GLOBAL EDUCATION MONITORING REPORT SUMMARY

2023

Technology in education:

A TOOL ON WHOSE TERMS?

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Global Education Monitoring Report

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Technology in education

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The Education 2030 Incheon Declaration and Framework for Action specifies that the mandate of the *Global Education Monitoring Report* is to be "the mechanism for monitoring and reporting on SDG 4 and on education in the other SDGs" with the responsibility to "report on the implementation of national and international strategies to help hold all relevant partners to account for their commitments as part of the overall SDG follow-up and review". It is prepared by an independent team hosted by UNESCO.

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KEY MESSAGES

Good, impartial evidence on the impact of education technology is in short supply.

- **There is little robust evidence on digital technology's added value in education.** Technology evolves faster than it is possible to evaluate it: Education technology products change every 36 months, on average. Most evidence comes from the richest countries. In the United Kingdom, 7% of education technology companies had conducted randomized controlled trials, and 12% had used third-party certification. A survey of teachers and administrators in 17 US states showed that only 11% requested peer-reviewed evidence prior to adoption.
- **A lot of the evidence comes from those trying to sell it.** Pearson funded its own studies, contesting independent analysis that showed its products had no impact.

Technology offers an education lifeline for millions but excludes many more.

- **Accessible technology and universal design have opened up opportunities for learners with disabilities.** About 87% of visually impaired adults indicated that accessible technology devices were replacing traditional assistive tools.
- **Radio, television and mobile phones fill in for traditional education among hard-to-reach populations.** Almost 40 countries use radio instruction. In Mexico, a programme of televised lessons combined with in-class support increased secondary school enrolment by 21%.
- **Online learning stopped education from melting down during COVID-19 school closures.** Distance learning had a potential reach of over 1 billion students; but it also failed to reach at least half a billion, or 31% of students worldwide – and 72% of the poorest.
- **The right to education is increasingly synonymous with the right to meaningful connectivity, yet access is unequal.** Globally, only 40% of primary, 50% of lower secondary and 65% of upper secondary schools are connected to the internet; 85% of countries have policies to improve school or learner connectivity.

Some education technology can improve some types of learning in some contexts.

- **Digital technology has dramatically increased access to teaching and learning resources.** Examples include the National Academic Digital Library of Ethiopia and National Digital Library of India. The Teachers Portal in Bangladesh has over 600,000 users.
- **It has brought small to medium-sized positive effects to some types of learning.** A review of 23 mathematics applications used at the primary level showed that they focused on drill and practice rather than advanced skills.
- **But it should focus on learning outcomes, not on digital inputs.** In Peru, when over 1 million laptops were distributed without being incorporated into pedagogy, learning did not improve. In the United States, analysis of over 2 million students found that learning gaps widened when instruction was exclusively remote.
- **And it need not be advanced to be effective.** In China, high-quality lesson recordings delivered to 100 million rural students improved student outcomes by 32% and reduced urban–rural earning gaps by 38%.
- **Finally, it can have detrimental impact if inappropriate or excessive.** Large-scale international assessment data, such as that provided by the Programme for International Student Assessment (PISA), suggest a negative link between excessive ICT use and student performance. Mere proximity to a mobile device was found to distract students and to have a negative impact on learning in 14 countries, yet less than one in four have banned smartphone use in schools.

The fast pace of change in technology is putting strain on education systems to adapt.

- **Countries are starting to define the digital skills they want to prioritize in curricula and assessment standards.** Globally, 54% of countries have digital skill standards but often these have been defined by non-state, mostly commercial, actors.
- **Many students do not have much chance to practise with digital technology in schools.** Even in the world's richest countries, only about 10% of 15-year-old students used digital devices for more than an hour per week in mathematics and science.
- **Teachers often feel unprepared and lack confidence teaching with technology.** Only half of countries have standards for developing teacher ICT skills. While 5% of ransomware attacks target education, few teacher training programmes cover cybersecurity.
- **Various issues impede the potential of digital data in education management.** Many countries lack capacity: Just over half of countries use student identification numbers. Countries that do invest in data struggle: A recent survey among UK universities found that 43% had trouble linking data systems.

Online content has grown without enough regulation of quality control or diversity.

- **Online content is produced by dominant groups, affecting access to it.** Nearly 90% of content in higher education repositories with open education resource collections was created in Europe and Northern America; 92% of content in the OER Commons global library is in English. Massive open online courses (MOOCs) mainly benefit educated learners and those from richer countries.
- **Higher education is adopting digital technology the fastest and being transformed by it the most.** There were over 220 million students attending MOOCs in 2021. But digital platforms challenge universities' role and pose regulatory and ethical challenges, for instance related to exclusive subscription deals and to student and personnel data.

Technology is often bought to plug a gap, with no view to the long-term costs…

- **…for national budgets.** The cost of moving to basic digital learning in low-income countries and connecting all schools to the internet in lower-middle-income countries would add 50% to their current financing gap for achieving national SDG 4 targets. Money is not always well spent: Around two-thirds of education software licences were unused in the United States.
- **…for children's well-being.** Children's data are being exposed, yet only 16% of countries explicitly guarantee data privacy in education by law. One analysis found that 89% of 163 education technology products recommended during the pandemic could survey children. Further, 39 of 42 governments providing online education during the pandemic fostered uses that risked or infringed on children's rights.
- **…for the planet.** One estimate of the CO2 emissions that could be saved by extending the lifespan of all laptops in the European Union by a year found it would be equivalent to taking almost 1 million cars off the road.

Major advances in technology, especially digital technology, are rapidly transforming the world. Information and communication technology (ICT) has been applied for 100 years in education, ever since the popularization of radio in the 1920s. But it is the use of digital technology over the past 40 years that has the most significant potential to transform education. An education technology industry has emerged and focused, in turn, on the development and distribution of education content, learning management systems, language applications, augmented and virtual reality, personalized tutoring, and testing. Most recently, breakthroughs in artificial intelligence (AI), methods have increased the power of education technology tools, leading to speculation that technology could even supplant human interaction in education.

In the past 20 years, learners, educators and institutions have widely adopted digital technology tools. The number of students in MOOCs increased from 0 in 2012 to at least 220 million in 2021. The language learning application Duolingo had 20 million daily active users in 2023, and Wikipedia had 244 million page views per day in 2021. The 2018 PISA found that 65% of 15-year-old students in OECD countries were in schools whose principals agreed that teachers had the technical and pedagogical skills to integrate digital devices in instruction and 54% in schools where an effective online learning support platform was available; these shares are believed to have increased during the COVID-19 pandemic. Globally, the percentage of internet users rose from 16% in 2005 to 66% in 2022. About 50% of the world's lower secondary schools were connected to the internet for pedagogical purposes in 2022.

The adoption of digital technology has resulted in many changes in education and learning. The set of basic skills that young people are expected to learn in school, at least in richer countries, has expanded to include a broad range of new ones to navigate the digital world. In many classrooms, paper has been replaced by screens and pens by keyboards. COVID-19 can be seen as a natural experiment where learning switched online for entire education systems virtually overnight. Higher education is the subsector with the highest rate of digital technology adoption, with online management platforms replacing campuses. The use of data analytics has grown in education management. Technology has made a wide range of informal learning opportunities accessible.

Yet the extent to which technology has transformed education needs to be debated. Change resulting from the use of digital technology is incremental, uneven and bigger in some contexts than others. The application of digital technology varies by community and socioeconomic level, by teacher willingness and preparedness, by education level, and by country income. Except in the most technologically advanced countries, computers and devices are not used in classrooms on a large scale. Technology use is not universal and will not become so any time soon. Moreover, evidence is mixed on its impact: Some types of technology seem to be effective in improving some kinds of learning. The short- and long-term costs of using digital technology appear to be significantly underestimated. The most disadvantaged are typically denied the opportunity to benefit from this technology.

Too much attention on technology in education usually comes at a high cost. Resources spent on technology, rather than on classrooms, teachers and textbooks for all children in low- and lower-middle-income countries lacking access to these resources are likely to lead to the world being further away from achieving the global education goal, SDG 4. Some of the world's richest countries ensured universal secondary schooling and minimum learning competencies before the advent of digital technology. Children can learn without it.

However, their education is unlikely to be as relevant without digital technology. The Universal Declaration of Human Rights defines the purpose of education as promoting the 'full development of the human personality', strengthening 'respect for … fundamental freedoms' and promoting 'understanding, tolerance and friendship'. This notion needs to move with the times. An expanded definition of the right to education could include effective support by technology for all learners to fulfil their potential, regardless of context or circumstance.

Clear objectives and principles are needed to ensure that technology use is of benefit and avoids harm. The negative and harmful aspects in the use of digital technology in education and society include risk of distraction and lack of human contact. Unregulated technology even poses threats to democracy and human rights, for instance through invasion of privacy and stoking of hatred. Education systems need to be better prepared to teach about and through digital technology, a tool that must serve the best interests of all learners, teachers and administrators. Impartial evidence showing that technology is being used in some places to improve education, and good examples of such use, need to be shared more widely so that the optimal mode of delivery can be assured for each context.

CAN TECHNOLOGY HELP SOLVE THE MOST IMPORTANT CHALLENGES IN EDUCATION?

Discussions about education technology are focused on technology rather than education. The first question should be: What are the most important challenges in education? As a basis for discussion, consider the following three challenges:

- Equity and inclusion: Is fulfilment of the right to choose the education one wants and to realize one's full potential through education compatible with the goal of equality? If not, how can education become the great equalizer?
- Quality: Do education's content and delivery support societies in achieving sustainable development objectives? If not, how can education help learners to not only acquire knowledge but also be agents of change?
- Efficiency: Does the current institutional arrangement of teaching learners in classrooms support the achievement of equity and quality? If not, how can education balance individualized instruction and socialization needs?

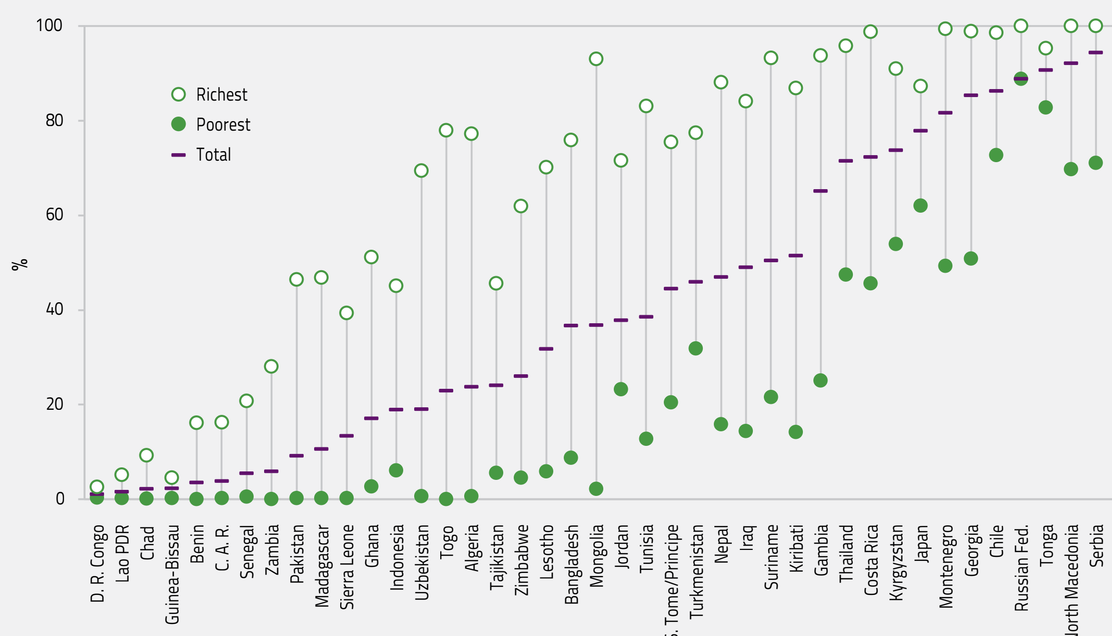
How best can digital technology be included in a strategy to tackle these challenges, and under what conditions? Digital technology packages and transmits information on an unprecedented scale at high speed and low cost. Information storage has revolutionized the volume of accessible knowledge. Information processing enables learners to receive immediate feedback and, through interaction with machines, adapt their learning pace and trajectory: Learners can organize the sequence of what they learn to suit their background and characteristics. Information sharing lowers the cost of interaction and communication. But while such technology has tremendous potential, many tools have not been designed for application to education. Not enough attention has been given to how they are applied in education and even less to how they should be applied in different education contexts.

On the question of **equity and inclusion**, ICT – and digital technology in particular – helps lower the education access cost for some disadvantaged groups: Those who live in remote areas are displaced, face learning difficulties, lack time or have missed out on past education opportunities. But while access to digital technology has expanded rapidly, there are deep divides in access. Disadvantaged

FIGURE 1:

Internet connectivity is highly unequal

Percentage of 3- to 17-year-olds with internet connection at home, by wealth quintile, selected countries, 2017–19



GEM StatLink: https://bit.ly/GEM2023_Summary_fig1
Source: UNICEF database.

groups own fewer devices, are less connected to the internet (**Figure 1**) and have fewer resources at home. The cost of much technology is falling rapidly but is still too high for some. Households that are better off can buy technology earlier, giving them more advantages and compounding disparity. Inequality in access to technology exacerbates existing inequality in access to education, a weakness exposed during the COVID-19 school closures.

Education **quality** is a multifaceted concept. It encompasses adequate inputs (e.g. availability of technology infrastructure), prepared teachers (e.g. teacher standards for technology use in classrooms), relevant content (e.g. integration of digital literacy in the curriculum) and individual learning outcomes (e.g. minimum levels of proficiency in reading and mathematics). But education quality should also encompass social outcomes. It is not enough for students to be vessels receiving knowledge; they need to be able to use it to help achieve sustainable development in social, economic and environmental terms.

There are a variety of views on the extent to which digital technologies can enhance education quality. Some argue that, in principle, digital technology creates engaging learning environments, enlivens student experiences, simulates situations, facilitates collaboration and expands connections. But others say digital technology tends to support an individualized approach to education, reducing learners' opportunities to socialize and learn by observing each other in real-life settings. Moreover, just as new technology overcomes some constraints, it brings its own problems. Increased screen time has been associated with adverse impact on physical and mental health. Insufficient regulation has led to unauthorized use of personal data for commercial purposes. Digital technology has also helped spread misinformation and hate speech, including through education.

Improvements to **efficiency** may be the most promising way for digital technology to make a difference in education. Technology is touted as being able to reduce the time students and teachers spend on menial tasks, time that can be used in other, educationally more meaningful activities. However, there are conflicting views on what is meaningful. The way that education technology is used is more complex than just a substitution of resources. Technology may be one-to-many, one-to-one or peer-to-peer technology. It may require students to learn alone or with others, online or offline, independently or networked. It delivers content, creates learner communities and connects teachers with students. It provides access to information. It may be used for formal or informal learning and can assess what has been learned. It is used as a tool for productivity, creativity, communication, collaboration, design and data management. It may be professionally produced or have user-generated content. It may be specific to schools and place-based or transcend time and place. As in any complex system, each technology tool involves distinct infrastructure, design, content and pedagogy, and each may promote different types of learning.

Technology is evolving too fast to permit evaluation that could inform decisions on legislation, policy and regulation. Research on technology in education is as complex as technology itself. Studies evaluate experiences of learners of various ages using various methodologies applied in contexts as different as self-study, classrooms and schools of diverse sizes and features, non-school settings, and at system level. Findings that apply in some contexts are not always replicable elsewhere. Some conclusions can be drawn from long-term studies as technologies mature but there is an endless stream of new products. Meanwhile, not all impact can be easily measured, given technology's ubiquity, complexity, utility and heterogeneity. In brief, while there is much general research on education technology, the amount of research for specific applications and contexts is insufficient, making it difficult to prove that a particular technology enhances a particular kind of learning.

Why is there often the perception nevertheless that technology can address major education challenges? To understand the discourse around education technology, it is necessary to look behind the language being used to promote it, and the interests it serves. Who frames the problems technology should address? What are the consequences of such framing for education? Who promotes education technology as a precondition for education transformation? How credible are such claims? What criteria and standards need to be set to evaluate digital technology's current and potential future contribution to education so as to separate hype from substance? Can evaluation go beyond short-term assessments of impact on learning and capture potential far-reaching consequences of the generalized use of digital technology in education?

Exaggerated claims about technology go hand in hand with exaggerated estimates of its global market size. In 2022, business intelligence providers' estimates ranged from USD 123 billion to USD 300 billion. These accounts are almost always projected forward, predicting optimistic expansion, yet they fail to give historic trends and verify whether past projections proved true. Such reporting routinely characterizes education technology as essential and technology companies as enablers and disruptors. If optimistic projections are not fulfilled, responsibility is implicitly placed on governments as a way of maintaining indirect pressure on them to increase procurement. Education is criticized as being slow to change, stuck in the past and a laggard when it comes to innovation. Such coverage plays on users' fascination with novelty but also their fear of being left behind.

The sections below further explore the three challenges this report addresses: equity and inclusion (in terms of access to education for disadvantaged groups and access to content), quality (in terms of teaching through and about digital technology) and efficiency (in terms of education management). After identifying technology's potential to tackle these challenges, it discusses three conditions that need to be met for that potential to be fulfilled: equitable access, appropriate governance and regulation, and sufficient teacher capacity.

EQUITY AND INCLUSION: ACCESS FOR DISADVANTAGED GROUPS

A wide range of technology brings education to hard-to-reach learners. Technology has historically opened up education to learners facing significant obstacles in access to schools or well-trained teachers. Interactive radio instruction is used in nearly 40 countries. In Nigeria, radio instruction combined with print and audiovisual materials has been used since the 1990s, reaching nearly 80% of nomads and increasing their literacy, numeracy and life skills. Television has helped educate marginalized groups, notably in Latin America and the Caribbean. The Telesecundaria programme in Mexico, combining televised lessons with in-class support and extensive teacher training, increased secondary school enrolment by 21%. Mobile learning devices, often the only type of device accessible to disadvantaged learners, have been used in hard-to-reach areas and emergencies to share educational materials; complement in-person or remote channels; and foster interactions between students, teachers and parents, notably during COVID-19. Adults have been the main target of online distance learning, with open universities having increased participation for both working and disadvantaged adults.

Inclusive technology supports accessibility and personalization for learners with disabilities. Assistive technology removes learning and communication barriers, with numerous studies reporting a significant positive impact on academic engagement, social participation and the well-being of learners with disabilities. However, such devices remain inaccessible and unaffordable in many countries, and teachers often lack specialized training to use them effectively in learning environments. While people with disabilities used to rely exclusively on specialized devices to gain access to education, technology platforms and devices are increasingly incorporating accessibility features, which support inclusive, personalized learning for all students.

Technology supports learning continuity in emergencies. Mapping of 101 distance education projects in crisis contexts in 2020 showed that 70% used radio, television and basic mobile phones. During the Boko Haram crisis in Nigeria, the Technology Enhanced Learning for All programme used mobile phones and radios to support the learning continuity of 22,000 disadvantaged children, with recorded improvement in literacy and numeracy skills. However, there are significant gaps in terms of rigorous evaluation of education technology in emergencies, despite some limited recorded impact. Meanwhile, most projects are led by non-state actors as short-term crisis responses, raising sustainability concerns; education ministries implemented only 12% of the 101 projects.

Technology supported learning during COVID-19, but millions were left out. During school closures, 95% of education ministries carried out some form of distance learning, potentially reaching over 1 billion students globally. Many of the resources used during the pandemic were first developed in response to previous emergencies or rural education, with some countries building on decades of experience with remote learning. Sierra Leone revived the Radio Teaching Programme, developed during the Ebola crisis, one week after schools closed. Mexico expanded content from its Telesecundaria programme to all levels of education. However, at least half a billion, or 31% of students worldwide – mostly the poorest (72%) and those in rural areas (70%) – could not be reached by remote learning. Although 91% of countries used online learning platforms to deliver distance learning during school closures, the platforms only reached a quarter of students globally. For the rest, low-tech interventions such as radio and television were largely used, in combination with paper-based materials and mobile phones for increased interactivity.

BOX 1:

Generative artificial intelligence is the latest technology touted as having the potential to transform education

Artificial intelligence has been applied in education for at least 40 years. Multiple examples are mentioned throughout this report, of which three stand out. First, intelligent tutoring systems track student progress, difficulties and errors, going through structured subject content to provide feedback and adjust the level of difficulty to create an optimal learning path. Second, artificial intelligence (AI) can support writing assignments and, conversely, can be used to automatically assess writing assignments, including identifying plagiarism and other forms of cheating. Third, AI has been applied to immersive learning experiences and games. Its creators expect that generative AI will increase all these tools' effectiveness to such an extent that their use could become widespread, further personalizing learning and reducing the time teachers spend on tasks such as marking and lesson preparation.

The potential implications for education are numerous. If repetitive tasks are increasingly being automated and more jobs require higher-order thinking skills, the pressure on education institutions to develop such skills will increase. If written assignments no longer indicate a mastery of certain skills, assessment methods will need to develop. If intelligent tutoring replaces at least some teaching tasks, teacher preparation and practices will need to shift accordingly. While many technologies previously promoted as transformative did not live up to expectations, the sheer growth in computing power behind generative AI raises the question whether this technology could be the turning point.

Generative artificial intelligence may not bring the kind of change in education often discussed. If and how AI should be designed and used in education remains an active question. The appeal of learning alone with chatbots may wear off quickly. Even if perfected, such tools may be cumbersome and fail to produce improvement. Personalization in education should vary learner paths not to reach the same learning levels but different ones that fulfil individual potential. More evidence is needed to understand whether AI tools can change how students learn, beyond the superficial level of correcting mistakes. By simplifying the process of obtaining answers, such tools could have a negative impact on student motivation to perform independent research and derive solutions. Their spread could magnify versions of risks mentioned throughout this report. For instance, different learning speeds between students may be mismanaged, widening achievement gaps.

There is a need to reflect on what it means to be well-educated in a world shaped by AI. Faced with new technology tools, the ideal response is unlikely to be further specialization in technology-related domains; rather, it is a balanced curriculum that maintains, if not strengthens, and improves the delivery of arts and humanities to reinforce learners' responsibility, empathy, moral compass, creativity and collaboration. The implication of intelligent tutoring systems cannot be that AI replaces teachers altogether, but that teachers are entrusted with more responsibility than ever to help societies navigate this critical moment. A consensus is forming about the need to enjoy AI's benefits while eliminating risks from its unchecked use, through regulation relating to ethics, responsibility and safety.

Some countries are expanding existing platforms to reach marginalized groups. Less than half of all countries developed long-term strategies for increasing their resilience and the sustainability of interventions as part of their COVID-19 response plans. Many have abandoned distance learning platforms developed during COVID-19, while others are repurposing them to reach marginalized learners. The digital platform set up in Ukraine during the pandemic was expanded once the war broke out in 2022, allowing 85% of schools to complete the academic year.

EQUITY AND INCLUSION: ACCESS TO CONTENT

Technology facilitates content creation and adaptation. Open educational resources (OERs) encourage the reuse and repurposing of materials to cut development time, avoid duplication of work and make materials more context-specific or relevant to learners. They also significantly reduce the cost of access to content. In the US state of North Dakota, an initial investment of USD 110,000 to shift to OERs led to savings of over USD 1 million in student costs. Social media increases access to user-generated content. YouTube, a major player in both formal and informal learning, is used by about 80% of the world's top 113 universities. Moreover, collaborative digital tools can improve the diversity and quality of content creation. In South Africa, the Siyavule initiative supported tutor collaboration on the creation of primary and secondary education textbooks.

Digitization of educational content simplifies access and distribution. Many countries, including Bhutan and Rwanda, have created static digital versions of traditional textbooks to increase availability. Others, including India and Sweden, have produced digital textbooks that encourage interactivity and multimodal learning. Digital libraries and educational content repositories such as the National Academic Digital Library of Ethiopia, National Digital Library of India and Teachers Portal in Bangladesh help teachers and learners find relevant materials. Learning management platforms, which have become a key part of the contemporary learning environment, help organize content by integrating digital resources into course structures.

Open access resources help overcome barriers. Open universities and MOOCs can eliminate time, location and cost barriers to access. In Indonesia, where low participation in tertiary education is largely attributed to geographical challenges, MOOCs play an important role in expanding access to post-secondary learning. During COVID-19, MOOC enrolment surged, with the top three providers adding as many users in April 2020 as in all of 2019. Technology can also remove language barriers. Translation tools help connect teachers and learners from various countries and increase the accessibility of courses by non-native students.

Ensuring and assessing the quality of digital content is difficult. The sheer quantity of content and its decentralized production pose logistical challenges for evaluation. Several strategies have been implemented to address this. China established specific quality criteria for MOOCs to be nationally recognized. The European Union developed its OpenupED quality label. India strengthened the link between non-formal and formal education. Micro-credentials are increasingly used to ensure that institution and learner both meet minimum standards. Some platforms aim to improve quality by recentralizing content production. YouTube, for example, has been funnelling financing and resources to a few trusted providers and partnering with well-established education institutions.

Technology may reinforce existing inequality in both access to and production of content. Privileged groups still produce most content. A study of higher-education repositories with OER collections found that nearly 90% were created in Europe or North America; 92% of the material in the OER Commons global library is in English. This influences who has access to digital content. MOOCs, for example, mainly benefit educated learners – studies have shown around 80% of participants on major platforms already have a tertiary degree – and those from richer countries. The disparity is due to divides in digital skills, internet access, language and course design. Regional MOOCs cater to local needs and languages but can also worsen inequality.

TEACHING AND LEARNING

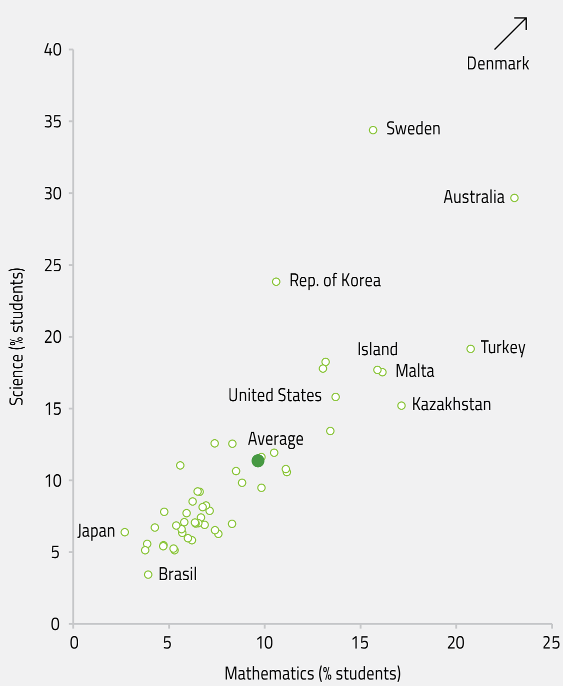
Technology has been used to support teaching and learning in multiple ways. Digital technology offers two broad types of opportunities. First, it can improve instruction by addressing quality gaps, increasing opportunities to practise, increasing available time and personalizing instruction. Second, it can engage learners by varying how content is represented, stimulating interaction and prompting collaboration. Systematic reviews over the past two decades on technology's impact on learning find small to medium-sized positive effects compared to traditional instruction. However, evaluations do not always isolate technology's impact in an intervention, making it difficult to attribute positive effects to technology alone rather than to other factors, such as added instruction time, resources or teacher support. Technology companies can have disproportionate influence on evidence production. For example, Pearson funded studies contesting independent analysis that showed its products had no impact.

The prevalence of ICT use in classrooms is not high, even in the world's richest countries. The 2018 PISA found that only about 10% of 15-year-old students in over 50 participating education systems used digital devices for more than an hour a week in mathematics and science lessons, on average (**Figure 2**). The 2018 International Computer and Information Literacy Study (ICILS) showed that in the 12 participating education systems, simulation and modelling software in classrooms was available to just over one third of students, with country levels ranging from 8% in Italy to 91% in Finland.

Recorded lessons can address teacher quality gaps and improve teacher time allocation. In China, lesson recordings from high-quality urban teachers were delivered to 100 million rural students. An impact evaluation showed improvements in Chinese skills by 32% and a 38% long-term reduction in the rural–urban earning gap. However, just delivering materials without contextualizing and providing support is insufficient. In Peru, the One Laptop Per Child programme distributed over 1 million laptops loaded with content, but no positive impact on learning resulted, partly due to the focus on provision of devices instead of the quality of pedagogical integration.

Enhancing technology-aided instruction with personalization can improve some types of learning. Personalized adaptive software generates analytics that can help teachers track student progress, identify error patterns, provide differentiated feedback and reduce workload on routine tasks. Evaluations of the use of a personalized adaptive software in India documented learning gains in after-school settings and for low-performing students. However, not all widely used software interventions have strong evidence of positive effects compared to teacher-led instruction. A meta-analysis of studies on an AI learning and assessment system that has been used by over 25 million students in the United States found it was no better than traditional classroom teaching in improving outcomes.

FIGURE 2:
Even in upper-middle- and high-income countries, technology use in mathematics and science classrooms is limited
Percentage of 15-year-old students who used digital devices for at least one hour per week in mathematics or science classroom lessons, selected upper-middle- and high-income countries, 2018



GEM StatLink: https://bit.ly/GEM2023_Summary_fig2
Source: 2018 PISA database.

Varied interaction and visual representation can enhance student engagement. A meta-analysis of 43 studies published from 2008 to 2019 found that digital games improved cognitive and behavioural outcomes in mathematics. Interactive whiteboards can support teaching and learning if well integrated in pedagogy; but in the United Kingdom, despite large-scale adoption, they were mostly used to replace blackboards. Augmented, mixed or virtual reality used as an experiential learning tool for repeated practice in life-like conditions in technical, vocational and scientific subjects is not always as effective as real-life training but may be superior to other digital methods, such as video demonstrations.

Technology offers teachers low-cost and convenient ways to communicate with parents. The Colombian Institute of Family Welfare's distance education initiative, which targeted 1.7 million disadvantaged children, relied on social media platforms to relay guidance to caregivers on pedagogical activities at home. However, uptake and effectiveness of behavioural interventions targeting caregivers are limited by parental education levels, as well as lack of time and material resources.

Student use of technology in classrooms and at home can be distracting, disrupting learning. A meta-analysis of research on student mobile phone use and its impact on education outcomes, covering students from pre-primary to higher education in 14 countries, found a small negative effect, and a larger one at the university level. Studies using PISA data indicate a negative association between ICT use and student performance beyond a threshold of moderate use. Teachers perceive tablet and phone use as hampering classroom management. More than one in three teachers in seven countries participating in the 2018 ICILS agreed that ICT use in classrooms distracted students. Online learning relies on student ability to self-regulate and may put low-performing and younger learners at increased risk of disengagement.

DIGITAL SKILLS

The definition of digital skills has been evolving along with digital technology. An analysis for this report shows that 54% of countries have identified digital skills standards for learners. The Digital Competence Framework for Citizens (DigComp), developed on behalf of the European Commission, has five competence areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. Some countries have adopted digital skills frameworks developed by non-state, mostly commercial, actors. The International Computer Driving Licence (ICDL) has been promoted as a 'digital skills standard' but is associated mainly with

Microsoft applications. Kenya and Thailand have endorsed the ICDL as the digital literacy standard for use in schools.

Digital skills are unequally distributed. In the 27 European Union (EU) countries, 54% of adults had at least basic digital skills in 2021. In Brazil, 31% of adults had at least basic skills, but the level was twice as high in urban as in rural areas, three times as high among those in the labour force as among those outside it, and nine times as high in the top socioeconomic group as in the two bottom groups. The overall gender gap in digital skills is small, but wider in specific skills. In 50 countries, 6.5% of males and 3.2% of females could write a computer program. In Belgium, Hungary and Switzerland, no more than 2 women for every 10 men could program; in Albania, Malaysia and Palestine, 9 women for every 10 men could do so. According to the 2018 PISA, 5% of 15-year-olds with the strongest reading skills but 24% of those with the weakest ones were at risk of being misled by a typical phishing email.

Formal skills training may not be the main way of acquiring digital skills. About one quarter of adults in EU countries, ranging from 16% in Italy to 40% in Sweden, had acquired skills through a 'formalised educational institution'. Informal learning, such as self-study and informal assistance from colleagues, relatives and friends, was used by twice as many. Still, formal education is important: In 2018, those with tertiary education in Europe were twice as likely (18%) as those with upper secondary education (9%) to engage in free online training or self-study to improve their computer, software or application use. Solid mastery of literacy and numeracy skills is positively associated with mastery of at least some digital skills.

A curriculum content mapping of 16 education systems showed that Greece and Portugal dedicated less than 10% of the curriculum to **data and media literacy** while Estonia and the Republic of Korea embedded both in half their curricula. In some countries, media literacy in curricula is explicitly connected to critical thinking in subject disciplines, as under Georgia's New School Model. Asia is characterized by a protectionist approach to media literacy that prioritizes information control over education. But in the Philippines, the Association for Media and Information Literacy successfully advocated for incorporation of media and information literacy in the curriculum, and it is now a core subject in grades 11 and 12.

Digital skills in **communication and collaboration** matter in hybrid learning arrangements. Argentina promoted teamwork skills as part of a platform for programming and robotics competitions in primary and secondary education. Mexico offers teachers and students digital education resources and tools for remote collaboration, peer learning and knowledge sharing. Ethical digital behaviour includes rules, conventions and standards to be learned, understood and practised by digital users when using digital spaces. Digital communication's anonymity, invisibility, asynchronicity and minimization of authority can make it difficult for individuals to understand its complexities.

Competences in digital **content creation** include selecting appropriate delivery formats and creating copy, audio, video and visual assets; integrating digital content; and respecting copyright and licences. The ubiquitous use of social media has turned content creation into a skill with direct application in electronic commerce. In Indonesia, the Siberkreasi platform counts collaborative engagement among its core activities. The Kenya Copyright Board collaborates closely with universities to provide copyright education and conducts frequent training sessions for students in the visual arts and ICT.

Education systems need to strengthen preventive measures and respond to many **safety** challenges, from passwords to permissions, helping learners understand the implications of their online presence and digital footprint. In Brazil, 29% of schools have conducted debates or lectures on privacy and data protection. In New Zealand, the Te Mana Tūhono (Power of Connectivity) programme delivers digital protection and security services to almost 2,500 state and state-integrated schools. A systematic review of interventions in Australia, Italy, Spain and the United States estimated that the average programme had a 76% chance of reducing cyberbullying perpetration. In Wales, United Kingdom, the government has advised schools how to prepare for and respond to harmful viral online content and hoaxes.

The definition of **problem-solving** skills varies widely among education systems. Many countries perceive them in terms of coding and programming and as part of a computer science curriculum that includes computational thinking, algorithm use and automation. A global review estimated that 43% of students in high-income countries, 62% in upper-middle-income, 5% in lower-middle-income but no students in low-income countries take computer science as compulsory in primary and/or secondary education. Only 20% of education systems require schools to offer computer science as an elective or core course. Non-state actors often support coding and programming skills. In Chile, Code.org has partnered with the government to provide educational resources in computer science.

EDUCATION MANAGEMENT

Education management information systems focus on efficiency and effectiveness. Education reforms have been characterized by increased school autonomy, target setting and results-based performance, all of which require more data. By one measure, since the 1990s, the number of policies making reference to data, statistics and information has increased by 13 times in high-income, 9 times in upper-middle-income, and 5 times in low- and lower-middle-income countries. But only 54% of countries globally – and as low as 22% in sub-Saharan Africa – have unique student identification mechanisms.

Geospatial data can support education management. Geographical information systems help address equity and efficiency in infrastructure and resource distribution in education systems. School mapping has been used to foster diversity and reduce inequality of opportunity. Ireland links three databases to decide in which of its 314 planning areas to build new schools. Geospatial data can identify areas where children live too far from the nearest school. For instance, it has been estimated that 5% of the population in Guatemala and 41% in the United Republic of Tanzania live more than 3 kilometres away from the nearest primary school.

Education management information systems struggle with data integration. In 2017, Malaysia introduced the Education Data Repository as part of its 2019–23 ICT Transformation Plan to progressively integrate its 350 education data systems and applications scattered across institutions. By 2019, it had integrated 12 of its main data systems, aiming for full integration through a single data platform by the end of 2023. In New Zealand, schools had been procuring student management systems independently and lack of interoperability between them was preventing authorities from tracking student progress. In 2019, the government began setting up the National Learner Repository and Data Exchange to be hosted in cloud data centres, but deployment was paused in 2021 due to cybersecurity concerns. European countries have been addressing interoperability concerns collectively to facilitate data sharing between countries and across multiple applications used in higher-education management through the EMREX project.

Computer-based assessments and computer adaptive testing have been replacing many paper-based assessments. They reduce test administration costs, improve measurement quality and provide rapid scoring. As more examinations shift online, the need for online cheating detection and proctoring tools has also increased. While these can reduce cheating, their effectiveness should be weighed against fairness and psychological effects. Evidence on the quality and usefulness of technology-based assessments has started to emerge, but much less is known about cost efficiency. Among 34 papers on technology-based assessments reviewed for this report, transparent data on cost were lacking.

Learning analytics can increase formative feedback and enable early detection systems. In China, learning analytics has been used to identify learners' difficulties, predict learning trajectories and manage teacher resources. In the United States, Course Signals is a system used to flag the likelihood of a student not passing a course; educators can then target them for additional support. However, learning analytics requires all actors to have sufficient data literacy. Successful education systems typically have absorptive capacity, including strong school leaders and confident teachers willing to innovate. Yet often seemingly trivial issues, such as maintenance and repair, are ignored or underestimated.

ACCESS TO TECHNOLOGY: EQUITY, EFFICIENCY AND SUSTAINABILITY

Access to electricity and devices is highly unequal between and within countries. In 2021, almost 9% of the global population – and more than 70% of people in rural sub-Saharan Africa – lacked access to electricity. Globally, one in four primary schools do not have electricity. A 2018 study in Cambodia, Ethiopia, Kenya, Myanmar, Nepal and Niger found that 31% of public schools were on grid and 9% were off grid, with only 16% enjoying uninterrupted power supply. Globally, 46% of households had a computer at home in 2020; the share of schools with computers for pedagogical purposes was 47% in primary, 62% in lower secondary and 76% in upper secondary education. There were at most 10 computers per 100 students in Brazil and Morocco but 160 computers per 100 students in Luxembourg, according to the 2018 PISA.

Internet access, a vital enabler of economic, social and cultural rights, is also unequal. In 2022, two in three people globally used the internet. In late 2021, 55% of the world's population had mobile broadband access. In low- and middle-income countries, 16% less women than men used mobile internet in 2021. An estimated 3.2 billion people do not use mobile internet services despite being covered by a mobile broadband network. Globally, 40% of primary, 50% of lower secondary and 65% of upper secondary schools are connected to the internet. In India, 53% of private unaided and 44% of private aided schools are connected, compared with only 14% of government schools.

Various policies are used to improve access to devices. Some one in five countries have policies granting subsidies or deductions to buy devices. One-to-one technology programmes were established in 30% of countries at one time; currently only 15% of countries pursue such programmes. A number of upper-middle- and high-income countries are shifting from providing devices to allowing students to use their own devices in school. Jamaica adopted a Bring Your Own Device policy framework in 2020 to aim for sustainability.

Some countries champion free and open source software. Education institutions with complex ICT infrastructure, such as universities, can benefit from open source software to add new solutions or functionalities. By contrast, proprietary software does not permit sharing and has vendor locks that hinder interoperability, exchange and updates. In India, the National e-Governance Plan makes it mandatory for all software applications and services used in government to be built on open source software to achieve efficiency, transparency, reliability and affordability.

Countries are committed to universal internet provision at home and in school. About 85% of countries have policies to improve school or learner connectivity and 38% have laws on universal internet provision. A review of 72 low- and middle-income countries found that 29 had used universal service funds to reduce costs for underserved groups. In Kyrgyzstan, renegotiated contracts helped cut prices by nearly half and almost doubled internet speed. In Costa Rica, the Hogares Conectados (Connected Households) programme, which provided an internet cost subsidy to the poorest 60% of households with school-age children, helped reduce the share of unconnected households from 41% in 2016 to 13% in 2019. Zero-rating, or providing free internet access for education or other purposes, has been used, especially during COVID-19, but is not without problems, as it violates the net neutrality principle.

Education technology is often underutilized. In the United States, an average of 67% of education software licences were unused and 98% were not used intensively. According to the EdTech Genome Project, 85% of some 7,000 pedagogical tools, which cost USD 13 billion, were 'either a poor fit or implemented incorrectly'. Less than one in five of the top 100 education technology tools used in classrooms met the requirements of the US Every Student Succeeds Act. Research had been published for 39% of these tools but the research was aligned with the act in only 26% of cases.

Evidence needs to drive education technology decisions. A review in the United Kingdom found that only 7% of education technology companies had conducted randomized controlled trials, 12% had used third-party certification and 18% had engaged in academic studies. An online survey of teachers and administrators in 17 US states showed that only 11% requested peer-reviewed evidence prior to adopting education technology. Recommendations influence purchase decisions, yet ratings can be manipulated through fake reviews disseminated on social media. Few governments try to fill the evidence gap, so demand has grown for independent reviews. Edtech Tulna, a partnership between a private think tank and a public university in India, offers quality standards, an evaluation toolkit and publicly available expert reviews.

Education technology procurement decisions need to take economic, social and environmental sustainability into account. With respect to economic considerations, it is estimated that initial investment in education technology accounts for just 25% or less of the eventual total cost. Regarding social concerns, procurement processes need to address equity, accessibility, local ownership and appropriation. In France, the Territoires Numériques Educatifs (Digital Educational Territories) initiative was criticized because not all subsidized equipment met local needs, and local governments were left out of the decisions on which equipment to purchase. Both issues have since been addressed. Concerning environmental considerations, it has been estimated that extending the lifespan of all laptops in the European Union by a year would save the equivalent of taking almost 1 million cars off the road in terms of CO_2 emissions.

Regulation needs to address risks in education technology procurement. Public procurement is vulnerable to collusion and corruption. In 2019, Brazil's Comptroller General of the Union found irregularities in the electronic bidding process for the purchase of 1.3 million computers, laptops and notebooks for state and municipal public schools. Decentralizing public procurement to local governments is one way to balance some of the risks. Indonesia has used its SIPLah e-commerce platform to support school-level procurement processes. However, decentralization is vulnerable to weak organizational capacity. A survey of administrators in 54 US school districts found that they had rarely carried out needs assessments.

GOVERNANCE AND REGULATION

Governance of the education technology system is fragmented. A department or an agency responsible for education technology has been identified in 82% of countries. Placing education ministries in charge of education technology strategies and plans could help ensure that decisions are primarily based on pedagogical principles. However, this is the case in just 58% of countries. In Kenya, the 2019 National Information, Communications and Technology Policy led the Ministry of Information, Communications and Technology to integrate ICT at all levels of education.

Participation is often limited in the development of education technology strategies and plans. Nepal established a Steering and a Coordination Committee under the 2013–17 ICT in Education Master Plan for intersectoral and inter-agency coordination and cooperation in its implementation. Including administrators, teachers and students can help bridge the knowledge gap with decision makers to ensure that education technology choices are appropriate. In 2022, only 41% of US education sector leaders agreed that they were regularly included in planning and strategic conversations about technology.

The private sector's commercial interests can clash with government equity, quality and efficiency goals. In India, the government alerted families about the hidden costs of free online content. Other risks relate to data use and protection, privacy, interoperability and lock-in effects, whereby students and teachers are compelled to use specific software or platforms. Google, Apple and Microsoft produce education platforms tied to particular hardware and operating systems.

Privacy risks to children make their learning environment unsafe. One analysis found that 89% of 163 education technology products recommended for children's learning during the COVID-19 pandemic could or did watch children outside school hours or education settings. In addition, 39 of 42 governments providing online education during the pandemic fostered uses that 'risked or infringed' upon children's rights. Data used for predictive algorithms can bias predictions and decisions and lead to discrimination, privacy violations and exclusion of disadvantaged groups. The Cyberspace Administration of China and the Ministry of Education introduced regulations in 2019 requiring parental consent before devices powered by AI, such as cameras and headbands, could be used with students in schools and required data to be encrypted.

Children's exposure to screen time has increased. A survey of screen time of parents of 3- to 8-year-olds in Australia, China, Italy, Sweden and the United States found that their children's screen exposure increased by 50 minutes during the pandemic for both education and leisure. Extended screen time can negatively affect self-control and emotional stability, increasing anxiety and depression. Few countries have strict regulations on screen time. In China, the Ministry of Education limited the use of digital devices as teaching tools to 30% of overall teaching time. Less than one in four countries are banning the use of smartphones in schools. Italy and the United States have banned the use of specific tools or social media from schools. Cyberbullying and online abuse are rarely defined as offences but can fall under existing laws, such as stalking laws as in Australia and harassment laws in Indonesia.

Monitoring of data protection law implementation is needed. Only 16% of countries explicitly guarantee data privacy in education by law and 29% have a relevant policy, mainly in Europe and Northern America. The number of cyberattacks in education is rising. Such attacks increase exposure to theft of identity and other personal data, but capacity and funds to address the issue are often insufficient. Globally, 5% of all ransomware attacks targeted the education sector in 2022, accounting for more than 30% of cybersecurity breaches. Regulations on sharing children's personal information are rare but are starting to emerge under the EU's General Data Protection Regulation. China and Japan have binding instruments on protecting children's data and information.

TEACHERS

Technology has an impact on the teaching profession. Technology allows teachers to choose, modify and generate educational materials. Personalized learning platforms offer teachers customized learning paths and insights based on student data. During the COVID-19 pandemic, France facilitated access to 17 online teaching resource banks mapped against the national curriculum. The Republic of Korea temporarily eased copyright restrictions for teachers. Online teacher-student collaboration platforms provide access to support services, facilitate work team creation, allow participation in virtual sessions and promote sharing of learning materials.

BOX 2:

Education affects technology

While the focus of this report is the impact of digital technology on education, the opposite relationship is just as important: The role of education in promoting technology transfer, adoption and development in economies and societies.

Most school curricula include learning about technology. There is wide variation among countries on how technology is taught and its importance. Technology education can be taught in separate subjects or integrated across disciplines. It can be compulsory or elective and be taught in various grades. As a stand-alone subject, technology has been conceived variably as skills and craft education, industrial arts, or vocational training. Its content remains highly contextualized, responding to national strategies and cultural contexts. In Botswana, the senior secondary school design and technology subject covers aspects of health, design tools, graphics and electronics. In Viet Nam, grade 3 to 9 pupils have studied ICT as a compulsory subject since 2018.

The quality of science, technology, engineering and mathematics (STEM) provision affects student achievement and disposition. More instruction time dedicated to STEM does not automatically lead to better understanding and achievement. Rather, teacher preparation and practices contribute to student performance. The 2019 Trends in International Mathematics and Science Study (TIMSS) showed that those most satisfied with instructional clarity in mathematics and science reported higher scores. Grade 8 students in schools with science laboratories tend to perform better. Out-of-field teaching also influences student engagement. Over 10% of lower secondary science teachers in at least 40 countries had not received any formal training in the subject.

Beliefs and dispositions influence the probability of engaging with STEM beyond schooling. Gender is one of the strongest determinants of the probability of pursuing STEM studies and careers. In 2016–18, 35% of tertiary graduates in STEM fields were women. Grade 8 boys were more willing to pursue a mathematics-related occupation than their female schoolmates in 87% of education systems in the 2019 TIMSS. Students from socioeconomically disadvantaged backgrounds are also less likely to pursue educational and professional careers in science and mathematics. Counselling can expose youth to pathways they would not otherwise have considered. Some countries introduce STEM before gender-role beliefs are established. The Little Scientists project, which originated in Germany, promotes STEM learning among pre-primary students; in Thailand, it has reached over 29,000 schools.

Higher-education institutions are key to national technological development. Universities, governments and businesses interact in the innovation process, collaborating in research, development, financing, application and the commercial use of ideas. Higher-education institutions play two key roles. First, they prepare and develop professional researchers through teaching and learning. Second, they generate knowledge, which forms the basis for developing technology and innovation, through their own research or in partnership with other actors. Their role is mediated through their engagement with governments, businesses and society, and through their organization and management.

University and education systems compete for talented STEM students. An average of 46% of international students in selected upper-middle income and high-income countries were enrolled in STEM fields. Countries support national students and attract foreign ones through scholarships. Since 2006, beneficiaries of grants related to STEM fields in higher and graduate education have accounted for 31% of global recipients. Saudi Arabia's King Abdullah Scholarship Programme, launched in 2005 and renewed in 2019 for five more years, supports some 130,000 students per year in STEM studies.

Obstacles to integrating technology in education prevent teachers from fully embracing it. Inadequate digital infrastructure and lack of devices hinder teachers' ability to integrate technology in their practice. A survey in 165 countries during the pandemic found that two in five teachers used their own devices, and almost one third of schools had only one device for education use. Some teachers lack training to use digital devices effectively. Older teachers may struggle to keep up with rapidly changing technology. The 2018 Teaching and Learning International Survey (TALIS) found that older teachers in 48 education systems had weaker skills and lower self-efficacy in using ICT. Some teachers may lack confidence. Only 43% of lower secondary school teachers in the 2018 TALIS said they felt prepared to use technology for teaching after training, and 78% of teachers in the 2018 ICILS were not confident in using technology for assessment.

Education systems support teachers in developing technology-related professional competencies. About half of education systems worldwide have ICT standards for teachers in a competency framework, teacher training framework, development plan or strategy. Education systems set up annual digital education days for teachers, promote OER, support the exchange of experiences and resources between teachers, and offer training. One quarter of education systems have legislation to ensure teachers are trained in technology, either through initial or in-service training. Some 84% of education systems have strategies for in-service teacher professional development, compared with 72% for pre-service teacher education in technology. Teachers can identify their development needs using digital self-assessment tools such as that provided by the Centre for Innovation in Brazilian Education.

Technology is changing teacher training. Technology is used to create flexible learning environments, engage teachers in collaborative learning, support coaching and mentoring, increase reflective practice, and improve subject or pedagogical knowledge. Distance education programmes have promoted teacher learning in South Africa and even equalled the impact of in-person training in Ghana. Virtual communities have emerged, primarily through social networks, for communication and resource sharing. About 80% of teachers surveyed in the Caribbean belonged to professional WhatsApp groups and 44% used instant messaging to collaborate at least once a week. In Senegal, the Reading for All programme used in-person and online coaching. Teachers considered face-to-face coaching more useful, but online coaching cost 83% less and still achieved a significant, albeit small, improvement in how teachers guided students' reading practice. In Flanders, Belgium, KlasCement, a teacher community network created by a non-profit and now run by the Ministry of Education, expanded access to digital education and provided a platform for discussions on distance education during the pandemic.

Many actors support teacher professional development in ICT. Universities, teacher training institutions and research institutes provide specialized training, research opportunities and partnerships with schools for professional development in ICT. In Rwanda, universities collaborated with teachers and the government to develop the ICT Essentials for Teachers course. Teacher unions also advocate for policies that support teachers. The Confederation of Education Workers of the Argentine Republic established the right of teachers to disconnect. Civil society organizations, including the Carey Institute for Global Good, offer support through initiatives such as providing OER and online courses for refugee teachers in Chad, Kenya, Lebanon and Niger.

RECOMMENDATIONS

Digital technology is becoming ubiquitous in people's daily lives. It is reaching the world's most distant corners. It is even creating new worlds, where the lines between the real and the imaginary are harder to discern. Education cannot remain unaffected, although there are calls to protect it from the negative influences of digital technology. However, this is a major challenge, as technology appears in multiple forms in education. It is an input, a means of delivery, a skill and a planning tool, and provides a social and cultural context, all of which raise particular questions and issues.

- It is an input: Ensuring the provision, operation and maintenance of technology infrastructure in education, such as electricity, computers and internet connectivity, at school or at home, requires considerable capital investment, recurrent expenditure and procurement skills. There is remarkably little reliable and consistent information on these costs.
- It is a means of delivery: Teaching and learning can benefit from education technology. But the fast pace of technological change and control of evidence by technology providers makes it difficult to know which technologies work best, in what context and under what conditions.
- It is a skill: Education systems are being called upon to support learners at various levels in acquiring digital and other technology skills, raising questions on content, the best sequence of relevant courses, appropriate education levels and provider modalities.
- It is a planning tool: Governments are encouraged to use technology tools to improve the efficiency and effectiveness of education system management, for instance in collecting information on student behaviour and outcomes.
- It provides a social and cultural context: Technology affects all spheres of life, expanding opportunities for connection and access to information but also posing risks to safety, privacy, equality and social cohesion, sometimes resulting in harm from which users need protection.

This report's basic premise is that technology should serve people and that technology in education should put learners and teachers at the centre. The report has tried to avoid an overly technology-centred view or the claim that technology is neutral. It also offers a reminder that, as much technology was not designed for education, its suitability and value need to be proven in relation to a human-centred vision of education. Decision makers are faced with four challenging trade-offs:

- The call for personalization and adaptation clashes with the need to maintain the social dimension of education. Those urging increased individualization may be missing the point of what education is about. Technology must be designed to respect the needs of a diverse population. An assistive teaching and learning tool for some may be a burden and distraction for others.
- There is a conflict between inclusivity and exclusivity. Technology can potentially offer an education lifeline to many. However, for many more, it raises a further barrier to equal education opportunities, with new forms of digital exclusion emerging. It is not sufficient to acknowledge that every technology has early adopters and late followers; action is also needed. The principle of equity in education and learning must be adhered to.
- The commercial sphere and the commons pull in different directions. The growing influence of the education technology industry on education policy at the national and international levels is a cause for concern. A vivid example is how the promise of open education resources and of the internet as a gateway to education content is frequently compromised. A better understanding and exposure of the interests underlying the use of digital technology in education and learning is needed so as to ensure that the common good is the priority of governments and educators.
- It is generally assumed that whatever efficiency advantage education technology offers in the short term will continue in the long term. Such technology is presented as a sound, potentially labour-saving investment that may even be able to replace teachers. However, its full economic and environmental costs are usually underestimated and unsustainable. The bandwidth and capacity of many to use technology in education are limited. And it is time to reckon with education technology's cost in terms of environmental sustainability and question whether such technology truly strengthens education systems' resilience.

Even more recently, a conflict between machines and humans has surfaced in the context of debates over generative AI, whose implications for education are only gradually emerging. These fault lines leave the education sector torn between hope for digital technologies' potential and the undeniable risks and harms linked to their application. 'It is at the level of trade-offs that a more complex and democratic debate ought to take place'.

Not all change constitutes progress. Just because something can be done does not mean it should be done. Change needs to happen on learners' terms to avoid the repeat of a scenario like the one observed during the COVID-19 pandemic, when an explosion of distance learning left hundreds of millions behind.

Technology created for other uses cannot necessarily be expected to be appropriate in all education settings for all learners. Nor can regulations set outside the education sector necessarily be expected to cover all of education's needs. What this report calls for in this debate is clear vision – as the world considers what is best for children's learning, especially in the case of the most marginalized.

The #TechOnOurTerms campaign calls for decisions about technology in education to prioritize learner needs after assessment of whether its application would be appropriate, equitable, evidence-based and sustainable. It is essential to learn to live both with and without digital technology; to take what is needed from an abundance of information but ignore what is not necessary; to let technology support, but never supplant, the human connection on which teaching and learning are based.

Accordingly, the following four questions have been framed for and are directed primarily at governments, whose responsibility it is to protect and fulfil the right to education. However, the questions are also meant to be used as advocacy tools by all education actors committed to supporting progress towards SDG 4 to ensure that efforts to promote technology, including AI, take into account the need to address the main education challenges and to respect human rights.

In considering the adoption of digital techology, education systems should always ensure that learners' best interests are placed at the centre of a framework based on rights. The focus should be on learning outcomes, not digital inputs. To help improve learning, digital technology should not substitute but instead complement face-to-face interaction with teachers.

The 2023 GEM Report provides a four-point compass for policy makers to use when deciding how to ensure that technology is used on their terms in education

Is this use of education technology appropriate for the national and local contexts? Education technology should strengthen education systems and align with learning objectives.

Governments should therefore:

- Reform curricula to target the teaching of the basic skills that are best suited to those digital tools that have been proven to improve learning and are underpinned by a clear theory of how children learn, without assuming either that pedagogy can remain the same or that digital technology is suitable for all types of learning.
- Design, monitor and evaluate education technology policies with the participation of teachers and learners to draw on their experiences and contexts and ensure that teachers and facilitators are sufficiently trained to understand how to use digital technology for learning, not simply how to use a specific piece of technology.
- Ensure that solutions are designed to fit their context, and that resources are available in multiple national languages, are culturally acceptable and age-appropriate, and have clear entry points for learners in given education settings.

Is this use of education technology leaving learners behind? Although technology use can enable access to the curriculum for some students and accelerate some learning outcomes, digitalization of education poses a risk of benefiting already privileged learners and further marginalizing others, thus increasing learning inequality.

Governments should therefore:

- Focus on how digital technology can support the most marginalized so that all can benefit from its potential, irrespective of background, identity or ability, and ensure that digital resources and devices comply with global accessibility standards.
- Set national targets on meaningful school internet connectivity, as part of the SDG 4 benchmarking process, and target investment accordingly to allow teachers and learners to benefit from a safe and productive online experience at an affordable cost, in line with the right to free education.
- Promote digital public goods in education, including free accessible e-pub formats, adaptable open education resources, learning platforms, and teacher support applications, all designed so as not to leave anyone behind.

Is this use of education technology scalable? There is an overwhelming array of technological products and platforms in education and decisions are often made about them without sufficient evidence of their benefits or their costs.

Governments should therefore:

- Establish bodies to evaluate education technology, engaging with all actors that can carry out independent and impartial research and setting clear evaluation standards and criteria, the aim being to achieve evidence-based policy decisions on education technology.
- Undertake pilot projects in contexts that accurately reflect the total cost of ownership and implementation, taking into account the potentially higher cost of technology for marginalized learners.
- Ensure transparency on public spending and terms of agreements with private companies to strengthen accountability; evaluate performance to learn from mistakes, including on matters ranging from maintenance to subscription costs; and promote interoperability standards to increase efficiency.

Does this use of technology support sustainable education futures? Digital technology should not be seen as a short-term project. It should be leveraged to yield benefits on a sustainable basis and not be led by narrow economic concerns and vested interests.

Governments should therefore:

- Establish a curriculum and assessment framework of digital competences that is broad, not attached to specific technology, takes account of what is learned outside school, and enables teachers and learners to benefit from technology's potential in education, work and citizenship.
- Adopt and implement legislation, standards and agreed good practices to protect learners' and teachers' human rights, well-being and online safety, taking into account screen and connection time, privacy, and data protection; to ensure that data generated in the course of digital learning and beyond are analysed only as a public good; to prevent student and teacher surveillance; to guard against commercial advertising in educational settings; and to regulate the ethical use of artificial intelligence in education.
- Consider the short- and long-term implications of digital technology deployment in education for the physical environment, avoiding applications that are unsustainable in terms of their energy and material requirements.

Monitoring education in the Sustainable Development Goals

Three in four countries have submitted benchmarks, or national targets, to be achieved by 2025 and 2030 for at least some of seven SDG 4 indicators: early childhood education attendance; out-of-school rates; completion rates; gender gaps in completion rates; minimum proficiency rates in reading and mathematics; trained teachers; and public education expenditure. This process, supported by the UNESCO Institute for Statistics (UIS) and the GEM Report, responds to the Education 2030 Framework for Action, which called on countries to establish 'appropriate intermediate benchmarks … for addressing the accountability deficit associated with longer-term targets'.

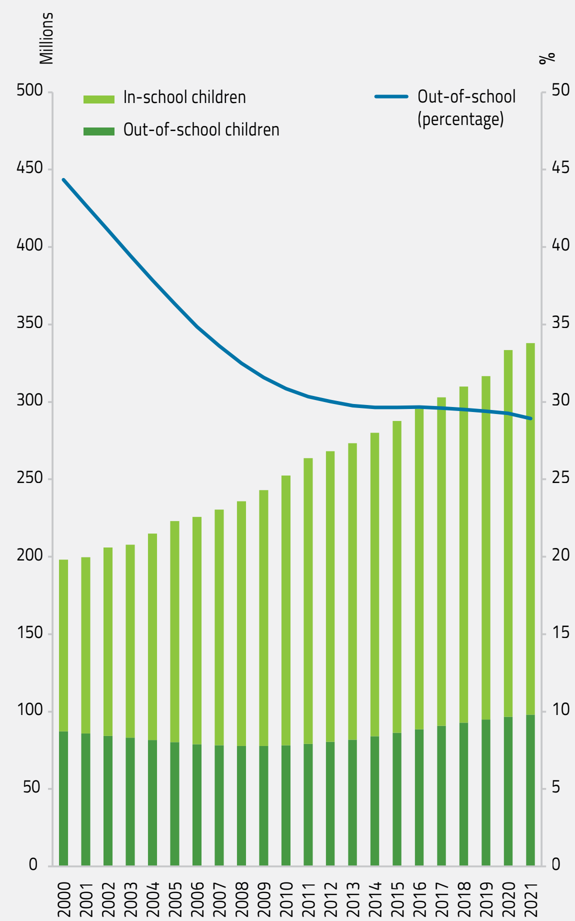
The first annual snapshot of country progress towards these national targets, the SDG 4 Scorecard, was published in January 2023. An analysis of historical progress rates between 2000 and 2015 from each country's starting point provides the context against which recent progress is being assessed. The analysis maps the past average progress of fast- and slow-moving countries against a range of starting points, indicating what ambitious but feasible trajectories might look like.

Progress between 2015 and 2020, up to the onset of COVID-19, informed the analysis of country prospects in achieving their 2025 national benchmarks, as the pandemic disrupted not only education development but also data collection. Summary progress towards actual and feasible benchmarks was provided for each of the seven indicators, while progress towards actual benchmarks was provided for each country for two indicators: the upper secondary completion rate and the participation rate in organized learning one year before primary. Among countries with benchmarks and data, 29% in the upper secondary completion rate and 43% in the participation rate in organized learning one year before primary were on course to achieve their 2025 benchmarks with high probability; these were mostly richer countries, especially in the case of the early childhood indicator.

FIGURE 3:

The out-of-school population in sub-Saharan Africa increased by 12 million over 2015–21

In-school and out-of-school population and out-of-school rate, sub-Saharan Africa, 2000–21



GEM StatLink: https://bit.ly/GEM2023_Summary_fig3

Source: UIS and GEM Report estimates based on the out-of-school rate model.

FIGURE 4:

Poorer countries improved reading proficiency levels faster than richer countries

Average annual percentage-point change in the share of students with minimum proficiency in reading at the end of primary education, by country income group, 2011–21

GEM StatLink: https://bit.ly/GEM2023_Summary_fig4

Source: UIS and GEM Report estimates based on the out-of-school rate model.

TARGET 4.1. PRIMARY AND SECONDARY EDUCATION

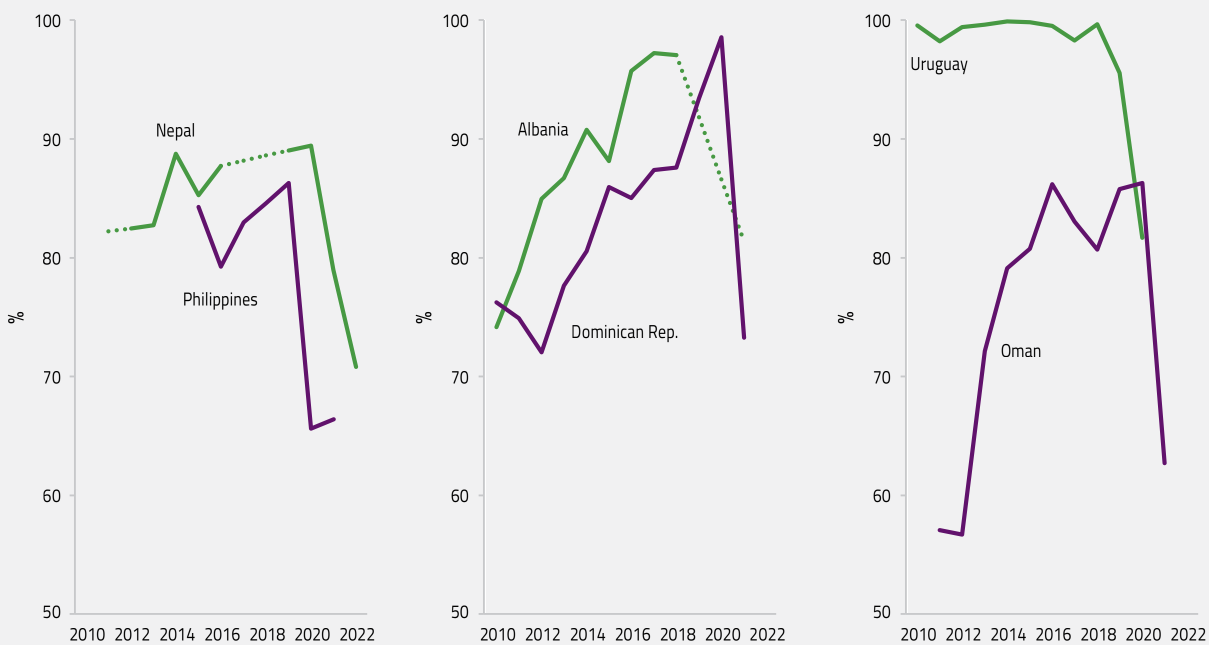
In 2022, the UIS and the GEM Report developed a new model to estimate the out-of-school rate, combining multiple data sources. It put the global out-of-school population of primary and secondary school age at 244 million in 2021, 9 million less than in 2015. The decline amounts to a slow decrease in the out-of-school rate, just over 0.2 percentage points per year. Over the same period, the out-of-school population in sub-Saharan Africa grew by 12 million despite a decline in the out-of-school rate of 0.1 percentage points per year (**Figure 3**). This is the result of rapid demographic growth, with the school-age population growing by 50 million in just 6 years.

However, the monitoring of progress has been hampered by the COVID-19 pandemic, which disrupted data collection. The out-of-school rate model may not be sensitive enough to capture a short-term impact such as that of COVID-19. Between 2019 and 2021, the UIS database has data for one in four countries on primary education and one in five on secondary education. Excluding India and the Philippines, which reported the largest decrease and largest increase in their out-of-school population, respectively, the data suggest no visible impact in primary and lower secondary education but an increase of just over half a million in the population of upper secondary youth out of school. These data also show that the longer the duration of school closures, the higher the increase in out-of-school rates.

FIGURE 5:

In some countries, early childhood education participation rates dropped drastically during the pandemic

Participation rate in organized learning one year before the official primary entry age, selected countries, 2010–22



GEM StatLink: https://bit.ly/GEM2023_Summary_fig5

Note: Dotted segments indicate that the trend was interpolated.

Source: UIS database.

Global completion rates increased between 2015 and 2021 from 85% to 87% in primary, from 74% to 77% in lower secondary and from 54% to 59% in upper secondary education. Sub-Saharan Africa remains well below the global average, by more than 20 percentage points in primary (64%) and by almost 30 points in lower secondary (45%) and upper secondary education (27%).

Of the 31 low- and lower-income countries for which there are data since 2019, only Viet Nam has a majority of children achieving minimum proficiency in both reading and mathematics at the end of primary school. In 18 of the countries, less than 10% of children reach minimum proficiency in reading and/or mathematics. For every child to achieve minimum learning proficiency by 2030, average annual progress must reach at least 2.7 percentage points, well above the average of 0.4 percentage points observed in 2000–19. Trend data remain scarce: There are only 13 low- and lower-income countries with two observations since 2013. Moreover, the quality of the trend data is sometimes not sufficient enough to allow robust assessment of change over time. But available evidence suggests that, since 2011, the share of students at the end of primary education with minimum proficiency in reading has increased faster in low- and lower-middle-income countries (by 0.71 percentage points per year), albeit from lower starting points, than in upper-middle- and high-income countries (where the share has fallen by 0.06 percentage points) (**Figure 4**).

Major concerns remain about the impact of COVID-19 on learning outcomes. The first robust piece of cross-national evidence is the 2021 Progress in International Reading Literacy Study (PIRLS) on grade 4 students, whose results were released in May 2023. Students from 57 mostly upper-middle- and high-income countries participated. Progress relative to 2016 could be assessed for 32 of the countries. In one way, the 2021 PIRLS seems to confirm that COVID-19 had a negative impact on learning: 21 of 32 countries performed worse in 2021 than in 2016, while 8 retained the same levels and 3 improved. But another way to interpret the results is that they are not as bad as they might have been. In 10 of the 21 countries whose achievement scores fell between 2016 and 2021, the scores also decreased between 2011 and 2016. And in absolute terms, the average decline in the PIRLS score between 2016 and 2021 was 8 points, which is about one fifth of what children learn in a school year, a small impact given the magnitude of the disruption.

Apart from PIRLS, several country-specific studies have been published. However, they are not anchored to the SDG 4 global proficiency level, and comparability is further hampered by the studies being carried out at different times, levels and subjects. While high-income countries, such as those that took part in PIRLS, experienced a far smaller impact or sometimes none, low- and middle-income countries, with longer school closures and fewer learning continuity opportunities, appear to have suffered a stronger impact. Findings from Brazil, Cambodia, Malawi and Mexico suggest children lost at least one year of learning. The longer schools stayed closed, the stronger the impact on learning losses.

TARGET 4.2. EARLY CHILDHOOD

Globally, the early childhood education participation rate remained stable at about 75% between 2015 and 2020. The largest increases, of about four percentage points each, took place in sub-Saharan Africa and in Northern Africa and Western Asia, the two regions with the lowest baseline values, which reached 48% and 52%, respectively.

About three quarters of countries still lack compulsory pre-primary education and half do not offer free provision. In 2022, 88 out of 186 countries with data for both did not have legislation committing to either free or compulsory pre-primary education. This matters because countries that guarantee free and compulsory pre-primary education tend to have higher enrolment rates. On average, the enrolment rate for children one year younger than the official primary entry age in countries that do not offer free pre-primary education is 68%, compared with 78% among those that guarantee one year free and 83% among those that guarantee at least two years.

COVID-19 caused sharp declines in pre-primary participation in many countries, across income groups (**Figure 5**). But the effect was not consistent globally. Out of 127 countries with available data, 54 saw a decline in participation in either 2020 or 2021. Participation was relatively stable in 30 countries and increased in 43 over the period. More data are needed to confirm the pandemic's impact on participation, as some observed changes could be due to challenges related to data collection during school closures.

The new Early Childhood Development Index, which assesses the interrelated domains of learning, psychosocial well-being and health, highlights significant inequality in development between children of different backgrounds. In Nigeria, for example, nearly 80% of children whose mother has a tertiary education are developmentally on track, but the same is true for only 31% of those whose mother has not completed primary school.

TARGET 4.3. TECHNICAL, VOCATIONAL, TERTIARY AND ADULT EDUCATION

Global enrolment in tertiary education grew over the previous decade, but at a slower pace after 2015: The gross enrolment ratio increased from 29% in 2010 to 37% in 2015 but had reached only 40% five years later. In most countries, women are more likely than men to be enrolled in tertiary education. In 2020, the gross enrolment ratio of women was 43%, compared with 37% for men. Of the 146 countries with available data, 106 have a gap in favour of women and 30 have a gap in favour of men; 22 of the latter are in sub-Saharan Africa. The higher the rate of tertiary enrolment, the more likely a gap in favour of women.

Fewer tertiary education students have been pursuing more advanced degrees. Overall, around 12% of tertiary students were pursuing master's or doctoral degrees in 2020, down from 14% in 2012. The share ranged from 24% in Europe and Northern America to about 6% in Latin America and the Caribbean and in Eastern and South-Eastern Asia. Skills are increasingly sought outside traditional higher education, as evidenced by the increasing popularity of micro-credentials.

The median adult participation rate in formal and non-formal education and training across 115 countries with recent data is 3%. However, data for this indicator can be difficult to compare given the variance in reference periods across surveys. All countries with participation above 10% are in Europe and Northern America, but surveys from these countries count participation during the last four weeks before the survey instead of the 12 months intended by the indicator. Other surveys only consider current participation, or participation during the previous week. These differences are likely to have a significant impact on the comparability of national averages.

TARGET 4.4. SKILLS FOR WORK

There is a shortfall of ICT skills. Globally, 4% of adults aged 15 and above can write a computer program using a specialized programming language. Prior education is a strong predictor of the likelihood that youth and adults have achieved at least a minimum level of proficiency in digital literacy skills. In 31 countries with data, those with tertiary education are almost twice as likely to have basic digital skills as those with less education. There is also a generational gap: Younger adults are at least twice as likely to have basic digital skills as older adults.

Globally, the supply of STEM graduates has remained remarkably stable since 2000. The share of graduates in digital technology subjects has grown slowly if at all, as have the shares in scientific and applied STEM subjects. Digital technology graduates make up around 5% of the total, science and mathematics graduates another 5%, and engineers a further 10–15%. Similar proportions of graduates in science, mathematics and digital technology are observed across country income groups, with a difference of just one percentage point between low-income and high-income countries in each case. But around 12% of students graduate in engineering in high-income countries, compared with 7% in low-income countries.

TARGET 4.5. EQUITY

In recent decades, progress on girls' education access and completion has been one of the main achievements in equality in education. Across education levels, all regions have achieved gender parity in education except sub-Saharan Africa, where there are 90 girls enrolled for every 100 boys. These aggregates mask higher levels of gender disparity in some countries. For example, in Chad, the number of girls enrolled for every 100 boys increased from 45 in 2015 to 58 in 2021; in Guinea, it increased from 65 in 2015 to 72 in 2020.

Regarding learning, UIS analysis suggests girls' learning has improved faster over time than that of boys. Among students assessed in reading at the end of primary education, the average annual progress for girls globally since 2000 was 0.16 percentage points, compared with 0.12 percentage points for boys. Girls almost consistently outperform boys in reading. Globally, for every 100 proficient boys, 115 girls are proficient in reading at the end of lower secondary education. In 90% of countries with data, girls outperform boys in reading at the end of primary school. They do so in all countries at the end of lower secondary education.

The COVID-19 crisis exacerbated education inequality: Learning losses tended to be higher among poorer students, who benefited less from remote learning. In the Netherlands, the learning loss was 60% higher for students with less educated parents. In Pakistan, citizen-led assessment data on 5- to 16-year-olds in rural districts suggested that the reading gender gap reversed between 2019 and 2021 from favouring girls (18% boys vs 21% girls) to favouring boys (16% boys vs 14% girls).

A disadvantaged group that is not explicitly mentioned in the SDG 4 framework is first-generation learners, i.e. the first in their family to attend a particular level of schooling. Completing a level of education that your parents did not is a formidable challenge, whether for schoolgoing children of illiterate parents in poor countries or university students of less educated parents in rich countries. The median relative gap in primary completion by first-generation status in low- and lower-middle-income countries is 23 percentage points; it exceeds 40 points in Cameroon and Nigeria, a gap even larger than the urban–rural gap. The median gap in lower secondary completion by first-generation status is 34 percentage points; it reaches almost 50 points in Madagascar.

TARGET 4.6. ADULT LITERACY

A literacy rate indicator based on direct assessment and recognizing multiple levels of proficiency was introduced in the SDG 4 monitoring framework to capture the evolution of thinking over what it means to be literate, as well as to motivate countries to invest in literacy assessments. However, the high cost of assessment, weak implementation capacity and insufficient demand means few upper-middle- and high-income countries have carried out such assessments since 2015. As a result, monitoring literacy has reverted to the traditional binary assessment of literate vs non-literate.

The youth literacy rate worldwide increased from 87% in 2000 to 91% in 2016, then plateaued. In sub-Saharan Africa and in Central and Southern Asia, literacy rates are below the global average, at 77% and 90%, respectively. The adult literacy rate reached 87% in 2016 and has also stagnated since. Among people older than 65, literacy rates improved fastest in Eastern and South-Eastern Asia, from 60% in 2000 to 84% in 2020.

Literacy is linked to significant development outcomes. For example, the gap in modern contraceptive use in urban Palestine between literate and illiterate women is 35 percentage points in urban areas and 22 percentage points in rural areas. In Fiji, the gap is around 12 percentage points in urban areas and 6 percentage points in rural areas.

The Programme for the International Assessment of Adult Competencies was carried out in three rounds in the 2010s in 37 upper-middle- and high-income countries. It is the only cross-national survey to both recognize various adult skills proficiency levels and assess numeracy. Less than half of adults in upper-middle-income countries that took part in the second (2015) and third (2017) rounds had minimum proficiency in numeracy, including in Ecuador (23%), Peru (25%), Mexico (40%) and Türkiye (49%). The only upper-middle-income country where the majority of adults had at least minimum numeracy skills was Kazakhstan (73%).

TARGET 4.7. SUSTAINABLE DEVELOPMENT AND GLOBAL CITIZENSHIP

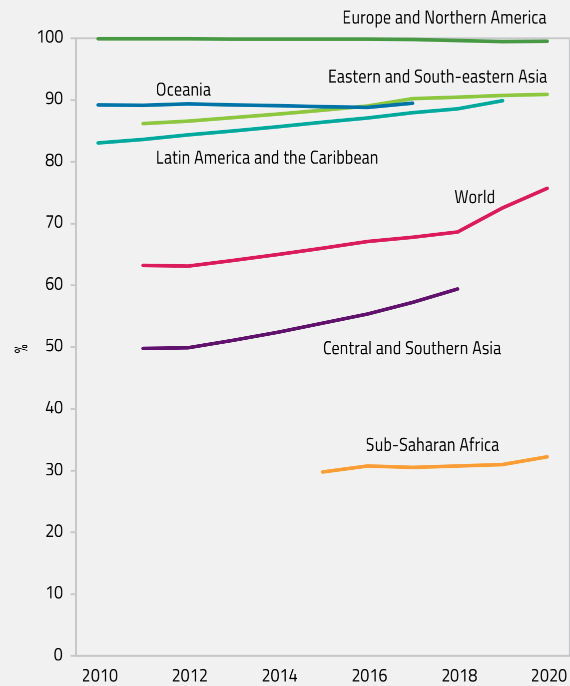
Monitoring of progress in mainstreaming global citizenship education and education for sustainable development in policies, curricula, teacher education and assessment has been based on a self-reporting mechanism on implementation of the 1974 Recommendation concerning Education for International Understanding, Cooperation and Peace and Education relating to Human Rights and Fundamental Freedoms. Reporting has taken place every five years. A UNESCO-led process aims to supersede the text with a new recommendation reflecting contemporary needs. The proposed new text includes, for the first time, a section on follow-up and review, which gives guidance on actions that can be taken to monitor the implementation of the recommendation and learn from best practices. However, neither the Recommendation itself nor the guidance included in the follow-up and review section would be binding on any party.

Climate change education was a discussion focus at the UN Transforming Education Summit in September 2022 in New York. An initiative supported by UNESCO aims to introduce an indicator on prioritization and integration of green content in national curricular frameworks, and in the syllabuses of selected science and social science subjects, to measure the extent to which sustainability, climate change and environmental themes are covered in primary and secondary education. A collection of official documents is being assembled for about 100 countries and the first results are to be released in early 2024.

FIGURE 6:

There has been hardly any progress in school electrification in sub-Saharan Africa

Proportion of primary schools with access to electricity, by region, 2010–20



GEM StatLink: https://bit.ly/GEM2023_Summary_fig6
Source: UIS database.

Another initiative, a collaboration between the GEM Report and the Monitoring and Evaluating Climate Communication and Education project, is collecting information on laws and policies in 70 countries to support peer learning on climate change education and communication. These profiles enable a comparison of countries' progress in relation to Article 6 of the United Nations Framework Convention on Climate Change and Article 12 of the Paris Agreement, through Action for Climate Empowerment, and on SDG Target 4.7. Analysis of the first 50 profiles shows that 39% of countries have included climate change content in their education laws, and 63% of countries have included climate change in a law, policy or plan for teacher training.

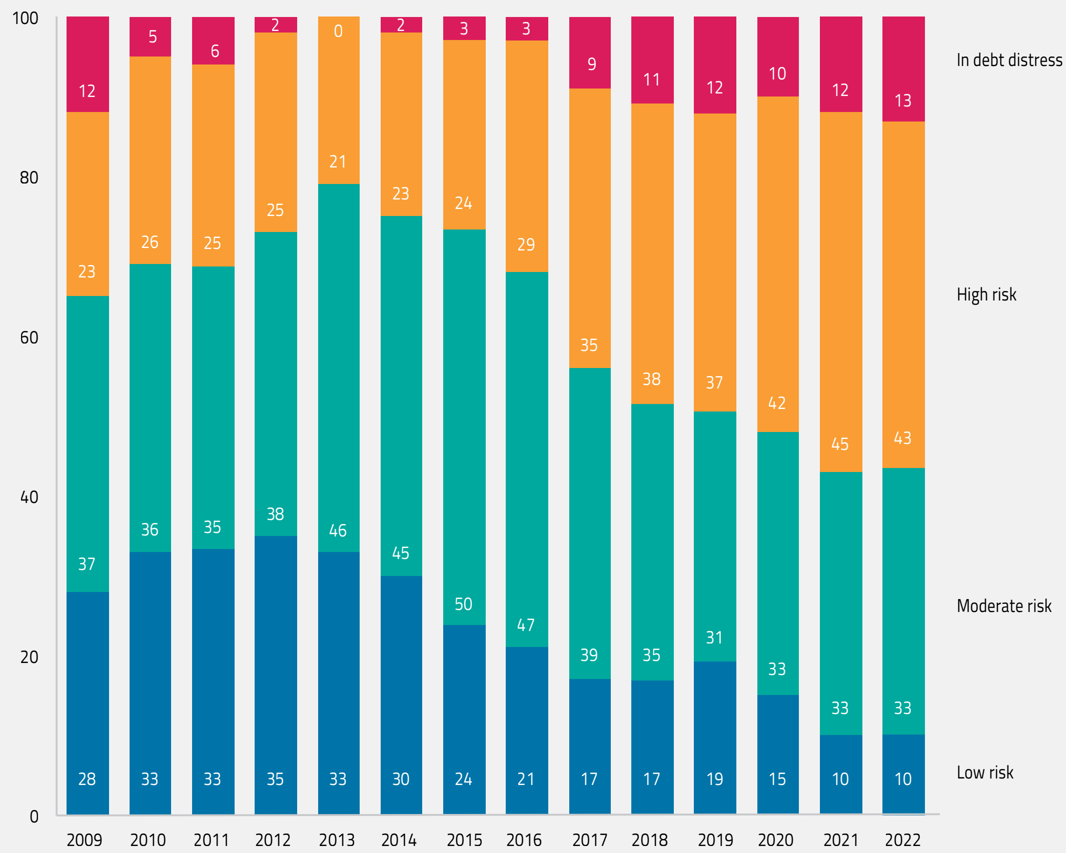
TARGET 4.A. EDUCATION FACILITIES AND LEARNING ENVIRONMENTS

Safe, welcoming environments are essential for effective learning and should be available to all. An important issue for gender equity is the availability of separate bathrooms for males and females. Over 20% of primary

FIGURE 7:

Most lower-income countries are in debt distress or at high risk of it

Degree of debt distress faced by lower-income countries, 2009-22



GEM StatLink: https://bit.ly/GEM2023_Summary_fig7

Source: IMF Annual Report 2022.

schools in Central and Southern Asia and in Eastern and South-eastern Asia lack functional single-sex bathrooms, as do 94% in Togo and 83% in Mali. Globally, single-sex bathrooms are more common in upper secondary than in primary schools. In Niger, for example, the share of schools with single-sex bathrooms increases from 20% in primary to over 80% in upper secondary education. But this might be too late for some girls: A lack of menstrual hygiene facilities, stigma and stress lead many girls to miss up to one week of school a month, increasing their chances of falling behind and dropping out.

Electricity is another basic need, but it is still lacking in around one quarter of schools worldwide (**Figure 6**). The share of schools with electricity is lower than average in Central and Southern Asia and, especially, in sub-Saharan Africa, where it barely increased from 30% in 2015 to 32% in 2020. Dissemination of solar power can help accelerate school electrification. Among 31 countries where more than half of primary schools lack electricity, 28 have solar-power potential above the global average.

Without electricity, students and teachers cannot use ICT in schools. In a considerable share of countries, many schools have either only internet or only computers for pedagogical purposes. In most cases, the share of schools with computers exceeds that of schools with internet. In Turkmenistan, for example, nearly all primary schools have a computer, but only 31% have the internet. But in a few countries, the opposite is true. In Lebanon and Maldives, over 90% of schools are connected to the internet, but only around 70% have a computer.

Technological innovation has been contributing to school building construction and safety improvements. Adapted materials can help protect from natural disasters. Air cleaning and sound insulation systems can improve overall health and well-being. Geographical information systems help minimize commute times and organize better pickup locations. But conflict continues to threaten students and teachers both in and on their way to school. Attacks on education and military use of schools and universities increased in 2020–21 relative to 2018–19, notably in Mali and Myanmar.

TARGET 4.B. SCHOLARSHIPS

Target 4.b is one of the few for which 2020 had been set as a deadline. In 2020, over USD 4.4 billion was disbursed in the form of scholarships and imputed student costs, an increase of USD 1.3 billion since 2015. This contrasts with the previous five-year period, when scholarships and imputed student costs remained relatively stable. Over 75% of scholarships and imputed student costs are disbursed to middle-income countries; only 11% go to low-income countries. However, low-income countries have benefited the most from the overall increase in scholarships and imputed student costs disbursed since 2015.

Target 4.b aims particularly to support student mobility for those in 'least developed countries, small island developing states and African countries'. Such countries have seen increased student mobility, albeit at a slower rate than the rest of the world. Globally, the number of outbound international students tripled between 2000 and 2020, whereas for sub-Saharan and Northern Africa it increased by about 2.2 times, and for small island developing states by about 1.5 times. By far the most common destination for students from these regions is North America and Western Europe, which accounts for nearly 60% of students.

TARGET 4.C. TEACHERS

Since 2015, progress on increasing the proportion of qualified teachers has been uneven across regions and education levels. The greatest improvement took place in sub-Saharan Africa, but the region still lags at all levels of education. At the pre-primary level, which had the lowest starting point, the share of qualified teachers increased from 53% in 2015 to 60% in 2020. In upper secondary education, it increased from 59% to 65%. Nevertheless, the region is far from achieving the 2030 benchmarks, based on countries' own targets of reaching 84% in pre-primary, 92% in primary and lower secondary, and 89% in upper secondary education.

Teachers are often qualified but not trained, or trained but not qualified. In Lebanon, for example, 77% of primary school teachers have the minimum required academic qualifications but only 23% have the minimum pedagogical training. Interpreting and comparing such statistics, however, is not possible without knowing the minimum required academic and training qualifications in each country. In Uruguay, a teacher must complete a bachelor's degree to teach in primary education, while in India an upper secondary certificate suffices. Comparing training requirements is arguably even harder, as there is no common international classification for training programmes. To address this knowledge gap, the UIS is developing the International Standard Classification of Teacher Training Programmes (ISCED-T), a framework to gather cross-nationally comparable statistics on teacher training programmes.

Efforts to increase the supply of qualified teachers must consider the significant issue of teacher attrition, which varies widely across countries and education levels. For instance, lower secondary teacher attrition is around 15% in both Rwanda and Sierra Leone, but in primary the level is 3% in Rwanda and 21% in Sierra Leone.

FINANCE

Public education expenditure accounts for 4.2% of gross domestic product (GDP) (ranging from 3.3% in Eastern and South-eastern Asia to 5.4% in Oceania) and 14.2% of total public expenditure (from 9.6% in Northern Africa and Western Asia to 16.5% in sub-Saharan Africa). High-income countries spend 1.3 percentage points of GDP more on education than low-income countries, while low-income countries allocate 4.4 percentage points more than high-income countries in total government spending on education.

The GEM Report has estimated that to achieve national SDG 4 targets for pre-primary, primary and secondary education in low- and lower-middle-income countries, there is an annual financing gap of USD 97 billion between 2023 and 2030. This gap represents 2.2% of GDP and 24% of the overall cost of education. The share of education spending on pre-primary and primary education would have to increase from around 40% of total spending in 2023 to 50% in 2030. These estimates do not include tertiary education, which would increase costs further.

A separate analysis for this report tried to calculate the cost of digital transformation, including digital learning, devices, electricity and internet connectivity. For low-income countries to achieve a limited level of digital learning and solar-powered electricity for all schools and for lower-middle-income countries to ensure fully internet-connected schools and higher availability of devices by 2030, these countries would need to devote USD 21 billion per year to capital expenditure between 2024 and 2030. In addition, the corresponding operational expenditure would have to increase by USD 12 billion per year. The combined cost would raise by 50% the annual financing gap these countries already face to reach their national SDG 4 benchmarks.

While OECD Development Assistance Committee members have committed to spend at least 0.7% of gross national income (GNI) on official development assistance (ODA), the actual level is about half that. It increased in 2022 from 0.33% to 0.36% of GNI in response to recent global events. Total aid to education decreased from USD 19.3 billion in 2020 to USD 17.8 billion in 2021. Aid to sub-Saharan Africa fell by 20%, from USD 5.6 billion to USD 4.5 billion.

The debt crisis in low-income countries has intensified in recent years. The International Monetary Fund has estimated that the number of countries either in debt distress or at high risk of it rose from 21% in 2013 to 58% in 2022 (**Figure 7**). This debt crisis poses similar challenges to that of the 1980s. Debt relief no longer plays a significant role in ODA, with its share declining since 2005. Some countries have used bilateral debt-for-development swaps as an alternative strategy to address debt burdens.

Technology in education:

A TOOL ON WHOSE TERMS?

Technology's role in education has been sparking intense debate for a long time. Does it democratize knowledge or threaten democracy by allowing a select few to control information? Does it offer boundless opportunities or lead towards a technology-dependent future with no return? Does it level the playing field or exacerbate inequality? Should it be used in teaching young children or is there a risk to their development? The debate has been fuelled by the COVID-19 school closures and the emergence of generative artificial intelligence.

But as developers are often a step ahead of decision makers, research on education technology is complex. Robust, impartial evidence is scarce. Are societies even asking the right questions about education before turning to technology as a solution? Are they recognizing its risks as they seek out its benefits?

Information and communication technology has potential to support equity and inclusion in terms of reaching disadvantaged learners and diffusing more knowledge in engaging and affordable formats. In certain contexts, and for some types of learning, it can improve the quality of teaching and learning basic skills. In any case, digital skills have become part of a basic skills package. Digital technology can also support management and increase efficiency, helping handle bigger volumes of education data.

But technology can also exclude and be irrelevant and burdensome, if not outright harmful. Governments need to ensure the right conditions to enable equitable access to education for all, to regulate technology use so as to protect learners from its negative influences, and to prepare teachers.

This report recommends that technology should be introduced into education on the basis of evidence showing that it would be appropriate, equitable, scalable and sustainable. In other words, its use should be in learners' best interests and should complement face-to-face interaction with teachers. It should be seen as a tool to be used on these terms.

Midway to the deadline, the 2023 Global Education Monitoring Report assesses the distance still to go to reach the 2030 education targets. Education is the key to unlocking the achievement of other development objectives, not least the goal of technological progress.

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Global Education Monitoring Report

4 QUALITY EDUCATION

Sustainable Development Goals

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