for teaching purposes (NBS 2021). The average number of computers used for teaching purposes per institution increased from 13 in 2011 to 24 in 2021, while the number of computers used for teaching purposes per 100 pupils also increased from 4.8 in 2011 to 9.0 in 2021. Although Chisinau has maximum number of computers compared to other parts of the country, the average number of students per computer is 31, while in the North, Center, and South, the number of students per computer are between 15 and 20 (Figure 20). PISA 2018 survey shows that only 4 percent of students had access to a computer at school on a 1:1 basis during the schools' activities, whereas a UNICEF report indicates that 121,444 computers are needed in schools in Moldova to reach the OECD average of 0.83 computer per student (Figure 21) (OECD 2020b).

Figure 20: Pupils per computer in primary and general secondary education institution by region

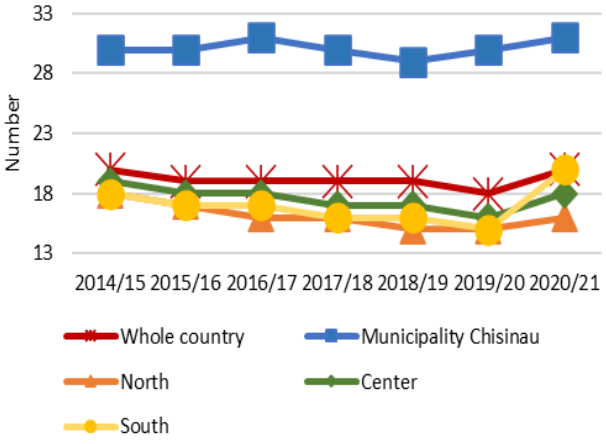
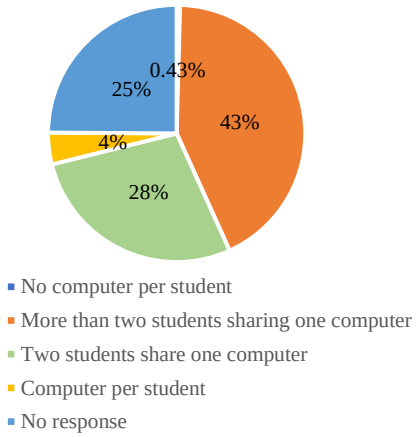


Figure 21: Proportion of available computers per student at school



Source: NBS 2021; OECD PISA 2018 database.
Note: Data are based on school principal's response.

87. **Most computers are outdated and many devices are also identified as dysfunctional, yet there is no clear mechanism and procurement process/strategy for upkeep, maintenance, upgrades, and replacements (Figures 22 and 23).** This relates to issues of wear and tear, aging, obsolescence of devices, which is especially important to be useful for teaching and learning, software provision, internet access, and so on. EMIS data[26] note that are over 65 percent of all desktop computers are over five years old and warrant replacement (UNICEF 2020). Furthermore, many of these computers were intended and adapted

[26] Desktop PC: Computers manufactured in the last 5 years, an EMIS indicator, has the value 5784 (Administrative data, MoER, February 2022). It is not clear when this data were measured and hence, should be taken as a rough estimate. There is another EMIS indicator, Desktop PC: Computers acquired in the last 5 years. It is not clear if a computer was acquired in the last 5 years, it would be an upgraded system and would meet the necessary standards.

for in-class use rather than distribution to students and teachers or use outside the classroom. This creates a significant impediment for students and teachers to process applications, access data and content that increasingly need high-capacity computing power.

Figure 22: The sufficiency of school capacity in digital infrastructure

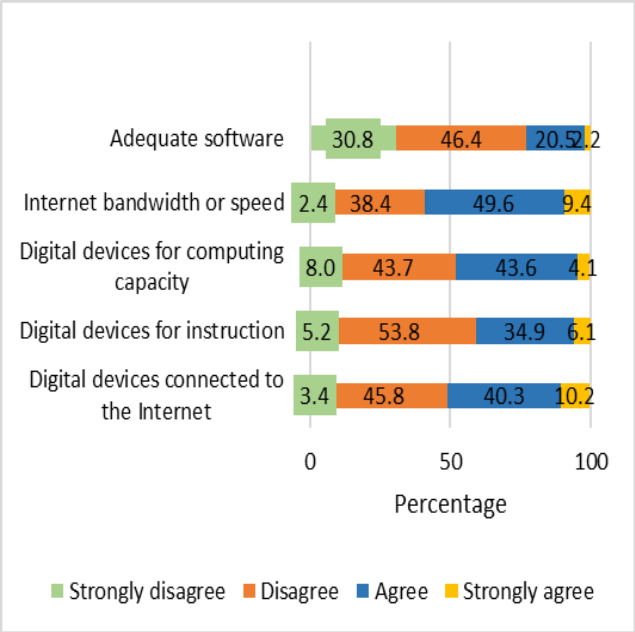
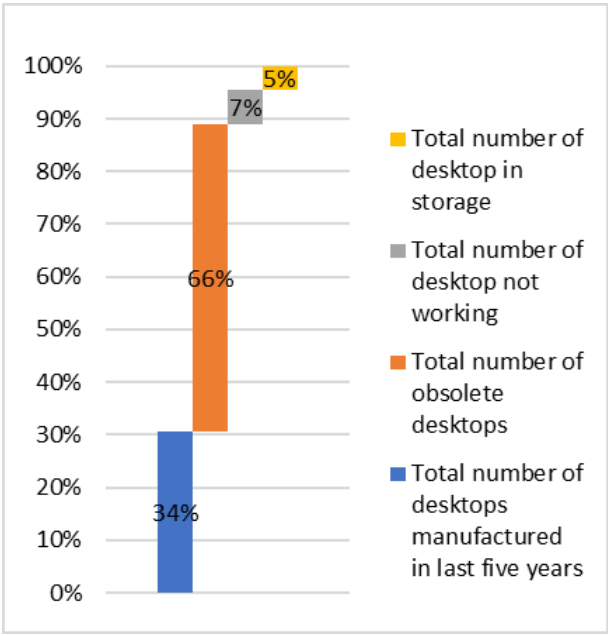


Figure 23: Desktops in Moldovan general education schools



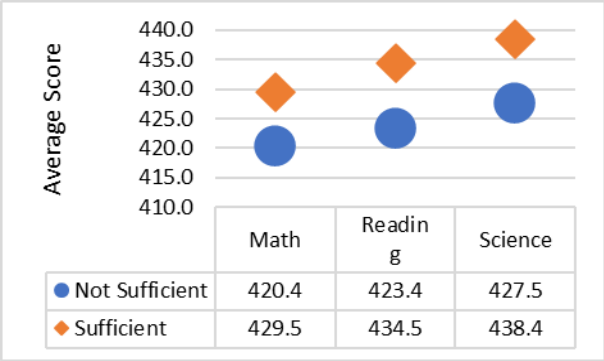
Sources: OECD PISA 2018 database; MoER EMIS data.
Note: PISA data are based on school principal's response.

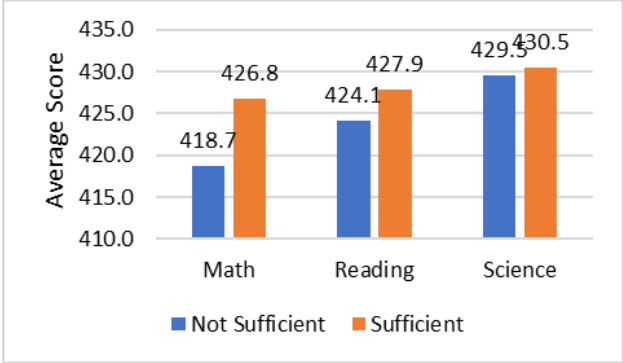
88. **There is no central system or mechanism to monitor the availability and usage of functional digital devices or of functional internet connections (speed and stability) in all public schools and no related provision for technical support**. Each community has been connected under different projects that were not integrated. Different schools are connected from different internet providers who do not monitor speed, quality and other parameters. Educational institutions purchase internet services, and the provider takes responsibility through the signed contract. This implies a large but fragmented network of connectivity services and hence results in loss of potential efficiency gains from economies of scale. Furthermore, over half of the survey respondents indicated no knowledge about the existence of such mechanisms.

89. **Adequate access to licensed software is the most acute problem, although other issues like speed of internet, and availability of sufficient and connected digital devices for instruction in school also are problematic.** PISA 2018 also shows that adequate software and higher computing capacity of devices used by students are positively associated with their learning scores across all subjects (Figures 24 and 25). Computing capacity has the greatest link with math scores for both boys and girls but has low association with reading and science. However, adequate software is found to be positively associated with both boys and girls, across all three subject areas (Annex 6). There is a need to monitor the share of schools that have access to licensed software. A distinction should also be made between general purpose software and educational software.

Figure 24: Sufficient number of educational software and students' learning outcome

Figure 25: Sufficient computing capacity of digital devices and students' learning





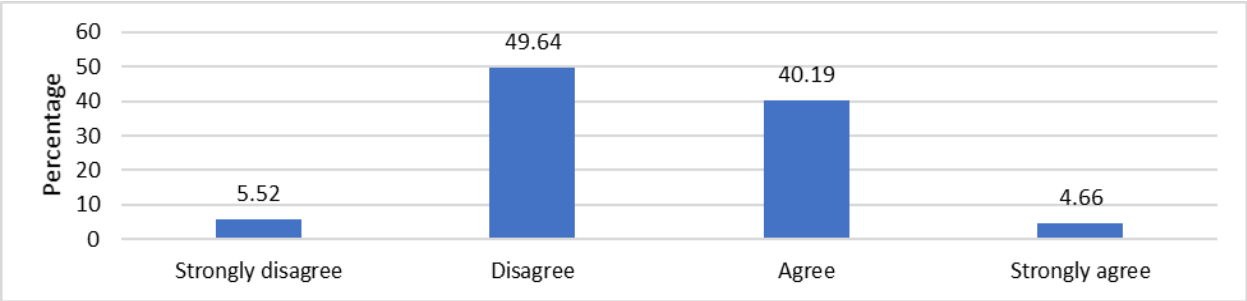
Source: OECD PISA 2018 database
Note: Data are based on school principal's response.

90. **A quarter of the respondents (25 percent) said that there are no special guidelines for adoption of digital devices and applications that can specifically cater to the learning needs of children with disabilities and children from other marginalized groups.** Over half have no awareness of such guidelines. However, there are general instructions on training children with special needs via distance learning that describe how to adapt digital devices. Around 100 local public schools have been equipped with electronic technology and specialized software to work with children with special needs.

91. **There is no active function of technical IT support to assist schools and national, regional, and local education administration with problems related to their technology infrastructure.** This pertains to hardware, software and applications, connectivity, and security. While some support exists, these are applied inconsistently. The country's cybersecurity service has developed some of the relevant mechanisms but cannot implement them widely due to the low capacity and capabilities in central and local public authorities and a lack of clarity on centralized and sustainable financing provision of such support. This issue is associated with the semi-decentralized[27] financing structure operational in practice, whereas technical IT support would likely be more efficient and effective if centralized. The PISA 2018 survey reveals that in half of the schools, there are insufficient qualified technical assistant staff to support schools' technology-specific activities (Figure 26). Furthermore, there are a 47,764 devices and equipment present in the 1,224 general education schools, based on MoER administrative data, as of March 2022. Of these, 1,431 are dysfunctional[28] or in storage, and yet a significant capital expenditure cost to the country. Consolidating the expenses to IT support can effectively help in managing the deployment, effective use, and maintenance of these devices and equipment and should be considered as part of the total cost of ownership.

[27] The primary and secondary education institutions in Moldova are financed based on GD 868/2014 and manage their own financial resources to a large extent. Respectively, each institution plans resources for infrastructure development. At the same time the MoER attracts partners to help institutions solve aspects related to ICT infrastructure.
[28] Of the 1,431 dysfunctional devices and equipment, 86 percent are desktops.

Figure 26: Sufficiency of school capacity in qualified technical assistant staff



Source: OECD PISA 2018 database.
Note: Data are based on school principal's response.

92. **The schools, subordinated institutions, and administrators do not have a shared network (such as an intranet) for data exchange, collaboration, and service provision and management**. Intranet is being considered, but currently they operated via emails. Institutionally, there are several gaps in areas, such as lack of a government domain email for each institution that can ensure secure communication, and a functional webpage (Figures 27 and 28). Although there is a catalogue of services such as MCloud, email, and e-signatures that are provided by the agency IT and Cybersecurity Services (STISC)[29], there is low awareness and the services is not widely used.

Figure 27: Distribution of general education institution by a .gov email availability

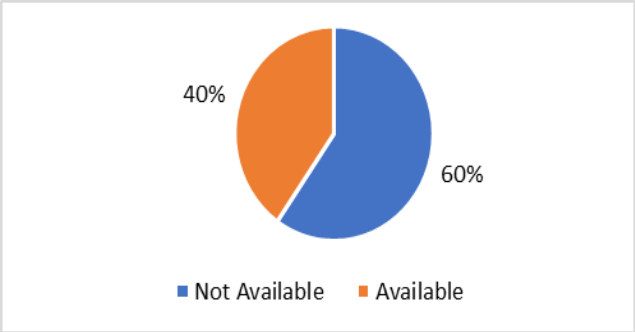
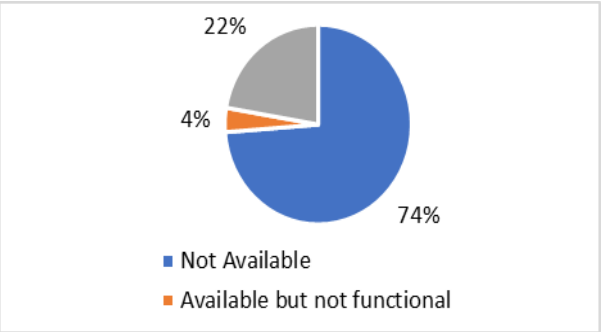


Figure 28: Distribution of general education institution by institution webpage



Source: OECD PISA 2018 database.
Note: Data are based on school principal's response.

Standards and interoperability across application, devices, and equipment

93. **Interoperability is the ability to share information and services through the development and use of data standards.** Standards enable consistent and accurate collection and exchange of information across systems.[30] This sub-area was identified at *latent to emerging level of readiness*. This includes the development and use of data standards that enable consistent and accurate collection and exchange of information across systems. This further includes mechanisms for information exchange across applications, devices, and equipment that support health, education, and social protection service delivery

[29] The STISC and eGA are founded by the State Chancellery and are in subordination of Deputy Prime Minister (DPM) for digitalization. The STISC is mainly responsible government-wide for the infrastructure (intranet, data centers, MCloud, PKI) and cybersecurity, as well as technical operation and maintenance of some sectoral information systems (ICMS, e-Integrity, and so on) and some official web sites (Government, State Chancellery, Line Ministries). The eGA is responsible for the development and maintenance of government-wide platform-level cross-sectorial system (MConnect, MLog, MNotify, MPass, and so on) and digitalization of selected administrative services (business registry, civil status documents, social assistance, and so on).
[30] This further includes mechanisms for information exchange across applications, devices, and equipment that support health, education, and social protection service delivery in the country. Defining the degree to which the information and services are to be shared is a critical architectural requirement, especially in a complex organization and/or extended enterprise.

in the country. Defining the degree to which the information and services are to be shared is a critical architectural requirement, especially in a complex organization and/or extended enterprise. This sub-area was identified at *latent level of readiness* with a sizable number of respondents indicating a lack of awareness in this area.

94. **Over half of the participants were unaware that there are commonly agreed principles and standards enshrined in the law for data interoperability applicable to all state information systems, including to education information systems.** The eGA, is recognized as the competent authority for data exchange and interoperability,[31] to ensure legal, semantic interoperability and establish the principles of organizational and technical interoperability. According to this 2018 Law, all state information systems, whether held by a public or private entity, are obliged (a) to integrate, from their own financial means, the information systems they have with the Interoperability Platform (MConnect) and (b) to ensure that any new information systems are interconnected and integrated with the Interoperability Platform (MConnect). This requires also ensuring that the necessary technical and operational conditions necessary for this exchange are met.

95. **The lack of common data standards, terminologies, and structures on education data is a significant barrier to advancement.** Education metadata is not standardized and integrated into all public informational systems. Such standards and structures would also be expected to contain specific provisions about management of information, design, data collection, data verification, archiving. Over 60 percent of respondents indicated no awareness or a latent level of readiness.

96. **There are very few specific and commonly agreed interoperability standards followed between education and other services.**[32] Almost 80 percent of all respondents indicated a lack of awareness or low levels of maturity in this area. For example, the interoperability of the EMIS sub-component called Automated Information System can only take place when the related conceptual documentation and government-approved regulations are adopted. There are some fragmented efforts, however, no systematic effort exists, for example, information systems are being implemented that will ensure interoperability between education and the department of labor, but a lack of data standards is likely to pose a challenge to integration efforts.

97. **Moreover, it is not clear if there is an entity with a formal mandate to develop and maintain the education data standards and other materials to support interoperability across the education sector.** Furthermore, over half of the respondents indicated that they were unaware of such an entity whereas the others identified the IT Department of the MoER and CTICE.

98. **Over 80 percent respondents noted that there is no standard package of software applications and tools used in schools to support the teaching, learning, and administrative functions of schools or indicated a lack of awareness of this.** However, there are notable bilateral agreements with Google, so that each institution can have a Google for Education account, including access to its learning tools. EMIS also contains the built-in electronic register, provided free of charge to institutions. There is a digital library EDUCATIEONLINE (https://educatieonline.md) developed at national level for general use of schools but there is no standard package of curated tools and applications that schools have access to through framework agreements negotiated by the MoER.

99. **MoER is represented in the 'digital public services portal' by two subordinate agencies but there is very low awareness (only 20 percent respondents).** This includes the Center for Information and Communication Technologies in Education (CTICE) offering information on authentication, and

[31] Interoperability is "the ability to share information and services." Organizational interoperability, ensured by legislation and general agreements, signifies the ability of organizations to use information systems for service provision to other organizations or clients. Semantic interoperability implies the ability of different organizations to interpret the exchanged data in the same way. Technical interoperability is based on the interoperability of infrastructure and software.

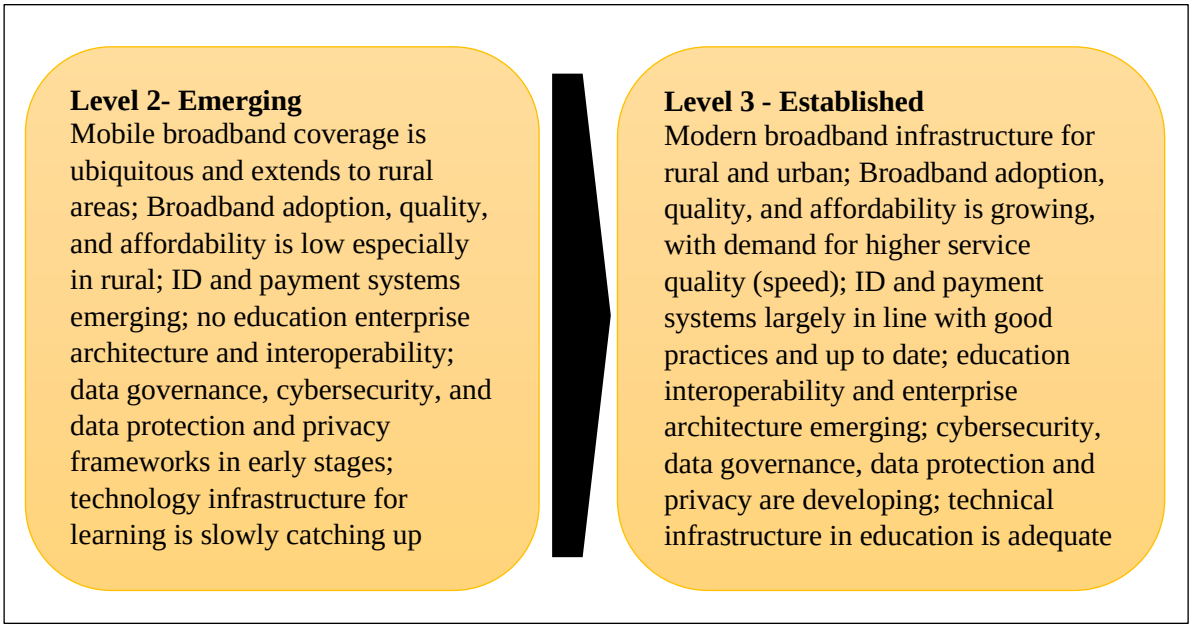
[32] Such as those in the labor dept., dept of social affairs or other relevant ministries.

personalization of study documents and recognition and equivalence of study documents and qualifications obtained abroad (such as necessary documents, tariffs, time for processing, location). Yet, CTICE's own digital platform allows digital verification of authenticity of the study documents issued by the MoER by entering personal data such as identification number (IDNO) and the series of the study document issued. This includes not only the Baccalaureate diplomas, but also the diplomas issued by the technical and higher vocational education institutions. Also, the ANACEC is listed for external evaluation of quality: in general, technical and higher professional education; continuing vocational training programs; research and innovation organizations; scientific and scientific-didactic staff. Overall, there is low awareness of the 'shared digital government platforms and applications' for education service use, although M-pass for authentication and M-sign for e-signatures in EMIS has been deployed in a limited way.

Recommendations and Actions

100. The below recommendations and actions have been identified to advance *enabling infrastructure* from current Emerging level to Established level of digital readiness of the education system (Figure 29).

Figure 29: Emerging to Established Digital Readiness on Enabling Infrastructure



101. ***Education enterprise architecture.*** **Strengthen implementation and monitoring mechanisms enabled by a well-designed enterprise architecture and related strategy**, including governance of education data and enhancement of digital capacity**.**

Proposed actions

- Undertake a diagnostic of the current education electronic data infrastructure (including EMIS, open educational resources [OERs], Learning Management Systems, Human Resource management systems, Open Data portal, National Bureau of Statistics databases, among others) and develop a data management and data use strategy.
- Develop an enterprise architecture for general education services. This should include data standards and mechanisms to connect fragmented systems to National Interoperability Service Bus.
- Assess EMIS resourcing, processes, and systems to determine the capacity needs, not only at the central ministry and agencies, but map this to rayon and school levels.

- Design and implement data dashboards that can support implementation and monitoring at district and local levels, improve decision-making, simplify documentation and reporting procedures.

102. ***Data governance.*** **Strengthen data governance ecosystem in education.** Governance of education data should be considered an area of highest priority and the specific gaps identified should be addressed.

Proposed actions

- Increase information sharing and intra-governmental dissemination of information on data exchange pillars, and the government's exchange platform MConnect collaboration for better coordination and strengthening of education service delivery. This can be achieved, for example, through an intra-governmental Steering Committee established under the Prime Minister's Office (see Box 5: Estonia Education Strategy 2021–2035).
- Operationalize collaboration with business and academia, securely and effectively.
- Promote the adherence to data privacy and protection policies for K-12 education sector data.

Box 5. Estonia Education Strategy 2021–2035: Management and Implementation

The implementation of the Education Strategy 2021–2035 in Estonia is coordinated by the MoER with implementation and reporting supported by a broad-based steering committee. It advises the Minister, supports the implementation of the Strategy by considering cross-sectoral links and impacts, as well as analyses reports and evaluates progress toward the objectives of the Strategy. The Steering Committee makes recommendations for the initiation, modification, and termination of programs, relying in these decisions on the performance reports linked to the Strategy, and assesses the modification and termination of the Strategy. The Steering Committee is composed of representatives of the MoER, the MoF, the Ministry of Culture, the Ministry of Economic Affairs and Communications, the Ministry of Social Affairs, the Ministry of the Environment, the Ministry of Rural Affairs, the Ministry of the Interior, the Government Office, the Estonian National Youth Council, the Estonian Language Council, the Estonian Chamber of Disabled People, the Association of Estonian Cities and Municipalities, the Estonian Employers' Confederation, the Estonian Chamber of Commerce and Industry, the Estonian Unemployment Insurance Fund, the Estonian Trade Union Confederation, and up to seven experts in the field.

Source: Republic of Estonia, MoER, n.d.
https://www.hm.ee/sites/default/files/haridusvaldkonna_arengukava_2035_kinnittaud_vv_eng.pdf

103. ***Connectivity.*** **Ensure affordable, high-quality, and stable access to high-speed internet for students, especially in remote and rural areas.**

Proposed actions

- Devise sustainable financing mechanisms that can reduce broadband costs.
- Ensure that all schools have enough routers and cables to ensure last mile connectivity to all the study rooms and common areas.
- Develop a mechanism to track the availability, quality, usage, and costs related to internet connectivity and provide support, such as through a helpline. It is also important to establish a mechanism to periodically ensure that devices provided for the disadvantaged and vulnerable students are functional, connected, and in use.

104. ***Technology infrastructure.*** **Provide education institutions with equipment and software products, as well as with ICTs.**

Proposed actions

- Develop and enforce clear standards on digital access. It would be useful to coalesce on a clear vision and guideline on the minimum digital environment for learners, at home and at school, with recommended specifications and cost estimates.
- Related to above, review and update the school ICT standards adopted in 2019 by the MoER before any new purchases are made. This should include a review of standards not only for desktop computers but include other individual devices like laptops and tablets, and other technical equipment and related software applications.
- Develop and implement a clear mechanism for monitoring the availability of functioning digital devices for students and teachers and their usage in all public schools and, relatedly, a strategy for obsolescence management.
- Develop and disseminate the standard package of licensed software applications and tools for schools, for educational purposes, as well as general purposes.
- Develop and implement mechanisms to assist schools with technology infrastructure problems pertaining to hardware, software and applications, connectivity, and security. Each school should have access to technical support for technology troubleshooting.
- Develop an intranet system for schools' administrators to have a shared network for data exchange, collaboration, service provision, and management.
- Extend the implementation of guidelines for adoption of digital devices and applications that can specifically cater to the learning needs of children with disabilities and children from other marginalized groups.

105. ***Standards and interoperability across application, devices, and equipment.*** **Harness the full value of data by ensuring standards are in place and implemented to unlock the potential interoperability offers in raising system effectiveness.**

Proposed actions

- Raise awareness and gain trust on the value added of standards and interoperability for core education service delivery through increased dissemination of the challenges in service provision, decision-making, and monitoring as well as qualitative and quantitative benefits such as efficiency and time-saving estimates.
- Develop and implement interoperability requirements and standards for education service delivery.

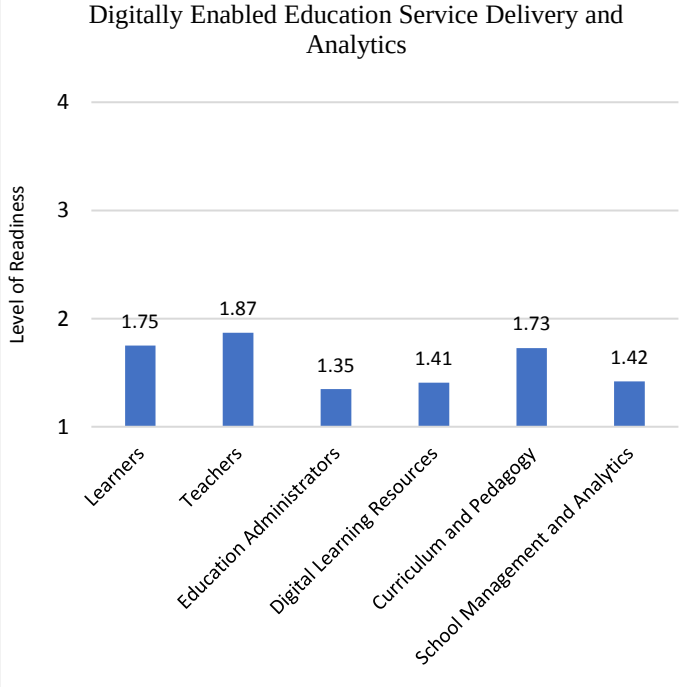
Pillar 3 - Digitally Enabled Education Service Delivery and Analytics

106. *When digitalization is embedded in education service delivery, it would enable personalization and dynamic response to the teaching and learning needs of students and teachers and better management and analytics to augment decision-making. The focus here is on the teacher, learner, administrator, curriculum and pedagogy, teaching learning materials, assessments, analytics, and school management. Hence, this pillar focuses on the demand side, that is, learners' and teachers' uptake, use and impact of digital products and services on their learning.*

107. Moldova was assessed on this pillar against five sub-areas: Learners, Teachers, Education administrators, Digital Learning Resources, Curriculum and pedagogy, School management and analytics. **The readiness level for this pillar is determined as emerging (Table 4).**

Table 4: Moldova's Pillar 3 - Digitally Enabled Education Service Delivery and Analytics score

Level 1 - Latent	Level 2- Emerging	Level 3 - Established	Level 4 - Advanced
Digital access and digital competencies in school and at home for students, teachers, and administrators is low; curriculum is not adapted; DLRs are very limited, and education data is not digitized.	Digital access and digital competencies in school and at home for students, teachers, and administrators are emerging opportunistically; curriculum adaptation and DLR development is still limited; and education data management is digitized with often one-way data flows.	Digital access, learning resources, and competencies in school and at home for students, teachers, and administrators are widespread and standardized to enable scale and equity; curriculum is adapted and integrated for ICT use; and education data and analytics support feedback loops for decision-making.	Digital access, learning resources, and competencies in school and at home for students, teachers, and administrators are widespread and standardized; curriculum is adapted and integrated for ICT use; and education data and analytics support dynamic feedback loops using frontier technologies.



Level 2 - EMERGING

Standardized average score = 1.62/4

Many *learners* have access to digital learning environments, but issues of quality, equity, and efficiency remain; competency frameworks under development and assessments are sporadic

Teachers have access to digital pedagogy and data literacy, but training, application, and use are not monitored, unclear impact on learning

Education administrators have access to digital tools, but application and use are largely opportunistic

There are no standards for *Digital Learning Resources*, both development and use are limited

Curriculum and pedagogy maybe de jure adapted to incorporate digital skills but limited in practice

School management data are digitized with often one-way data flows, *analytics* are ad hoc reports

Learners

108. ***There* is a policy on access to digital devices and internet connectivity for general education schools, but this is implemented inconsistently and lacks a monitoring mechanism.** A review of the existing standards of equipment and devices, software, and internet connectivity indicate these are not sufficiently specific and technical and do not respond to the learning, pedagogical, and administrative needs of the students and staff (MoER 2019a). For example, these documents specify one device per fifteen students, without clarifying the purpose and relevant technical details. It is also not clear what is applicable at the student, teacher, and classroom levels. Currently, students have access to available desktops in computer labs during Informatic lessons, but less so during the rest of the school day. Furthermore, there is no mechanism to monitor the level of implementation or support the financing needs required to meet such standards or assess the extent of relevance of the standards to learner needs. From the survey, almost 70 percent participants indicate non-existence of standards or indicate lack of awareness of this. In practice, there are sporadic efforts to equip schools, prompted in part by COVID-19 and are usually budget driven rather than needs driven. Similarly, on internet connectivity, there are no defined standards on the quality (speed, strength) and affordability of the connections. Hence, schools are likely to be very sensitive to market forces, both in terms of cost as well as bandwidth, given internet access is negotiated by individual schools with different ISPs instead of as part of a centralized or rayonal aggregated agreement with telecom providers (MoER 2019b). There is also no indication of how the policy and standards will enable an equitable distribution, especially in remote and rural areas. A clear vision and guideline on the minimum digital environment for learners, at home and at school, with recommended specifications and cost estimates are needed.

109. **There is a mechanism in EMIS to track the provision, usage, and functional status of devices including laptops, desktops, pads, projectors, and interactive whiteboards. However, these may or may not be connected to the internet, although all schools have fiber optic internet provision**. According to the MoER data, distribution of type of device seems largely fit for purpose—more desktops are provided in the computing labs in schools, more laptops are made available for distribution and use by students, teachers, and administrative staff. However, tablets (Pads) are much more limited in number, despite their greatest advantage in terms of ease in mobility. These could be carefully considered and evaluated for supporting monitoring activities in the country. Also, almost 4,000 laptops are identified as stored or not working. In terms of availability of interactive whiteboards and projectors, these are tracked but there is no information about usage, relevance for teaching and learning, and related impact on learning. Overall, there is no mechanism to track the availability, quality, usage, and costs related to internet connectivity and provide support such as through a helpline. It would also be important to measure distribution of devices for the disadvantaged and vulnerable students.

110. **Finally, since 1:1 device provision by the State is not mature yet, policies and standards related to 'bring your own device' (BYOD) in schools, particularly for secondary schools, could be evaluated for relevance, with careful consideration of the risks and benefits, in the Moldovan context (Figures 30 and 31).** There are serious risks of worsening inequity among students in a school environment, as well as risks related to IT safety and network security. For example, students who own no or outdated devices will have to use State-provided devices, but this can lead to unintended consequences, if not managed carefully. Low teacher capacity to manage and take advantage of device use in classrooms is also a significant constraint. Relevant IT safeguard policies and procedures need to be established, consistently implemented, and monitored at the school level, making this more challenging, especially in rural and remote areas. However, these risks have to be balanced with the benefits of cost-effectiveness and the advantages of familiarity and seamless use for students both inside and outside school. At the minimum, establishing and implementing a BYOD policy[33] and an Acceptable Use Policy to protect students and schools is necessary.

[33] See example of a BYOD policy adopted in Fairfax County public schools in the USA: https://www.fcps.edu/resources/technology/bring-your-own-device-byod

Figure 30: Distribution, usage, and active status of digital devices in general education

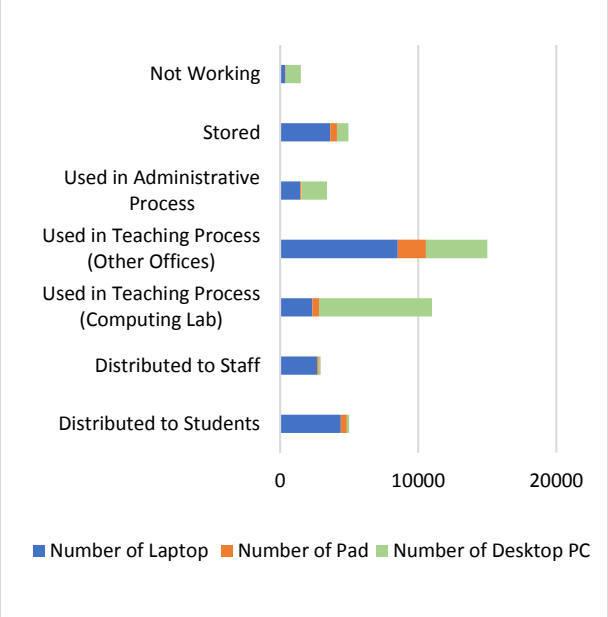
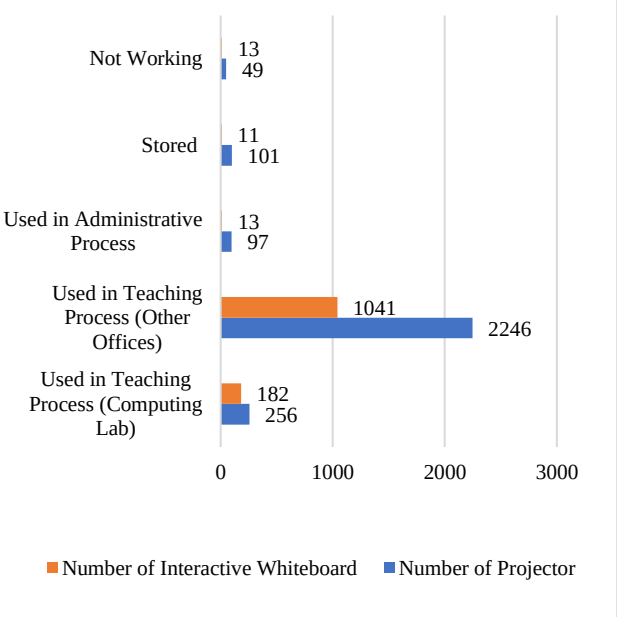


Figure 31: Status of projector and interactive whiteboard in general education institutions



Source: OECD PISA 2018 database.
Note: Data is based on school principal's response.

111. **The home digital learning environment of learners in Moldova is more strongly associated with better outcomes than a school digital learning environment, based on pre-pandemic data from PISA 2018 (Figures 32 and 33).** Although learners are learning digitally at home and at school in Moldova, these may have different impacts on the outcomes. There is a consistent higher performance by those students who had access to a quiet place to study, had a computer at home, had access to software and internet than those who did not. The average score difference between those with and without access is greater at home than at school, across all three variables analyzed – access to devices, internet, and software. The differences are larger for the lowest SES quintiles, that is, the bottom 40 percent by SES who have least digital access at home. The survey responses for the question, "when outside school, to what extent do poor and vulnerable learners have access to devices and connectivity for the purpose of academic learning?" 40 percent respondents indicated that this information is not being collected, whereas another 40 percent indicated no awareness on this. See Annex 6 for complete analysis.

Figure 32: Home digital learning access and student learning outcomes

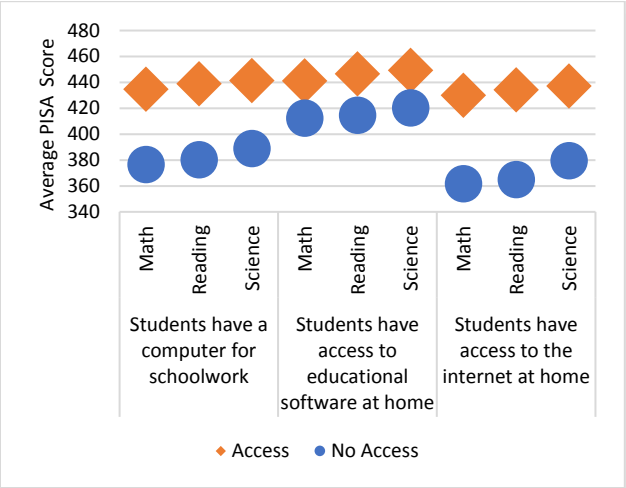
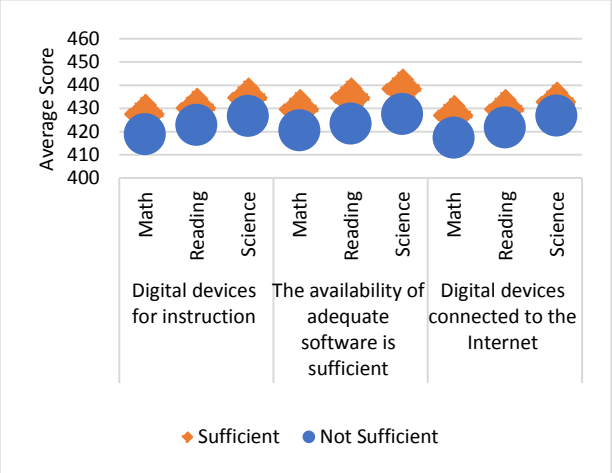


Figure 33: School digital environment and student learning outcome



Source: OECD PISA 2018 database. See Annex 6, Figure 46 and Figure 47 for details.

112. **In the Republic of Moldova, there was no provision for distance learning or for digital learning environments at home in general education prior to the pandemic, although regional disparity in access to devices and internet at home is high.** About 71.5 percent of the wealthiest households have computers compared to 35.7 percent of the poorest households. Moreover, about 90 percent of households with higher education and only 25 percent of households with primary education have computers. Hence, the access for vulnerable children to devices and internet connectivity at home received greater prominence when the pandemic[34] struck. However, it is quite conceivable that the most vulnerable with no or limited access to a home digital learning environment were removed from any structured learning opportunities and suffered substantive learning losses.

113. **Better learning outcomes are associated with access to a digital learning environment, especially at home.** Only about 65 percent of Moldovan students have access to the internet at home (Figure 34). The gap is even larger for students from the poorest SES quintile compared to students from the wealthiest quintile (Figure 35). Among all SES quintiles, students who had access to a digital learning environment (access to the internet, a computer, educational software, and a quiet place to study) performed better across all subjects, indicating that there are potential effects that need to be isolated and evaluated. Additionally, learning outcomes are more strongly associated with access to computers and internet at home than at school. Thus, it is critical to provide quality and affordable access to connected devices for learning at home for the most vulnerable, such as through social support schemes. This signifies the importance of using technology for supporting learning recovery for vulnerable students, such as through small group online tutoring programs in the short term that can be delivered flexibly inside or outside school.

[34] During COVID-19, in 2020, from the state budget resources and the PRIM project, financial resources were allocated for procurement of laptops (in the context of the pandemic, it was necessary to help more educational institutions that had vulnerable children). Also, via the World Bank, 10,000 laptops were distributed to vulnerable groups. Under Tekwill, a Digital Labs initiative (fully equipped classrooms for IT-related classes) was implemented in 19 schools at USD 25,000 per school. This came as a need because 10,000 students claimed they do not have access to devices.

Figure 34: Distribution of households with internet connection by location

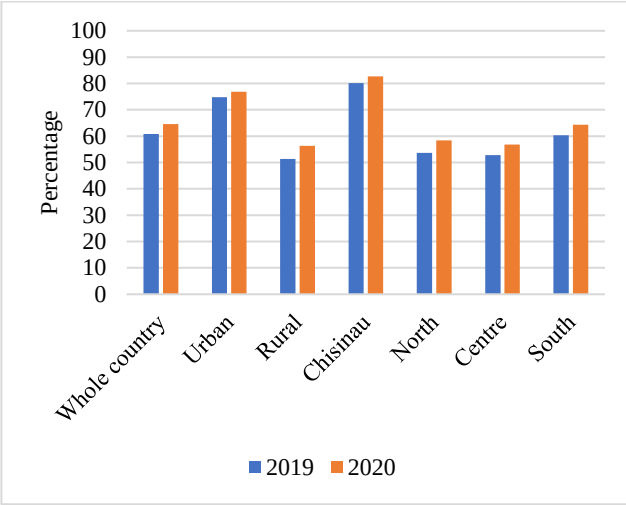
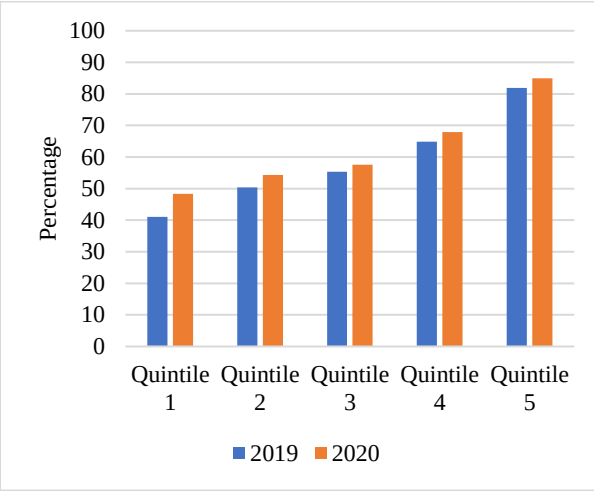


Figure 35: Distribution of households with internet connection by SES



Source: OECD PISA 2018 database.

114. **To ensure strong reading performance, digital learning tools should complement paper-based formats.** Based on PISA 2018, only 40–70 percent of Moldovan students reported engaging in specific digital learning activities in school (Figure 36). Nevertheless, students who indicated a higher frequency of digital activities, such as using online search engines for information had higher reading outcomes. Further, average reading outcomes based on the reported modality of reading, digital or paper-based, indicates that paper-based reading should not be undermined for learners even when digital access is ubiquitous and that digital tools for reading must be complementary to paper-based formats (Figure 37).

Figure 36: Distribution of students reporting digital learning activities in school

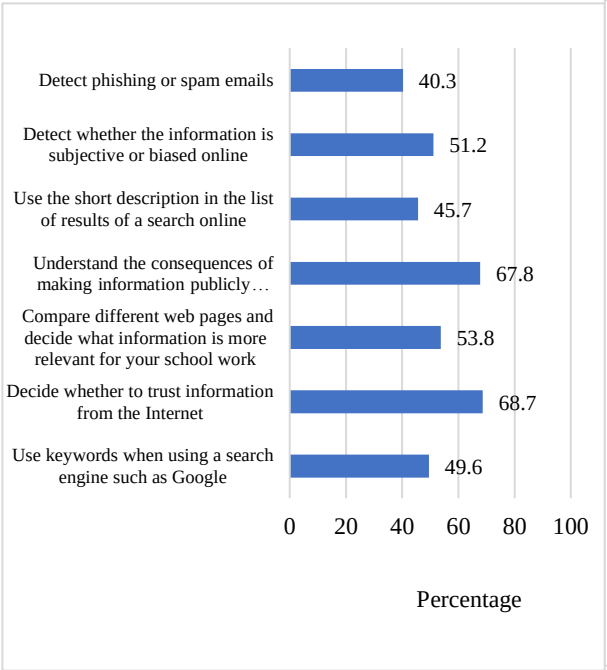
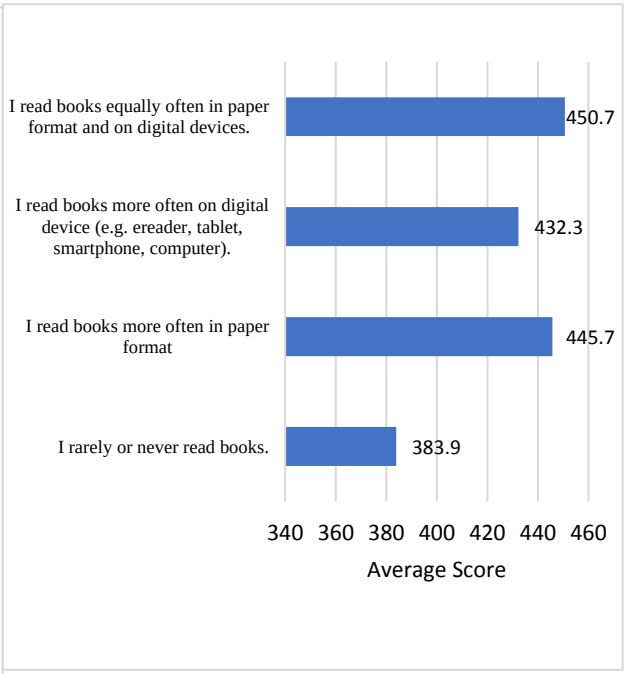


Figure 37: Book reading habit and reading performance



Source: OECD PISA 2018 database.

115. **More in-depth analysis regarding the acquisition and application of digital and data skills by students is needed.** While over 60 percent of survey respondents noted that most students usually acquire basic digital skills (for example, internet use, email, word processing, presentation software) and most use digital competencies and data skills as transversal competencies in their coursework on other subject areas (for example, in the study of math, science, music, language), this is not systematically assessed in line with the digital competency framework (MoER 2020b). Notably, the Informatics curriculum was developed in accordance with the digital competence standards, including those recommended by the EU. However, the digital competency standards were developed in 2015 by the MoER and need to be updated. Also, Digital Education modules for grades 1–4 are being implemented in a phased manner, including digital support for students and teachers, as well as training courses for teachers to teach the Digital Education module. There is a need for monitoring to determine the extent of implementation in schools.

Teachers

116. **It is unclear to what extent teachers have and use digital pedagogic competencies and data literacy skills in their practice and more in-depth analysis is necessary.** Individual teachers may use freely available online trainings and assessments on digital pedagogy and data skills as per their interest levels according to 43 percent of survey respondents. While all public-school teachers are required to complete trainings on digital pedagogy[35] skills and data literacy as part of their professional development, it is not clear how many do so and to what extent this is applied in teaching (Figures 38 and 39). This was complicated by the COVID-19 context where these skills were necessary to conduct virtual classes but also could be used to teach digital skills to students as part of the learning process. To address some of these challenges, during the pandemic, the MoER and Centers for Continuous Education of Teachers provided an opportunity to all teachers to participate in the National Digital Literacy Program[36] and various trainings were organized by Future Classroom, Agiro.md, Tekwill, and so on. All pre-service and in-service teacher training programs include training on how to develop digital skills and implement ICT in education.

Figure 38: Availability of training programs for teaching and learning in digital education

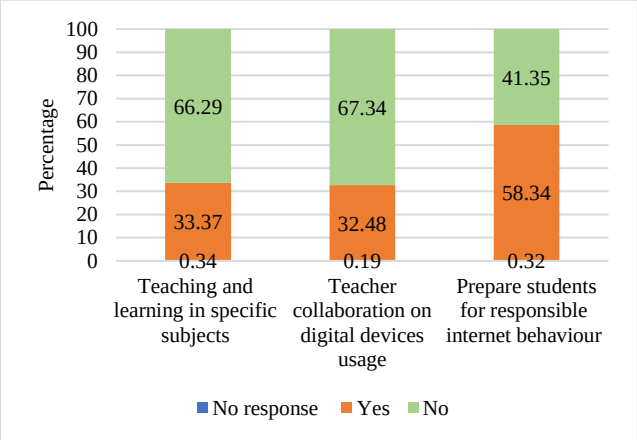
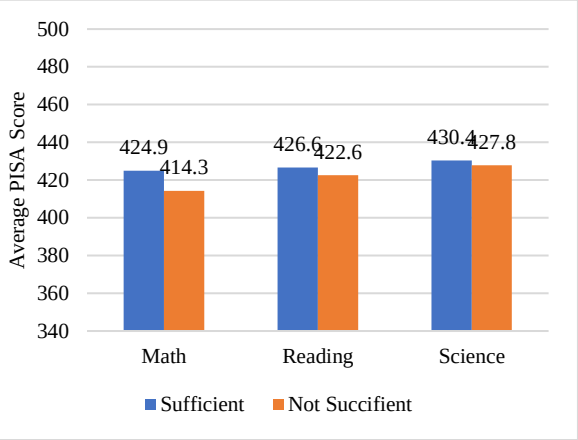


Figure 39: Adequacy in teaching of digital skills and students' learning outcomes



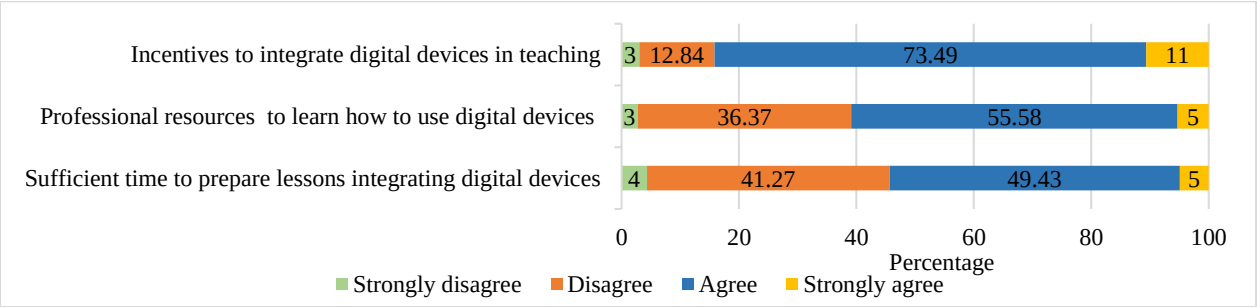
Source: OECD PISA 2018 database.
Note: Data are based on school principal's response.

117. **Moldova's digital pedagogy skills competency framework does not include specific data literacy competencies and is not actively applied, used, or assessed.** About 40 percent of respondents indicated that they did not know this framework existed. Moreover, over 75 percent of survey respondents

[35] Digital pedagogy is the study of how digital technologies can be used to best effect in teaching and learning.
[36] The National Digital Literacy Program is not an official national program approved by the government and published in an Official Gazette. It is the title given to a range of activities carried out within certain projects.

indicated no awareness or systematic approach of assessments related to the Informatics course. For example, it is not clear to what extent basic (such as, using email and search), intermediate (such as, using basic IT tools and applications), and advanced skills (such as, computational thinking, programming languages, coding) are assessed. Further, there may be existing tools and mechanisms to assess the level of competency in digital pedagogy skills and data literacy in teachers, but it is not clear when and by whom these are applied (Figure 40). Only 25 percent of survey respondents indicate that there is an assessment for teachers, whereas only one respondent indicated the availability of certificates and resources for strengthening and advancing these skills.

Figure 40: Sufficiency of school capacity in digital education teaching support

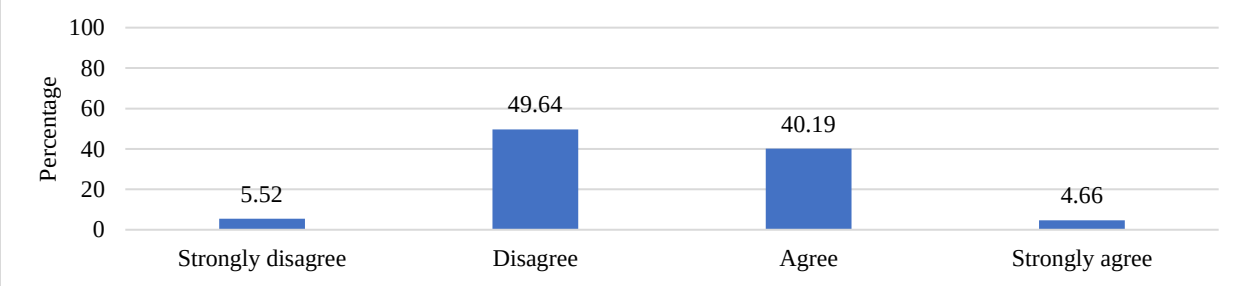


Source: OECD PISA 2018 database.

Education Administrators

118. **All public-school administrators are offered trainings on digital skills and data literacy as part of their professional development such as in leadership training and continuing education programs.** Half of the respondents indicate that administrators may use freely available online trainings and assessments on digital and data skills as per their interest levels with 22 percent stating that this is not a requirement for the role. Although there are available trainings offered, there is no information on the level of participation and extent of use of digital skills and data literacy for administrative work and for teaching and learning. Moreover, nearly half of the principals indicate that the digital capacity of school administrators is not sufficient (Figure 41).

Figure 41: Sufficiency of technical capacity of qualified administrative staff



Source: OECD PISA 2018 database.
Note: Data are displayed at student level based on school principal's response.

119. **There is no competency framework or systematic assessment of digital skills and data literacy tailored for administrator needs in general education.** Some training provided through continuing education programs aims at the development of needed skills for data entry and data analysis. About 47.8 percent do not know about the assessment tool for administrators whereas 43 percent indicate that no such assessments exists. The most acute issue with administrators is that they are not remunerated for this activity, but the workload is high. This maybe a possible reason for high staff turnover in this position.

Box 6. Support teachers to strengthen pedagogical and administrative practice (UK, Spain)

In the UK, skilled teaching staff are vital in determining the quality of digital education. To strengthen the pedagogical and administrative practice in education using technology, the UK partnered with the Chartered College of Teaching to launch a free online training course available for all teachers and education leaders. This training course strives to improve the use of technology in teaching alongside other training opportunities offered by the ICT industry. Additionally, the UK has also been supporting the BESA LearnED program, which brings together teachers and industry to showcase EdTech products and best teaching practices using technology through eight accredited continuing professional development roadshow events free of charge. Teachers and education leaders are invited to observe a range of technology in action and share practical technology-based teaching practices with each other. The UK will also launch a network of 'demonstrator' schools to showcase best teaching practices using technology, with the support of the EdTech Leadership Group. The network will draw on industry expertise and learning from various school leaders. The 'demonstrator' schools are expected to leverage the scales and provide peer-to-peer support and training programs to their visiting schools.

In Spain, ICT is compulsory in initial teacher education, designed with a mixture of a theoretical and a hands-on approach to enable future teachers to be capable of using ICT in class. Over the initial teacher training, primary teachers are required to take at least a one-semester subject covering ICT in education. Secondary school teachers must take a course to learn how ICT can be integrated into the teaching of their subject of expertise. On the contrary, ICT in in-service teacher education is not compulsory, where courses are widely offered by expert teachers and occasionally by university lecturers at national and regional levels. Teachers can sign up for the ICT courses provided by educational authorities (online or face-to-face) according to their preferences and needs.

Sources: Hinds 2019; European Schoolnet 2018.

Digital Learning Resources

120. **All students and teachers have access to some digital learning resources, but the quality and variety is quite limited.** There are various initiatives on educational portals, but they are not centrally managed. Furthermore, these resources exist in siloes and are connected through a single access portal. There is potential to enhance the usefulness and effectiveness of these DLRs by considering a shared network platform delivering these through a single access portal, leveraging online social connectivity and interactivity features, among others, that can enhance student and teacher experience. There were four educational resources referenced frequently by survey participants. These are as follows:

- https://educatieonline.md/ In 2021 MEC invested 5 million lei in the development of this platform and is the co-owner and implementing partner of the project with the City Hall of Chisinau Municipality. It covers all the grades and all the disciplines, however, not all the topics from the curricula are covered. The digital library contains 7,674 video lessons: 4,512 in Romanian and 3,162 in Russian.
- http://ctice.gov.md/ This site contains the textbooks in electronic version for all the grades and all the disciplines.
- https://studii.md/ This site reproduces the same information as CTICE with additional options related to Electronic Catalogue for students as well as online courses for most grades and disciplines, but not for all topics.
- https://platformeonline.md/ This site offers some resources and options for teachers' communication and tools for development of assessment quizzes.

121. **There are no access and quality standards for DLRs for general education, although there are ongoing discussions to develop such standards. Also, there are no clearly defined procedures for aligning and updating digital educational resources in line with curriculum requirements**. This would

include aligning relevant curricular disciplines such as science, technology, engineering, art, mathematics (STEAM) subjects with digital competencies, considering also issues of inclusion such as those related to local culture or language, and adaptations for students with disabilities.

Box 7. Develop open educational learning resources for digital education (Romania)

Romania has initiated various projects to develop open educational resources (OERs). The digital platform for OER—Virtual Library—was launched for the gymnasium cycle of education for two years, with a total value of nearly €100 million financed by European funds. Digital textbooks for pre-university education have been freely available to download from the Ministry of Education website since 2014. The textbooks law adopted in 2019 specified digital textbooks as OER in Romania. Digital textbooks are available for 26 disciplines in 9 languages of national minorities and are being tailored for pupils with hearing disabilities.

The primary drivers of developing educational learning resources are individuals and CSOs. Association for Technology and Internet (ApTI), an independent NGO, contributes to improving digital policies and practices in Romania. ApTI has been actively engaged in operating OER-related training for librarians and higher education staff. Though a national OER repository has not been implemented yet, Romania has established collections of OER on the websites of the counties' inspectorates. Many online communities and private companies are the leading players in initiating the directories and projects for providing open access to digital resources for the pre-university level. For instance, a digital education program funded by Orange (https://digitaliada.ro), an online community for the primary education sector (https://kidibot.ro), and a platform for publishing educational digital textbooks (https://livresq.com).

Source: Grosseck, Holotescu, and Andone 2020.

Curriculum and pedagogy

122. **A new competency-based curriculum was introduced in 2018 and is being implemented nationwide taking a phased approach**. This curriculum focuses on students' ability to think critically, computationally, and innovatively, and hence a separate teacher's guide to support classroom practice maybe considered useful. This is relevant as the skills needed to teach a competency-based curriculum among teachers are developing, teachers often do not have continuous coaching and classroom observational support and can have wider responsibilities that constrain their capacity to effectively adopt and apply the curricular revisions in their individual professional practice. Recognizing this, the MoER has elaborated methodological guidelines on the implementation of the curriculum (MoER 2018). However, these are aligned with the now-expired 'Education 2020' Strategy and should be updated. Local public administration, schools, and teachers have been made aware of new curriculum. Given the phased rollout, grades 1–4 have been implemented and other grades will be able to adopt the new curriculum in due course.

123. **ICT-assisted instruction is integrated into the education curriculum, but its implementation is not sufficiently supported and monitored.** According to the curricula, there is a computer science course covering digital skills, computer skills, and other skills. Starting with first grade, this Digital Education course is required to be implemented in all Moldova schools from 2018 (MoER 2019a). Despite the new curriculum's focus on STEM education, it continues to be a low priority in practice. The new curriculum emphasizes STEM subjects, including Informatics, and is a departure from the previous general education curriculum, which was skewed toward the humanities. Nevertheless, only in 2021, the distribution of hours came to a balance—in previous curriculum twice as many teaching hours were allocated to humanities-related disciplines than for STEM disciplines, on average.

124. **There is a separately developed competency framework for digital skills for students which is applied in a limited way and not evaluated.** The MoER developed these standards for primary,

secondary, and high school students in 2015. These should be implemented by all teachers for all disciplines according to the Curriculum Reference Framework for implementation of national curriculum. At the same time, the curriculum for the Informatics discipline for all grades was also revised and placed on the MoER website. According to the new Reference Framework of 2018, but also of the new Curriculum developed in 2018 and 2019, it is well-recognized that digital competencies in students develop transversally, with regard to all school subjects, not only in the discipline of Informatics. Relatedly, methodological guidance on school subjects describes ways of implementing ICT in the teaching-learning-evaluation process. These are relevant policy actions. Yet, the challenge of monitoring and support for effective implementation remains.

125. **There is an attempt to emphasize students' ability in critical thinking, computational thinking, and innovative thinking as part of the new curriculum, but teaching and students' assessments continue to follow traditional methods**. Despite the training conducted for teachers and principals, teachers' methods remain mostly didactic with learning activities based on the teachers' delivery of the course information to students via lecturing. There are no clear guidelines on class practice.

126. **More teachers and students have access to the tools and equipment required to participate in blended teaching and learning effectively compared to the pre-pandemic situation**. **However, there are large regional and institutions disparities.** For example, there are institutions in Chisinau that have 100 percent coverage with computer technology, but there are villages that have institutions with few students in classes and only a few computers. Rural remote areas are relatively worse off than urban areas. Among survey respondent, approximately 70 percent of respondents state that 40–70 percent of teachers and students have access to the tools and equipment required to participate in blended teaching and learning effectively.

127. **The purpose and opportunities lent by digital communities of learning (such as a sense of community and collaboration) in a blended setting are relatively less known.** About 43.5 percent respondents indicated a lack of awareness. At the same time, another 48 percent indicated different levels of access to information and resources for students to connect and participate. It may be that the pandemic context of school closures has created new opportunities to explore innovative mechanisms for communication and engagement, which should be explored and exploited to promote interactive learning.

School Management and analytics

128. **While school management practices require the use of ICT for teaching and learning activities as well as for administrative and management activities, there is no monitoring and evaluation of implementation practices.** There is a general guideline on managing teaching and learning activities using ICT in schools however implementation has been challenging for a variety of reasons. In terms of administrative work, there is a list of digitalized education services with certain centrally driven services and others by local LPAs. For example, the enrollment registration for kindergartens and schools is performed exclusively online in Chisinau, but this is not implemented outside Chisinau (as the service was developed, owned, and managed by the city authorities).

129. **Furthermore, the use of EMIS is largely limited to inputting data from schools to enable the central ministry to collect data, analyze, and make centralized policy decisions.** This is limiting because the value of data in EMIS could be powerfully deployed for electronically managing a variety of school related information analyzed for supporting learning and managerial decisions. At the next level of maturity, an upgraded EMIS could be seamlessly integrated into an education service delivery platform for both top-down and bottom-up information flows to support learning and enable managerial and policy decisions.

130. **There are persistent issues with maintaining data integrity in EMIS that need to be addressed in a cost-effective and sustainable manner.** Data integrity refers to consistency of data on the same

variables collected from different sources (Annex 1: Glossary). Implemented since 2016, EMIS is at an emergent level of development and use. As mentioned in the analysis under *Pillar 2 Enabling Infrastructure*, data governance and interoperability mechanisms will enable taking the EMIS to developing and advanced levels of maturity. Data-based decision-making can only become prevalent when data analysis and data literacy are prevalent.

Box 8. Management and learning analytics for school management in Turkey

Turkey is equipped with a well-developed national EMIS, which is the foundation of educational opportunity for a large number of out-of-school children and children refugees from Syria. The EMIS is designed with seven modules in administration, ministry/local authority, school process, student information, enrollment, examination, and reporting to collect, record, analyze, report, disseminate, control, monitor, and manage students' data. The enrollment module can locate out-of-school children automatically based on children's school enrollment status and home address information stored in the information system of the Ministry of the Interior. Meanwhile, the EMIS initially consists of e-Okul for formal education and e-Yaygin for non-formal education. Education Management Information System for Foreign Students (YOBIS) was developed in 2014 to be a complementary system collecting key educational data on Syrian students under temporary protection and Syrian volunteer education personnel working in temporary education centers (TECs). YOBIS tracks the attendance and performance of refugee children enrolled in TECs and helps students without valid ID numbers to enroll in Turkish public schools. YOBIS is compatible with e-Okul, and the data from the two systems can be integrated. The attendance records in YOBIS are further applied to monitor the attendance of students enrolling in the conditional cash transfer for education program.

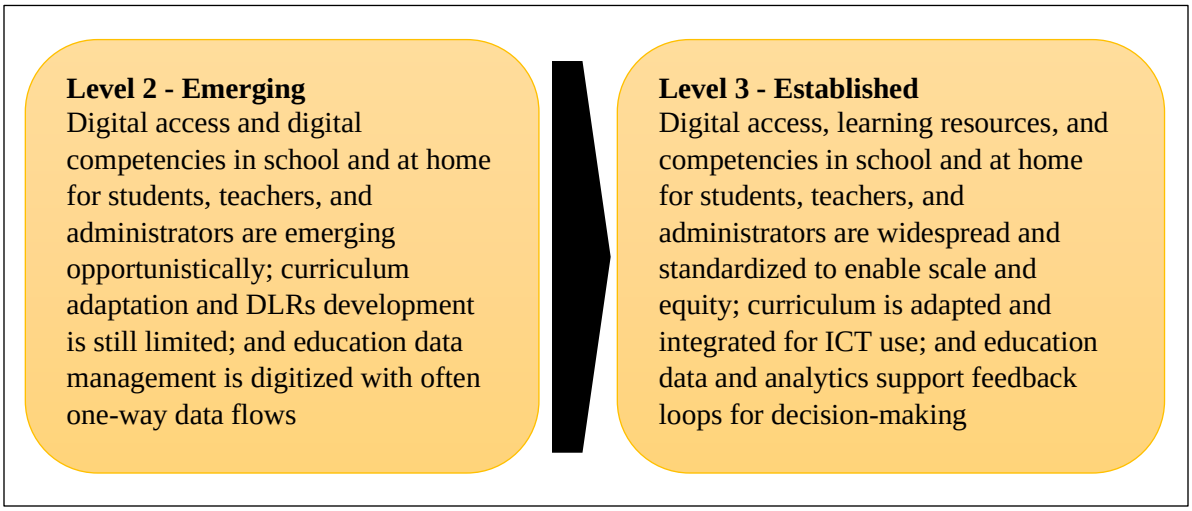
Furthermore, Turkey has advanced its plans for better school management to develop digital education after the pandemic. First, Turkey plans to systematically integrate data from existing systems within an easily accessible *Educational Data Warehouse*, which will also run an analytic learning platform to evaluate students' data on their academic performance, interests, talents, and temperament. Meanwhile, online platform for school-level database management with analytics and dashboarding capabilities will be built for the ministry and school administrators to monitor implementation and progress made in school development plans. Furthermore, a qualification-based evaluation system is to be established to identify, monitor, and support children's qualifications in all courses and education levels. An e-portfolio will be prepared to monitor, evaluate, improve, and orient the child from early childhood until the end of upper secondary education (Ministry of National Education of Turkey, 2019, p. 30).

Source: Government of Turkey and UNICEF 2019; Durnali 2013; OECD 2020c.

Recommendations and Actions

131. The below recommendations and actions have been identified to advance *digitally enabled education service delivery and analytics* from current Emerging level to an Established level of digital readiness of the education system (Figure 42).

Figure 42: Emerging to Established Digital Readiness on Digitally Enabled Education Service Delivery and Analytics



132. ***Learners.*** **Focusing on learning recovery in the immediate term is critical while also preparing the ground for more systematic changes to learner's digital experience and learning, especially for the disadvantaged.**

Proposed actions

- Focus on digitally enabled education services for learning recovery in the pandemic context of learning disruption through small-group high-dosage tutoring for the most disadvantaged, vulnerable, and at-risk students, including refugees, by leveraging PPPs for design and delivery of students' support.
- Develop a strategy and a costed action plan to identify and support students who do not have computers and a broadband or 5G internet connection at home, such as provision of study place in institutions after class. Mobilize local libraries, community centers, youth clubs, and other venues.
- Conduct an in-depth analysis on the acquisition and application of digital and data skills by students as this is currently not assessed in line with the digital competency framework for students.
- Develop a clear vision and guideline on the minimum digital environment for learners, at home and at school, with recommended specifications and cost estimates, complementing the provision of paper-based books with digital learning materials.

133. ***Teachers.*** **Develop and implement an efficient human resource and performance management system in the teaching profession from the perspective of promoting innovations, teaching excellence, and meritocracy.**

Proposed actions

- Strengthen digital pedagogy skills competency frameworks through allocation of resources, implementation plan, certificates, and link to incentives, and include as part of hiring strategy of new teachers and as part of promotions.
- Develop a micro credential system to assess the capability of all teachers to have and use digital pedagogic competencies and data literacy skills in their professional practice.
- Develop a system for yearly continuous professional development in digitalization of teacher practices, using professional trainers, classroom observation tools, and coaching, based on differentiated level of competence.

- Design and implement a mechanism to identify effective young teachers and incentivizing them to teach remotely to students in rural areas in several subject areas, including in Informatics and in the application traversal digital skills.

134. ***Education Administrators.*** **Develop and implement an efficient human resource and performance management system in the education administrative function from the perspective of promoting innovations, administrative excellence, and meritocracy.** Digitalization often entails an organizational and cultural shift demonstrated by the leadership at various levels, rather than only a techno-pedagogical shift among service delivery staff at the school level.

Proposed actions

- Develop a digital and data competency framework for education administrators through allocation of resources, implementation plan, certificates, and link to incentives and include as part of hiring strategy and as part of promotions.
- Develop a system for yearly continuous professional development in digitalization of education pedagogical and administrative leadership practices, using professional trainers and coaches, based on differentiated level of competence.

135. ***Digital Learning Resources.*** **Strengthen the quality and learning experience from digital learning resources.**

Proposed actions

- Develop access and quality principles and standards for DLRs for general education.
- Develop a clear mechanism for aligning and updating digital educational resources to the curriculum requirements, local culture, or language, and adapting digital educational resources to students with disabilities.
- Consider connecting existing resources via a shared network platform delivering these through a single access portal for all students and teachers, leveraging online social connectivity and interactivity features, among others, that can enhance student and teacher experience.
- Monitor and support teachers in development of digital learning materials and apply them in the classroom. Develop teachers' capacity to elaborate DLRs and establish standard resources.

136. ***Curriculum and pedagogy.*** **Strengthen the curriculum and pedagogical practices for digitally enabled learning.**

Proposed actions

- Emphasize students' ability in critical thinking, computational thinking, and innovative thinking. In this sense new teaching models should be developed to support constructivist learning approaches.
- Review and revise periodically as needed the competency and curriculum framework to incorporate digital skills in (i) informatics with a purpose, (ii) as transversal skills relevant to learn specific subject content, and (iii) as a way to live and work.
- Set up a mechanism to monitor and evaluate the implementation of the digital skills competency framework for students.

137. ***School management and analytics.*** **Enhance the effectiveness and efficiency of the education management system to support better learning outcomes by developing the data and technology foundations to support better analytics and decision-making.**

Proposed actions

- Develop digital monitoring and assessment tools for school management and analytics at the level of school managers and administrators, leveraging data and interoperability to enable continuous improvements in the system performance.
- Develop an incentivized program for advanced ICT expertise and capacity development at the national, regional, and local levels to be able to act as 'translators' that can lead and implement policy and strategy enabled by technology solutions but rooted firmly in equitable and high-quality learning for all.
- Consider an upgraded networked education information system that can be seamlessly integrated into an education service delivery platform for both top-down and bottom-up information flows to support learning, enable managerial and policy decisions.

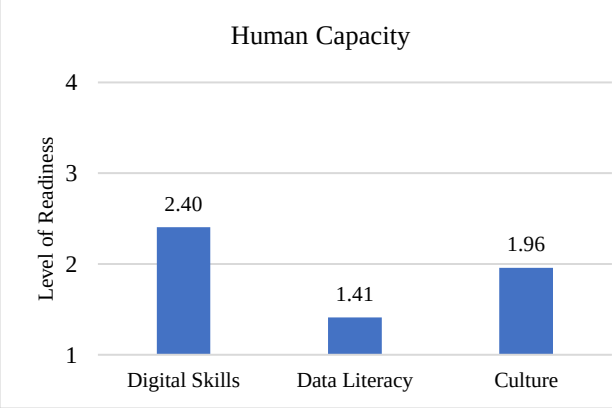
Pillar 4 - Human Capacity

138. *This pillar covers the knowledge, skills, and capacity of a wide range of stakeholders to collaborate to bring the vision of digitally enabled education to life and an environment that fosters a focus on the service users, incentivizes collaboration and inclusion, and uses evidence to manage change. Foundational literacy, data literacy, digital skills, and social emotional skills that are needed for successful technology uptake, adoption, and use. Culturally, fostering an environment that focuses on the user, develops a calculated risk appetite for innovation, incentivizes collaboration, attempts to increase trust in governance and data, and takes an evidence-based approach for managing change and disruption.*

139. Moldova was assessed on this pillar against three sub-areas: Digital Skills, Data Literacy, and Culture. **The readiness level for this pillar is determined as emerging (Table 5).**

Table 5: Moldova's Pillar 4 - Human Capacity score

Level 1 - Latent	Level 2 - Emerging	Level 3 - Established	Level 4 - Advanced
Digital and data literacy is a challenge among large portions of the population and advanced skills are scarce; collaborative and data-driven innovative practices are not the norm.	Basic and intermediate digital and data literacy is growing; advanced skills are still scarce; collaborative and data-driven innovative practices emerge in small pockets.	Basic and intermediate digital literacy is widespread; data literacy is growing; demand for and supply of digital talent increases; collaborative, data-driven, and user-focused innovations in education are rewarded and promoted.	Intermediate digital and data literacy skills are widespread; consistent demand for and supply of digital talent in both public and private sectors; talent pool and demand for advanced digital skills is growing; collaborative, data-driven, and user focused innovations in education are rewarded and promoted.



Level 2 - EMERGING

Standardized average score = 1.92/4

Basic and intermediate *digital skills* and *data literacy* are growing; advanced skills are still scarce

Culturally collaborative and data-driven innovative practices emerge in small pockets

Digital Skills

140. **Several government agencies are actively engaged in the development and implementation of the country's digital skills strategy.** The Information and IT Department is an MoER sub-division in charge of digitalization and collaborates with main stakeholders at the national level, such as the Deputy Prime Minister for Digitalization, eGA, and IT and Cybersecurity Service. Furthermore, digital skills are incorporated in the curriculum through the Informatics discipline as well as through all other school subjects, recognizing that these develop transversally in students. Basic digital skills development among students is a responsibility under the MoER and begins in grades 1–4, with compulsory Digital Education modules and in later grades through methodological guidelines for school subjects that describe ways of implementing ICT in the teaching-learning-evaluation process (MoER 2020b). To implement this, there are coordination mechanisms between the national and local levels to advance digital skills. However, capacity

is extremely limited in terms of human and financial resources. Nevertheless, the eGA is mandated to promote innovation and e-government products in the public sector and society, organize training related to the development and implementation of electronic public services and information systems, and organize trainings on the implementation of minimum cybersecurity requirements for cybersecurity coordinators in public authorities. Furthermore, the eGA structure includes the Institute of Innovation and Training in Digital Governance, responsible for the development and implementation of training programs, development and consolidation of basic digital skills to reduce the digital divide, promote digital governance solutions and products, ensure assimilation and widespread use of information solutions. The unit is required to serve as a focal point for all training and professional development initiatives in the field of digital governance, both for the public sector, the private sector, academia, and civil society in general. Thus, in practice, digital skills promotion and development in Moldova is governed primarily by the MoER and eGA.

141. **The domestic and international private sector is actively engaged in Moldova to ensure digital skills plans meet workforce needs and companies' technology deployment plans.** The private sector plays an important role in the development of a competitive and higher-quality workforce. They most often collaborate with universities, modifying existing programs and providing resources for the student scholarship and in response to skilled labor. One-third of survey respondents consider that the government agencies actively cooperate with the private sector including CSOs to meet the workforce needs especially the needs of vulnerable groups (for example, ethnic minorities, persons with disabilities, women) usually implemented through collaboration memorandums or agreements. Often-cited examples are the ISPs Orange Moldova, StarNet, and Moldcell, which offer support for the implementation of the digital literacy program for teachers; the National Association of ICT Companies, a private sector consortium of ICT companies, that helped aggregate educational video content to facilitate distance learning during the pandemic such as through http://educatieonline.md/ implemented by the MoER, the City Hall of the Municipality of Chisinau, and the National Center for Digital Innovations in Education 'Class of the Future' (Collaboration Agreement in 2019 and 2021) as well as through the Tekwill project; a Memorandum of Understanding entitled 'Development of Digital Skills, IT and STEM throughout Life' was signed by the Ministry of Economy and Infrastructure, the MoER, the National Association of Information Technology and Communications Companies, and the Tekwill ICT Training and Innovation Centre in July 2020, in response to the COVID-19 crisis, to provide information on the development of digital teaching aids and equipment for the introduction of digital education at all school levels.

142. **To develop digital skills, specific training programs are offered by different stakeholders regularly to teach and improve digital skills in addition to digital skills forums, yet the demand for skills needs far exceed supply.** Over 60 percent of survey respondents responded affirmatively that most individuals have basic digital skills and few have intermediate digital skills, indicating a strong coalition and a *developing level of readiness* in this sub-area. Basic and intermediate digital skills education is included in formal general education curriculum. In addition to this, basic and intermediate digital skills are also offered by non-formal education (for example, public libraries, community technology centers, NGOs and clubs, and makerspaces), targeting learners without age limitation. On advanced digital skills, most respondents note that these training are integrated into higher education, technical and vocational schools, and employers with apprenticeship programs. In addition, it is also offered by coding bootcamps and other commercial training programs, and makerspaces to align with the needs of the industry.

143. **Given the pace of growth of the ICT sector in Moldova (2,400 companies with over 30,500 employees in the IT sector, and a share of GDP of about 7 percent), it is essential that the supply of advanced ICT skills keep pace with technology innovations and labor market needs.** However, the number of students in ICT-related specializations represent only about 5 percent of the total number of students enrolled in higher education, although 62.54 percent of females enroll in HEIs at the master's level and 56.85 percent females at the bachelor's level (NBS 2020, 2021). This is a far cry from the real needs of the national economy and requires dedicated attention to STEM education in schools, with a special

focus on girls. The curricular topics on advanced digital skills should be reviewed periodically to catch up and keep pace with labor market needs.

Box 9. Establish public-private partnership for education development (The Netherlands)

In the Netherlands, in response to the growing need for a larger number of STEM graduates and higher-quality training practices, several government ministries and leading larger and medium-size companies in the industry are forging closer relationships with public education. The PPP centers are established at schools providing upper-secondary VET and higher professional education in collaboration with various-sector private companies. The PPP centers are supported by state grants and co-financed with private capital, aiming to enhance product-market and educational innovation through a structural exchange relationship between schools and the labor market. The approach of PPP centers is diverse and autonomous to create their own market niche and value. The centers are allowed to provide paid services to the private sector. Currently, there are more than 160 operational PPP centers across the country, involving over 9,800 companies, 5,000 teachers, and 84,000 students. An average PPP center engages 35 companies and other organizations.

Source: van der Meer et al. 2020.

144. **Despite a wide range and variety of digital skills training programs, developing teachers' digital skills continues to be a challenge, especially in rural schools where the proportion of older teachers is high.** Of the total number of teachers in primary and general secondary institutions in 2021, over 19.5 percent were 60 years and older, of whom about 20.5 percent were in village schools and 18.4 percent in city schools. Their proportion is more than double compared to young specialists up to 30 years of age, and 26.7 percent of teachers are expected to reach retirement age in the next decade. Past qualitative research studies conducted by the Center of Sociological Investigations and Marketing Research (CBS-AXA) on the quality of education in rural Moldova indicate that older teachers may be more reluctant to engage in in-service training opportunities, including in the use of participatory methods and application of the competency-based curriculum and maybe reluctant to use ICT in their pedagogic process. Teachers are essential in the educational process and hence, the quality of teachers in the country may be considered a significant barrier to advance learning outcomes for students fit for the 21st century.

145. **In the ICT sector, women and girls are under-represented in the labor market accounting for only 31 percent of the jobs and only 19 percent of the digital professions. In stark contrast, in the education sector, women account for 86 percent of all teaching staff (NBS 2020, 2021).** The low presence of women in the labor market in the ICT sector and their high presence in the education sector is indicative of the relatively low participation rate of girls in higher education in STEM subjects with ICT specialization. As a result, women in the sector may have lower-skilled and lower-paying jobs, respectively, including in the education field. The share of women with higher education working in the labor market in the ICT sector is 10 percentage points lower than the share of men with higher education, and women's salaries are 38 percent lower, which is the largest wage gap in the national economy (NBS 2020). Meanwhile, the ICT sector pays women, on average, almost twice and men three times the average salaries in the education sector (2020). Together, these factors lead to a disadvantageous recursive loop and impose severe structural limitations on the ability of the education system to digitally transform itself to become both the producer and employer of people with digital skills and data savvy. The role and value of the teaching profession and within that the role and value of the traditional 'IT/Informatica teacher' also come into prominence.

146. **The low participation of girls in ICT-related STEM specialties creates profound gender imbalances on the labor market in the ICT sector.** The probability that female graduates would choose a profession in the field of core sciences and engineering is five times lower, and that they would choose a profession in the field of IT is ten times lower. Girls are less likely to choose ICT-related STEM courses both in higher education and in VET programs, although their net enrollment at these levels is higher than

males. In HEI, the share of females enrolled in higher education in ICT as a general field of study associated with STEM in 2019/20 was only 20.7 percent (NBS 2020) whereas the share of females registered in post-secondary Technical Vocational Education and Training in ICT-related fields of professional training associated with STEM such as 'using a computer' and 'creation and administration of databases and information networks' was 9.5 percent and 21.1 percent respectively (NBS 2020).

Box 10. Several national digital training and validation programs have been highlighted to develop digital skills of teachers:

- National Digital Literacy Program https://mecc.gov.md/ro/content/programul-national-de-alfabetizarea-digitala-continua-prin-etapa-ii-destinata-cadrelor started in 2020 with the support of UNICEF and USAID. In the first phase 20045 teachers in general education were trained: 3, 000 teachers took the initial digital literacy course, and more than 17, 000 - intermediate and advanced level, based on the Google toolkit for education. In July 2021, the program entered its second phase focusing on early education institutions. The program contains 90 hours of training;
- https: //ceiti. md/validare-competente/ - Validation of IT competencies acquired in nonformal and informal context offered by VET Center of Excellence in ICT;
- https: //fundatia. orange. md/fundatia-orange-moldova-dezvolta-abilitatile-digitale-ale-cadrelor-didactice-din-moldova/ - Internet provider, Orange Moldova, is developing IT skills of teachers;
- https: //egov. md/ro/communication/news/formarea-competentelor-digitale-un-obiectiv-important-activitatea-age – E-gov is providing training for the development of digital skill;
- VET Center of Excellence in ICT (CEITI) is providing continuous training for teachers from of different disciplines in for development of digital skills of VET teachers https://ceiti.md/language/en/continuous-formation/;
- In addition, the Class of the Future and Educational Robotics programs trained teachers from more than 200 schools. There is a network of 9 Fablabs, plus the Tekwill program in each school.

Source: MoER.

147. **Development and implementation of specialized programs to develop digital skills, encouragement and preparation of youngsters, especially girls for ICT studies under STEM programs demonstrates positive impacts and need to be promoted (ITU 2018)**. Continuation, support and extension of such initiatives as the Tekwill project, the Tech Women Moldova platform, the National IT Training Program for Girls and Women, the 'GirlsGoIT' Program, and others implemented and supported by development partners, academia, the private sector, and NGOs encourage girls to test STEM professions, inspire them to choose ICT studies and careers, create effective digital skills development platforms, ensure interaction with private ICT companies, and prepare for the inclusion of participants in the labor market and overcoming stereotypes in society.

148. **Moldova's education system needs to become both a rapid producer and an avid[37] consumer of digital and data skills.** However, there is a very limited availability of human resources with intermediate and advanced ICT skills to work in digitalization initiatives in general education—teachers, administrators, Information Ssystems management functions, data intermediary functions, among others. This is likely the biggest barrier in advancing the growth path for Moldova's economy since it affects both the supply and demand side simultaneously. This maybe potentially addressed by employing a combination of solutions such as (a) importing talent; (b) designing a mechanism to identify effective young teachers and incentivizing them to teach remotely students in rural areas in several subject areas, including in Informatica, and in the application traversal digital skills; and (c) opening all doors to encourage, support, and incentivize young females in Moldova to enter the STEM fields from lower secondary school onwards to join both the ICT workforce and the education system. However, wage differentials between these sectors

[37] This includes due consideration and management of increasing issues in the digitally enabled settings such as mis- and dis-information.

may not disappear any time soon and implies additional incentives are needed to encourage more qualified digitally skilled personnel—both male and female—to enter the education workforce.

Data Literacy

149. **Overall data literacy is likely at an emergent level of readiness and there are not many data specialists hired in the education system.** Although data literacy skills training is carried out for relevant government officials in the education sector and integrated into teacher training programs, there are no specific assessment tools that are widely applied to personnel in the education system to determine the level of competence of teachers, school managers, and other administrators at the rayonal level. For example, majority of respondents indicated that there is low awareness of the need for and importance of data cleaning before processing for analysis. Notably, more advanced data analysis skills are at a latent level of development, for example, ability to clean and combine large datasets using automated scripts such as clustering, forecasting, and working with advanced statistics, skills often needed to analyze and draw value from education datasets. Related to data ethics and security management there is some awareness of the impacts of data use, but much needs to be done.

150. **Data-based decision-making can progress when data literacy skills that enable reflection and interpretation are developed.** There is a growing awareness for critically assessing data outputs and interpreting results. Skills and competencies related to data visualization across the education system are available but varied, from abilities to find specific outputs based on information that needs to be represented (for example, written, numerical, and graphic) and abilities to create interactive charts/dashboards manipulating data through multiple software (for example, Excel, Google charts, Tableau).

151. **Data literacy can be offered as a specific training program to different stakeholders regularly to teach and improve digital skills using the state-owned Distance Learning Platform (e-Learning) (MoER 2020c).** The e-Learning platform is a government-owned platform information system designed to provide efficient, reliable, and modern employee training mechanism to create, develop, and share online training resources, as well as provide public employees access to information for professional development. The basic objectives of the e-Learning platform are (a) diversifying options and increasing access to the process of professional development of public administration employees and (b) digitization and automation of the professional development and certification process.

Culture

152. *This section is not an in-depth review of the nuanced cultural aspects that affect digitalization in the education system of the economy of Moldova. This must be consumed from the lens that it represents an aggregate view of relevant and purposefully selected technical experts in education digitalization efforts, since often, digital transformation is more an organizationally and culturally led change management effort than a technological one.*

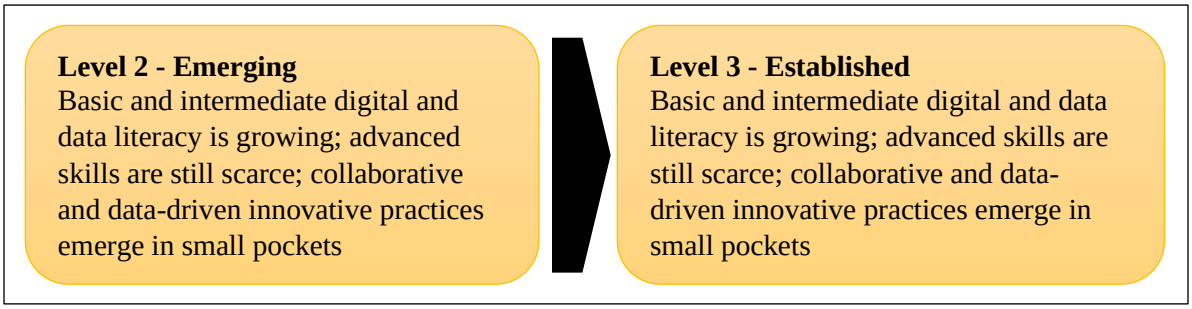
153. **Although 50 percent respondents indicated that there is an attempt toward collaboration, with experts sharing knowledge openly when it is needed, there are no performance-driven mechanisms to drive results and impact for teachers and for administrators with 46 percent respondents indicating no awareness.** On promotion, provision, and incentives across the education system for engagement with new and emerging technologies, most responded that some selected individuals are offered such opportunities. On the question of whether user-centered design of education service delivery is valued and incentivized, 37.5 percent respondents indicated no information while 25 percent respondents said that feedback and complaints are systematically recorded, analyzed, and used to improve user-centered design of education delivery especially for the most marginalized. On the question on the value and support for innovations and new ideas in the education system, participants were mostly equally distributed, yet indicating that there is strong hesitation to question the status quo and often difficult to get buy-in for innovations. To the question of how individuals perceive risks and failures associated with

innovation: 17 percent perceive innovations as high risk, 21 percent respondents consider that individuals attempt to work with innovation, but they try to disguise the mistakes associated with innovation, while 29 percent respondents state that it is considered 'safe to fail', innovation is encouraged and incentivized, and individuals can openly discuss their failures with coworkers and collaborate on new solutions, without retaliation whereas 29 percent respondents do not know. A meager 4 percent indicate that individuals consider failure as part of learning and can engage in an open discussion on failures.

Recommendations and Actions

154. The below recommendations and actions have been identified to advance *human capacity* from the current Emerging level to a more Established level of digital readiness of the education system (Figure 43).

Figure 43: Emerging to Established Digital Readiness on Human Capacity



155. ***Digital skills and data literacy.*** **Continue to develop and implement specialized programs to develop digital skills and data literacy.**

Proposed actions

- Adopt a capability-based approach to delineate responsibilities between ministries and agencies under MoER and non-MoER including for budget and resources to capitalize on the unique strengths of these institutions, with a clear focus on advancing digital skills outcomes.
- Design and offer a certification-based digital skills and data literacy course and a certification on data ethics and security management tailored for the education system users, as a specific training program to different education stakeholders regularly to improve these skills using the state-owned Distance Learning Platform.
- Encourage and prepare youngsters, especially girls for ICT-related STEM study programs.
- Open all doors to encourage, support, and incentivize young females in Moldova to enter STEM fields from lower secondary school onwards to join ICT and/or education workforce.
- Develop and assess students', teachers', and administrators' skills on data processing and use, including analysis, visualization, and interpretation for decision-making.

156. ***Culture.*** **Recognizing that digital transformation is more an organizationally and culturally led change management effort than a technological one, many micro-, meso- and macro-level practices maybe needed over the long term for sustainable shifts.**

Proposed actions

- Modernize the administrative functions of public education by recognizing and strengthening existing talent through targeted capacity development as well as importing relevant talent from other public institutions and departments on secondments or through external hires.

- Hire more data specialists and keep a strong communication relationship for effective feedback loops with non-specialists to manage the data pipeline, support proper interpretations. and overall advance the culture of data-based decision-making process.

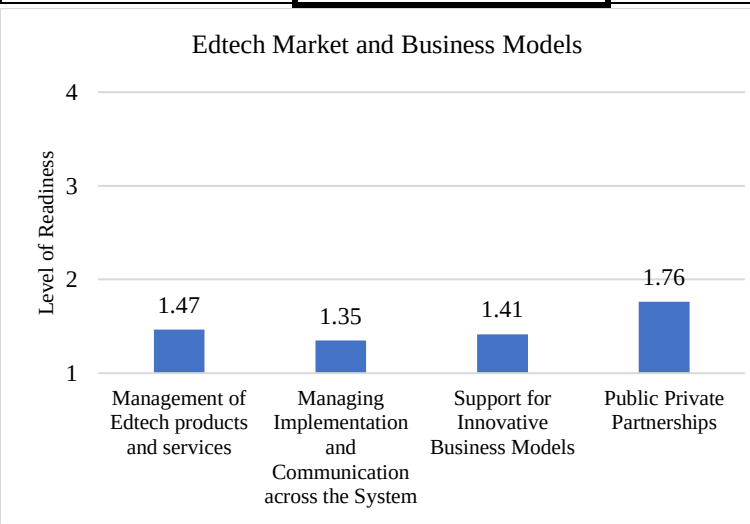
Pillar 5 - EdTech Market and Business Models

157. *This pillar focuses on the appropriate selection and procurement of relevant EdTech products and services in the market and objective ways of matching these to identified needs. It also briefly covers the support for innovation and equitable distribution of education technology products and services including access to capital and viable business models for the private sector (for profit and non-profit) to produce consistent revenues, particularly in the early stages. These business models could be sustained in a variety of ways—through direct consumer purchasing power, government procurement or grant programs, or private investment, or some combination thereof.*

158. Moldova was assessed on this pillar against four sub-areas: Management of EdTech products and services, Managing implementation and communication across the system, Support for innovative business models; PPPs. **Readiness level for this pillar is determined as emerging (Table 6).**

Table 6: Moldova's Pillar 5 – EdTech Market and Business Models score

Level 1 - Latent	Level 2- Emerging	Level 3 - Established	Level 4 – Advanced
Digital services industry/tech sector is practically non-existent including in education; no practice of needs assessments of learners, teachers, schools; and no active management of EdTech tools and services.	Digital services industry/tech sector to service education sector needs is emerging, early stages of EdTech management, such as a library of tools; and ad hoc needs gathering.	There is a vibrant digital education services industry/EdTech sector; EdTech management is systematized with inventory databases and needs assessments.	There is a vibrant digital education services industry/ EdTech sector; EdTech products and services are systematically managed using inventory databases, needs assessments, and vetting and effectiveness measurements.



Level 2 - EMERGING

Standardized average score = 1.46/4

Management of EdTech products and services is not systematized and there are a variety of tools and services that are procured and used by the public system in a fragmented manner, without a clear sense of purpose, use, impact

Managing implementation and communication across the system is nascent

Support for innovative business models is developing*; Public-private partnerships* emerge opportunistically

Management of EdTech products and services

159. **The Republic of Moldova is in the latent stages of development and use of 'EdTech'[38] products and services with most respondents stating that the country is in the early stages[39] of EdTech management and does not have any formal systems or processes for this.** Since the system is semi-

[38] Educational technology (commonly abbreviated as EdTech) often refers to a variety of products and services that support learning.
[39] For reference, the Advanced stage is described as, "We have a database that classifies all products and services, tracks product/service usage for our students and educators, enables access to individualized student data, and provides a system for us to regularly run analyses on EdTech usage, cost, and impact." The Developing stage is, "We have an organized database that tags products and services by category (e.g., subject, grade level, platform, and privacy status), and indicates whether they are approved for use." The Emergent stage, "We have a library of EdTech tools that provides information on each product."

decentralized in practice, the schools may or may not be autonomously purchasing EdTech tools for supporting teachers, students, and school management activities. For example, this could be tools for conducting formative assessments, for tracking student attendance and observations on a weekly basis, for language support such as dictionaries, for managing school calendars and schedules, for managing equipment inventories, and thousands of other functions. Thus, there are no formal systems or processes for organizing and managing EdTech tools (43 percent respondents). Responses to survey questions in this sub-area related to inventory management, tracking, and request and review processes indicate high divergence and low awareness.

160. **Both the supply and demand for EdTech tools and services is nascent with most respondents indicating that a systematic needs assessment should be prioritized as well as finding the EdTech tools and services that meet those needs (48 percent respondents).** At the same time, around 40 percent indicate that the management and analysis of the tools currently in use should be prioritized. Currently, the basic needs of the various stakeholders for tech products and services—students, teachers, administrators, teacher colleges, accreditation agencies, and so on, including from an equity standpoint are determined using ad hoc sources collected via the MoER and technical assistance projects as indicated by a third of respondents. However, one-third of respondents do not know how the needs for EdTech are identified while another one-third of respondents mention that the education system is developing a needs assessment tool for this purpose.

161. **It is not clear how decisions on procurement or in-house development of EdTech products and services are made. Data used to buy EdTech tools and products are based on tracking some product usage, but mostly rely on recommendations from peers and colleagues (47.8 percent respondents).** Responses indicate that decisions are based on perception of needs and ad hoc market information such as cost, reputation, while there may also be processes to determine information on readily available tools such as usage, functionality, cost, but these cannot be easily compared with related estimates of building in-house products. About 60 percent say that the method for piloting and evaluating new EdTech products is based on isolated product pilots and evaluations, but often without clearly defined research questions or that there is no consistent method. The process for ensuring legal compliance of EdTech products like those for student data privacy and accessibility is also less known. There is a high divergence in awareness of processes for keeping track of contracts, costs, renewals of EdTech products and services—be it in-house or market-based—and who is paying for what.

Managing implementation and communication across the system

162. **Communication on EdTech resources that are approved for use is mainly done through the MoER and development partner initiatives.** The package of digital tools and resources in education are few and hence managing communication is less of a concern than enhancing usage and gaining insights on relevance and impact. However, over 60 percent of respondents indicate that they are unaware of existence of the processes for creating, reviewing, and sharing EdTech-related reporting for national and regional purposes, with another 20 percent indicating that there is no consistent method. How evidence on the costs, usage, effectiveness, and relevance of existing tools and services is collected and decision made about effectiveness are unknown, as noted by 47.8 percent respondents, whereas 30.4 percent state that education institutions are making individual or site-based decisions with no central oversight. Critically, there are very divergent views on the extent of support for teachers when implementing EdTech. Responses range from lack of a consistent method to less widespread sharing of best practices and resources to an advanced level of support through training, knowledge management for best practices, and active measurement of EdTech implementation to see which approaches are getting the best results.

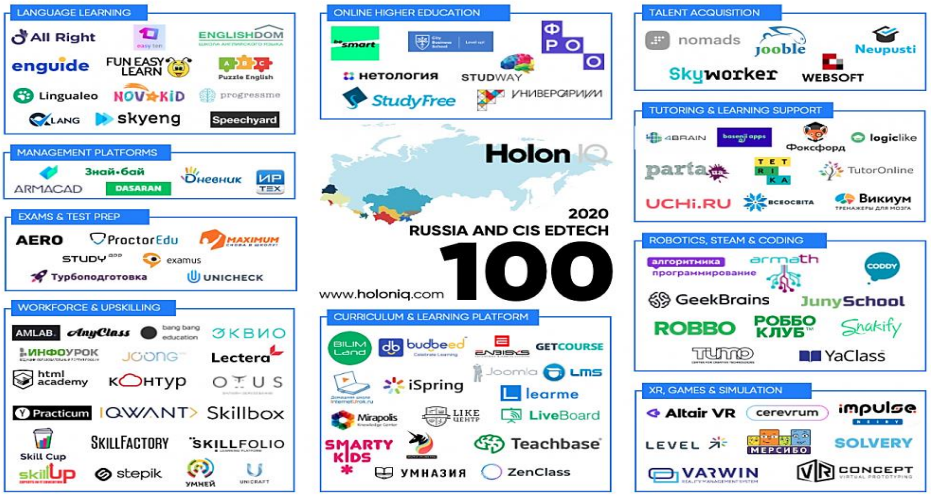
Support for innovative business models

163. **The EdTech innovation ecosystem in Moldova maybe considered at a latent to emerging level of readiness with limited access to customers and capital markets.** Although the business and policy

environment can be considered conducive to start and run EdTech businesses as such, and the country has a competitive and growing ICT industry,[40] access to customers (B2B, B2G, B2C) remains a challenge be it for digital education goods, consultancy, or services such that marketing, sales and distribution mechanisms are cost efficient and allow entrepreneurs to survive and thrive. Determining the specific support needed for innovation in EdTech requires in-depth analysis and strategic actions. One critical barrier is the limited uptake and use of the internet in Moldova (lowest in the ECA region) despite its ubiquitous provision. For this, advancing basic digital literacy through nudges and incentives such as making many public services 'digital first', including in rural and remote areas is considered effective, in which the country is making progress. Another approach is to leverage the regional markets for both developing innovative products and for accessing customers, such as with Romania and Poland which are larger and relatively more vibrant EdTech markets.

164. **Regionally, the Commonwealth of Independent States (CIS) is recognized for deep technology leadership (Figure 44).** The ecosystem of education and training for technology learning, from early years STEM, Coding and Robotics, through to tech upskilling in the workforce and new applications of virtual, augmented, and simulated reality illustrates the strong support for technology in learning across the region. Language Learning, Tutoring, Test Prep, and Online Higher Education are well represented and key to global reach and growth.

Figure 44: CIS EdTech ecosystem



Source: Holon IQ 2020.

165. **Similarly, access to financing through innovative business models is considered a challenge as the market attractiveness to draw in capital for EdTech innovations is low.** Although the enabling environment for smaller players, in particular microenterprises and small and medium enterprises (SMEs) is moving toward a potential tipping point that favors increased entrepreneurship and investments in domestic enterprises. To reach this tipping point, Moldova requires continued forward motion with respect to a number of priorities: among them, improving both traditional and ICT infrastructure within and between centers of commerce; building human capital; and addressing regulatory constraints that interfere with entrepreneurship and investment. Moldova's current system of capital markets falls far short of its potential to raise capital for domestic enterprises, including larger companies and even SMEs, and acts as one of the key barriers for advancing EdTech businesses that can support the changing labor market needs of the economy (USAID 2018).

[40] The legal framework of Moldova establishes the necessary premises for boosting the development of the ICT sector as well as a tax regime to facilitate the residents of IT parks, which consists of (a) applying a single tax of 7 percent; (b) guaranteeing a preferential tax regime for 10 years for the residents of IT parks; (c) virtual residence system: resident companies that already carry out their activity in any locality in the Republic of Moldova can gain from the benefits after fulfilling the legal obligations as members of a virtual IT park.

166. **Advanced educational qualifications and skills are a key factor in becoming an entrepreneur in the ICT sector, and by extension in the EdTech space in Moldova.** The level of training of entrepreneurs in the sector is higher compared to other economic sectors: about 92 percent of all entrepreneurs in the ICT sector have higher education compared to 78 percent - the average for the economy. Therefore, the promotion of ICT studies, especially for girls, as well as the implementation of specialized training programs on ICT entrepreneurship would likely contribute to the growth of the EdTech sector. Although women's participation in entrepreneurship in the sector is improving, in 2017 only 20 percent of businesses were run by women, compared to 34 percent - the average for the economy (Nicoară and Vremiș 2019). Encouraging female entrepreneurship in the ICT sector could bring several economic and social benefits to society.

Box 11. A quick Google search on Moldova's EdTech companies identifies three startups:

Codifun which provides online and offline solutions to educate youth code while gaming, using innovative learning methods to teach design, animation, developing, 3D printing, and software testing. They have had over 9,000 students so far.

FunEasyLearn is a free and offline language learning platform that helps any user learn a foreign language from their mother tongue. They offer courses in 34 languages taught in 62 mother tongues. Using science and game-based methods they adjust the learning experience to personal interests, knowledge level and learning abilities of every user. The app has been downloaded 60 million times and has about a million active users every month.

Smartest is an online education platform that offers personalized learning and tutoring to help students and educational institutions accurately evaluate their knowledge and potential gaps in several school subjects. The platform can also pinpoint specific learning needs of a student and track their learning progress.

Source: Seedstars 2021.

Public-Private Partnerships

167. **There are several mutually beneficial public and private sector partnerships in Moldova that support access to, use of, and impact of technology products and services in education service delivery (Annex 3).** Often-cited initiatives that support mainstreaming digital tools at all levels of the educational system are Tekwill in every school, Future Classroom initiative, National Program for Digital Literacy among Teaching Staff, as well as the online educational platforms studii.md and invat.online, and so on. While 44 percent indicate that there have been few initiatives, 35 percent also acknowledge that these numbers are increasing. On the question of incentives for entities to partner via PPPs to strengthen digitalization of education service delivery, majority of participants indicate that these are sufficient.

168. **After the pandemic, the government sought to establish several PPPs to alleviate gaps in digitalization and their negative impacts on educational outcomes for students.** Most recently, the MoER has signed Memorandum of Understanding agreements with Microsoft and with Google and continues to actively support the Future Classroom program and the Tekwill in Every School program. Other examples are the Connecting Teachers campaign, which was made possible with the support of Orange Moldova. Additionally, Moldtelecom, StarNet, and Moldcell, in cooperation with the Ministry, provided free access to 50 GB data packages for teachers during the first two months of the COVID-19 pandemic. Two examples of education content digitalization to facilitate the remote teaching process are

Educație Online and Învăț.Online developed under the leadership of the Mayor of Chisinau and Association of ICT Companies,[41] respectively, in the pandemic context.

169. **Several efforts are also being made in PPPs to attract girls to ICT so that they can choose to continue their studies and be active in terms of employment in this field.** Recently, important initiatives have taken place: Tech Women Moldova, a national-level IT Training Program for Girls and Women, the 'GirlsGoIT' Program, and so on. These initiatives try to encourage more girls to study and choose a career in the field of ICT, overcoming stereotypes in society that the exact sciences are predominantly predestined for men.

Box 12. Establish public-private partnership for education development

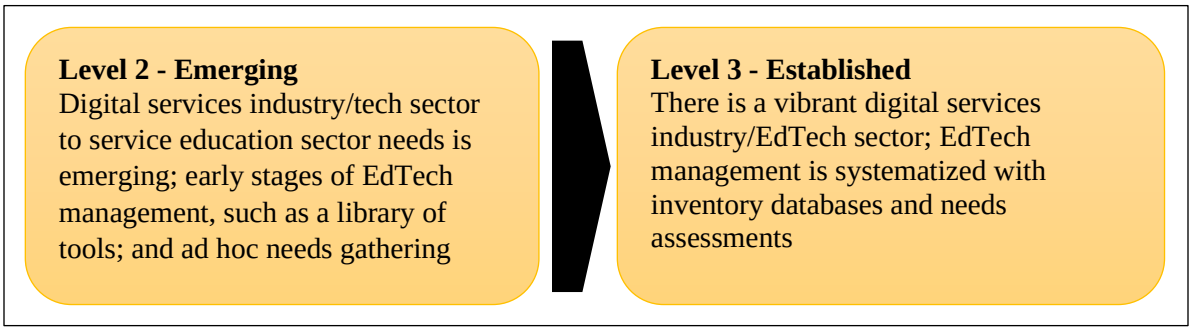
PPPs can help advance digital skills to bring the public and private sectors together to complement each other's strengths in financing and delivering digital education services. The UK government has been actively supporting the thriving of the EdTech business sector with clear vision, guidance, and financing support mechanisms and working closely with EdTech businesses and key sector organizations to ensure that EdTech products match the education sector's needs. The Department of Education has partnered with the British Educational Suppliers Association (BESA) in designing LearnED—an online platform—to match teachers with relevant quality EdTech products and assist teachers in becoming more informed buyers of EdTech products. On this platform, the free trial service of EdTech products is available with case studies detailing the impact of each product on school education. In collaboration with the Department for Business, Energy and the Industrial Strategy (BEIS), F6S, and Nesta, UCL Educate—a leading research accelerator program for EdTech—has helped EdTech companies to work with schools, colleges, and higher education providers to design EdTech products aligning with the needs of educators and students.

Source: Hinds 2019.

Recommendations and Actions

170. The below recommendations and actions have been identified to advance *EdTech market and business models* from the current Emerging level to a more Established level of digital readiness of the education system (Figure 45).

Figure 45: Emerging to Established Digital Readiness on EdTech Market and Business Models



171. ***Management of EdTech products and services.*** **More efforts are needed in leveraging the innovations and benefits offered by effective and proven EdTech products and services. Also, where possible, and enhance usage and gain insights on relevance and impact.**

[41] ATIC https://ict.md/ or Association of ICT companies is an umbrella business organization uniting more than 92 entities covering 9,000 employees promotes the development of the ICT sector in the Republic of Moldova through viable partnerships between companies, similar organizations, government, state institutions, and international organizations. The association was founded to represent the industry on different policy and legislative issues and to facilitate the exchange of best practices between members. ATIC's mission is to protect and promote the Association members' interests as well as facilitate a more favorable ICT business climate.

Proposed actions

- Develop a centralized national system for organizing and managing EdTech tools based on systematic needs assessment and systemic finding of the EdTech tools and services that meet those needs, including procurement and maintenance.
- Develop a process for creating, reviewing, and sharing EdTech-related reporting for national and regional purposes that would analyze the effectiveness, cost, functionality.
- Establish an inventory management of the EdTech tools and services along with the costs, utilization, effectiveness, and relevance.
- Develop a clear mechanism for piloting new EdTech products, verifying the compliance for students' data privacy and accessibility before procurements.

172. ***Support for innovative business models.*** **Improving access to financing and capital markets as well as customers are key for supporting an EdTech sector that can contribute to many aspects of education digitalization in the long term.**

Proposed actions

- Approach regional markets for both developing innovative products and for accessing customers, such as with Romania and Poland which are larger and relatively more vibrant EdTech markets.
- Encourage female entrepreneurship in the ICT sector, especially in EdTech products and services as this can bring several economic and social benefits to society.
- Make public services 'digital first' in urban and rural areas for possible spillover effects.

173. ***Public-Private Partnerships.*** Develop incentive mechanisms for raising private sector interest in developing digital education goods, consultancy, and services via access to capital, customers, and mutually beneficial public and private sector partnerships.

Proposed actions

- Actively leverage to support the learning recovery process through high dosage online tutoring programs, especially for the disadvantaged and vulnerable.
- Continue to support the STEM-oriented curricula, including coding and robotics at local and national levels.
- Promote ICT-related STEM programs, especially for girls, as well as implement specialized training programs on ICT entrepreneurship to contribute to the growth of the EdTech sector.

VI. Digital Education Readiness Assessment Result Summary

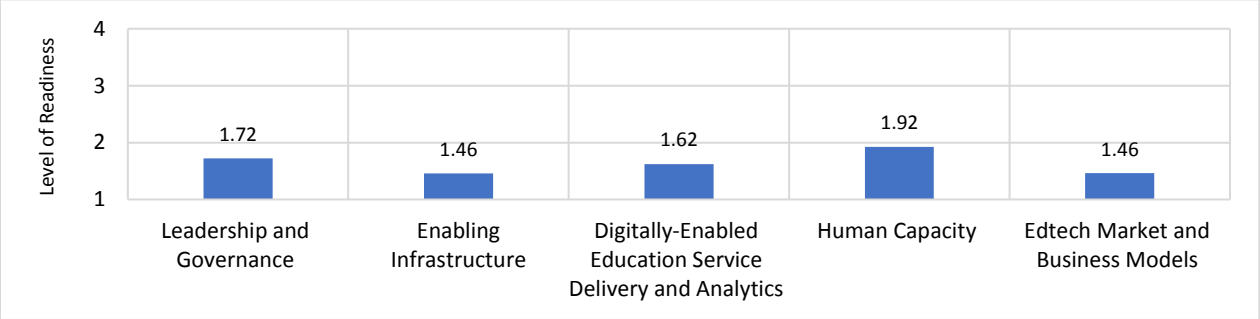
174. **Overall, the assessment results indicate that digital readiness of Moldova's education system is at an *Emerging* level (Table 7).**

Table 7: Moldova's overall Digital Education Readiness Assessment results

Level 1 - Latent	Level 2 - Emerging	Level 3 - Established	Level 4 - Advanced
Foundational investments that are required for technology solutions to be adopted are lacking and impede further progress.	Foundational investments have progressed, but many issues remain. Functional investments are growing opportunistically.	Foundational investments have taken root and stabilized. Functional investments are used to build evidence to scale systematically. There are marginal opportunities for frontier investments.	Foundational and functional investments are scaled up and continue to be managed and updated for decision-making. Skills available to test new technologies within a framework of evidence.

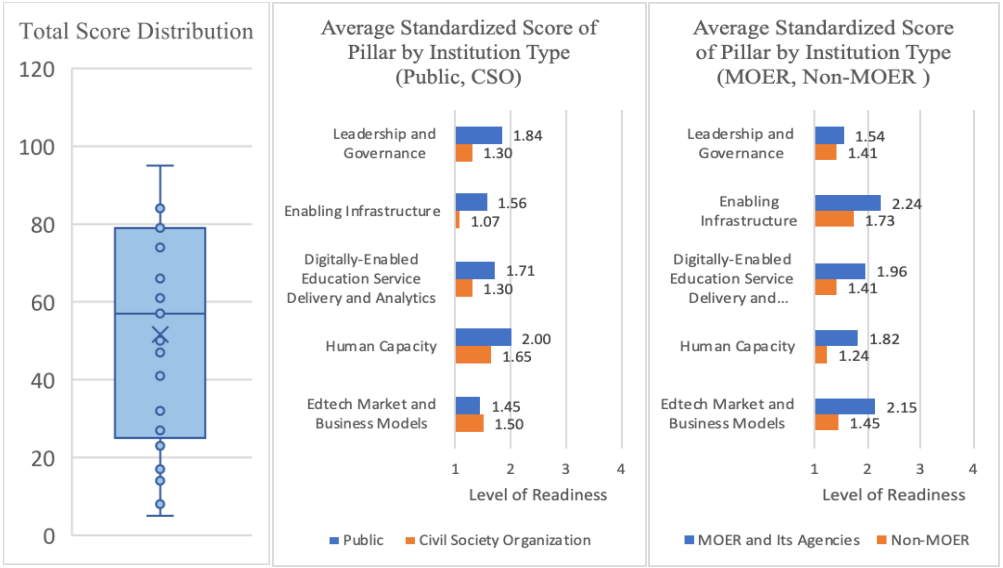
Source: Elaborated by authors.

Figure 46a: Distribution of average score for five domains of digital education assessment



Source: Elaborated by authors based on survey results.

Figure 46b: Total score distribution and average standardized score by pillar and institution type



Source: Elaborated by authors based on survey results.

Note: Public refers to the GoM and its subordinate ministries and agencies; Non-MoER refers to all those not subordinated to the MoER.

Key Insights

175. **The current level of readiness in the education system for digital transformation is determined to be at an *emerging stage* although the enabling environment at the level of the economy is at a 'differentiating'[42] stage of digital readiness.** Moldova has made massive strides in its digital transformation in the past decade by ensuring that it has many of the right ingredients in place for a strong digital backbone that can be leveraged to offer more and better services to its people, strengthen decision-making in public administration, and strengthen the capacity and skills base in the country for the population to participate in an increasingly digital social and economic life. With strong ownership and consistent vision and a whole of government approach to citizen-centered service delivery over the past decade, the country has made impressive progress in areas such as connectivity infrastructure and a national governance structure. The existence of agencies such as eGA, the STISC, and the office of Deputy Prime Minister on Digitalization indicates the presence of a consistently strong and supportive political environment and a demonstrated appetite for digital transformation through integration and interoperability. These ensure the development, implementation, and oversight of durable policies, laws, and regulations such as on data governance and regulation environment and emergence of centralized government digital platforms such as digital identity, digital payments, data exchange, and interoperability that provide the right mix of an enabling environment to capitalize on these developments to service the economy.

The economy-level advancements should be carefully leveraged by the GoM and the MoER to support learning recovery in the short term and strengthen equity, effectiveness, and resilience of the education system to support economic growth in the medium to long term.

176. ***Pillar 1 - Leadership and Governance*. According to the assessment, implementation and monitoring is identified as the biggest roadblock in Moldova's education reform efforts.** While there has been some progress due to the impetus provided by the pandemic, there is significant room for improvement. Although many reforms are conceptually well-developed, be it for administrative reforms, financing reforms, teacher reforms, decentralization reforms, and now reforms related to digital adaptation, widespread adoption and support systems are lacking. A semi-decentralized governance structure, an inadequate number of teaching staff, a large proportion of retirement or post-retirement age staff, and an inefficient network of schools make implementation challenging. Technology can be a great aid for effective implementation and consistent monitoring and help provide evidence-based support to those who need it the most. It can enable substantial progress when it is designed with the end-user in mind and when the governance systems and processes are put in place, including incentives, rewards, and performance indicators.

177. ***Pillar 2 - Enabling Infrastructure.*** **Effective data governance in education is a clear policy implementation bottleneck in advancing the system's ability to effectively monitor and support progress in learning.** The design and implementation of data governance in education is a technical and organizational activity for the MoER and its entities that requires close coordination with relevant legal and technological entities. The current data governance enables some monitoring, but it needs to further develop the standards and mechanisms for verification of the quality and integrity of education data. Implementation and monitoring assisted by relevant and integrated data and technology architecture can significantly improve decision-making, help customize instruction to be specific and timely through dynamic and responsive feedback loops,[43] and even make Moldova's data systems ready to harness predictive

[42] The UNDP 2021 Digital Readiness economy-level assessment identified the country at a *differentiating* stage of readiness, that is, "the country has clear strengths in digital transformation and foundational elements in place."

[43] A feedback loop is a process of checking for and affirming understanding that is specific, non-evaluative, manageable, and focused on a learning target. This can be dynamic and responsive to learning needs informed by digital formative assessments, national assessments reports, and dashboards customized for every school and classroom, and adaptive learning solutions. This draws from dynamic feedback loops in systems research.

capabilities that more advanced technology can offer to enhance learning, identify students at risk, and offer necessary support measures.

178. ***Pillar 3 - Digitally Enabled Education Service Delivery and Analytics.*** According to this assessment, digital access and digital competencies in school and at home for students, teachers, and administrators are emerging opportunistically, curriculum adaptation and DLRs development is still limited, and education data management is digitized with often one-way data flows. Focusing on learning recovery in the immediate term is critical while also preparing the ground for more systematic changes to learners' digital experience and learning, especially for the disadvantaged. At the same time, for enhancing the effectiveness, equity, and resilience of the system, developing and implementing an efficient human resource and performance management system for the teaching profession as well as in pedagogical and administrative management functions from the perspective of promoting innovations, teaching excellence, and meritocracy is essential. Moreover, the education management system can support better learning outcomes by developing the data and technology foundations and platforms to support better analytics and decision-making in education.

179. ***Pillar 4 - Human Capacity.*** **Moldova's education system needs to become both a rapid producer and avid[44] consumer of digital and data skills.** However, there is a very limited availability of human resources with intermediate and advanced ICT skills to work in digitalization initiatives in general education—from teachers, administrators, Information System management functions, and data intermediary functions, among others. This is likely the biggest barrier in advancing the growth path for Moldova's economy since it affects both the supply and demand side simultaneously. This could potentially be addressed by employing a combination of solutions such as (a) importing talent, (b) designing a mechanism to identify effective young teachers and incentivizing them to teach remotely to students in rural areas in several subject areas, including in Informatica, and in the application traversal digital skills and; (c) opening all doors to encourage, support, and incentivize young females in Moldova to enter ICT-related STEM fields from lower secondary school onward to join the ICT and/or education workforce. At the same time, there is a need to develop (micro) credentialing and recognition mechanisms to identify and encourage the development of advanced skills.

Adopt a capability-based approach to delineate responsibilities between ministries and agencies under MoER and outside MoER purview including for budget and resources to capitalize on the unique strengths of these institutions, with a clear focus on advancing digital skills outcomes.

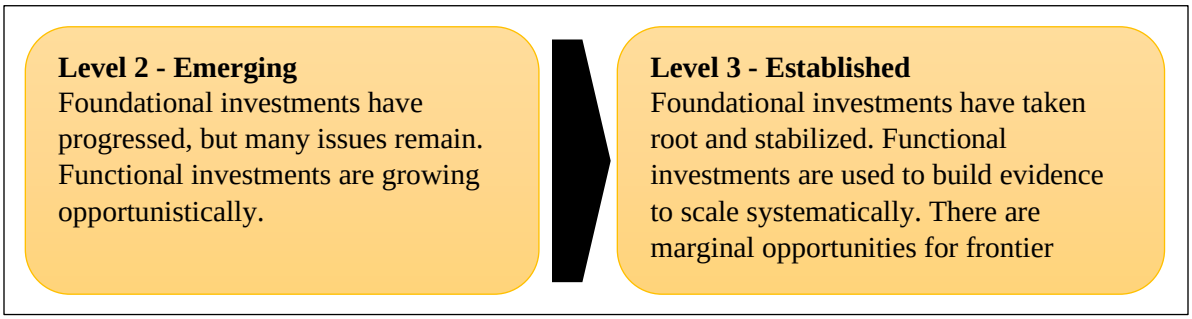
180. ***Pillar 5 - EdTech Market and Business Models*** **This pillar was identified as least developed in supporting digitalization efforts in education.** With the digital services industry/tech sector underdeveloped to service the education sector, Moldova is at very early stages of EdTech management with ad hoc needs gathering approaches. Among the main barriers are the market attractiveness and ease of access to capital markets that can encourage and support EdTech entrepreneurs in Moldova. At the same time, encouragingly, the country has been supporting technology adoption in education through PPPs, for several years, even before the pandemic. This experience was fruitful in responding to the school closures, and the lessons learned from education PPPs can be further leveraged to advance the digitalization readiness of general education in the country.

Summary of recommendations

181. **Based on the above systemic assessment that shows an *emerging level* of digital readiness of the education system in Moldova, the detailed recommendations made for each pillar (by sub-area) in Chapter V are further prioritized to encourage dialogue and stimulate action to move to a more *established level* of readiness.** As highlighted earlier,[45] the challenge is particularly complex in that the education system must digitally transform itself while also building a well-endowed and competitive labor force. This involves advancing the system's foundational and functional digital capabilities to deliver effective and quality services for its students, parents, teachers, and administrative staff**,** both for teaching and learning as well as for pedagogic and administrative management (Figure 47).

[44] This includes due consideration and management of increasing issues in the digitally enabled settings such as misinformation and disinformation.
[45] Paragraph number 24

Figure 47. Emerging to Established Digital Readiness of Education System, Overall



182. **The assessment identified four strategic goals for the country's education system and related areas that will benefit from greater digital readiness**: A) *supporting learning recovery* including targeted remediation services and assessment and regular review, simplification, and adjustments to the curriculum, as needed; B1) *improving effectiveness*[46] *of administrative management* by strengthening the management, monitoring, and evaluation of the system through data management and analytics; B2) *improving effectiveness of pedagogic management* by advancing digital pedagogy skills and data literacy competencies; B3) *improving effectiveness of teaching and learning* by advancing learning outcomes in all subject areas, with a special focus on ICT-related STEM subjects; C) *improving equity and inclusion* by improving access to digital learning environments at home and at school for the vulnerable and disadvantaged; D) *improving resilience* by strengthening the digital readiness of the education system to absorb and pivot quickly in the face of future shocks. The following recommendations aim to support a prioritized set of actions for achieving these goals based on urgency and importance while considering the related risks and returns.

A) Supporting learning recovery including targeted remediation services using digitally enabled solutions. In the immediate term, the urgent and critical focus for education needs to be on supporting learning recovery leveraging technology enabled tools and services. This should include using rapid assessments across all grades, recognizing that a loss of foundational skills in any grade level has a compounding negative effect on future learning and hence earning potential. With the ongoing multifold crises including increasing inflation and tightening fiscal space, technology can be used to reach the most vulnerable students at scale, effectively and at relatively lower marginal costs. Digitally enabled learning solutions can allow greater degree of personalization to teach at the right level to support learning recovery.

Prioritized actions

- **Conduct internet-based rapid assessments implemented at scale** to determine the current learning levels of students and target interventions accordingly.
- **Review, simplify, and adjust the curricular content as needed** to ensure the core foundational skills are well supported based on assessment findings.
- **Provide supplementary, high dosage small group tutoring, especially for the most vulnerable students.** Tutoring also allows a greater degree of personalization to address academic learning gaps and support social emotional needs. It can be adapted to several languages, and therefore, applicable to refugees, Roma, and other marginalized groups (see Box 13 for international examples of tech-enabled tutoring programs to support learning recovery).

[46] Effectiveness for this analysis is defined as efficiency, quality, and relevance of education under B1, B2, B3

Box 13. Tech-enabled tutoring for learning recovery (Italy, Spain, and many others)

In the current pandemic and security emergency context, many children have been forced to disengage from learning. This silent crisis requires swift and decisive action based on evidence-based strategies that can support learning recovery at scale while reducing costs significantly. Unless cost-effective and scalable public policies are implemented to counteract the adverse effects of crises, education gaps will widen with significant reductions in opportunities, social cohesion, and economic growth in the future.

Tech-enabled small-group, high-dosage tutoring has enormous potential for facilitating learning recovery and supporting educational reengagement of millions of students. This has been consistently found effective for educational catch-up for vulnerable pupils. It can not only support learning recovery and increase learning equity but can also reduce cost significantly at scale. This intervention offers personalized support at the right level and yields consistent and substantial positive impacts on learning outcomes as measured by a slew of randomized trials. The effect sizes are found to be similarly large for both in-person delivery and tech-enabled delivery, but the tech-enabled interventions are much less costly.

There are several pedagogical benefits of high dosage small group tutoring, which technology can enhance through careful design and by leveraging the unique attributes of connectivity, interactivity, multimedia, and data processing. This intervention can be scaled up with speed and support learning engagement, rapid feedback, and more time on task. It can support real-time dynamic response to specific learning gaps and increase anonymity, along with automated real-time data processing enabling nimble adjustments with opportunities for mentoring relationships and human connection. Two online tutoring programs have been designed and systematically evaluated with large positive effects of 0.26 standard deviation (SD) in Italy by Carlana and La Ferrara (2021), and 0.26 SD in Spain by Arriola et al. (2021) during the COVID-19 health emergency when children were in lockdown. Similarly, SMS- and phone-based tutoring in low resource settings has also been found to be effective (Angrist, Bergman, and Matsheng 2020; Radhakrishnan et al. 2021, Angrist et al. 2022).

Source: Author's analysis.

B1) Improving effectiveness of administrative management by strengthening the management, monitoring, and evaluation of the system through data management and analytics. This includes strengthening implementation and monitoring mechanisms through better governance of education data and by enhancing digital capacity. Governance of education data should be considered an area of highest priority and the specific gaps identified should be addressed.

Prioritized actions

- Diagnose the current management systems in education (including EMIS, OERs, LMS, HR, Open Data portal, and NBS, among others).
- Strengthen the data governance ecosystem in education, including through strengthening the institutional capacity for implementing a digitalization vision for education and developing the data and technology foundations to support better analytics and decision-making.
- Design and implement an education enterprise architecture that can support implementation and monitoring at district and local levels, in addition to the national level.

B2) Improving effectiveness of pedagogic management by advancing digital pedagogy skills and data literacy competencies. Ensure this by systematically developing and implementing an efficient human resource and performance management system to promote innovations, pedagogic excellence, and meritocracy.

Prioritized actions

- Strengthen institutional capacity for digital pedagogy skills in education by systematic training provision and qualification certification mechanisms, linked to incentive mechanisms.

- Set up automated assessment feedback reports and dashboards that can deliver school-/classroom-level reports on student work and a management dashboard for school directors on learning indicators and other school performance indicators.
- Encourage PPPs and innovative education technology business models to strengthen pedagogic management.

B3) Improving effectiveness of teaching and learning process to advance learning outcomes in all subject areas, with a special focus on ICT-related STEM subjects. Ensure that pedagogical practices—both in person and remote—are observed in classrooms to provide timely feedback and support to teachers to strengthen their professional practice.

Prioritized actions

- Strengthen the quality and access to digital learning experiences and incentivize the use of digital learning resources.
- Develop a system for yearly continuous professional development in digitalization of teacher practices, using professional trainers, classroom observation tools, and coaching.
- Design and implement a mechanism to identify and incentivize effective young teachers to teach remotely to students in rural areas in several subject areas, including in Informatica, and in the application traversal digital skills.

C) Improving equity and inclusion by improving access to digital learning environments at home and at school for the vulnerable and disadvantaged. Target support to vulnerable students through greater institutional coordination and improved access to technology infrastructure, especially at home (see Annex 6 for details) and improve capacity for data management and analytics.

Prioritized actions

- Develop or appropriately adapt a vulnerability index and mapping for identification of students and families, including NEETs, using the social benefits registry database—here data exchange and interoperability regulations and functions should be leveraged.
- Provision of devices, connectivity, and licensed software packages at home for students, especially those from low SES groups, girls, and disadvantaged Roma and refugees and those living in remote rural and disconnected areas.
- Adopt a collaborative capability-based approach on data management and analytics for the MoER entities and departments, such as CTICE, ANACEC, and the IT department of the MoER, while leveraging the wider agencies, such as the eGA, for their capacity and platform resources effectively.

D) Improving resilience by strengthening the digital readiness of the education system to absorb and pivot quickly in the face of future shocks. Most prioritized actions above would undoubtedly contribute to increasing resilience, but there are specific steps outside the purview of general education.

Prioritized actions

- Develop advanced digital skills programs in pedagogical universities to affect changes in education and in the economy over the medium to long term.

183. **Table 8 provides a matrix of recommendations, aligned with education system goals and identifying key actors.** It summarizes the identified priority recommendations and actions across the five assessment pillars and maps these against the relevant sections of the assessment, including clickable cross-referencing links. These specific sections in the analysis in Chapter V lay out specific actions to support

that recommendation. An indicative list of key stakeholders and relevant actors are also identified to catalyze and influence a dialogue that goes beyond the education system to the wider net of decision-makers, influencers, and broader stakeholders to affect change.

Table 8: Matrix of Recommendations

Goals	Actions	Relevant Paragraphs with links	Indicative Key Actors
A. Recover learning losses. Provide targeted remediation services using digitally enabled solutions.	**Action 1:** Conduct internet-based rapid assessments at scale. **Action 2:** Review, simplify, and adjust the curriculum based on assessment findings. **Action 3:** Provide supplementary, high dosage, small group tutoring, especially for the most vulnerable students.	132. Learners, 133. Teachers, 68. Financing and Procurement, 103. Connectivity, 104. Technology Infrastructure, 135. Digital Learning Resources, 173. PPPs, 136. Curriculum and pedagogy,	Leverage private sector and civil society given current capacity constraints within national and regional education governance.
B1. Effectiveness (efficiency, quality, relevance) of administrative management. Strengthen management, monitoring, and evaluation through data management and analytics.	**Action 1:** Diagnose the current management systems in education. **Action 2:** Strengthen data governance ecosystem and institutional capacity in education. **Action 3:** Design and implement education enterprise architecture to support implementation and monitoring at all levels	Recommendations and Actions Pillar 1 and Recommendations and Actions Pillar 2, 134. Education Administrators, 137. School Management and Analytics, 155. Digital skills and data literacy, 156. Culture	MoER and its agencies, relevant entities identified as key influencers under Figure 8, Section Stakeholder mapping and profile analysis
B2. Effectiveness (efficiency, quality, relevance) of pedagogic management. Advance digital pedagogy skills and data literacy competencies. Improve parent-school interactions.	**Action 1:** Systematic training provision and qualification certification mechanisms, linked to incentive mechanisms. **Action 2:** Set up automated assessment feedback reports. **Action 3:** Encourage public-private partnerships and innovative education technology business models.	132. Learners, 136. Curriculum and pedagogy, 155. Digital skills and data literacy, 133. Teachers, 134. Education Administrators, 172. Innovative Business Models, and 173. PPPs.	MoER including NACE, ANACEC, CTICE, and pedagogical colleges, CSOs, PPP entities
B3. Effectiveness (efficiency, quality, relevance) of teaching and learning. Focus on all subject areas, with a special focus on ICT-related STEM subjects especially for girls' education	**Action 1:** Strengthen quality and access to digital learning resources, especially for girls. **Action 2:** Implement continuous professional development on digital pedagogical practices. **Action 3:** Incentivize effective young teachers to teach remotely.	133. Teachers, 135. Digital Learning Resources, 136. Curriculum and pedagogy, 155. Digital skills, 173. PPP, 172. Innovative Business Models	LPAs I and II, MOER and its agencies, CSOs and PPPs, schools, and pedagogical universities
C. Equity and inclusion. Target support to vulnerable students through greater institutional coordination, improved access to technology, and capacity for data management and analytics.	**Action 1:** Develop/adapt vulnerability index and identification mechanism. **Action 2:** Provide necessary technology infrastructure - devices, connectivity, licensed software packages at home. **Action 3:** Adopt a collaborative capability-based approach on data management and analytics.	See 67. Legislation, Policy and Compliance, and 68. Financing and procurement 155. Digital skills and data literacy and Pillar 2 Recommendations and Actions	MoER, MoLSP, Labor Market Observatory (LMO), Data privacy commission, DPM, LPAs I and II
D. Resilience. Strengthen the digital readiness of education to absorb and pivot quickly in face of future shocks.	**Action 1**: Develop advanced digital skills programs in pedagogical universities to affect changes in education and in the economy	155. Digital skills and data literacy.	HEIs including universities and research entities, ANACEC, MoER

VII. Conclusion

184. **The skills, knowledge, and mindsets acquired by Moldovan youth today need to be of value as they become ready to live and work in a digitally enhanced future.** As technological advances in the coming decades maybe even more accelerated, for education to be relevant and useful, we are essentially asking "Are we teaching and learning that which will create and generate value that is relevant in the world economy over the next 20–30 years? Are we doing this effectively, efficiently, and equitably? Do I, as a student, have voice in my learning? Is it joyous, engaging, and at a pace and place of my liking and ability?"

185. **Thus, the role of digitalization in the coming decades must not be underestimated.** Moldova's ability to leverage technological advances to engage competitively in the global economy is only possible by advancing the human capital base in the country through equitable, high-quality, and technology-enabled education. Recursively, advancing the human capital base fit for the digital age requires catalytic actions *now to* transform systems' digital capabilities to meet the needs of a rapidly changing future. This is critical for Moldova's economic growth path in the context of the declining and aging population, high number of NEETs, impact of the pandemic and war, and economic contractions.

186. **This Digital Readiness Assessment of Moldova's education system was conducted between October 2021 and May 2022, a period when the country was under the grasp of multiple crises (and continues to be so).** It is still emerging from the COVID-19 pandemic, which disrupted learning globally for over two years, and already is facing the ramifications of an extended war in neighboring Ukraine, with significant adverse effects on inflation amid emerging global economic contractions. The system was fraught with many challenges even before the pandemic, but this situation has driven a massive wedge in an education system that has been actively and successfully improving its performance over the last decade, in terms of its equity, efficiency, quality, and relevance.

187. **Yet, these crises are also an opportunity to initiate long awaited structural changes in education services to deliver better learning outcomes equitably to be fit for a digital age.** To realize this once-in-a-lifetime transformational opportunity of the education system, digitalization has been identified as a key enabler. Much of this thrust is coming from the recent pandemic-related experience, where remote learning strategies had to be quickly adopted in Moldova, despite the lack of a formal program of distance learning for general education. This experience, or lack thereof, has highlighted the criticality of keeping pace with technological changes in education—as a way of transforming the system to be more efficient, effective, and equitable to support learning, as a way of strengthening resilience to future shocks, and as a way of effecting transformative changes in the economy by building a human capital base that can compete globally on priority sectors such as ICT, which is seen both as a productive sector and as an enabler for economic and social development in Moldova.

188. **The assessment aimed to better understand the key barriers to use of technology-based solutions in the education system and determine relevant policy recommendations.** Existing instruments, indicators, and available data were used to triangulate insights and perspectives from a systems' level survey and interviews of key technical experts in various parts of Moldova's education and digital ecosystem. This enabled the assessment analysis to develop a wholesome picture and identify relevant recommendations. Toward this end, the assessment approach was designed to be

(a) **Comprehensive, using a systems lens,** recognizing that digitalization can affect many aspects of education, from teaching and learning to pedagogic and administrative management to research, assessments, and accreditation. It is also now well-recognized from education technology and related systems research that understanding and engaging the existing ecosystem is critical. Hence, the assessment not only reviewed the core education service delivery areas but also actively pursued the development of an assessment methodology and related instruments that can help identify the

key influencers and broader stakeholders that have the power to affect change in education through deeper and wider collaboration;

(b) **Evidence-based, balancing hard data with perspective and knowledge of key stakeholders,** recognizing that for digitalization efforts to fructify, it is not only enough to assess the current state of policy readiness but also to map this against the current state of practices, perspective, and knowledge. It was actively recognized at the genesis of this assessment that missing information is also relevant and valuable as it may indicate gaps that need to be actively addressed, and hence, an emphasis was placed on uncovering such evidence or highlighting the lack thereof; and

(c) **Flexible and adaptable,** recognizing that governance and policy making are challenging in the current context and hence, taking an approach of working with what we have and adapting and adjusting as new resources and insights became available. In this process, the education system demonstrated its ability to be nimble and portrayed a cultural mindset of continuous improvement, both of which are critical traits for digitalization efforts.

189. **The assessment helped determine the 'as is' state of *emerging* readiness and helped identify a logical pathway to a potential 'to be' state of an *established* digital readiness.** Toward this end, the analysis revealed that there are four overarching goals of education, specifically general education, in Moldova—learning recovery, effectiveness, equity, and resilience, and that each of these outcomes can be affected by digitalization strategies and efforts. The assessment brings out a comprehensive pool of recommendations for each of the five pillars of the assessment framework—leadership and governance, enabling infrastructure, digitally enabled service delivery and analytics, human capacity, and EdTech markets and business models—to aid policy dialogue, planning, and implementation. Simultaneously, the clarification of goals and mapping the recommendations to these in the current country context enabled the identification of important and urgent actions that can help catalyze a transformation. However, considering digitalization of education as the next horizon will require not only substantial allocation of resources and time but also close coordination and prioritization between different stakeholders, commitment to a collaborative and strength-based approach, and significant efforts to up the institutional capacity, including using advanced digital skills to implement many of the reform actions.

Annexures

Annex 1: Glossary

Blended Learning refers to a pedagogic approach that involves a mixed modality of face-to-face teaching and learning as well as distance learning through online, mobile, or other modes for teachers, trainers, and students.

B2B, B2C, and B2G: B2B refers to business to business, B2C refers to business to consumer, B2G refers to business to government. These are three common types of marketing strategies.

Common data standards, terminologies, and structures on education data refer to specific provisions about management of information, design, data collection, data verification, and archiving.

Computational thinking refers to a set of problem-solving methods that involve expressing problems and their solutions in ways that a computer could also execute. It involves automation of processes and using computing to explore, analyze, and understand processes (natural and artificial).

Data specialist refers to a person with specialized competencies in developing, monitoring, and maintaining databases, monitoring performance, and interpreting raw data and turning it into usable feedback and applications. These are often experts in statistics and computer science who can manage the data pipeline and find information signals in the noise of big data.

Data exchange refers to the process of sending and receiving data in such a manner that the information content or meaning assigned to the data is not altered during the transmission.

Data governance refers to a collection of processes, roles, policies, standards, and metrics that ensure the effective and efficient use of information in enabling an organization to achieve its goals. It establishes the processes and responsibilities that ensure the quality and security of the data used across a business or organization. Data governance defines who can take what action, upon what data, in what situations, and using what methods.

Data integrity refers to consistency of data on the same variables collected from different sources.

Data quality refers to adequacy, accuracy, relevance, and explanatory capacity of data to inform decisions.

Digitization refers to the conversion of data from analog to electronic (databases) formats.

Digitalization refers to the wider process of using digital technologies for transformational impact.

Interoperability Standards across Applications, Devices, and Equipment refers to the development and use of data standards that enable consistent and accurate collection and exchange of information across systems. This further includes mechanisms for information exchange across applications, devices and equipment that support health, education, and social protection service delivery in the country.

Digital competencies refer to confident and critical usage of the full range of digital technologies for information, communication, and basic problem solving in all aspects of life.

Digital pedagogy refers to pedagogy supporting the development of digital skills and targeted and methodically meaningful use of digital solutions and learning resources and content in teaching and learning.

Digital literacy refers to the ability to access, manage, understand, integrate, communicate, evaluate, and create information safely and appropriately through digital technologies for employment, decent jobs, and entrepreneurship. It includes competences that are variously referred to as computer literacy, ICT literacy, information literacy, and media literacy.

Digital skills refer to "…skills and competencies needed to make use of digital technology and benefit from its growing power and functionality…" encompassing "…a range of different abilities, many of which are not only 'skills' per se, but a combination of behaviors, expertise, know-how, work habits, character traits, dispositions, and critical understandings… best understood as existing on a graduated continuum from basic functional skills to higher level, specialist skills."

(Basic) Digital skills refer to skills required to operate devices; find and use information; communicate and collaborate; create basic content; and understand and apply safety, ethics, and privacy issues as well as simple problem solving and basic computational thinking. Related cognitive domain skills focus on remembering, understanding, and applying. Relevant for all citizens.

(Intermediate) Digital skills refer to basic digital skills as well as media creation, problem solving, computational thinking and coding, fundamentals of data analysis, AI, robotics, Makers. It may also include digital entrepreneurship skills including starting and running an online business and using digital tools to run any business. Related cognitive domain skills focus on analysis, evaluation, and creation. Relevant for secondary school and HEIs.

(Advanced) Digital skills refer to skills needed by specialists in ICT professions such as computer programming and network management, including for advancing the digitalization of education systems. These include applications of advanced computational thinking, cutting edge technologies like (AI) and big data, coding, cybersecurity, Internet of Things (IoT), and mobile app development, and related transversal skills.

Education technology (EdTech) refers to the combination of ICT products and services aimed at facilitating and enhancing learning.

Enterprise architecture refers to a coherent, integrated 'blueprint' to optimize the often-fragmented legacy of processes (both manual and automated) into an integrated environment that supports service delivery, while being responsive to changes. It provides a common vocabulary to discuss implementation across entities. This includes the overall design of a computing system and the logical and physical interrelationships between its components in reference to computers, software, or networks. The architecture specifies the hardware, software, access methods, and protocols used throughout the system.

Electronic data infrastructure refers to the structure and interaction of the major types and sources of data including logical and physical data assets and related data management resources. Data quality (adequacy, accuracy, relevance, explanatory capacity), data flows, storage, protection, standards, interoperability, foundational data such as IDs, birth registries, and so on are often important enabling factors. Electronic education records or any other data assets would capture information regarding a child/teacher/parent's engagement with the education system.

E-governance refers to the use of emerging ICT to facilitate the processes of government and public administration. It is about providing citizens with the ability to choose the manner in which they wish to interact with their governments and the choices governments make about how ICT will be deployed to support citizen choices.

Integration refers to the process of linking independently designed applications to work together as one system, so that the data contained in each becomes part of a larger, more comprehensive system that quickly

and easily shares data when needed. Integration also enables access to data and functionality from such independent applications through a single interface or service.

Interoperability refers to the ability to share information and services. Defining the degree to which the information and services are to be shared is a very useful architectural requirement, especially in a complex organization and/or extended enterprise. This enhances the ability of organizations to interact toward mutually beneficial goals by means of exchange of data with other systems using common standards. Interoperability also includes the ability of systems to provide and receive services from other systems and to use the services so interchanged to enable them to operate effectively together.

Interoperability framework refers to an agreed approach for interoperability for entities that wish to work together toward the joint delivery of public services (without having to integrate all of their subsystems into one large system).

Microservices architecture refers to a type of application architecture where the application is developed as a collection of services. It provides the framework to develop, deploy, and maintain microservices architecture diagrams and services independently. Each microservice is a single service built to accommodate an application feature and handle discrete tasks. Each microservice communicates with other services through simple interfaces to solve business problems. This allows for greater adaptability and flexibility and improves fault isolation.

Mobile apps. The term ‘app’ has evolved to specifically connote software that is designed to reside on a mobile platform such as a tablet or mobile phone. It encompasses a user interface that interoperates with web-based resources that provide access to a wide array of information that is relevant to the app and local processing capabilities that collect, analyze, and format information in a manner best suited to the mobile platform. Additionally, a mobile app provides persistent storage capabilities within the platform. Mobile apps are generally downloaded from application distribution platforms which are operated by the owner of the mobile operating system.

Procedures refer to the steps that define the specific use of each system element or the procedural context in which the system resides.

Socioemotional skills refer to noncognitive, soft, or character skills, which are foundational human capabilities involved in achieving life goals, interacting with others, and managing emotions.

Annex 2: Detailed Approach, Methodology, and Framework

Approach

Overall, the team took a comprehensive, evidence-based, yet flexible approach to developing the Digital Education Readiness Assessment. The team leveraged existing instruments, indicators, and available data to the extent possible and applied survey instruments and interviews given the multiple crises unfolding in the country. The five steps outlined below describe the methodology undertaken to conduct the assessment in Moldova. As part of this exercise, related instruments and tools were developed.

Methodology

1. **Development of country landscape profile indicators.** These indicators were developed using a selection of existing quantitative data that provided a snapshot of the current situation both in education and on enablers for digitalization. Much of this information was available as open data and provided an initial background for the next step in the development of the readiness assessment.

2. **Literature review.** A stocktaking exercise through desk review was conducted to understand the ongoing efforts on digital transformation in the country, especially in the education sector. This activity included reviewing any existing assessments on the education sector and the larger digitalization ecosystem, identifying key stakeholders, reviewing policies and practices in the domains of the assessment framework, and capturing key challenges, trends, and features.[47] Additionally, a review was undertaken to understand the global digital ecosystem affecting Moldova, such as the EU Digital Strategy, European Commission Digital Education Action Plan, the OECD Going Digital efforts, and the past and ongoing efforts of the World Bank and its affiliate agencies, as well as to identify relevant best practices, including from Romania, Estonia, and other EU countries.

3. **Stakeholder mapping and analysis.** A stakeholder map using a digital education stakeholder framework and a power interest matrix was developed (Ackerman and Eden 2011). This was used to develop and purposefully select a technical expert group for engaging in the next stage of the analysis. In Moldova, this can be utilized to develop a network analysis to identify (a) key leverage points and target interventions based on roles and (b) dynamics for strengthening the digitalization efforts in education.

4. **Digital Education Readiness survey and analysis.** Primary data was collected through an in-depth survey-based assessment using a comprehensive Digital Education Readiness Assessment instrument. The survey was based on the assessment framework described in Chapter 4 covering five domains—(a) leadership and governance, (b) enabling infrastructure, (c) human capacity, (d) education service delivery and analytics, and (e) EdTech market and business models—and targeted a technical expert group from the stakeholder mapping stage. The survey was intended to determine stakeholder perceptions and knowledge as well as to gather relevant information for analysis. Therefore, the instrument was adapted to systematically respond to the digitalization areas and needs identified by the GoM. Since the survey collected personal profile information of the survey participants, the World Bank Personal Data Protection Policy was applicable and a data license agreement was prepared and signed with counterparts.

5. **Administrative and learning assessment data analysis.** This analysis included collecting quantitative and qualitative data on several areas, such as spending, privacy, cybersecurity, interoperability legislation, procurement, quality assurance processes for digital tools and services, and so on.

[47] For example, the UNDP has recently completed a Digital Readiness Assessment of the Moldovan economy and the World Bank is currently undertaking an assessment of the human development sectors in Moldova and an assessment of learning losses and strategies for future resilience in the pandemic context.

Additionally, EMIS data on school resources, distribution of broadband availability (for example, access, speed, and costs), and student performance was also used. This was based on primary data shared by the government as well as secondary data sources, specifically PISA 2018, ITU, UNESCO, and other relevant sources.

Assessment rubric

The readiness assessment rubric is based on evaluating investments across three areas—foundational, functional, and frontier (Table 9). Taken together, the readiness level in the five pillars of the assessment framework indicate the mix of investments needed, as defined by the 3F framework (World Bank 2022a, Annual Meeting Human Capital Project Conclave paper, forthcoming).

Foundational investments start with the data and data platforms, such as investments in technology infrastructure, data collection and management, cybersecurity, identification systems, and data governance for individuals, families, and households. The most urgent and important task is to distinguish among the data that pertain to human capital service delivery, such as by conducting an inventory and analysis across the human development space.

Functional investments would need to be made in scaling processes and technology platforms that have proven to work and synergistically help meet human capital needs, while supporting proof of concept technologies. These platforms represent a wide range of investment decisions in integrated information systems, such as integrated social information systems, social registries, payment systems, education management information systems, and health management information systems.

Frontier investments test new technologies within a framework of evidence as part of a systemwide transformation. Frontier investments include new and creative policies, processes, and technologies that together enable leapfrogging over current ways of working, with an eye toward solving intractable challenges or 'wicked problems' that have hitherto eluded obvious solutions. These are the most ambitious investment decisions. There should be a technology and service delivery transformation blueprint that is tied into government-wide digitization strategies and plans, and significant investments in highly skilled human resources.

Table 9: Digital education assessment readiness rubric

Description	Latent	Emerging	Established	Advanced
Overall	Foundational investments that are required for technology solutions to be adopted are lacking and impede further progress.	Foundational investments have progressed, but many issues remain. Functional investments are growing opportunistically.	Foundational investments have taken root and stabilized. Functional investments are used to build evidence to scale systematically. There are marginal opportunities for frontier investments.	Foundational and functional investments are scaled up and continue to be managed and updated for decision-making. Skills are available to test new technologies within a framework of evidence.
Pillar 1 - Leadership and governance *Vision and strategy* *Institutional capacity*	There are low or no governing structures, vision and plan, and low institutional capacity for supporting digitally enabled education	There is a governing structure with a vision that may/may not be articulated, basic institutional capacity for supporting digitally	There is a well-defined governing structure with a clearly articulated vision, implementation plan and budgets, and sufficient	There is a well-defined governing structure with a clearly articulated collective vision and roadmap, and advanced institutional

Description	Latent	Emerging	Established	Advanced
Legislation, policy, and compliance *Financing, and* *Procurement*	services, leading to scarce resources and weak policy and mechanisms for implementing.	enabled education services, and some resources and mechanisms for implementing.	institutional capacity including resources, talent, and mechanisms for implementing digitally enabled education services.	capacity including champions, experts, earmarked resources, and mechanisms for implementing digitally enabled education services.
Pillar 2 - Enabling infrastructure *Infrastructure design and management* *Data governance* *Connectivity* *Technology infrastructure* *Standards and interoperability across applications, devices, and equipment*	Digital technology infrastructure is not well developed outside key urban areas; mobile broadband coverage is limited; digital enabling environment is less advanced, including data governance, telecom, and ID and payment systems.	Mobile broadband coverage is ubiquitous and extends to rural areas; broadband adoption, quality, and affordability is low especially in rural areas; ID and payment systems are emerging; no education enterprise architecture and interoperability; data governance, cybersecurity and data protection, and privacy frameworks are in early stages; technology infra for learning is slowly catching up.	Modern broadband infrastructure is available for rural and urban areas; broadband adoption, quality, and affordability is growing, with demand for higher service quality (speed); ID and payment systems are largely in-line with good practices and up to date; education interoperability and enterprise architecture are emerging; cybersecurity, data governance, data protection, and privacy are developing; tech infra in education is adequate.	Penetration of modern broadband infra is ubiquitous; broadband adoption, quality, and affordability is widespread; ID and payment systems are in-line with good practices and up to date; cybersecurity, data governance, data protection, and privacy are mature; education interoperability and enterprise architecture are mature; tech infra in education is adequate and up to date.
Pillar 3 – Digitally enabled education service delivery and analytics *Learners* *Teachers* *Education administrators* *Digital learning resources* *Curriculum and pedagogy* *School management and analytics*	Digital access and digital competencies in school and at home for students, teachers and administrators is low, curriculum is not adapted, DLRs are very limited, and education data is not digitized.	Digital access and digital competencies in school and at home for students, teachers and administrators are emerging opportunistically, curriculum adaptation and DLRs development is still limited, and education data management is digitized with often one-way data flows.	Digital access, learning resources, and competencies in school and at home for students, teachers, and administrators are widespread and standardized to enable scale and equity, curriculum is adapted and integrated for ICT use, and education data and analytics support feedback loops for decision-making.	Digital access, learning resources, and competencies in school and at home for students, teachers, and administrators are widespread and standardized, curriculum is adapted and integrated for ICT use, and education data and analytics support dynamic feedback loops using frontier technologies.

Description	Latent	Emerging	Established	Advanced
Pillar 4 - Human capacity *Digital skills* *Data literacy* *Culture*	Digital and data literacy is a challenge among large portions of the population and advanced skills are scarce; collaborative and data driven innovative practices are not the norm.	Basic and intermediate digital and data literacy is growing; advanced skills are still scarce; collaborative and data driven innovative practices emerge in small pockets.	Basic and intermediate digital literacy is widespread; data literacy is growing; demand for and supply of digital talent increases; collaborative, data driven, and user focused innovations in education are rewarded and promoted.	Intermediate digital and data literacy skills are widespread; there is consistent demand for and supply of digital talent in both public and private sectors; talent pool and demand for advanced digital skills is growing; collaborative, data driven, and user focused innovations in education are rewarded and promoted.
Pillar 5 - EdTech market and business models *Management of EdTech products and services* *Managing implementation and communication across the system* *Support for innovative business models and PPPs*	Digital services industry/tech sector is practically non-existent including in education; no practice needs assessments of learners, teachers, schools; and no active management of EdTech tools and services.	Digital services industry/tech sector to service education sector needs is emerging; early stages of EdTech management, such a library of tools; and ad hoc needs gathering.	There is a vibrant digital services industry/EdTech sector, EdTech management is systematized with inventory databases and needs assessments.	There is a vibrant digital services industry/EdTech sector, EdTech products and services are systematically managed using inventory databases, needs assessments, and vetting and effectiveness measurements.

Source: Elaborated by authors.

Survey instrument

This questionnaire consisted of 6 sections with 140 items, including profile and feedback questions:

- Survey instructions and participant profile information - *10 questions*
- Leadership and governance - *30 questions*
- Enabling infrastructure - *25 questions*
- Education service delivery and analytics - *25 questions*
- Human capacity - 22 questions
- EdTech market and business models - *20 questions*
- Feedback - *8 questions*

Scoring

- Every pillar's score was a simple standardized average of the scores received for that pillar, aggregated by sub-areas, as identified in the assessment questionnaire table above.

- All questions received equal weights, especially given the small sample size.

- Every question was scored on a scale of 1 (Latent) to 4 (Advanced), based on the response.

- Survey respondents had the option to choose 'I don't know' in response to any question; all questions were mandatory for all participants. Hence, a score of 0 was assigned and the response was taken as valid entry since it may indicate both a lack of knowledge or maybe an unrelated area. Only in responses where the participant did not answer any of the survey questions under a pillar, the response was considered invalid.

- Aggregate scores for each question under a sub-area were then rolled up to determine a simple average. This was then standardized using theoretical minimum and theoretical maximum values (as determined by the minimum and maximum possible scores) to get a standardized average score. This score was scaled to 4 to determine the average score for the survey response for that sub-area.

$$x' = \frac{[x - \min(x)]}{[\max(x) - \min(x)]} * 4$$

- To determine the score on a scale of 1 to 4 for each pillar, the scores for all the sub-areas were aggregated, averaged, standardized, and scaled to get a score for each pillar.

- Finally, the summary analysis scores for each pillar were viewed against the identified four levels of readiness—Latent, Emerging, Developing, and Advanced—based on the definitions and readiness levels defined in the previous section.

- The overall readiness level of the system was determined based on the definitions of three investment horizons—Foundational, Functional, Frontier[48]—to advance digital readiness in human development.

- For each pillar, the response distribution as well as its disaggregation by the MoER and its agencies and others as well as by CSO and the GoM were also developed.

- The data analysis included a question-by-question review and analysis of distribution of responses, which is presented in the analytical description of each pillar.

[48] World Bank, 2022a, Human Development Conclave Annual Meetings Conference brief (forthcoming).

Annex 3: Moldova landscape review

Structure of the education system

The GoM identifies education as a national priority and recognizes the role of education in building a knowledge-based society. Education is considered as a determinant of quality of life and opportunities. The education sector in the country is transitioning from a centralized, traditional system to a student-centered one.

Per the Education Code, compulsory education in Moldova covers one year of preschool education followed by nine years of general education up to age 16. After that comes the tracking of students into three different streams: (a) a three-year lyceum (general academic stream); (b) colleges (vocational stream with access to higher education); and (c) professional schools. Although only one year of preschool education is mandatory, children typically enroll as early as age 3 and continue until age 6–7.

Historically, basic education in Moldova has been provided mainly in public schools, with less than 1 percent of students going to private schools. This tends to diversify in upper secondary education, and more so with colleges (between 5 percent and 8 percent private provision) and in HEIs, with almost 20 percent of education provided privately.

Human capital outcomes

Human capital development in Moldova has registered an increase in recent years. Yet, the country lags its regional peers. In 2020, Moldova's HCI was 0.58, which means that a child born in Moldova today would be about 58 percent as productive when he/she grows up as she could be if he/she enjoyed complete education and full health. Between 2010 and 2020, the HCI value for Moldova increased from 0.56 to 0.58. While this is progress, Moldova's HCI is below the average for ECA (0.69). The HCI for boys is lower compared to girls (0.56 versus 0.61) and is slightly above average for its upper-middle-income group (0.56). However, Moldova has room to improve to reach the human capital levels of more advanced high-income countries, which have an average HCI of 71 percent.

Table 10: HCI 2020 for Moldova and international comparators

	2010	**2020**					
	Moldova	**Moldova**			**Europe and Central Asia**	**Upper Middle Income**	**High Income**
	Male + Female	Male + Female	Male Only	Female Only	Male + Female	Male + Female	Male + Female
HCI Component 1: Survival							
Probability of Survival to Age 5	0.983	0.984	0.982	0.986	0.993	0.983	0.994
HCI Component 2: School							
Expected Years of School	12.0	11.8	11.8	11.8	13.1	11.8	13.2
Harmonized Test Scores	413	439	430	448	479	411	487
HCI Component 3: Health							
Survival Rate from Age 15–60	0.804	0.836	0.764	0.905	0.904	0.856	0.921
Fraction of Children Under 5 Not Stunted	0.893	0.936	0.942	0.930	0.903	0.867	0.803

Source: World Bank 2020a.

Previous Education Policy on ICT 2014–2020

The GoM approved and adopted an Education Development Strategy[49] 2014–2020, developed with support from the Global Partnership for Education. This development of this strategy included a diagnosis of the then state of education, revealed key challenges, and proposed solutions and strategic direction. Moldova's main challenges were identified as those related to early childhood education coverage, especially for minority and disadvantaged children, and the management, monitoring, and evaluation of the education sector. The development strategy included a chapter dedicated to the efficient integration of ICT in education as elaborated below.

STRATEGIC DIRECTION 3: EFFICIENT INTEGRATION OF ICT INTO EDUCATION

Educational policies should support training of young people to enable them to actively engage in building and developing a society of knowledge that is the engine of competitive social-economic development of the whole country. Information and communication technologies have enabled development of a wide range of educational and vocational training tools so that use of ICT in education has become a common feature of developed countries with strong economies. Analysis of the current situation in Moldova showed that familiarization of pupils with ICT is limited as provision with computers and their late use is not sufficient. Since interactive ICT methods and devices for teaching and management purposes are used to a limited extent only, quality, inclusion, and efficiency objectives to prepare young people to meet labor market demands and to get fully integrated into social-economic life, cannot be reached. To effectively integrate ICT into education, priority actions aligned to the specific objectives described below, have been envisaged.

Specific Objective 3.1. Enhancing access to quality education by providing education institutions with modern equipment useful to the educational process.

Priority Actions:
3.1.1. Implementation of the pilot project 'One computer for each pupil' in 10 schools, since 2013.
3.1.2. Elaboration of a medium-term plan on provision of education institutions with modern equipment, access to the Internet and the infrastructure 50 necessary for successful implementation of information and communication technologies in the educational process.
3.1.3. Provision of school libraries with modern equipment and access to the Internet so that the needs of information and documentation of pupils and teachers are met.
3.1.4. Provision of access to quality education by putting in place distance learning models, especially for pupils in small schools.
3.1.5. Facilitation of creation of networks of communication and exchange of best practices among teachers.
3.1.6. Provision of schools with special equipment needed to train people with disabilities.

Specific Objective 3.2. Development of digital competencies by preparing and applying digital educational contents in the educational process.

Priority Actions:
3.2.1. Development of ICT skills, including skills to develop and use digital pedagogical contents in the future teaching staff of higher education.
3.2.2. Development and implementation of programs on training and incentivizing teachers to use ICT in education, including to create and publish their own digital contents.
3.2.3. Diversification of the offer of optional courses in primary and general education by introducing courses in which information technologies are used or promoted.

[49] This was approved and adopted by a Government Decision Approved by the Government Decision no. 944 of November 14, 2014.

3.2.4. Development of standards for digital textbooks and their application at textbook tenders.
3.2.5. Creation of a unique educational platform that combines digital educational contents in the Republic of Moldova and that can be accessed by pupils, teachers and parents.
3.2.6. Use of ICT in examination and assessment.
3.2.7. Fostering of use of existing digital educational contents (e.g., Discovery School, Khan Academy, etc.).
3.2.8. Improvement of quality of university education by integrating online courses (Massive Open Online Courses - MOOC) into university curricula.

Specific Objective 3.3. Enhancing effectiveness and efficiency of school management at system, school and class levels by means of information technologies.
Priority Actions:
3.3.1. Implementation of an Educational Management Information System, comprising a register of schools, pupils and teachers, based on the school census, and regular and accurate collection of data in schools.
3.3.2. Improvement of school management by providing training for management staff with school management software (accounting, budget planning, etc.).
3.3.3. Improvement of the quality of teaching-learning, pupils' performance record keeping and communication between pupil, teacher and parents by gradually introducing classroom management software into schools.
Source: MoER 2014

Background on EMIS in Moldova

Based on the priority actions identified in the Education sector strategy 2014-2020, and as a part of an extensive educational reform by the Ministry of Education, Culture and Research , an EMIS was created in 2017, with World Bank assistance. This project was implemented with the support of the Centre for Information and Communication Technologies in Education, district education departments and schools from across the whole country. The EMIS allows the planning and management of educational resources at the national level. The system accumulates and systemizes data about institutions, infrastructure, pupils, classes, evaluations, school dropout, school networks, distance between pupils' home and school, budget of institutions and districts/municipalities/autonomous territorial units, and teaching, managerial, non-teaching and auxiliary staff, among other categories.

The EMIS contains separate modules for different levels of education: pre-school, general and vocational. It stores various data on every element of the educational process, making it possible to analyze the educational system from different aspects and incorporate such data into evidence-based policy- and decision-making. Currently, in Republic of Moldova the most important components of National Informational Systems for Educational Management are:

- Information System for Personalized Education Certificates/Diploma (SIPAS) (implemented in 2016)
- Automated Data Processing System (SAPD) (implemented in 2017
- Portal SIME (implemented in 2017)
- EMIS General Education Module (implemented in 2017)
- EMIS Preschool Education Module (implemented in 2018)
- Dual VET (implemented in 2019)
- National Qualifications Register (NQR) (implemented in 2019)
- EMIS VET Module (implemented in 2020)

As part of recent efforts for digitalization of the education system, the Ministry of Education and Research developed an "Electronic catalogue" module within EMIS. for general education institutions in 2020. During the 2020-2021 academic year, the process of piloting the system in 180 general education institutions was initiated. The most important benefits were identified as:

- Uninterrupted and synchronous access to the electronic catalogue of all participants in the educational process;
- High level of security, providing limited access to information/operations in the system, depending on the user's rights.
- Ensuring physical security;
- The principle of interaction with other government systems, ensuring the exclusion of repeated data entry;
- Reporting according to several criteria;
- Ability to perform in-depth data analysis to improve the quality of organization of educational processes;
- Storing data in electronic archives does not require additional premises and special actions.

Examples of existing PPPs in education in Moldova

In 2020, the Ministry of Education, Culture and Research signed a Memorandum of Understanding with Microsoft, under which a strategic partnership will be built to support the education system in Moldova using the most innovative information technologies. Through this partnership, educational institutions in the country will gain access to Office 365 A1, interactive platforms for teacher development and training, and support in implementing distance education methods (UNICEF and ITU 2021).

The MoER and Google have signed a Memorandum of Understanding on the implementation of Google for Education in Moldova. The partnership with Google was facilitated by the Moldova Competitiveness Project, funded by USAID, Sweden, and UK Aid through the Clasa Viitorului (Class of the Future) Centre, which will provide advice and technical support to train educational representatives in the use of the Google Education app suite.

Through the Class of Life Class program, 42 schools in the Republic of Moldova are equipped with modern digital equipment, which contributes to the efficient participation in combined teaching and learning. This equipment can be used for both computer science and other STEM objects. More than 200 schools in Moldova are equipped with educational robotics kits to effectively participate in teaching and blended learning.

Under the Tekwill in Every School program six optional extracurricular courses were developed: programming, artificial intelligence, graphic design, mobile applications, web development, and information security. These subjects are offered in 234 schools and from the next year 333 schools will be connected covering 50,000 students. Besides this over 3,000 teachers have been trained in the program.

Box 14. Ongoing World Bank operational support in general education

The Moldova Education Reform Project (MERP) is supporting the GoM's reform program by financing activities that will improve the quality of education and lead to a more efficient education sector. Through this project, the World Bank supports the GoM in implementing reforms, which include the following initiatives: Improving learning conditions in targeted schools; Strengthening education monitoring systems; and Promoting efficiency reforms in the education sector. For digitalization and internet connectivity, the following actions were performed as part of this project:

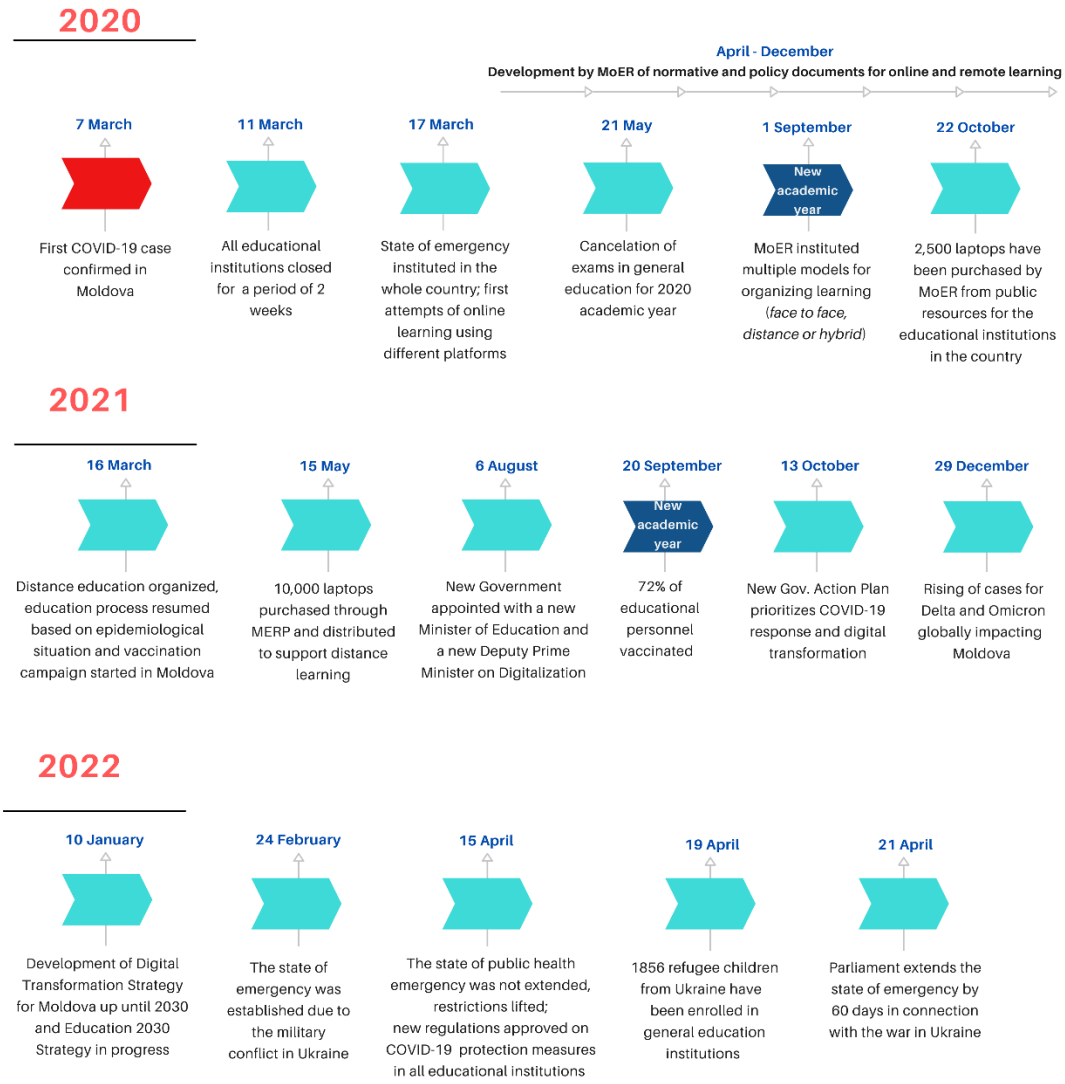
- Procuring 10,000 laptops for remote learning in general education, which fully covered the needs of students from 5th to 12th grades in accessing the remote learning process
- Providing 23 schools renovated under the project with IT equipment (laptops, printers, projectors, and interactive whiteboards)
- Providing 100 schools with specialized IT equipment for students with special educational needs and/or disabilities
- Improving the quality of data and the EMIS, specifically by developing and incorporating a VET module into the EMIS and modernizing the EMIS portal for open data for public use
- Procuring specialized software to be used by teaching support staff and educational psychologists working with students with special educational needs and/or disabilities
- Procuring IT equipment for PISA 2021 (200 laptops and 200 memory sticks)
- Procuring IT equipment for the National Agency for Quality Assurance in Education and Research (4 laptops, 2 video projectors, 1 interactive table, 10 USB external memory drives) for use in training.

Source: Elaborated by authors.

Figure 48: Mapping of the educational system in ICT

Source: ICT sector Overview, Invest Moldova 2020.

Figure 49. Evolution of the pandemic and effects on education



Source: Elaborated by authors

Annex 4: Mapped stakeholders and their level of influence on education digitalization

Table 11: Stakeholder analysis related to digitalization in Moldova				
No	**Name of stakeholder**	**Summary of responsibilities and area of work**	**Key Influencers, Engaged Stakeholders, Decision-Makers, Broader Stakeholders**	**Low/ moderate/ high on how supportive and influential for digitalization of education**
1	Ministry of Education and Research	The MoER is the central specialized body of the public administration, responsible for the elaboration of public policies for development of the education system, as well as the assurance of their realization. The MoER has the mission to analyze the situation and problems in its fields of activity, to develop effective public policies in the areas provided below, to monitor the quality of policies and normative acts and to propose justified government interventions for efficient solutions in the areas of competence, ensuring the best ratio between the expected results and the expected costs. The Ministry shall perform the functions established by its Regulation of activity in the following areas: education, youth, physical culture and sports, interethnic relations and the functioning of languages spoken on the territory of the Republic of Moldova.	Decision-Maker	High - policy development and budget allocation for digitalization of education. Mobilization of social partners
2	MoER, General Education Department	The General Education Department of the MoER is responsible for development of policies for the general education system, development of legal framework for the general education system, monitoring implementation of the general education legal framework, development of national curricula, and monitoring of national results via EMIS and other statistical tools.	Department of the MoER, part of Decision-Maker	High
3	Ministry of Labor and Social Protection, Occupational Policy and Migration Regulation Department	The Ministry of Labor and Social Protection (MoLSP) oversees and manages the development process of occupational Policies and Migration Regulations, monitoring of labor market and making adjustments into the National Classifier of Economic Activities and Classifier of Occupations in Republic of Moldova. Also, the MoLSP participates in designing the state planning for government scholarships in training of specialized staff by trades.	Key Influencer	Moderate to low - the influence is via expression of need for raising the digital competence of labor force
4	Ministry of Economy	The Ministry of Economy carries out labor market analysis and participates in designing the state planning for government scholarships in training of specialized staff by trades	Key Influencer	Moderate to low - the influence is via the expression of need for digital competence for adults/business

5	National Employment Agency (NEA)	The National Employment Agency's (NEA) mission is to increase employment opportunities for jobseekers and support employers in identifying skilled workers and creating new jobs. The NEA carries out its attributions in the following fields: (a) Implementation of the employment promotion policy; (b) Labor migration; (c) Unemployment insurance. The NEA performs the following tasks: (a) Establishes procedures and coordinates the provision of employment services, employment measures and social protection in case of unemployment, labor migration; (b) Researches, monitors, and forecasts of the labor market at national level; (c) Establishes the annual objectives regarding the implementation of services and employment measures for the territorial subdivisions and evaluating their achievement; (d) Assesses the impact of active employment measures to establish their effectiveness; (e) Provides methodological support to the territorial subdivisions regarding the implementation of services and employment measures.	As part of the MoLSP, Key Influencer	Low - training provision for unemployed people
6	Labor Market Observatory (LMO)	The LMO is a structural subdivision within the NEA whose mission is to produce systematic information about the labor market. The LMO establishes the priority areas of analysis and research to be carried out related to labor market, labor force supply and demand structure, develops methodologies for analysis of labor market, carries out the research of labor market, develops the prognosis and forecasts for national labor market The LMO also ensures collection, systematization, and analysis of statistical data produced by various public institutions, including other NEA structures.	As part of the MoLSP, Key Influencer	Low - analysis of labor market gaps, missing competences and expression of need for professional training
7	e-Governance Agency	The mission of the eGA is to bring leading technologies into the government, rethink processes, improve public services, and make them work for the benefit of the citizens. Strategic goals: **1. Modernize public services through re-engineering and digitization** Electronic services facilitate the interaction and communication between citizens and the government, generating benefits to both: accessible, inclusive, and efficient services for the citizens and increased citizens' trust in the government.	Decision-Maker	High - influence on the macro level, but not directly involved at general education level

		2. Increase governance efficiency by ensuring data exchange between public service providers Public institutions will overcome isolation, will operate and interact on a joint technological platform for data exchange - MConnect. Personal data will be provided to public authorities only once, and will be further reused by the public institutions to deliver government services **3. Diversify access channels to public services** To diversify the public service delivery channels citizens will be offered the choice to receive services either online through government portal of public services http://servicii.gov.md or offline at the Universal Centers for Public Service Delivery (CUPS) on platforms such as the Multifunctional Centers of the Public Services Agency, Novateca modernized libraries, post offices, and so on. **4. Ensure information security** Governance e-Transformation requires citizens' trust, guaranteeing the confidentiality, integrity and availability of information. To this end, the eGA jointly with its partners is taking complex legal, organizational, and technical measures.		
8	National Agency for Quality Assurance in Education and Research (ANACEC)	ANACEC is an administrative authority subordinated to the Ministry of Education, Culture and Research. It is a legal public body, responsible for quality assurance in the field of education and research. In its areas of activity, the Agency collaborates with central and local public authorities, as well as with international bodies. The Agency aims at ensuring the quality of services provided by institutions in the field of education and research, thus contributing to the fulfillment of the requirements of society and the labor market in the training of competent staff. The Agency stimulates the increase of the level of responsibility of the institutions in the fields of education and research toward the quality of the services provided. ANACEC fulfills the following tasks: • Quality assurance in general education; • Quality assurance in VET; • Quality assurance in higher education; • Evaluation of continuous professional training programs; • Evaluation of organizations in the field of research and innovation; • Evaluation of the scientific and scientific-didactic staff.	Key Influencer	Moderate - ANACEC supervises the Raion Department of Education
9	National Agency for Curriculum and Evaluation	The Agency is an administrative authority subordinate to the Ministry of Education, which has the mission to contribute to the implementation of state policy in the field of education by ensuring the development and implementation of a relevant and effective national curriculum for all institutions in	As part of the MoER - Decision-Maker	High - as part of the Ministry can influence the policy in digitalization

		preschool, primary, secondary and high school education, as well as a national system of evaluation of school results oriented toward international standards and efficient organization, as well as the correct administration of examinations and assessments in general education (primary, middle school and high school).		
10	Center for Information and Communication Technologies in Education (CTICE)	The center provides: • Continuous training for computer science teachers who teach computer science at middle school and high school; • Production, personalization, and duplication of study documents; • Authentication of study documents; • Elaboration and maintenance of information systems in education.	As subdivision of the MoER - Decision-Maker	Moderate to low - teachers training provider in IT in education
11	Institute of Education Sciences	The Institute of Education Sciences (I.Ș.E.) is a structure of the Ministry of Education and functions as a public, state institution, based on its normative acts and regulations. The Institute of Education Sciences is a profile member of the Academy of Sciences of Moldova. The institute represents the research in sciences of education and post-graduate education of teachers based on the major objectives: research, design, implementation, and evaluation in the field of education and teaching; complex and continuous development of teachers in pre-university education. The institute carries out the following types of activities: (a) Scientific research (fields of education sciences and social sciences); (b) Training of highly qualified scientific staff; (c) Continuous professional training of teachers and management (training, specialization, retraining/additional qualification, professional conversion/polyqualification); (d) Expertise/approval of curricular materials and products; (e) Other forms of adult training; (f) Publishing and producing magazines, newspapers, books, brochures, and other publications.	Engaged Stakeholder	Moderate to low - training provision for teachers. The quality of training on IT for teachers was not assessed.
12	Tekwill	Tekwill is a national PPP between the GoM, USAID, Microsoft, and IBM to answer the needs of the ICT industry to close the gap of the human capital shortage, as well as support the development of the entrepreneurship ecosystem. It is a center where people, community, ideas, resources, science, and industry meet to identify, facilitate, and enhance excellence in IT. Driving the Moldovan ecosystem, as a leading connecter and networking facilitator, organizing and supporting local and regional tech-related events	Broader Stakeholders	Low - private training provider for all ages, programming, coding

		(deploying relevant ICT educational content and entrepreneurship activities in the regions Chișinău, Bălți, Cahul, Comrat). Tekwill was created with the support of USAID and the Government of Sweden through Swedish International Development Agency (SIDA) in the framework of the project "Development of Moldova ICT Excellence Center" implemented by Moldovan Association of ICT Companies (ATIC) in partnership with the Technical University of Moldova.		
	Class of the Future (Clasa Viitorului) State Pedagogical University I. Creanga	The Class of the Future is a digital education transformation project, implemented in Moldovan educational institutions. It brings a new concept in pedagogy, offering an open and inspiring learning space with interdisciplinary and innovative approaches, through the use of digital technologies, which favor the student-centered learning process. The Class of the Future is based on the successes of the national project of Educational Robotics, both STEAM education initiatives. These lead to the transformation of the Moldovan education system, emphasizing the importance of the scientific, technological, engineering, arts, mathematics, entrepreneurship and design fields, and the cultivation of the skills and competencies of the 21st century. The Class of the Future is a PPP between - Ministry of Education, Culture and Research; - Moldova Competitiveness Project funded by USAID, Government of Sweden, UK; - Orange Moldova Foundation; and - Liechtenstein Development Services Foundation (LED). The project implementation partners are Ion Creanga State Pedagogical University, Tiraspol State University and the University Information Center. The technology partner of the Class of the Future is Google.	As division financed partially by the MoER - Engaged Stakeholder	Moderate to low - public training provider of IT in education
	1. Institute of Education Sciences (mentioned above) 2. Technical University of Moldova 3. Center for Information and Communication Technologies in Education (mentioned above)	All these institutions provide teachers' continuous education for teachers from general education and VET. The majority of them provide training on development of digital competences of teachers. The quality of those training was not assessed. Some of these programs were accredited, but not all of them.	Engaged Stakeholder	Moderate to low - training providers of IT in education

	4. "Bogdan Petriceicu Hasdeu" State University of Cahul 5. Step by Step Educational Program 6. "Constantin Stere" University of European Political and Economic Studies 7. State University of Moldova 8. "Ion Creanga" State Pedagogical University of Chisinau (mentioned above) 9. Tiraspol State University 10. Pro Didactica Educational Center 11. "Alecu Russo" State University of Balti 12. State University of Physical Education and Sports 13. Comrat State University 14. Academy of Music, Theater and Fine Arts 15. Academy of Economic Studies of Moldova 16. Institute of Continuing Education			

Source: Elaborated by authors.

Annex 5: Survey data analysis

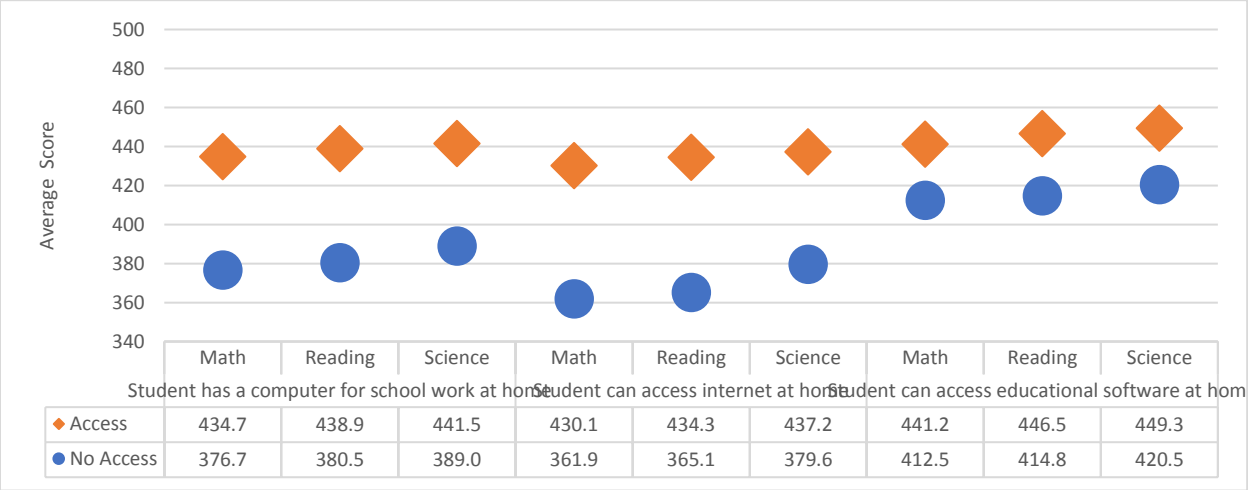
Table 12: Moldova Assessment of Digital Readiness in Education survey data analysis						
Pillar and sub-area	**Obs**	**Average Score**	**Std Dev**	**Max Avg Score**	**Standardized score**	**Response Rate**
Leadership and Governance	**23**	**51.65**	**28.04**	**120**	1.72	
Vision and Strategy	23	11.87	6.03	24	1.98	91 percent
Institutional Capacity	23	5.7	3.17	12	1.90	100 percent
Legislation, Policy, and Compliance	23	17.43	9.79	40	1.74	96 percent
Financing	23	12.78	9.67	32	1.60	78 percent
Procurement	23	3.87	3.49	12	1.29	61 percent
Enabling Infrastructure	**24**	**36.42**	**23.19**	**100**	1.46	
Infrastructure Design and Management	24	2.92	2.21	8	1.46	75 percent
Data Governance	24	7.88	5.41	16	1.97	83 percent
Connectivity	24	8.75	6.18	20	1.75	75 percent
Technology Infrastructure	24	6.29	5.52	24	1.05	75 percent
Standards and Interoperability across Applications, Devices, and Equipment	24	10.58	7.84	32	1.32	92 percent
Digitally Enabled Education Service Delivery and Analytics	**23**	**40.52**	**23.32**	**100**	1.62	
Learners	23	12.26	7.44	28	1.75	83 percent
Teachers	23	7.48	4.56	16	1.87	87 percent
Education Administrators	23	5.39	4.18	16	1.35	78 percent
Digital Learning Resources	23	4.22	2.83	12	1.41	83 percent
Curriculum and Pedagogy	23	6.91	4.07	16	1.73	83 percent
School Management and Analytics	23	4.26	3.00	12	1.42	78 percent
Human Capacity	**24**	**40.42**	**15.99**	**84**	1.92	
Digital Skills	24	16.83	6.38	28	2.40	100 percent
Data Literacy	24	9.88	6.26	28	1.41	88 percent
Culture	24	13.71	6.63	28	1.96	100 percent
EdTech Market and Business Models	**23**	**29.22**	**12.22**	**80**	1.46	
Procurement and Management of EdTech products and services	23	16.13	8.08	44	1.47	100 percent
Managing Implementation and Communication across the System	23	6.74	3.88	20	1.35	87 percent
Support for Innovative Business Models	23	2.83	2.42	8	1.42	70 percent
Public-Private Partnerships	23	3.52	2.06	8	1.76	83 percent

Source: Elaborated by authors.

Annex 6: Digital learning environment at home and in school

The access to a learning environment at home and at school is defined here in terms of sufficient access to a computer, internet connectivity, and educational software. The average PISA score of Moldovan students with access to a digital learning environment at home and at school was consistently higher than those without access, across all subjects. However, the average score gap between students with and without access at home was found considerably larger than the average score gap between students with and without sufficient access in school. While no causation can be directly concluded between home access and learning outcomes, the effects should be rigorously evaluated.

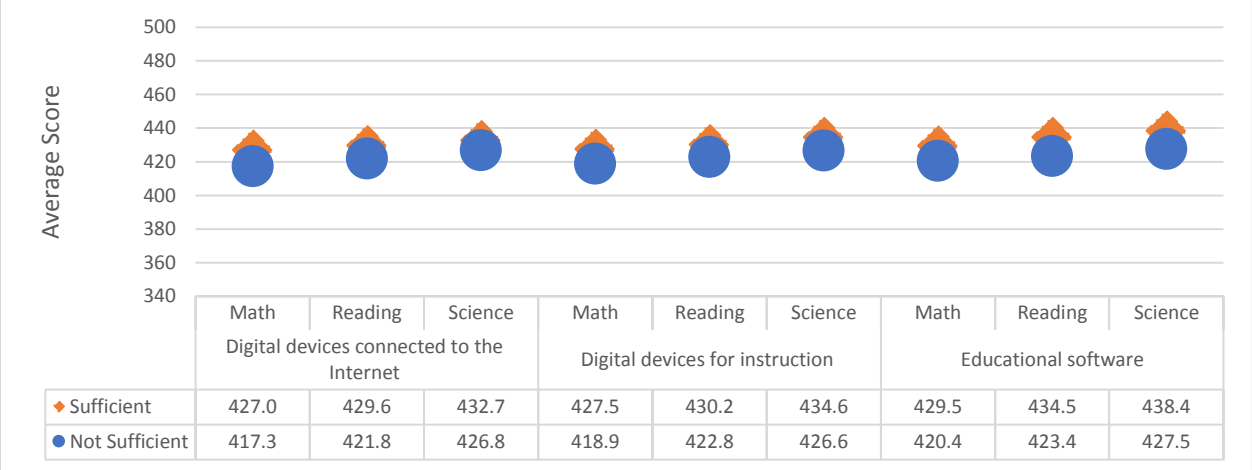
Figure 50: Learning outcome and home digital learning environment



	Student has a computer for school work at home			Student can access internet at home			Student can access educational software at hom		
	Math	Reading	Science	Math	Reading	Science	Math	Reading	Science
Access	434.7	438.9	441.5	430.1	434.3	437.2	441.2	446.5	449.3
No Access	376.7	380.5	389.0	361.9	365.1	379.6	412.5	414.8	420.5

Source: Created by author based on students' response in PISA 2018 Moldova database.
Note: 40 scores are roughly equivalent to one year of schooling.

Figure 51: Learning outcome and school digital learning environment



	Digital devices connected to the Internet			Digital devices for instruction			Educational software		
	Math	Reading	Science	Math	Reading	Science	Math	Reading	Science
Sufficient	427.0	429.6	432.7	427.5	430.2	434.6	429.5	434.5	438.4
Not Sufficient	417.3	421.8	426.8	418.9	422.8	426.6	420.4	423.4	427.5

Source: Created by author based on school principals' response in PISA 2018 Moldova database.
Note: 40 PISA points are roughly equivalent to one year of schooling.

Conclusion of digital learning environment and learning outcomes by gender, SES, and location (Urban/Rural). The access to a digital learning environment at home has been defined here as a student having access to a computer at home to do schoolwork, with internet and software access. At school this is defined in terms of sufficient 'provision' of access to a computer, internet connectivity, and educational software. The average PISA score of Moldovan students with access to a digital learning environment at home and at school was consistently higher than those without access, across all subjects. Girls with access on average had better reading scores than boys. Students with access in higher SES and in urban areas on average had better scores across all subjects than those in lower SES and in rural areas. The average score of students with access at home—in all subjects—was greater than the average score of students studying at schools with access, regardless of gender, SES (except for quintile 5), and location (urban/rural).

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