2026
GSENet Annual Report

Smart Education Around the World

Partners’ Perspectives from Seven Regional Reports

Smart Learning Institute of Beijing Normal University

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Foreword

Today, the rapid development of artificial intelligence presents both new opportunities and new responsibilities for education systems. The question is no longer whether AI will influence education, but how it can be harnessed to expand learning opportunities while preserving the human values at the heart of education.

This report examines that question through the lens of Smart Education. Our understanding of Smart Education goes beyond the adoption of digital technologies or AI tools alone. It refers to an approach that thoughtfully integrates pedagogy, governance and technology to create learning systems that are more responsive to the diverse needs of learners, teachers and societies. Smart Education places educational purpose at the centre, ensuring that technology serves learning, strengthens human capabilities and contributes to sustainable development.

Across seven regions of the world, this report explores how countries are integrating AI and digital technologies within diverse educational, social and economic contexts. For some, Smart Education is reflected in national digital platforms serving millions of learners; for others, it is about maintaining learning in fragile environments or supporting teachers with new tools. Together, these experiences demonstrate that there is no single pathway to Smart Education, but there are shared aspirations and common lessons.

Guided by ten Smart Education indicators, the report examines both educational outcomes and the conditions needed to sustain them. The findings consistently show that technology alone does not transform education. Meaningful change depends on capable teachers, effective leadership, sound governance and sustained investment.

Three messages emerge across all regions. First, equity remains a central concern. Access to technology must be accompanied by opportunities for meaningful learning, particularly for those who have traditionally been underserved. Second, teachers remain the cornerstone of educational transformation. Their professional judgement, supported by continuous learning, determines whether AI enriches teaching and learning. Third, governance has not kept pace with technological change. Stronger frameworks for data security, ethics and accountability are essential if AI is to serve the public good.

The regional reports also look ahead, presenting possible futures for Smart Education while recognising that lasting progress depends on long-term vision and sustained commitment. National initiatives such as China's vision for future schools and the African Union's Agenda 2063 illustrate how education, science and technology can contribute to inclusive and sustainable development.

The report aligns with the Education 2030 Agenda by contributing to ongoing efforts to ensure inclusive and equitable quality education and lifelong learning opportunities for all. At the same time, it recognises that emerging developments beyond 2030 will require education systems to respond to new challenges and opportunities by looking beyond immediate technological trends, towards long-term thinking about how education can be more equitable, resilient and responsive to the needs of all learners.

The report is also informed by the ongoing collaborative efforts of Beijing Normal University (BNU) and the UNESCO Institute for Information Technologies in Education (IITE) through joint projects, research initiatives and international cooperation. The organisation of the annual Global Smart Education conferences and the establishment of the Global Smart Education Network (GSENet) are concrete examples of how this partnership has contributed to advancing dialogue, knowledge exchange and practical approaches for implementing Smart Education.

This report has been made possible through the commitment of the GSENet partners and the many experts who contributed their knowledge and experience. We are deeply grateful for their collaboration and for the dedicated support provided by the SLIBNU team throughout this process. It is our hope that the report will strengthen international cooperation and contribute to wiser, more inclusive decisions as education systems navigate an increasingly AI-enabled future.

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Executive Summary

Artificial intelligence (AI) is reshaping education at unprecedented speed, creating new opportunities to improve teaching, learning and educational management while raising complex questions about equity, governance and human agency. As education systems increasingly adopt intelligent technologies, the central challenge is no longer whether AI will influence education, but how it can be governed to advance educational goals, safeguard human values and ensure that no learner is left behind.

The **GSE 2026 Report** examines the global transition towards Smart Education through evidence gathered from GSENet's international webinar series and regional analyses spanning Africa, the Arab Region, Asia, Europe, Latin America and the Caribbean, North America, and the Pacific. Drawing on contributions from education leaders, researchers, teachers and learners representing more than twenty countries, the report provides a global assessment of current progress, emerging challenges and future directions for Smart Education in the age of AI.

Four global messages

Four overarching findings emerge across all regions.

First, AI should strengthen rather than replace human judgement. Participants consistently emphasized that technology is most effective when it augments teachers' professional expertise, creativity and decision-making instead of automating core human relationships in education.

Second, equity remains the defining challenge of Smart Education. While AI offers significant opportunities to expand access and personalise learning, many existing technologies do not reflect local languages, cultures and educational contexts, particularly in low-resource settings. Without deliberate policy interventions, AI risks reinforcing existing educational inequalities.

Third, teachers' roles are evolving rapidly. Across all regions, educators are moving beyond content delivery towards learning design, facilitation, mentoring and the ethical use of AI. This transformation requires sustained investment in professional learning and institutional support.

Fourth, governance has not kept pace with technological change. Although AI adoption is accelerating, coherent frameworks for data governance, accountability, transparency and ethical implementation remain underdeveloped in many education systems.

Together, these findings demonstrate that Smart Education is fundamentally a process of educational transformation rather than technological adoption alone.

Regional perspectives

Regional analyses reveal diverse pathways towards Smart Education while highlighting common priorities.

Sub-Saharan Africa illustrates both the opportunities and constraints of rapid digital transformation. Mobile technologies, public-private partnerships and national teacher development initiatives are expanding educational access, yet infrastructure limitations, teacher shortages and contextual relevance remain significant barriers.

The Arab Region reflects substantial diversity, ranging from advanced national AI strategies in high-income countries to education systems operating under conflict and humanitarian crises. Economic disparities continue to shape access to Smart Education across the region.

Asia demonstrates the most extensive government-led implementation of Smart Education through large-scale national digital platforms. The principal challenge is ensuring that substantial investments translate into meaningful improvements in teaching quality and learning outcomes.

Europe has established strong foundations in ethical governance, regulation and human-centred AI. Nevertheless, implementation remains uneven, assessment frameworks continue to evolve and institutional capacity varies considerably across countries.

Latin America and the Caribbean are experiencing accelerating digital transformation through emerging national policies and system-wide initiatives. However, limited governance capacity and unequal access continue to threaten equitable implementation.

North America is characterised by a highly innovative but decentralised landscape. State and institutional autonomy has generated diverse approaches to AI integration, producing significant innovation alongside fragmented governance and inconsistent implementation.

The Pacific demonstrates how Smart Education can be adapted to geographically dispersed and resource-constrained contexts through blended approaches combining digital technologies with radio, offline resources and regional collaboration.

Cross-cutting findings

Despite differing regional contexts, several common patterns emerge.

Teacher capacity represents the single most significant enabling factor for successful Smart Education, yet investment in professional learning consistently lags behind investment in technological infrastructure. Data governance remains an area of widespread weakness, with few education systems possessing comprehensive frameworks for privacy, security and responsible AI use. Sustainable financing also remains a concern, as many initiatives depend on short-term external funding rather than long-term national investment.

To assess progress, the report applies a framework of ten indicators encompassing both educational performance and system capacity. Strongest performance is observed where institutions are mature and teacher support is sustained. Across all regions, however, data security and governance remain the weakest-performing dimension, representing a critical vulnerability for future development.

Looking ahead

The report identifies three possible trajectories for Smart Education between 2026 and 2030. The most probable future is one of continued but uneven expansion, with growing disparities in implementation and capacity. More transformative futures include the emergence of sovereign AI ecosystems, AI-enabled credentialing and increasingly hybrid models of education. The preferred future envisions Smart Education that is intentionally designed to promote equity, strengthen teacher agency, support multilingual and culturally responsive learning, ensure transparent governance and build resilient education systems. This preferred future would help accelerate progress towards achieving the targets of SDG 4.

Strategic priorities

The findings point to several priorities for action.

Governments should treat teacher development as a prerequisite for AI adoption, establish coherent governance frameworks, invest in equitable digital infrastructure to ensure resilience in education systems. Educational leaders should foster teacher-led innovation, evaluate technologies according to their educational value and ensure that equity remains central to planning and implementation. Practitioners should strengthen AI literacy, integrate AI in ways that enhance learning rather than replace professional judgement and adopt assessment approaches that value higher-order thinking and reasoning.

Conclusion

The GSE 2026 Report concludes that the future of Smart Education will be determined not by technological innovation alone but by the capacity of education systems to govern its use in ways that advance educational quality, equity and human development. Across all regions, sustainable transformation depends on coherent alignment between technology, pedagogy, curriculum, assessment and governance. While regional contexts differ, the evidence consistently shows that investing in teachers, strengthening governance and prioritising equity are the essential foundations for Smart Education that benefits all learners.

List of Abbreviations

- ADB – Asian Development Bank
- AfCFTA – African Continental Free Trade Area
- AI – Artificial Intelligence
- BECF – Basic Education Curriculum Framework (Kenya)
- CBC – Competency-Based Curriculum (Kenya)
- CBE – Competency-Based Education
- CEIBAL – Plan Ceibal (Uruguay's digital education project)
- CHED – Commission on Higher Education (Philippines)
- DIKSHA – Digital Infrastructure for Knowledge Sharing (India)
- E-CAIR – Education Centre for AI Research (Philippines)
- EADTU – European Association of Distance Teaching Universities
- GAI/GenAI – Generative Artificial Intelligence
- GCC – Gulf Cooperation Council
- GDPR – General Data Protection Regulation (EU)
- ILO – International Labour Organization
- KICD – Kenya Institute of Curriculum Development
- LLM – Large Language Model
- LMS – Learning Management System
- MOOC – Massive Open Online Course
- NeLC – National eLearning Center (Saudi Arabia)
- NEP – National Education Policy (India)
- ODFL – Open, Distance and Flexible Learning
- OECD – Organisation for Economic Co-operation and Development
- OER – Open Educational Resources
- PacREF – Pacific Regional Education Framework
- PBEQ – Pacific Board for Educational Quality
- SDAIA – Saudi Data and Artificial Intelligence Authority
- SKSI – Samoa Knowledge Society Initiative
- TALIS – Teaching and Learning International Survey
- TEL – Technology-Enabled Learning
- UUNDP – United Nations Development Programme
- UNESCO – United Nations Educational, Scientific and Cultural Organization
- UNICEF – United Nations Children's Fund
- USAID – United States Agency for International Development

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Chapter 1

Smart Education in the Age of AI

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Chapter 1 Smart Education in the Age of AI

Status of AI in Education Globally

Generative AI (GenAI) has moved decisively from an emerging technology to an embedded reality across global education systems (Stanford Institute for Human Centered AI, 2026). This report documents that GenAI tools are now being used in educational contexts ranging from K-12 classrooms to higher education institutions, with adoption accelerating at a pace that continues to outstrip both institutional policy and pedagogical preparation. This rapid diffusion is not confined to technologically advanced nations; rather, it reflects a global phenomenon in which students and educators are incorporating AI into daily academic practices, often without formal guidance or institutional oversight (Chiu, 2025). Indeed, a comprehensive meta-analysis by Tlili et al. (2025) confirms that AI is now integrated into various aspects of education, including lesson planning, assessment, tutoring, writing, research, administration, and self-study, underscoring the breadth and depth of AI's penetration into educational practice globally.

In its Digital Education Outlook 2026, the Organisation for Economic Co-operation and Development (OECD) offers an assessment: GenAI is fundamentally transforming education both within and outside of traditional teaching and learning paradigms (OECD, 2026). This transformation is propelled by the ubiquitous availability of AI tools, their increasingly user-friendly interfaces, and their widespread use without institutional regulation or control. However, the OECD provides a significant caveat: AI can enhance learning outcomes only when implemented within a well-defined pedagogical framework. Without such guidance, AI risks expanding students' ability to perform tasks without genuine learning, creating a performance-understanding disconnect that undermines educational goals (Dong et al., 2025). This challenge is compounded by the fact that even with significant investment in digital infrastructure, learning outcome disparities persist, suggesting that isolated technological interventions are insufficient and that systemic, multi-dimensional reform is required (Liu et al., 2026).

This concern is also echoed by UNESCO (2025a), that states that AI is not merely a tool for automation but a catalyst that challenges the purpose, values, and responsibilities of education systems. The UNESCO report emphasizes that technical performance alone is insufficient; human judgment, responsible implementation, transparency in use, and a renewed emphasis on learning goals must guide the integration of AI. This perspective aligns with the findings presented in Radical Solutions for Artificial Intelligence and Digital Transformation in Education, which explores the role of AI in enabling transformation across diverse educational contexts, including in learning innovation, learning management systems, data analytics, strategic planning and governance (Burgos et al., 2024). Taken together, these publications underscore the complexity of the issue. Yet, determining the global prevalence of AI in education in 2026 is a challenge as no comprehensive authoritative dataset exists to measure it worldwide (Xu, 2025).

Smart Education

The overall trend of AI integration falls under the paradigm of "Smart Education", a strategic approach that leverages intelligent technologies to revolutionize learning spaces, tailor teaching methods, and create inclusive, adaptive education systems. Smart Education fundamentally reimagines teaching, learning, governance, and content to equip learners for a dynamic world, while advancing equity, quality, and relevance in the digital era (Huang et al., 2024). AI is not just a technological solution but a catalyst for pedagogical shifts, institutional development, and systemic transformation in the realm of Smart Education.

Marking 2025 as the inaugural year of Smart Education, China is integrating intelligent technologies across the entire teaching–learning process, reforming educational philosophy, systems, models, content, methods, and governance to establish new talent standards and high-quality educational development. President Xi stressed balancing technological reform with core educational missions: updating teaching tools and student competencies while maintaining the focus on enlightening minds, nurturing spirits, and cultivating problem-solving abilities (Ministry of Education of China. 2025). The Ministry of Education enriched the National Smart Education Platform with "moral-intellectual-physical-aesthetic-labor" digital resources to foster well-rounded development at all levels of education.

At the 2026 World Digital Education Conference, Minister Huai Jinpeng highlighted the National Strategy for Digital Education which has expanded accessible high-quality resources, personalized learning platforms, cross-sector collaboration, and sector-wide digital transformation. With the goal of becoming a leading education country by 2035, he underscored values education, intelligent thinking and creativity, research commercialization, and teachers' digital competence, and proposed three international initiatives: building consensus on AI-empowered transformation, jointly developing new educational models, and co-constructing a new ecosystem for educational governance (Ministry of Education of China. 2026).

While China already has a mature system in place, order to understand the status of Smart Education across the different regions of the world, we examine research evidence across four areas: policy and governance, teachers, students, and lifelong learning.

Policy and Governance

The development of institutional policy is advancing, but unevenly across regions and types of institutions. In 2025, UNESCO conducted a survey of higher education institutions and found that only 19 percent of the institutions had formal policies on AI, while 42 percent were in the process of developing policies. Europe and North America are the most advanced in this respect, with about 70 percent of institutions having established or in the process of developing guidance, as compared to 45 percent in Latin America and the Caribbean (UNESCO, 2025c). In a comprehensive study on the global understanding of Smart Education, Huang et al. (2024) analyzed 48 digital education policies from Africa, the Americas, Asia-Pacific and Europe, and found that the primary concern in the vision and planning of digital education policy is the development of a high-quality, inclusive and sustainable digital education ecosystem.

Teachers

The TALIS 2024 survey reveals that there are large regional differences in teachers' use of AI, with Asia-Pacific countries at the forefront, with around 75 percent of teachers using AI in Singapore and the UAE, and 66 percent in Australia. In Europe, there are significant internal differences, with Eastern European countries such as Albania (52 percent) and Romania (46 percent) much more advanced than Western European countries such as France (14 percent). In addition to usage rates, the survey reveals that teachers are most likely to use AI for practical applications, such as creating lesson plans (64 percent) and summarizing topics (68 percent), while 72 percent are worried about academic dishonesty and 66 percent are concerned about inaccurate recommendations. The most significant obstacle to adoption is not school policy but a lack of skills: 75 percent of non-users report that they lack knowledge or training in AI, and 76 percent of teachers in Singapore have received AI training, compared to 9 percent in France, highlighting that regional success is less about access to technology and more about systematic investment in teacher preparedness and competence (TALIS 2024).

A secondary analysis of TALIS 2024 data by Xu (2025) shows that 53.5% of Shanghai's junior high school teachers used AI in their teaching in the previous year, which is significantly higher than the OECD average of 36.3%. This puts Shanghai on par with Singapore and the UAE as a global leader in AI adoption. Xu (2025) also categorizes the use of AI into three categories: shallow-level (content generation to support teaching), deep-level (personalized learning with adaptive technologies), and complex-level (VR/AR integration for higher-order skills training). Shanghai teachers were more proficient in deep and complex-level applications, with 58.3% using AI to assess student engagement or performance, compared to less than one-third of teachers in Singapore and OECD countries.

Students

The use of AI in higher education is more widespread than in K-12. In a 2025 survey of 1,041 undergraduate students in the United Kingdom, 92 percent of respondents reported using some type of AI tool, and 88 percent reported using generative AI (GenAI) to complete assessment-related tasks, a significant rise compared to 53 percent the year before. Interestingly, only 36% of these students reported that their institution provided them with training in AI skills, indicating that there is a gap between the use of technology and formal training (Watermeyer et al., 2025). A survey of 400 respondents from 90 countries conducted by UNESCO (2025b) revealed that nine out of ten respondents had used AI in their daily work, but more than half were not fully confident of the effectiveness of AI in teaching or research.

In K-12 settings, data from the United States shows that 54 percent of middle and high school students reported using AI for schoolwork in 2025, with use rising by grade level, 41 percent of middle schoolers compared to 61 percent of high schoolers (Doss et al., 2025). Similarly, a nationwide survey of over 8,500 Chinese students found that more than 60 percent of primary and secondary school students had used AI, with nearly one in five doing so regularly (China Youth and Children Research Center, 2025). These figures suggest that while K-12 adoption is substantial, higher education students report notably higher usage rates, potentially reflecting greater academic demands and access to institutional resources. In the context of continuing education and professional practice, the UNESCO (2025b) survey revealed that 25% of the universities surveyed had encountered ethical challenges related to AI,, such as students' excessive dependence on AI tools, copyright issues, and research bias.

Lifelong Learning

AI is also influencing lifelong learning and professional development outside of formal education environments. Recent studies show that about 10% of adults worldwide use ChatGPT, with 49% of their interactions related to learning activities such as tutoring, creative development, health and cooking, which is a major shift towards self-directed learning through GenAI (UNESCO UIL, 2025a). Investment trends reported by HolonIQ (2025) and Stanford Institute for Human-Centered AI (2025) show that investors are increasingly aware of the importance of AI in workforce development and lifelong upskilling, and are looking for platforms that have a clear link to employability outcomes.

In the workplace, AI-backed education is becoming more common as companies are increasingly under pressure to ensure that their employees' skills are up to date, and AI technologies are increasingly influencing employee training programmes in cognitive, affective, and behavioural aspects. However, technical, ethical, legal and pedagogical issues persist (Kazancı-Yabanova, 2025).

The gap between AI use and formal training in higher education settings (Watermeyer et al., 2025) could create similar challenges for lifelong learning systems in preparing learners for an AI-enhanced workforce. To address this, UNESCO has created a new self-learning course for adult educators based on the Digital Empowerment for Lifelong Learning Teaching and Andragogy (DELTA) Framework, which aims to provide adult educators with basic and practical knowledge to help them understand and manage new technologies and AI in inclusive learning environments (UNESCO UIL, 2025a). The course covers ethical issues, adaptive and assistive technologies, and the application of GenAI in instructional design, assessment, and learner engagement. In addition, major AI companies such as Anthropic, OpenAI, and Google have introduced educational offerings, further blurring the lines between AI platforms and edtech, and potentially challenging traditional education systems (UNESCO UIL, 2025b). This convergence has led to the need for public AI infrastructure, including open algorithms, datasets, and learning platforms, to provide inclusive, equitable, and quality learning opportunities throughout life (UNESCO UIL, 2025a).

Emerging Trends in AI and Education

There is an emergence of AI agents that are moving beyond chatbots to plan, guide, and evaluate complex workflows, and the OECD has identified three models of human-machine collaboration: replacement, complementarity, and augmentation, with augmentation being the most promising as it maintains teacher expertise (Kim, 2026; OECD, 2026). AI is also becoming a necessity in education rather than just an option for efficiency. UNESCO has established frameworks for students and teachers (2025g; 2025h) that have made AI literacy a key competency, and thirty countries have adopted them, while nine countries have introduced national frameworks (UNESCO, 2025a). Human agency and control have also been the central focus around the world. OECD and UNESCO highlight human-centred teaching, human rights, and the role of humans in decision-making (OECD, 2026; UNESCO, 2025g; 2025h). Finally, a counter-trend of resistance has emerged, based on concerns about cognitive development, academic honesty, and educational goals (Doss et al., 2025). UNESCO (2025a, p. 112) that states "teaching is inherently relational... which cannot be automated" showing that educators, learners, and communities are active agents calling for technology to align with human values.

The emphasis on agency and governance raises the question: *"who is leading the way for the integration of AI in education?"*

SHAPING AI OR BEING SHAPED BY AI?: Voices from the field: GSENET Panels/Webinars

The theme of this report is the fundamental tension in the current debate on education and AI: are we shaping AI to serve educational values and or are we being shaped by AI systems that are built elsewhere, typically by commercial actors with market-driven motivations?

Shaping AI suggests that education systems are proactive in harnessing the affordances of AI to transform teaching and learning. This proactive strategy includes capacity building in AI literacy, curriculum standards, investment in publicly accessible AI tools that focus on educational outcomes, ethical principles that safeguard student data and well-being, local language models that do not ignore linguistic diversity, and systematic redesign of assessment. Teachers should be actively involved in the co-design of AI systems, ensuring that tools are designed to meet the actual needs of learners and that they are grounded in educational values (UNESCO, 2025a).

Being shaped by AI is a passive adaptation scenario in which institutions, teachers, and students adapt to available tools. In this reactive setting, proprietary platforms set the default rules for writing, feedback, learning pathways, academic integrity, data collection, and most fundamentally, what is deemed as successful learning outcomes.

This conflict leads to the question: *Who is at the steering wheel: educators, learners, public institutions, communities, or AI companies?* As AI-based education is here to stay (Doss et al.,

2025) the question is whether education systems will proactively shape AI to reflect the values of education or whether they will permit AI systems to influence education in line with market logic and standards set by a few powerful technology companies (OECD, 2026). UNESCO's (2025a, p. 8) stance is clear: "AI is not the future of education, it is the future of educators".

In order to explore the complex impact of AI on educational leadership, teacher practice, learner experience, and lifelong learning, the Global Smart Education Network (GSENet) organised two panels and five webinars during 2025-2026 with voices of stakeholders from over 20 countries. This section provides an analytical synthesis of the main themes, tensions and insights that emerged in the discussions.

Theme 1: The Agency-Automation Tension

A recurring theme throughout the panels/webinars was the balance between the potential of AI and the need to maintain human control. A common thread in all the discussions was that while AI should complement, not replace human judgment, the rapid pace of technological evolution can hinder this goal.

Educational leaders highlighted the importance of "domesticating" AI, which involves a systematic process of access, adoption, integration, and responsible use, where technology serves educational purposes rather than defines them. This view is in line with Filgueiras et al. (2024), who state that AI should be used for educational purposes and not as a force that drives change. The panel/webinar discussions, however, uncovered a disconnect between aspiration and reality: leaders expressed their commitment to human-centred AI, but they also spoke of institutional pressures to implement AI quickly, sometimes for competitive reasons and stakeholder expectations, rather than pedagogical ones.

Teachers also reported a similar conflict. They saw AI as a tool that could handle repetitive tasks and free up time for more meaningful human interaction. However, they expressed concern about maintaining professional autonomy and the risk of deskilling as AI takes over tasks traditionally requiring professional judgment. Interestingly, the participants repeatedly emphasized the need for augmentation (AI as an extension of professional judgment), while recognizing that the tools they were using were frequently designed for replacement or complementarity, driven by the commercial interests of the technology vendors, not pedagogical values.

The agency-automation conflict was experienced by learners and youth as a fear of cognitive offloading and loss of critical thinking. During the discussions, young people expressed ambivalence about AI, appreciating its convenience but also expressing concerns about its impact on their intellectual growth and critical thinking. This ambivalence indicates that learners are not mere consumers of AI but active participants in its evaluation, challenging the narrative of uncritical AI use.

Theme 2: The Equity-Inclusion Imperative

Equity and inclusion were key issues throughout all panels/webinars. Participants repeatedly emphasized the need for AI to be culturally, linguistically, and contextually responsive to diverse learners, rather than follow a one-size-fits-all approach. This perspective aligns with Kotsis (2025), who emphasizes the need for adaptive and transparent feedback systems that cater to the needs of individual learners, and with Lazanyuk et al. (2025), who argue that AI can either exacerbate or mitigate inequalities, depending on the access to infrastructure, digital literacy, and governance capacity.

The discussions, however, uncovered a disconnect between the rhetoric and implementation of equity. Leaders expressed their intentions to tackle digital divides and algorithmic biases, but also recognized that resource limitations, infrastructure gaps, and a lack of AI literacy among educators and learners hinder these intentions. This disconnect was especially stark when participants from the Global South shared their experiences with AI tools created in and for the Global North, which do not consider local languages, cultural contexts, and infrastructural realities.

The equity-inclusion imperative also surfaced in the conversation about the AI literacy divide. Participants emphasized that unequal access to AI knowledge and skills could be as important as traditional digital inequalities. This concern aligns with the findings of Khodabin and Arsalani (2025) who suggest that AI literacy must be considered as a right and be addressed by equity-focused policies and community-based initiatives. Participants, however, took this argument further, highlighting that AI literacy is not just about technical skills, but also about ethical considerations, critical thinking, and the ability to engage in AI governance.

There is a consensus that AI should promote equity, but the prevailing paradigm of AI development and procurement is commercial, with the primary goal of benefiting shareholders. This structural misalignment suggests that equity commitments are largely aspirational and could remain so without substantial public investment in AI literacy, infrastructure, and context-specific tools. The webinar conversations indicated that achieving equity will not be possible without a reimagining of the development, funding, and governance of AI tools.

Theme 3: The Transformation of Professional Roles

The third key theme that emerged from the webinars was the shift in professional roles in education. This shift for leaders was from a hierarchical governance structure to more distributed and collaborative leadership. Participants discussed how AI is changing the nature of authority, as educators, students, and informal leaders are increasingly playing a role in institutional innovation and decision-making. This view is consistent with that of Dai et al. (2025) who define distributed leadership as one of the defining features of AI-enabled organisations. Webinar participants also noted that leaders are still accountable for establishing institutional vision, delegating authority, resolving conflicts, and holding others accountable. Distributed leadership was therefore seen not as the lack of leadership but as a reconfiguration of leadership roles in more collaborative systems.

The shift in teacher roles was even more dramatic. Participants proposed that AI is changing the role of teachers from content delivery to learning design, facilitation, mentoring, and socio-emotional support. AI can handle tasks like lesson planning, grading, and administrative duties, freeing up time for teachers to focus on meaningful human interaction and enriching learning experiences. This view aligns with Creely and Carabott's (2025) insight that AI can boost teacher efficiency while freeing up time for more meaningful pedagogical tasks. The participants also recognized the need for substantial investment in professional development, as many teachers are not AI-literate or have the pedagogical skills necessary to effectively incorporate AI into their teaching.

The shift in roles for learners was from passive consumers of knowledge to active co-creators of AI-enhanced education. Participants emphasized the need to cultivate skills like creativity, interdisciplinary thinking, and ethical judgment, and that AI should complement rather than supplant these abilities. This view is in line with Romero (2025), who calls for a transition from consumption to co-creation in AI-supported learning. But webinar participants also pointed out that this transition will need substantial institutional support, such as opportunities for learners to engage in AI training, governance and design processes. Learners were particularly concerned about future employment and of being accused of plagiarism and cheating.

The shift in professional roles identified,is both a challenge and an opportunity. The challenge is that educational systems are not equally equipped to facilitate the changes. The promise is that AI can help free up time for teachers and students to focus on more meaningful and human-centred learning experiences.

Theme 4: The Governance Gap

Another key theme that emerged throughout the discussions was the governance gap between AI adoption and institutional policy. Participants highlighted the importance of governance structures that go beyond technical and operational issues to include ethical, social, and pedagogical considerations for AI integration. This view is consistent with that of Rogerson and Sherman (2025), who emphasize the importance of considering the use of AI in public education in relation to school demographics, fairness, different cultural understandings of privacy, and the broader context of AI surveillance. The panels/webinars also highlighted a number of tensions in governance approaches. Some participants called for international cooperation to tackle the environmental, ethical, and societal impacts of AI, while others raised concerns about digital sovereignty and the centralization of AI technologies in a few countries. This tension, as noted by Hamadeh and Amin (2025), also poses significant questions regarding the balance between global cooperation and local autonomy.

The governance gap was a recurring theme where the speed of technological change was outpacing the ability of institutions to keep up with matters of governance. This is not a phenomenon exclusive to AI, but it is especially pronounced in education, where governance systems are often slow to change and adapt. Creating AI policies is not enough to fill the governance void; it is also essential to reimagine the way educational institutions make decisions about technology. This rethinking needs to consider issues of procurement, data security, ethical oversight, and accountability, by engaging all stakeholders: educators, learners, parents, and communities. What were the overarching trends of AI integration in the different regions of the world?

AI Integration in Education Systems Across Regions

The integration of AI in education is unfolding unevenly across the globe, shaped less by technological potential alone than by distinct regional priorities, governance models, and infrastructural realities (Zhu et al. 2025). While some regions pursue rapid, government-led adoption, others prioritize regulatory safeguards, mobile-driven leapfrogging, or grassroots experimentation (Chigbu & Makapela, 2025). Together, these divergent trajectories reveal not a single global AI-in-education narrative, but a complex landscape where each region's approach reflects its unique educational challenges, cultural values, and capacity for systemic change.

Asia: Government-Led Integration and Emerging National Frameworks

Asia is advancing a government-led and large-scale model of AI integration in education, setting it apart from other regions. While implementation hurdles remain in some contexts, national efforts signal a decisive shift toward an AI-enhanced educational future. (Rogerson & Sherman, 2025). The government-led AI integration in education is one of the most advanced in the world. In Singapore, the Ministry of Education has integrated AI-powered tools into the national Student Learning Space platform, which includes teaching and learning assistants that guide students' thinking through a series of questions to support metacognition (Kim, 2026). China and the UAE have officially entered the era of AI education by introducing AI education in the 2025-26 school year (Stanford Institute for Human Centered AI, 2026).

China outlines a series of measures to advance the transformation of education through AI, under the banner of the Education Construction Plan (2024-2035) (Xinhua News Agency, 2025). In addition to the impressive results of Shanghai's deep-level AI integration, China has implemented AI integration into its education system at scale. India has become a prominent voice in defining a vision for AI in public education. While the Indian government has been more explicit than China and the United States in articulating a vision for how AI can be used to reshape public education for the better, implementation challenges remain (Rogerson & Sherman, 2025).

Africa: Leapfrogging with mobile and context specific tools

Africa is leapfrogging through mobile tools and teacher-focused solutions, not costly infrastructure. Despite resource challenges, growing momentum from national frameworks and UNESCO collaborations points to a sustainable, context-driven path forward.

The World Bank has documented the large scale AI-enabled learning gains in Edo State, Nigeria, and digital learning in Kenya. A 2025 case study by the World Bank on the disruptive potential of AI in education systems in low and middle income countries highlights that successful implementation of AI in education systems must be defined by the identification of educational problems and then investing in teacher capacity as the basis of sustainable change (Srinivasan & Twinomugisha, 2025).

Rogerson and Sherman (2025) report that while countries across Africa are interested in using AI for educational purposes, they continue to struggle with infrastructure and resource issues. Countries such as Benin, Burundi, Côte d'Ivoire, Egypt, Tanzania, and Nigeria are actively creating national AI competency frameworks for teachers and students through UNESCO's South-South cooperation framework (UNESCO, 2025e). Countries such as Namibia, Ethiopia, Tanzania, Nigeria and Mauritius have developed national level AI initiatives. For instance, Nigeria's Open School Initiative is working towards a faculty-centric strategy for AI literacy, and the Mauritius Institute of Education is developing AI and digital skills in teacher education (UNESCO, 2025e).

Europe: Regulation and Trust

The European approach to AI in education is much more regulatory. The European Commission's AI Act of the European Union is the first legal framework on AI, which emphasizes trustworthy, human centric AI (European Commission, 2025). Article 4 of the AI Act, is compulsory and enforceable and requires providers and deployers of AI systems to ensure sufficient AI literacy of employees and other users of the system. (DLA Piper,2025).

Despite the European Union's considerable resources for AI in education, implementation has proceeded at a slow pace because of the compliance demands stemming from the AI Act (Rogerson & Sherman, 2025). This regulatory-first approach is different from the adoption-focused models in Asia and the Middle Eastexemplifying the general European phenomenon of "adhering to humanistic educational traditions" (Xu, 2025). This cautious, human-centric approach has led to slower adoption and lower teacher usage setting it apart from other regions.

Latin America and the Caribbean: Emerging Frameworks and Equity Challenges

Latin America and the Caribbean is advancing its AI in education agenda, but infrastructure and equity issues persist. Rogerson and Sherman (2025) report that countries across Latin America are interested in using AI for educational purposes, but are constrained by resources.

A regional seminar organised by UNESCO in December 2025, was based on the 2024 Santiago Ministerial Declaration, which highlighted the importance of digital technologies to facilitate innovative educational experiences grounded in human interaction and inclusion, especially for indigenous peoples, Afro-descendants, persons with disabilities, among others (UNESCO, 2025f). Uruguay, was a leader in the region with its pioneering CEIBAL digital education project. Brazil is translating UNESCO's AI competency frameworks for government leverage (UNESCO, 2025f). PaideIA is a national AI education plan launched by Argentina that emphasizes algorithmic thinking and ethics education from primary school, aiming to equip students with the skills needed to navigate the AI driven future. Chile has drawn up a comprehensive action plan to close the gender gap in education, acknowledging that AI can both widen and narrow the gap (UNESCO, 2025f).

Latin America and the Caribbean are making strategic progress through regional collaboration to address infrastructure and equity constraints required for inclusive implementation.

North America: Fast Adoption with Policy Gaps

In the United States, a 2025 RAND survey revealed that 54% of students and 53% of English, mathematics, and science teachers used AI in school-related activities. But just 45% of school principals said they had formal AI policies, and more than 80% of students had not been instructed on using AI to complete schoolwork (Doss et al., 2025). According to Pew Research Center (2025), 67% of US teens use GenAI for schoolwork, with 42% using it weekly, while 62% of teachers were interested in AI professional development, but only 28% had received it. According to a survey conducted by the Center for Democracy & Technology (2025), 73% of high school students use AI, and 58% are not sure of their school's policy regarding AI use.

The policy gap also exists at the state level: 16 states have issued comprehensive guidance for K-12 AI, 22 states have partial guidance, and 12 states have no guidance (Education Commission of the States, 2026). Teacher confidence in the use of AI in education was 31% higher in states that had formal guidance (National Education Policy Center, 2026). The implications are profound: Stanford's Graduate School of Education (2026) reported that students who used AI without explicit instruction experienced a 15% drop in critical thinking scores, whereas those with structured AI literacy training saw a 22% increase. Similar trends are observed in Canada: 47% of K-12 teachers and 58% of secondary students use AI, while only 22% of schools have formal AI policies and 61% of teachers have not received any professional development on AI (Canadian Digital Learning Research Association, 2025; Canadian Teachers' Federation, 2025).

Commercial influence exacerbates these governance issues: US schools spent $2.1 billion on AI edtech in 2025, accounting for 43% of the global market, but only 31% of technology leaders reported that procurement was based on educational outcomes rather than vendor marketing (HolonIQ, 2025; EdTech Market Insights, 2026). Rogerson and Sherman (2025) characterize the US context as "humble beginnings" with revolutionary potential yet to be realized. Reingold (2025) suggests that the spread of AI tools is not just a technological shift but a "fundamental challenge to educational governance" (p. 27), and that policies must be proactive and responsive to innovation while maintaining educational values.

Pacific/Oceania: Emerging Frameworks and Capacity-Building

The Pacific/Oceania region offers a unique context for AI in education due to its geographic isolation, small populations, and diverse digital infrastructure (Hua & Brimble, 2025). In contrast to the government-led integration in Asia and the regulatory-first approach in Europe, Pacific countries are prioritizing the development of basic digital skills and the creation of culturally relevant frameworks before widespread AI adoption (AI Asia Pacific Institute, 2024).

In 2025, the Pacific Community's education mandate included AI and digital education, which was endorsed by the Pacific Board for Educational Quality for the first time in a coordinated effort to integrate AI into the region's education system (Pacific Community, 2025). The Pacific Islands Forum Secretariat is working on an AI policy framework, and the Pacific Community report on progress annually, ensuring that integration is in line with regional needs and Pacific values (Pacific Community, 2025). However, no country in the Pacific has a national AI strategy, though Fiji and Papua New Guinea are working on one (Hua & Brimble, 2025). There are no comprehensive legal frameworks in place in key areas like data privacy, intellectual property, and cyberactivity, which are critical for safe AI adoption, in the region (AI Asia Pacific Institute, 2024). Moreover, regional collaboration initiatives to facilitate cross-border AI adoption have been irregular and fragmented, rather than sustained and long-term (Hua & Brimble, 2025).

The AI Asia Pacific Institute has urged the establishment of a Pacific Islands AI Technical Assistance Facility to help the region in the development of national AI strategies, modernization of regulatory frameworks, regional collaboration and building AI talent pipelines (AI Asia Pacific Institute, 2024). Australia has acknowledged this challenge and is investing some of its foreign aid in promoting locally suitable AI solutions in the Asia-Pacific region (Hua & Brimble, 2025). Capacity building is ongoing in higher education and teacher training in partnership with multilateral organisations such as the Commonwealth of Learning and institutions such as the University of Melbourne.

The Pacific/Oceania area is in a nascent yet critical phase of AI adoption. While there are no statistics available for large-scale adoption, the region is focusing on capacity building, culturally relevant frameworks, and teacher training. The next few years are a pivotal moment to build the groundwork for responsible use of AI and avoid an increasing AI divide (AI Asia Pacific Institute, 2024; Hua & Brimble, 2025).

Cross-Cutting themes Across all seven regions, a common pattern emerges: the tension between shaping AI proactively and being shaped by it reactively.

This analysis reveals three cross-cutting tensions. First, there is a conflict between speed and safety: regions that are fast in adoption may fall behind on equity and ethical issues, while regions that focus on regulation may lose the agility required to stay current with technological advancements. Second, there is the tension between top-down and bottom-up approaches: government-led initiatives can be scaled up but may be less relevant to the local context, while grassroots innovations are more relevant to the local context but may be less scalable. Third, there is the tension between global and local: international frameworks and partnerships offer valuable guidance, but need to be adapted to local contexts to be effective.

Ultimately, the future of AI in education will not be defined by technology, but by the ability of education systems to make human decisions, take ethical responsibility and demonstrate pedagogical leadership in increasingly AI-mediated environments. The issue for each region is not if, but how, to use AI in a way that supports educational values, not detracts from them. It is not only a matter of investment in infrastructure and policy, but also a commitment to teacher professional development, learner agency, and the protection of human dignity in an age of AI.

Conclusion

In 2026, AI is no longer a future prospect but an active reality in global education. Will education systems proactively shape AI to serve pedagogical values, or will they be passively shaped by tools developed largely by commercial actors?

The GSENet panel/webinar series revealed both convergences and divergences with the existing literature. Participants and researchers broadly agreed on the need for teacher agency, ethical governance, human-centred design, and AI literacy as a core competency. However, tensions emerged around the pace of learner adaptation: while literature often emphasizes gradual, structured integration, webinar participants noted that students are already adopting AI rapidly, often without institutional guidance, leaving over 80% of students untrained in proper AI use.

Assessing Smart Education Across Regions

In order to further explore the status of Smart Education across the seven regions, GSENet partners led the development of individual chapters: Asia (SEAMEO), Africa (OUK), the Arab region (ALECSO), the Americas (ISTE), Europe

(ICDE), Latin America and the Caribbean (IFHT/UERJ), and the Pacific (NUS) through a structured analytical framework that moves beyond simple adoption metrics to assess the depth and quality of systemic transformation. *First*, each regional analysis examines Smart Education through three critical lenses: *what may be gained* from AI integration (benefits including personalized learning, equitable access, and alignment with real-world skills); *what may be reshaped* (transformations in curriculum design, assessment models, and learning delivery structures); and *what may be at risk* (fairness concerns, data privacy vulnerabilities, accountability gaps, and trust deficits, particularly in contexts with developing governance mechanisms).This multi-dimensional assessment reveals Smart Education maturity level not only across regions but within them.

Second, a case study from every region has been analyzed using a ten-indicator framework of Smart Education spanning Performative Features (student-centred teaching, holistic assessment, smart learning environments, school organizational leadership, and educational equity) and Constructive Features (school cultural development, data security and governance, teacher capacity building, sustainable education reform, and cross-sector collaboration), to provide a comprehensive framework for understanding where regions are advancing, adapting, or facing challenges (Huang et al., 2024).

Third, each regional report uses the Amara (1981) framework to assess where the region is heading in terms of three scenarios: probable, possible, and preferable futures which offer a structured way to imagine this trajectory.

Looking Beyond 2030

As we look toward 2030 and beyond, the future of Smart Education will be shaped by how education systems navigate the tension between technological possibility and human purpose. The answers to the questions above will be crucial in determining which future path we follow. The Amara scenarios of probable, possible, and preferable futures offer a framework for imagining this future. If current trends continue (probable), we will see continued fragmentation: rapid adoption in well-resourced contexts, widening digital divides, and persistent governance gaps. A possible future could involve transformative public-private partnerships, open AI infrastructure, and radically reimagined assessment systems. The preferable future is the one we must actively work to create, where Smart Education systems are deliberately shaped to advance equity and human development. This is where the technology serves pedagogical values rather than market imperatives, and where educators, learners, and communities remain at the centre of decision-making. As UNESCO (2025a) asserts, "*AI is not the future of education, it is the future of educators*" a future that must be shaped deliberately, equitably, and with human agency at its core.

References

AI Asia Pacific Institute. (2024). State of Artificial Intelligence in the Pacific Islands [Report]. https://pacificislands.ai/

Amara, R. (1981). The futures field: Searching for definitions and boundaries. The Futurist, 15(2), 25–29.

Burgos, D., Branch, J. W., Tlili, A., Huang, R., Jemni, M., Stracke, C. M., ... & Berrada, K. (Eds.). (2024). Radical Solutions for Artificial Intelligence and Digital Transformation in Education: Utilising Disruptive Technology for a Better Society. Springer Nature.

Canadian Digital Learning Research Association. (2025). National survey on AI use in Canadian K-12 education: 2025 report. CDLRA Research Series.

Canadian Teachers' Federation. (2025). AI in Canadian classrooms: Teacher perspectives and policy gaps. Canadian Teachers' Federation

Publications.

Center for Democracy & Technology. (2025). Students and AI: Navigating academic integrity and autonomy in the age of generative AI. CDT Research Report.

Chigbu, B. I., & Makapela, S. L. (2025). AI in education, sustainability, and the future of work: An integrative review of industry 5.0, education 5.0, and work 5.0. Journal of Open Innovation: Technology, Market, and Complexity, 100645. https://doi.org/10.1016/j.joitmc.2025.100645

China Youth and Children Research Center. (2025). Survey on the use of artificial intelligence among primary and secondary school students [Unpublished raw data].

Chiu, T. K. F. (2025). AI literacy and competency: definitions, frameworks, development and future research directions. Interactive Learning Environments, 33(5), 3225–3229. https://doi.org/10.1080/10494820.2025.2514372

Commonwealth of Learning. (2024). Advancing STEM education in Tonga with Generative AI and Open Educational Resources. http://dev.col.org/news/advancing-stem-education-in-tonga-with-generative-ai-and-open-educational-resources/

Commonwealth of Learning. (2024). Pacific educators leverage OER and AI integration in STEM education. https://www.col.org/news/pacific-educators-leverage-oer-and-ai-integration-in-stem-education/

Commonwealth of Learning. (2025). Samoa STEM teachers gain skills in Open Educational Resources. https://pacificpartnership.col.org/2025/07/17/samoa-stem-teachers-gain-skills-in-open-educational-resources/

Creely, E., Carabott, K. (2025). Teaching and learning with AI: an Integrated AI-Oriented Pedagogical Model. Aust. Educ. Res. 52, 4633–4654. https://doi.org/10.1007/s13384-025-00913-6

Dai, R., Thomas, M.K.E. & Rawolle, S. (2025). The roles of AI and educational leaders in AI-assisted administrative decision-making: a proposed framework for symbiotic collaboration. Australian Educational Researcher. 52, 1471–1487. https://doi.org/10.1007/s13384-024-00771-8

DLA Piper. (2025). EU AI Act: Article 4 AI literacy requirements – Compliance timeline and obligations. DLA Piper Global Law Firm.

Dong, L., Tang, X., & Wang, X. (2025). Examining the effect of artificial intelligence in relation to students' academic achievement: A meta-analysis. Computers and Education: Artificial Intelligence, 8, 100400. https://doi.org/10.1016/j.caeai.2025.100400

Doss, C. J., Bozick, R., Schwartz, H. L., Chu, L., Rainey, L. R., Woo, A., Reich, J., & Dukes, J. (2025). AI use in schools is quickly increasing but guidance lags behind: Findings from the RAND survey panels (Report No. RR-A4180-1). RAND Corporation. https://doi.org/10.7249/RRA4180-1

EdTech Market Insights. (2026). North American K-12 AI procurement trends and decision-making 2025-2026. EdTech Market Insights Research.

Education Commission of the States. (2026). State AI policy tracker for K-12 education. ECS Policy Analysis Series.

European Commission. (2025). AI Act: First legal framework on artificial intelligence. European Commission Directorate-General for Communications Networks, Content and Technology.

Filgueiras, F. (2024). Artificial intelligence and education governance. Education, Citizenship and Social Justice, 19(3), 349-361. https://doi.org/10.1177/17461979231160674

Hamadeh, S., & Amin, H. (2025). AI, education and digital sovereignty. Frontiers in Education. 10:1677727.https://doi.org/10.3389/feduc.2025.1677727

HolonIQ. (2025). 2025 Global edtech investment report. HolonIQ.

Hua, D., & Brimble, P. (2025). Bridging the divide:

Building Pacific agency in the AI era. Development Policy Centre. https://devpolicy.org/bridging-the-divide-building-pacific-agency-in-the-ai-era-20250711/

Huang, R., Liu, D., Kanwar, A. S., Zhan, T., Yang, J., Zhuang, R., ... & Adarkwah, M. A. (2024). Global understanding of Smart Education in the context of digital transformation. Open Praxis, 16(4), 663-676. DOI: 10.55982/openpraxis.16.4.761

Kazancı-Yabanova, E. (2025). Artificial Intelligence-Supported Workplace Education: A Systematic Review of Learning Outcomes, Opportunities, and Challenges. Educational Process: International Journal, 19, e2025602. https://doi.org/10.22521/edupij.2025.19.602

Khodabin, M., & Arsalani, A. (2025). Artificial Intelligence Literacy as National Strategy: A Systematic Review of Policy, Equity, and Capacity Building across the Global South. Journal of World Sociopolitical Studies, 9(4). https://doi.org/10.22059/wsps.2025.396472.1530

Kim, J. (2026). AI agency and human collaboration in education: OECD perspectives. OECD Digital Education Papers, No. 45. OECD Publishing.

Kotsis, K. T. (2025). Integrating artificial intelligence into higher education curricula: Challenges and opportunities for science-based programs. International Journal of Artificial Intelligence Engineering and Transformation, 6(1), 04-12. DOI:10.54660/ijaiet.2025.6.1.04-12. https://doi.org/10.54660/ijaiet.2025.6.1.04-12

Lazanyuk, I.V., Eyeberdiyeva, M.M., Diaz, M.H.A.Z. (2025). AI and the Digital Divide: Challenges and Opportunities. In: Popkova, E.G. (eds) Management of Digital Technologies in the Innovative Economy. Advances in Science, Technology & Innovation. Springer, Cham. https://doi.org/10.1007/978-3-031-83331-1_46

Ministry of Education of China. (2025). Dialectics Embodied in Xi Jinping's Guidance on Education Work. http://www.moe.gov.cn/jyb_xwfb/s5147/202503/t20250311_1182360.html

Ministry of Education of China. (2026). Educational Transformation and Development in the Intelligent Era: Keynote Speech from Huai Jiinpeng at the 2026 World Digital Education Conference.http://www.moe.gov.cn/jyb_xwfb/xw_zt/moe_357/2026/2026_zt05/qthy/qthy_zzyj/202605/t20260514_1436569.html

National Education Policy Center. (2026). State-level AI guidance in K-12 education: A comparative analysis of policy approaches. NEPC Research Report.

OECD. (2026). Digital education outlook 2026: AI and the transformation of learning. OECD Publishing.

Pacific Community. (2025). Pacific Board for Educational Quality 2025: Celebrating Pacific's decade-long progress and the dawn of AI integration into Pacific education. https://www.spc.int/updates/news/media-release/2025/08/pacific-board-for-educational-quality-2025-celebrating-pacifics

Pew Research Center. (2025). Teens and generative AI: Usage patterns, attitudes, and concerns. Pew Research Center.

Reingold, A. (2025). "The governance gap: Educational policy and AI adoption in US schools." Journal of Educational Policy, 42(3), 18-35.

Rogerson, K., & Sherman, J. (2025). AI in public education: Humble beginnings and revolutionary potential. In The Political Economy of Robots: Prospects for Prosperity and Peace in the Automated 21st Century, 2nd edition (pp. 117-143). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-95171-8_6

Romero, M. (2025). From Consumption to Co-Creation: A Systematic Review of Six Levels of AI-Enhanced Creative Engagement in Education. Multimodal Technologies and Interaction, 9(10), 110. https://doi.org/10.3390/mti9100110

Srinivasan, S., & Twinomugisha, A.

(2025). Disruptive potential of AI in education systems in low- and middle-income countries: A case study approach. World Bank Education Working Paper Series.

Stanford Institute for Human Centered AI. (2025). AI Index Report 2025. Stanford University.

Stanford Institute for Human Centered AI. (2026). AI Index Report 2026. Stanford University.

Stanford University Graduate School of Education. (2026). Longitudinal study on AI literacy and critical thinking outcomes in high school students (Working Paper #2026-04). Stanford GSE.

TALIS (2024). Teaching and Learning International Survey: Teachers and artificial intelligence. OECD Publishing.

Tlili, A., Saqer, K., Salha, S., & Huang, R. (2025). Investigating the effect of artificial intelligence in education (AIEd) on learning achievement: A meta-analysis and research synthesis. Information Development, 41(3), 825-842. https://doi.org/10.1177/02666669241304407

UNESCO Institute for Lifelong Learning. (2025). Digital empowerment for adult educators in the age of AI and other emerging technologies [Self-learning course]. https://www.uil.unesco.org/

UNESCO Institute for Lifelong Learning. (2025). The evolving right to education in the age of generative AI. UNESCO. https://thelifelonglearningblog.uil.unesco.org/2025/12/

UNESCO. (2025a). AI and the future of education: Disruptions, dilemmas and directions. UNESCO Publishing.

UNESCO. (2025b), November 10). Nine out of ten university staff use AI yet remain unconvinced of its effectiveness, UNESCO survey finds. UNESCO Press Release. https://www.unesco.org/

UNESCO. (2025c). Higher education and AI: Global policy landscape survey 2025. UNESCO Publishing.

UNESCO. (2025d). From promise to practice: harnessing generative AI to improve foundational learning in Sub-Saharan Africa. UNESCO Publishing.

UNESCO. (2025e). Sub-regional seminar for Anglophone countries in Africa: Advancing digital and AI competencies for teachers and students – Seminar report. UNESCO Publishing.

UNESCO. (2025f). Empowering teachers and students with AI competencies: Regional seminar for Latin America and the Caribbean – Final report. UNESCO Publishing.

UNESCO. (2025g). AI competency framework for students. UNESCO Publishing.

UNESCO. (2025h). AI competency framework for teachers. UNESCO Publishing.

University of Melbourne. (2026). Strengthening AI capability in higher education across Papua New Guinea. https://about.unimelb.edu.au/education-melbourne/our-people-in-action/strengthening-ai-capability-in-higher-education-across-papua-new-guinea

Watermeyer, R., Crick, T., Knight, C., & Goodall, J. (2025). Student AI use and institutional training gaps in UK higher education. [Survey report].

Xinhua News Agency. (2025). *Education 强国 construction plan (2024-2035)*. https://english.www.gov.cn/policies/latestreleases/202501/20/content_WS678d85c6c6d0868f4e8eef83.html

Xu, J. (2025). Global landscape and local reflections on teachers' AI application in teaching: Based on OECD TALIS 2024 survey. Open Education Research, 31(5), 21-29.

Zhu, Y., Zhu, Z., Xu, W., & Zhu, Y. (2025). Cross-border higher education cooperation under the dual context of artificial intelligence and geopolitics: opportunities, challenges, and pathways. In Frontiers in Education (10), 16-26. https://doi.org/10.3389/feduc.2025.1656518

2

Chapter 2

Smart Education Status Report for Sub-Saharan Africa

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Chapter 2 Smart Education Status Report for Sub-Saharan Africa

Introduction to Sub-Saharan Africa: Demographics, Connectivity, and Developmental Trajectory

Sub-Saharan Africa (SSA) presents a paradoxical development landscape, combining emerging economic hubs with highly fragile states. Some countries, such as South Africa, Botswana and Mauritius, are upper-middle income countries with stable governance, while others, in the Sahel and Great Lakes region are underdeveloped and face political instability (World Bank, 2025; UNDP, 2024). The Human Development Index is between 0.80 in developed pockets and 0.35 in fragile states, while poverty rates range from less than 10% to more than 70% respectively (UNDP, 2024).

The most transformative aspect of the region is the unprecedented youth bulge, where 70% of the population is under 30 years (African Union Commission, 2024). One in four people in the world will be African in 2050 (UNDESA, 2022) but regrettably, almost 60% of SSA youth are either unemployed or underemployed, which poses risks of instability and emigration (ILO, 2025). To realize this demographic dividend, it is necessary that educational challenges, such as the shortage of 15 million teachers are addressed by the year 2030 (UNESCO, 2023).

The potential of the youth dividend is also threatened by a widespread connectivity crisis. Internet penetration in SSA is 40%, compared to a global average of 67% (ITU, 2025). Mobile subscriber growth is the highest, but most subscribers are still on 2G/3G networks, making AI and video-based learning impractical (GSMA, 2025). Furthermore, in SSA, data costs take up 6.5% of average monthly income, while in the developed markets, it takes up less than 1%. This results in a 'two-speed' Africa, with urban areas becoming more connected to the rest of the world, and rural areas largely left behind (GSMA, 2025; World Bank, 2025).

The African Union's Agenda 2063 is a fifty-year plan for technological leapfrogging, with the goal of achieving universal access to high-speed internet and digital learning platforms by 2030 (African Union Commission, 2015; 2024). SSA is at a pivotal moment: strategic investments in mobile-first AI education and digital infrastructure can make the region a global manufacturing and innovation hub (AfDB, 2024; Bloom et al., 2020). On the other hand, if investments are not made, the billion-plus youth population could become a migration and security challenge (UNCTAD, 2025).

Smart Education, which is based on intelligent technologies for personalized and adaptive learning, is a strategic solution (Huang et al., 2024). However, there is a lack of representation of African countries in AI education research and policy discussions (Sebihi et al., 2025) and African languages are underrepresented in AI training data, with only 45 out of 517 languages having more than one dataset (Adebara et al., 2025). The rapid diffusion of large language models has outpaced ethical and policy safeguards (Soko, 2025). Furthermore, there are challenges of cognitive offloading, western ideologies and digital neo-colonialism (Baek & Wilson, 2024; Nyaaba et al., 2024).

However, the advantages of Smart Education technologies are greater than the risks. The remainder of this report explores the concept of Smart Education using case studies of South Africa, Rwanda, Nigeria and Cameroon, which represent the various demographic, cultural and educational realities of Southern, Eastern, Western and Central Africa.

This is followed by a detailed case study of Smart Education in Kenya based on a global framework for tracking Smart Education in Section 3. Section 4 presents a model institution implementing Smart Education, while Section 5 provides recommendations.

> In the African context, Smart Education extends beyond technology infrastructure to encompass culturally responsive pedagogy, localized content, and flexible delivery models. It recognizes that 'smart' is not defined by bandwidth alone, but by the ability to adapt digital tools to diverse linguistic, geographical, and socioeconomic realities across the continent.

Regional Analysis of Smart Education in Sub Saharan Africa (SSA)

What May Be Gained: opportunities and emerging benefits

The adoption of AI in these four African countries (South Africa, Rwanda, Nigeria, Cameroon) offers a promising opportunity to tackle the complex educational issues of access, quality, and scale.

One of the key benefits is the ability to provide personalized and adaptive learning to help address learning gaps. In South Africa, the Smart Education initiative has introduced personalized learning in underserved communities through the application of AI (Nkosi, 2022), while in Rwanda, the Competency-Based Curriculum has demonstrated positive outcomes in student mastery with the implementation of continuous formative assessment (Ndayisenga, 2025). AI teacher training programs in Nigeria such as Naija Teacher AI are designed to empower teachers, where more than 40 million children are enrolled in basic education (Adeniran et al., 2025; Imoniri, 2025).

Efficiency and system scalability are of great importance and present several opportunities for Smart Education in SSA. The creation of an AI Scaling Hub (World Economic Forum, 2025) and the Smart Rwanda Master Plan illustrate a strategic approach to scaling digital literacy and high impact AI solutions in Rwanda. The 3 Million Technical Talent Programme (3MMT) is a massive initiative to create a skilled workforce in AI, encompassing education and economic development in Nigeria (3MMT, 2023). Cameroon's new Intelligent Classroom initiative is a sign of the shift towards more technology-enhanced learning environments (Cameroon News Agency, 2026).

Last but not least, AI integration is tied to the cultivation of future-oriented skills. The National AI Policy of Rwanda explicitly mentions that curricula should focus on digital and AI literacy (ICTworks, 2023) to support the Vision 2050 of Rwanda. Likewise, Nigeria's policy of integrating robotics and AI into the curriculum (Imoniri, 2025) is aimed at equipping the country's youthful population for the digital economy.

What May Be Reshaped: systemic and pedagogical transformation

Pedagogical models, curricula, and governance are starting to change in the four countries, but not uniformly, as a result of AI.

Pedagogically, there is a move towards more learner-centred and data-driven teaching. The shift from using laptops to developing adaptive, child-centred learning environments (Wallet et al., 2019) in Rwanda is a step away from the traditional teacher-led approach. This is reflected in South Africa where AI is being employed to tailor learning experiences, suggesting a shift in the role of the teacher from a transmitter to a facilitator (Nkosi, 2022). The nature of assessment is also changing, as Rwanda has introduced continuous formative assessment, which is a departure from the traditional end-of-cycle testing (Ndayisenga, 2025).

In addition, curricula are being radically restructured to incorporate new skills. Nigeria's policy to embed digital literacy and AI into the curriculum and Rwanda's focus on ICT and AI literacy are key examples. However, South Africa's experience shows that this process is not without its challenges, as an initial AI policy was withdrawn because of procedural problems (Reuters, 2026).

The establishment of a dedicated National AI Policy (Access Partnership, 2023) and a Responsible AI Office (ICTworks, 2023) in Rwanda provides a groundbreaking approach to structured and ethical AI governance. Its collaborations with international organizations, including the Gates Foundation (World Economic Forum, 2025), further demonstrate a reconfiguration of the funding and governance of educational innovation, with new actors and accountability mechanisms emerging.

What May Be at Risk: inequalities, governance gaps, and ethical tensions

The opportunities created by the same processes also bring significant risks, which can further aggravate existing vulnerabilities in the region.

The most important issue is the exacerbation of inequalities. The digital divide is significant and if left unaddressed, the benefits of AI will be felt in better-resourced regions. The continuing impact of apartheid in South Africa has resulted in significant inequalities in access to connectivity and digital resources (Mulaudzi, 2024; Mokoena & Seeletse, 2025). Likewise, Cameroon is facing connectivity and electricity issues, which exclude thousands from digital learning (UNICEF, 2020). Nigeria has a significant urban-rural digital divide (UNICEF, 2023), while Rwanda, although making strides, continues to grapple with a persistent rural-urban divide (Sangwa & Mutabazi, 2025). The prevalence of English in digital spaces also poses a threat to the further marginalisation of learners in South Africa and beyond whose identities are based on indigenous languages (Mokoena & Seeletse, 2025).

The second major risk is governance failures and moral conflicts. There are few structured policies to guide the deployment of AI. The teachers in Cameroon are in a "policy vacuum" (Haji & Djeumeni, 2025), and South Africa's failed policy experiment (Reuters, 2026) reveals governance weaknesses. This raises the possibility of technological dependency and a possible transfer of educational control from public systems to external providers.

Lastly, there are pedagogical and professional dangers. If not backed by robust pedagogical structures, over-reliance on AI may result in superficial learning. Lack of training and ethical concerns are identified as challenges by teachers in all four countries (Mhlanga, 2023; Spice, 2025; Imoniri, 2025), while teachers in South Africa report concerns about redundancy (Mhlanga, 2023) and teachers in Cameroon report a mismatch between teacher training and teacher absorption (Allamine & Souck, 2026). This suggests that decisions may be made without adequate evidence or professional consensus, which can affect teacher autonomy and teaching quality.

Overall profile of SSA

The overall maturity level of Smart Education in SSA is emerging as initiatives are siloed, most technology policies are in the formation stage, and in most instances, the one-size-fits-all approach of face-to-face learning is prevalent.

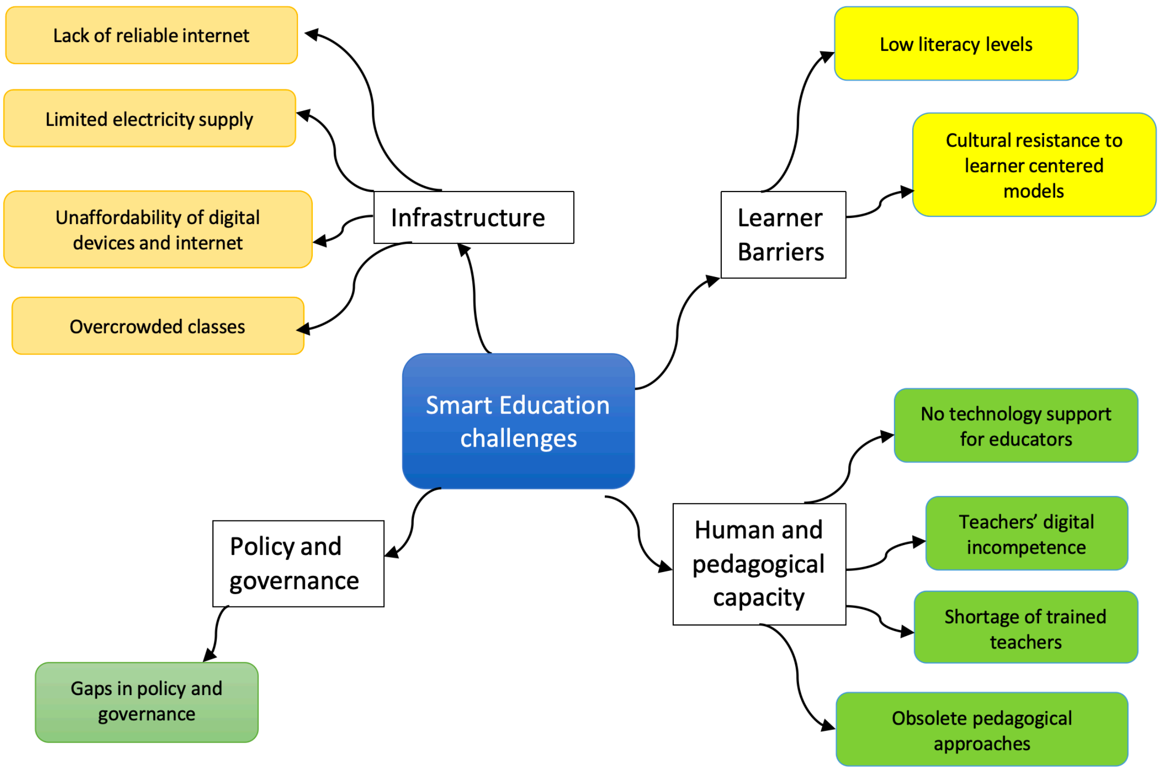
The key underlying challenge in SSA is that of inequality, while a key strength is the public-private partnerships for Smart Education initiatives (see Table 2.1).

The region has critical gaps in policy and governance frameworks, limited teaching staff (most of whom lack adequate training, digital skills, and have to attend to large class sizes), infrastructural challenges (such as unreliable internet and a lack of stable electricity supply), and learner barriers like low illiteracy levels as depicted in Figure 2.1.

Table 2.1 Key strengths for Smart Education implementation in SSA

Representative Country strengths for Smart Education implementation	
Nigeria -Public private partnerships for Smart Education -Digital policy initiatives -Infrastructure upgrades by the govt. Teacher training programmes	**South Africa** -Public private partnerships for Smart Education -Policy initiatives to improve education access Teacher training programmes
Rwanda -Government support for Smart Education initiatives -Investment in ICT infrastructure -Forward looking policy frameworks -Digital literacy initiatives in schools Public private partnerships for Smart Education	**Cameroon** -Public private partnerships for Smart Education -Policies to improve education access

Figure 2.1 Challenges facing Smart Education implementation in SSA



Despite the challenges, SSA has the strategies to address these, including: collaborative partnerships between governments and the private sector that supplement funding gaps, training programs to equip teachers with digital skills, and nations' efforts to improve the infrastructure, such as the internet, and targeted initiatives to bridge the gender divide.

The dominant gap, however, across the region is access to equitable education. The inequalities in access to equitable education risk leaving a huge population behind in the Fourth Industrial Revolution (4IR), making such nations less competitive and impacting negatively on other development aspects, such as health.

Current Status: Case Study of Kenya

The case study of Kenya provides a deeper examination of how Smart Education policies, practices, and systems operate in the nation's context. Kenya is recognized as a country with a strong record of technological and innovation in Africa and is dubbed the 'Silicon Savannah'.

Kenya has made commendable progress in expanding access to education, with 49,033 registered learning institutions in 2023 serving approximately 15 million learners from early childhood to tertiary levels (KNBS, 2024). Onsomu et al. (2025) note that this growth has been accompanied by digitization efforts, including the National Education Management Information System (NEMIS), biometric student attendance tracking, and digital curriculum delivery platforms. AI is increasingly being woven into the lives of Kenyan citizens, and the Digital Global Update report reveals that Kenya ranks high for AI tools usage (Datareportal, 2026). The nation was among the top-scoring countries in Sub-Saharan Africa, ranking 67th globally and 3rd in Africa on the global AI Readiness Index (Oxford Insights, 2025).

The Key Indicators of Smart Education at the National Level (Huang et al., 2024) is used to provide a deep dive into how Smart Education is maturing across Kenya, including a diagnosis of strengths, gaps, and trajectories. We discuss the case of Kenya by looking at the Performative Features and constructive features of Smart Education in the nation

Performative Features of Smart Education in Kenya

To determine the Performative features of Smart Education, we discuss education in Kenya using the following primary indicators:

Student-Centered Teaching

The Basic Education Curriculum Framework (BECF) calls for more learner-centered education (LCE) and advances seven core competencies: citizenship, digital literacy, creativity, critical thinking, self- efficacy, collaboration, and communication (KICD, 2019). However, large class sizes have continued to increase due to prioritizing universal public education, while the budget remains constrained (Kerkhoff et al., 2025). Despite the challenges, modern digital technology platforms have risen to positively influence teaching and learning (Omutange et al., 2025), effectively transforming teaching to be more active in some institutions. Online textbooks, GenAIcollaboration platforms, wikis, and digital repositories enable students to engage with educational material and assignments with ease (Adiguzel et al., 2023) due to the large number of educational resources available.

However, several tutors in Kenya still view technology as a major distraction in the classroom and therefore resist its adoption (Omutange et al. 2025). There is a risk that overdependence on AI tools in teaching could lead to a reduction in human interaction with content creation and course design, ultimately diminishing teachers' pedagogical skills and professional value (Wainaina et al., 2025).

Holistic Learning Assessment

The Competency-Based Curriculum (CBC) in Kenya emphasizes a holistic approach to learning through formative assessment and digital literacy integration, among other measures, which have helped students navigate the online education platforms and effectively use digital tools. Platforms such as Moodle enable educators to administer e-assessments, collect results, and provide immediate feedback, enabling efficient evaluation and enhancing the learning experience (Ndiangui et al., 2025). The assessments and peer reviews available across online platforms can be taken from any location and are automatically graded in real-time, thereby facilitating a dynamic and responsive learning process.

The Kenya National Education Assessments Council Bill of 2025 sought, among other things, to introduce AI for marking assessments and to align them with CBC, as well as to introduce AI-assisted scoring with higher penalties for exam malpractice to streamline the assessment process. However, the black-box nature of AI needs to be addressed to ensure that biases are not reinforced or introduced, and explanations are provided on how a given score was arrived at by the algorithms across online education platforms.

Smart Learning Environment

There exist disparities in educational resources, with electricity and internet access being less reliable in rural areas than in urban areas (Mugendi 2021), with learners in rural areas likely to lag in education. Other challenges in the rural areas include a lack of devices and technical support, a high student-to-device ratio, and an overloaded curriculum devoid of digital literacy (Kerkhoff et al., 2025). Being cognizant of the challenges, the government, in its 2026 budget policy statement, commits to bridging the digital divide by installing 37,645 kilometers of backbone fiber optic network, extending high-speed internet connectivity to underserved rural and remote areas (Government of Kenya, 2026). In the government's plan, internet connectivity will be provided to 18,680 public institutions nationwide, while 27,516 public Wi-Fi hotspots will be installed to expand affordable internet access. Over 1450 digital hubs have been established by the government (Jitume, 2026).

School Organizational Leadership

Outdated or incomplete data continues to hamper strategic planning in schools (Onsomu et al., 2024). Furthermore, data is often not used effectively in decision-making, partly due to weak data infrastructure, lack of analytical capacity, and low levels of data literacy among education administrators, as exhibited by education officers in Uasin Gishu county who rarely used NEMIS data for strategic decision-making due to limited technical capacity and insufficient integration of data use into institutional processes (Wamutoro et al., 2022).

However, the institutions that have well-organized and updated records and consist of tech-competent staff,the situation is different . AI has been prominently employed for decision-making in Kenyan senior and junior secondary schools (Omwenga et al., 2025), mainly due to the benefits it offers, such as faster response times, less human bias, and increased efficiency.

Educational Equity

The gender digital divide is evident in Kenya, with disparities in access to digital infrastructure and internet usage (Gachugu et al. 2025), hindering females' participation in education and the digital economy.

ICT adoption has significant disparities between urban and rural schools, as well as between students with different abilities (Owidi, 2025). Many educational institutions lack the necessary resources to acquire computers, build labs, hire qualified teachers, and establish reliable internet connectivity, with most learners, especially in marginalized areas, encountering computers for the first time in school (Ouma-Odero, 2025).

Kenya's use of AI in mobile learning applications has helped bridge the gap between urban and semi-urban education, demonstrating the broader applicability of AI in different contexts (Otieno, 2024). However, Ouma-Odero (2025) notes that while EdTech promises to advance the CBC goals of digital literacy and critical thinking, access is still highly uneven.

Constructive Features of Smart Education in Kenya

The Constructive Features, which outline the actionable pathways to achieve Emart education in Kenya, are discussed below:

School Cultural Development

BECF calls for the use of indigenous language to be integrated alongside English and Kiswahili literacy in the teaching of early grade reading (Iyenga et al., 2025). However, there is no evidence of this policy being implemented in recent years, even though there exist resources like the Kenya education cloud that offer educational materials in indigenous languages. The mismatch between home and school language and low socio-economic status negatively impacts reading outcomes among young learners (Wawire et al., 2024). Improving teacher competence through Continuous Professional Development (CPD) as part of pre-service and continuous in-service teacher education training on second language acquisition, second language pedagogy and assessment, world readiness standards for learning languages, and proficiency guidelines should be adopted by the mother ministry and cascaded to all learning institutions, which may improve learning outcomes (Wawire et al., 2024)).

Kenya carried out curriculum reforms that incorporated coding and digital literacy in elementary school, and computer science in junior secondary school (Fundi et al., 2024). With digital literacy, improvements in the learning behaviors of pupils have been reported.

Data Security and Governance

A study by Kariuki et al. (2025) reveals a mixed perception of AI surveillance tools in monitoring student behavior in Kenyan secondary schools. For instance, constant monitoring of students undermines the trust necessary for successful implementation. This calls for transparency regarding data collection, use, and security.

The Konza Cloud Platform, which is powered by high-capacity secure data storage and capabilities enabled by the National Data Center, was set up and supports secure, scalable education delivery for academic computing, digital libraries, and research data storage (Konza Technopolis, 2026).

Kenya has a set of laws and strategic frameworks, but no explicit set of laws that cover AI. Regulation of AI is based on broader laws and frameworks, which were not designed to address AI-specific concerns. Recently, a draft Artificial Intelligence Bill 2026 was tabled in the Kenyan Senate. The bill introduces a comprehensive, risk-based regime governing the development, deployment, and use of AI systems, emphasizing ethical use, transparency, and safeguarding of human rights (Bowmans, 2026), but raises controversies of over-regulation, stifling innovation, and censorship.

Teacher Capacity Building

The Teachers Service Commission (TSC), in collaboration with the Ministry of Education, launched CPD programs to support CBE implementation (Mauti et al., 2025). CPD is necessary to stay abreast of technological and pedagogical advances driving education sector transformation (Nyarieko & Wachira, 2024). However, negative attitudes among teachers and parents to the CBE persist, as well as confusion and uncertainty about it (Materea, 2024). The CPD programs rolled out to support CBE implementation have inconsistent delivery models, limited resources, and fragmented oversight, which hinder their effectiveness, particularly in underserved regions (Wambugu & Mungai, 2023).

Kenya faces a skills shortage in the AI and ICT sector, with 30% of employers globally citing the general skills gap as a challenge (UNESCO, 2025). While some educators have received training in the use of ICT tools, many still lack the necessary skills and knowledge to effectively incorporate AI into their teaching practices (Owino & Otieno, 2021).

Government training institutions like the Kenya School of TVET offer AI literacy workshops for senior school teachers and TVET trainers. In 2025, for instance, over 5400 senior school teachers were trained on how to utilize AI in CBE and how to use virtual labs to support experiential learning. The government, in partnership with Huawei, has established AI centers of excellence across many TVET institutions, which teach trainers skills such as how to leverage AI to generate exams. Additionally, the government, via the ICT Authority, created the Smart Academy Initiative, an e-learning platform that trains public servants and citizens on digital skills like data analysis, information security, and AI for SDGs. Through the Smart Academy, over 1 million Kenyans have been equipped with relevant digital skills.

Sustainable Education Reform

The CBE curriculum launched in 2017 promises a learner-centred, flexible, and stress-free education with pathways that promise opportunity for everyone. However, nine years into implementation, it is bedeviled with complaints of poorly trained educators, strained institution infrastructure, offloading of instructional responsibility onto parents, declining competitiveness among learners, increased costs, and widened education inequality.

The nation's 2026 budget underscores the need to expand digital learning programs, the provision of ICT infrastructure, and support the implementation of CBE, and has proposed increased financial allocation to these components of education (Government of Kenya, 2025). However, it is unfortunate that such funds are not always utilized efficiently. For instance, nearly one-third of the total expenditure on education in developing nations like Kenya is wasted due to inefficiency, such as leakage or poor program targeting (IIEP-UNESCO, 2026). Furthermore, education is underfunded as part of the education budget is financed by donors, and this has proven to be an unsustainable solution, given that donors have shifted focus to other global crises (World Bank and UNESCO, 2024)

Cross-Sector Collaboration

E-government is a powerful instrument that can transform structures, processes, and cultures of government, making it more transparent and efficient (Kauma et al., 2022), and can help achieve specific outcomes in crucial policy areas like boosting the use of an educational program.

The Kenya Open Data Initiative (KODI) offers a centralised platform for accessing datasets in many areas, including education. Citizens equipped with digital data skills can explore the datasets in ways that may end up holding the government accountable for its actions. However, it lacks a coordinating body for open data governance, has not ratified Convention 108+, the Budapest Convention, or binding trade agreements on cross-border data flows (Onsomu et al., 2025).

The Kenyan government has drafted the data governance policy and is currently validating it with the hope that it will be formally adopted to promote interoperability and eliminate fragmented legal frameworks, siloed data systems across government institutions, inconsistent standards, and limited capacity in data management and analytics.

A model institution for Smart Education: Case of the Open University of Kenya

The Open University of Kenya (OUK) has stood out in its implementation of Smart Education. OUK is a specialized public university that has democratized education by using AI and other forms of technology to offer education to diverse learners with a digital-first, flexible, open, and inclusive education. It prides itself as one of the first few universities in Kenya to curate programmes that focus on learner-centeredness, as it has repackaged them to align with CBE. OUK is also the first public university in Kenya that is proactively offering micro-credentials in order to introduce targeted skills for a short time to learners, allowing them to flexibly upgrade their skills in line with the changing job market. With over 25,000 learners, the OUK online platform uses cloud computing for the creation of virtual laboratories and simulations, thereby providing students with an immersive learning experience. OUK integrates AI and the latest online delivery methods to support programme development and ensure quality education. For instance, in a partnership with MindHYVE.ai, the university hopes to embed agentic AI in its digital ecosystem to support personalized learning, faculty enablement, data-driven curriculum innovation, and workforce-aligned upskilling (Intelligent CIO, 2026).

Dynamic and interactive platforms such as social media are provisioned for connection, collaboration, and information exchange within the institution. The university is sought by most Kenyans as it offers a range of academic and professional courses that are required for the 4IR, including courses in AI, Cybersecurity and Digital Forensics, and Data Science. Among its students is

President William Ruto, who enrolled to pursue a Master in AI course, signifying the top leadership's endorsement of the high quality, cutting-edge nature and relevance of OUK's programmes and faculty.

Conclusion

We acknowledge the reality that AI and other 4IR technologies are here to stay. The key question, however, in the current era is how we can adapt such technologies in education. There is a need for a more holistic approach that includes curriculum reform, faculty capacity building, ethical guidelines, and institutional policy development, as such technologies are adopted in education. Currently, with the fragmented application of 4IR technologies like AI in Smart Education and a lack of policies that establish guardrails for their ethical and responsible use, most institutions and education stakeholders may continue viewing 4IR technologies as a 'nice-to-have' layer on top of manual processes and shun their usage if their fears and misconceptions are not addressed.

The Probable Future. If the current trend continues, in which some students are marginalized, deepening inequalities with funding models that perpetuate the cycle of disadvantage persist, and 4IR technologies like GenAI are adopted in education in a disenfranchised manner without any clear guidelines, then the probable future would be that students from disadvantaged backgrounds would remain trapped in the same economic conditions they were born in, and would have limited opportunities to pursue higher education given their disadvantages.

The Possible Future. Outside the current expectations, the following would happen: there would be a learning environment in which digital technologies like AI would flourish, and learning would be self-directed. Multimodal learning environments will be the norm, and these will end up greatly improving spatial skills. Technology advancements in education would eliminate the need to separate education subjects, as learners will have a seamless, holistic view of the world around them.

The Preferable Future. The future we aim to create is one in which critical thinking and problem-solving skills are inculcated among learners. We would like to have order in the education sector through the introduction of AI and policies and guidelines that would not over-regulate but encourage innovation. By showcasing AI's transformative potential in education, collaborative efforts among policymakers, educators, technologists, and communities can be inspired in Sub-Saharan Africa to drive positive change. Both educators and learners will need to focus on developing their reasoning skills, andconsequently, Smart Education will need to establish a kind of education that helps them know where they are at any moment and to choose wisely the future they desire.

Educators must be at the center of Smart Education strategies, and for this reason, they must be trained to develop digital skills and confidence to harness the potential of technologies innovativelyand encourage students to embrace such technologies ethically and responsibly in a way that will enhance learning. Multi-user educational experiences can be built in such a way that they connect students from vastly different locations in the globe, seamlessly pairing individuals with similar levels of experience, interest, and sometimes even opposite skillsets to encourage collaboration around a particular problem.

Recommendations for Smart Education in the 4IR for SSA

1.Many countries in SSA lack access to AI and specific policies and guidelines, which leads to inconsistent practices and grey areas in various sectors such as education. Nations should work towards creating AI policies and education sector guidelines that ensure AI design, development, and use aligned with human values and legal standards. The process can be made smoother through cross-border AI governance cooperation that would encourage learning from best practices. Without such policies and guidelines in the education domain, the 4IR tools would be used in a fragmented manner that may prove to do more harm than good.

2.With industry operating in the real world, focusing on solving immediate problems, while academia focuses on the pursuit of knowledge and research, collaboration and partnerships between the two entities should be encouraged. Some of the ways that this can be achieved include the establishment of hubs, updated curriculum to focus on skills, competencies, and the sharing of research, which will help in fostering education that meets the developmental needs of society in Sub-Saharan Africa. With these collaborations, innovative research will be accelerated, complex societal problems will be tackled, the workforce will be future-proofed, and the digital divide will be reduced.

3.Decolonise most of the curricula in the region in order to incorporate local knowledge and perspectives, which would improve the intellectual quality, honesty, authenticity, and relevance of education itself. This can partly be achieved by expanding AI to support underrepresented languages through curation of local datasets that would, in turn, enable communities to maintain their linguistic heritage and make these languages accessible to future generations. This would include integrating previously marginalized voices into the curriculum and even questioning the generation of knowledge. This would raise a generation that would be proud of native knowledge systems and have the confidence to assert their identity.

4.Workforce reskilling is crucial for Smart Education in the4IR. Educators must be trained to actively engage with technology, modify the way they instruct, and maintain an atmosphere geared towards ongoing learning. They should be skilled and reskilled to embed adaptive digital technology in their teaching methodology through comprehensive training pathways that integrate emerging technologies. Educators are thus called upon to be agile by adopting adaptive learning pathways like micro-credentials for teaching, be self-motivated, and willing to experiment with innovative approaches in education. With the reskilling efforts, employees would be better equipped for their roles in the 4IR, and their productivity would be boosted.

5.Governments in Sub-Saharan Africa must take tangible efforts in bridging the digital divide through measures such as partnering with the private sector to expand broadband internet access, providing free internet access to educational institutions, supporting students from disadvantaged backgrounds by providing refurbished digital devices, offering incentives for low-cost electricity supply, among others. Such measures would open up the economies, drive up investments which would equally translate into better education systems to serve diverse populations.

6.Governments as well as institutions of learning should leverage partnerships with the private sector and donors to bring down the costs of smart learning and maximize impact, for instance, by encouraging the use of open-source software to develop Smart Education systems. Funding should focus on structured, problem-driven investments that lead to meaningful, scalable change in the education sector. Furthermore, governments must enforce measures that will ensure that corruption is eliminated so that educational funds are utilized in the right manner. This will encourage different players to invest in local education systems as they would trust systems to ensure that funds reach the rightful recipients.

Africa is a young continent where appropriate technologies in the hands of the young 'digital natives', and inclusive education can lead to sustainable development and infinite possibilities. Smart Education is a significant strategy. Africa's Smart Education journey is characterized by leapfrogging mobile-first solutions, offline-accessible platforms, and community-driven learning hubs redefining educational access. It demonstrates that Smart Education is as much about resilience, a vision for inclusive and equitable learning, educator empowerment as well as peer collaboration as it is about artificial intelligence and learning analytics.

References

3MMT.(2023).Shaping the Future of Nigeria's Digital Workforce. https://3mtt.nitda.gov.ng/

Adiguzel, T., Kaya, M. H., & Cansu, F. K. (2023). Revolutionizing education with AI: Exploring the transformative potential of ChatGPT. Contemporary educational technology, 15(3).

Access Partnership. (2023). National AI Readiness Index 2023. Retrieved May 17, 2025, from https://www.accesspartnership.com

Adebara, I., Toyin, H. O., Ghebremichael, N. T., Elmadany, A. A., & Abdul-Mageed, M. (2025, July). Where are we? evaluating llm performance on african languages. In Proceedings of the 63rd Annual Meeting of the Association for Computational Linguistics (Volume 1: Long Papers) (pp. 32704-32731).

Adeniran, A., Onyekwere, S. C., Okon, A., Atuhurra, J., Chaudhry, R., & Kaffenberger, M. (2025). Instructional alignment in Nigeria using the Surveys of Enacted Curriculum. International Journal of Educational Development, 114, 103256.

African Development Bank. (2024). African Economic Outlook 2024: Driving Africa's transformation through technology and youth employment. AfDB Publishing.

African Union Commission. (2015). Agenda 2063: The Africa we want. African Union.

African Union Commission. (2024). Agenda 2063: First continental report on the implementation of the ten-year plan 2014–2023. African Union Publishing.

Allamine, H. A.., & Souck, E. N. (2025). Strategies For School Workforce Mastery in Teacher Training in Cameroon and the Quality of Education: Towards an Analysis of Forward Planning. European Journal of Education Studies, 12(11).

Baek, E. O., & Wilson, R. V. (2024). An Inquiry Into the Use of Generative AI and Its Implications in Education. International Journal of Adult Education and Technology, 15(1), 1–14. https://doi.org/10.4018/IJAET.349233

Bloom, D. E., Kuhn, M., & Prettner, K. (2020). Africa's demographic transition and the demographic dividend. Journal of Demographic Economics, 86(2), 123-149. https://doi.org/10.1017/S0047279419000314

DataReportal. (2026).Digital 2026 Mid-Year Global Update Report

Gachugu, E., Mutisya, M., Ireri, M., & Mwarange, M.(2025). Gender Disparities in the Online Gig Economy in Kenya Case Study of the Ajira Digital Programme. Available at SSRN 5145689.

STATEMENT.https://www.treasury.go.ke/sites/default/files/Latest%20updates/2026%20Budget%20Policy%20Statement.pdf

GSMA. (2025). The Mobile Economy: Sub-Saharan

Africa 2025. GSMA Intelligence.

International Labour Organization. (2025). World Employment and Social Outlook: Trends 2025. ILO Publishing.

Haji, S. A., & Djeumeni, M. T. (2025, May). Ethical and Pedagogical Challenges in the Use of AI in Science Education: Perspectives from Teachers in Secondary Schools in Cameroon. In 7ème Colloque international du RAIFFET du 5 au 8 mai 2025 à l'IPNETP d'ABIDJAN en CÔTE d'IVOIRE.

ICTworks. (2023). AI policy implementation and digital transformation in Rwanda. Retrieved May 17, 2025, from https://www.ictworks.org

Imoniri, A. R. (2025). Harnessing artificial intelligence in science education for skills development and economic transformation in Nigeria. Teacher Education and Curriculum Studies, 10(3), 77-83.

Intelligent CIO. (2026). MindHYVE.ai and The Open University of Kenya collaborate on AI-powered learning and academic innovation. https://www.intelligentcio.com/africa/2026/01/16/mindhyve-ai-and-the-open-university-of-kenya-collaborate-on-ai-powered-learning-and-academic-innovation/

International Institute for Educational Planning (IIEP-UNESCO). (2026). Financing education for gender equality. IIEP-UNESCO. https://www.iiep.unesco.org/en/projects/financing-education-gender-equality

International Telecommunications Union (2025). Facts and Figures 2025. https://www.itu.int/itu-d/reports/statistics/2025/10/15/ff25-internet-use/

International Telecommunication Union. (2025). Global Connectivity Report 2025: Measuring digital development. ITU Publishing.

Jitume (2026). Jitume Program Access Digital Opportunities. https://jitume.konza.go.ke/#/home/about-program

Kariuki, T. N., Ruto, P., Gichanga, R. W., & Wainaina, H. (2025). A Comparative Analysis of Artificial Intelligence Learning and In-Class Learning in Kenyan Universities. African Multidisciplinary Journal of Research, 1(1), 443-460.

Kauma, J. G., Irerib, W. N., & Olweny, N. O. (2022). Challenges facing coherent digitization of government processes across all policy areas and levels of government to enhance efficient public service delivery in Kenya. Soc. Sci. Psychol, 111, 220-228.

Kenya Institute of Curriculum Development. (2019). "Basic Education Curriculum Framework."

https://kicd.ac.ke/curriculum-reform/basic-education-curriculum-framework/

Kenya National Bureau of Statistics. (2024). Statistical abstracts. https://www.knbs.or.ke/wpcontent/uploads/2024/12/2024-Statistical-Abstract1.pdf

Kerkhoff, S. N., Makubuya, T., Napitupulu, A., Falter, M. M., Webb, J. M., Wanyonyi, P., & Misra, N. R. (2025). Learner-centered teaching in rural Kenya: a case study. Teacher Development, 29(5), 1061-1087.

Khimulu, M.(2025). Five Years On: A Review of the Impact of Kenya's Computer Misuse and Cybercrimes Act, 2018. https://www.kictanet.or.ke/wp-content/uploads/2025/11/Five-Years-On-A-Review-of-the-Impact-of-Kenyas-Computer-Misuse-and-Cybercrimes-Act-2018.pdf

Konza Technopolis (2026). Konza Cloud Expansion And Smart City Facilities Feasibility Study Report. https://pppkenya.go.ke/wp-content/uploads/2020/07/Annex-I-to-Addendum-II-Feasibility-study-Report-Nov-2025-EXECUTIVE-SUMMARY-Rev.pdf

Matere, A. (2024). Effectiveness of artificial intelligence tools in teaching and learning in higher education institutions in Kenya. Journal of the Kenya National Commission for UNESCO, 5(1).

Mauti, J. M., Moindi, R., & Masagara, G. A. (2025). Teacher Education in the Advent of Transition of Education Systems in Kenya. Journal of the Kenya

National Commission for UNESCO.

Mhlanga, D. (2023). Open AI in education, the responsible and ethical use of ChatGPT towards lifelong learning. In FinTech and artificial intelligence for sustainable development: The role of smart technologies in achieving development goals (pp. 387-409). Cham: Springer Nature Switzerland.

Mokoena, O. P., & Seeletse, S. M. (2025). AI in rural classrooms: Challenges and perspectives from South African educators. International Journal of Current Educational Studies, 4(2), 30-52.

Mugendi, J. (2021). "Challenges in Implementing Digital Technologies in Rural Kenya." https://www.engineeringforchange.org/news/challenges-implementing-digital-technologies-rural-kenya/ .

Mulaudzi, L. (2024). Evaluating impact: South Africa's e-education white paper on digital equity and post-COVID education leadership. Cogent Education, 11(1), 2415749

Ndayisenga, J. D. A. (2025). The Impact of Competency-Based Curriculum in Enhancing Learning Outcomes: A Study of Rwandan Secondary Schools. Journal of Education, Learning, and Management, 2(2), 144-151.

Nyaaba, M., Wright, A. L., & Choi, G. L. (2024). Generative AI and Digital Neocolonialism in Global Education: Towards an Equitable Framework. ArXiv Preprint ArXiv:2406.02966. https://doi.org/https://doi.org/10.48550/arXiv.2406.02966

Omutange, E., Mutai, W. K., & Barasa, V. M. (2025). Impact of Integration of Modern Digital Technology Platforms in Teaching and Learning at the Technical and Vocational Education and Training (TVETs) in Kenya. American Journal of Education and Information Technology, 9(1), 1-10.

Otieno, D. (2024). Adoption and effectiveness of AI surveillance in Murang'a County secondary schools. Kenyan Journal of Educational Technology and Innovation, 6(2), 115–130.

Ouma-Odero, M. (2025). Edtech Integration in Kenya's Competency-Based Curriculum: Challenges and Opportunities. Edulearn25 Proceedings, 6522-6525.

Owidi, S. O.(2025). Incorporating AI in Kenya's ICT Education System: Are We Ready to Embrace this Change Inclusively? A Systematic Literature Review.

Owino, S., & Otieno, D. (2021). ICT infrastructure in Kenyan schools: Challenges and opportunities. Journal of Information Technology and Education, 8(4), 97-112.

Oxford Insights (2025). Government AI Readiness Index 2025.

https://oxfordinsights.com/ai-readiness/government-ai-readiness-index-2025/?#download-reports

Republic of Rwanda (2024). Education Sector Strategic Plan (ESSP) 2024-2029. Accessible at https://planipolis.iiep.unesco.org/sites/default/files/ressources/Rwanda_The_Education_Sector_Strategic_Plan__ESSP__2024-2029.pdf

Reuters (2026). South Africa withdraws AI policy due to fake AI-generated sources. https://www.reuters.com/world/africa/south-africa-withdraws-ai-policy-due-fake-ai-generated-sources-2026-04-27/

Sangwa, C., & Mutabazi, R. (2025). Rwanda's Artificial Intelligence Strategy in Education: Opportunities and Roadblocks. Journal of African Digital Policy, 6(3), 110–126.

Soko, J. J. (2025). Ethical Concerns and Institutional Policy Responses to Artificial Intelligence (AI) in Higher Education Across Sub-Saharan Africa. Journal of the Kenya National Commission for UNESCO.

Spice, K. J. (2025) The Impact of Artificial Intelligence in Secondary Education: A Case Study of Wellspring Academy, Rwanda.

UNESCO (2025). Kenya: artificial intelligence readiness assessment report. https://unesdoc.unesco.org/ark:/48223/pf0000392693

UNICEF Cameroon (2020). Quality Education for all. https://unicefcameroon.medium.com/quality-education-for-all-cf89aaf53445

Wainaina, P. K., & Sun, Y. (2025). Educators' perceptions and willingness to integrate Generative Artificial Intelligence in teaching and research: evidence from Kenyan higher education. Discover Education, 4(1), 347.

Wallet, P., Kimenyi, E., Miao, F., & Domiter, A. (2019). Improving quality and relevance of education through mobile learning in Rwanda: a promise to deliver: case study by the UNESCO-Fazheng project on best practices in mobile learning.

Wambugu, G. M., & Mungai, N. J. (2023). Bridging the digital divide: The role of ICT in CBC

implementation in rural Kenyan schools. International Journal of Educational Technology and Learning, 13(2), 120–129. https://doi.org/10.20448/journal.509.2023.132.120.129

Wamutoro, M., Kessio, D. K., & Wambua, B.K. (2022). Effectiveness of EMIS for student information management in public secondary schools in Uasin Gishu County, Kenya. Reviewed Journal International of Business Management, 3(1), 122–133. https://doi.org/10.36348/jaep.2022.v06i11.002

Wawire, B. A., Wawire, G. N., & Kiroro, F. (2025). The Structural Relations of Component Reading Comprehension Skills in Kiswahili: The Influence of Socio-Economic Status and Home Literacy Environment. Reading Research Quarterly, 60(1), e593.

World Bank & UNESCO. (2024). Education finance watch 2024. The World Bank; The Global Education Monitoring (GEM) Report; UNESCO Institute for Statistics (UIS). https://share.google/t0SeXSlvhlQOjwZ3L

World Economic Forum (2025). New Rwanda AI Scaling Hub Announced at Global AI Summit on Africa.

https://c4ir.rw/global-ai-summit-on-africa/news/New-Rwanda-AI-Scaling-Hub-Announced-at-Global-AI-Summit-on-Africa

UNCTAD. (2025). Economic Development in Africa Report 2025: Harnessing the demographic dividend through digital industrialization. United Nations Conference on Trade and Development.

UNDESA. (2022). World Population Prospects 2022: Highlights. United Nations Department of Economic and Social Affairs, Population Division.

UNDP. (2024). Human Development Report 2024: Breaking the gridlock – Reimagining cooperation in a polarized world. United Nations Development Programme.

UNESCO. (2023). Global education monitoring report 2023: Technology in education – A tool on whose terms?. UNESCO Publishing

UNICEF Cameroon (2020). Quality Education for all. https://unicefcameroon.medium.com/quality-education-for-all-cf89aaf53445

World Bank. (2025). World Development Indicators 2025. World Bank Group. https://databank.worldbank.org

3

Chapter 3

Smart Education in the Arab Region

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Chapter 3 Smart Education in the Arab Region

Regional Profile and Status

The Arab Region in Context

The Arab region encompasses 22 ALECSO Member States that vary considerably in economic resources, political stability, digital infrastructure, and educational capacity. High-income Gulf Cooperation Council (GCC) economies have made significant strides in integrating digital and AI tools across their education systems. Saudi Arabia has launched a national AI literacy curriculum spanning all K-12 grade levels in the 2025–2026 academic year. At the other extreme, low-income and conflict-affected states such as Sudan, Yemen, Syria, Libya, and Palestine face education emergencies where learning continuity itself is the primary challenge. Between these poles, many Arab countries pursue digital transition constrained by infrastructure gaps, policy coherence deficits, teacher capacity shortfalls, and nascent data governance frameworks. This internal diversity is the defining analytical reality of Arab Smart Education in 2026.

Smart Education represents a holistic approach integrating intelligent technologies to support improved teaching and learning, characterized by adaptive content, data-driven equity promotion, and on-demand services (Demir, 2021; Jemni & Khribi, 2017a; Huang et al., 2024). With a combined population of nearly 500 million (World Bank, 2025b), over 60 per cent under 30 years of age (UNDP Arab States, 2025), the region faces both an urgent educational imperative and significant opportunity. Youth unemployment stands at 27.6 per cent (UNDP Arab States, 2025), giving the Smart Education agenda particular urgency as a human capital priority. Performance on knowledge economy indicators remains uneven, with significant variation between GCC and non-GCC states (UNDP & Mohammed bin Rashid Al Maktoum Knowledge Foundation, 2025).

This chapter assesses Smart Education using the Key Indicators framework (Huang et al., 2024): Performative Features (PF1–PF5) and Constructive Features (CF1–CF5). The analysis organizes the region into three groupings: high-income GCC states; active digital-transition countries; and low-income/conflict-affected states. This tripartite architecture is not rigid; progress in higher education frequently outpaces K-12 reform, and TVET remains the least digitally integrated sector. Drawing on Roy Amara's futures framework, the chapter outlines three trajectories—probable, possible, and preferable—to 2050, with five strategic priorities including equity by design, Arabic AI for education, teacher transformation at scale, data governance leadership, and South-South collaboration. Ten actionable recommendations for policymakers, educational leaders, and practitioners are grounded in the Saudi Arabia case study, emphasizing that teacher capacity must be treated as the primary implementation variable and that data governance frameworks must be developed in parallel with platform deployment.

The chapter is grounded in two baselines: the ALECSO and ITU smart learning survey (2015) covering all 22 Member States, and the UNESCO-ICHEI and ALECSO (2023) report on higher education digital transformation across ten Arab countries.

What May Be Gained

Across the Arab region, Smart Education investment points to potential gains in learning access, pedagogical quality, and human capital development, though much remains unevenly realized. Adaptive platforms are expanding, particularly in the GCC, with four dominant AI use areas: personalized learning, curriculum/content development, student support, and institutional management (Amu & Schmitt, 2026). ALECSO's portfolio—including Arab Code Week across 22 Member States, OER development, and AI capacity-building—represents the most visible pan-Arab effort (ALECSO & ITU, 2015; ALECSO, 2025). The Edraak platform, with over 10 million registered Arabic-language learners, demonstrates scalable demand for Arabic digital learning (Edraak, 2026).

Among GCC states, the UAE launched a mandatory K-12 AI curriculum from 2025–2026; Saudi Arabia introduced a comparable initiative reaching over six million students (Saudi Press Agency, 2025); and Qatar adopted a National Education Strategy 2024–2030 prioritizing digital pedagogy (Ministry of Education and Higher Education Qatar, 2024). Active digital-transition countries—Algeria, Egypt, Jordan, Morocco, and Tunisia—are expanding hybrid learning, though policy coherence and teacher readiness remain uneven (UNESCO-ICHEI & ALECSO, 2023).

The UNESCO Dubai Declaration on OER (2024) positions OER as digital public goods, connecting to regional research on accessibility and AI-generated OER (Khribi et al., 2022; Belhadj et al., 2026). Yet OER ecosystems remain uneven in licensing, reusability, and accessibility, with AI-enabled OER development largely absent (Khribi et al., 2026). On equitable access, progress is visible but not equally distributed: gender parity in tertiary enrolment has been achieved or exceeded in six Arab countries (Arab Barometer, 2025).

Alignment with workforce needs is a consequential gain. GCC economies have invested in digital and AI skills programmes connecting education to employment. The ILO projects 14.6 per cent of Arab jobs could benefit from AI augmentation, while skills mismatches reach 40–70 per cent in several countries (ILO, 2025; World Bank MENA, 2024).

Investment in Arabic-first AI tools—Jais (UAE), Fanar (Qatar), and ALLaM (Saudi Arabia)—represents meaningful progress (UNESCWA, 2024). Gaps persist in cultural/pedagogical alignment, advanced reasoning, and dialectal Arabic. Sustained investment in Arabic-specific educational AI tools remains essential for the region to move beyond consuming global systems toward shaping AI-enhanced learning in its own languages and contexts.

What May Be Reshaped

The Arab region is in active transformation across several dimensions of Smart Education, with curriculum design, assessment, and learning delivery all undergoing meaningful change, at different paces and across very different contexts.

Curriculum reform is the most visible dimension. A growing number of Arab countries are introducing or expanding digital literacy and AI-related content across school and higher education systems, with the most ambitious example being Saudi Arabia's national AI curriculum reaching over six million K-12 students in 2025–2026 (Global Business Outlook, 2025). Beyond individual country initiatives, there is a broader regional shift underway: the understanding of what students need to know and be able to do is changing, and curricula are, however unevenly, beginning to reflect that.

Assessment models are also evolving. In GCC higher education in particular, there is growing adoption of competency-based frameworks, learning analytics, and AI-assisted feedback tools that begin to complement, though not yet replace, more traditional evaluation approaches. This shift is significant because assessment shapes what teaching looks like in practice, and its transformation is a leading indicator of deeper pedagogical change.

Learning delivery has been substantially influenced by the disruptions of the COVID-19 pandemic and, more recently, by the regional instability that has prompted several countries to expand distance and online learning modalities. Hybrid approaches are now more common across much of the region, and learning management systems have seen wider institutional adoption. Whether this shift represents genuine pedagogical transformation or simply a change in delivery mechanism remains an open and important question across the region.

Governance architectures are being reshaped as well. Several countries have established dedicated national bodies to coordinate AI and digital education policy: Saudi Arabia's SDAIA and the UAE's AI Office are the two most prominent examples (UAE Government, n.d.; EDT & Partners, 2025), each providing Smart Education with a more stable institutional home than it previously had. TVET and lifelong learning are also being reoriented in several contexts, reflecting growing recognition that the Smart Education agenda extends beyond formal schooling.

What May Be at Risk

The risks facing Arab Smart Education are severe. The most structurally significant is the "intelligent divide"—uneven access to AI tools, capabilities, and benefits (Zeng et al., 2023; Huang et al., 2025). This maps onto existing economic disparities: at least 30 million children are out of school across 12 MENA countries, including 16.5 million in Sudan and 645,000 in Gaza (UNICEF MENA, 2025). Left unaddressed, Smart Education risks amplifying regional inequality. Although nearly 340 million people in MENA have mobile internet access, they do not use it. The primary barriers are affordability, limited digital skills, and a shortage of locally relevant content (GSMA, 2025).

Conflict and fragility require dedicated attention. Several Arab states face education emergencies where learning continuity is the primary challenge, requiring differentiated approaches beyond conventional edtech frameworks. OER offers one practical modality for sustaining learning (Khribi, 2022). Yet conflict-affected contexts also generate resilient responses: Yalla Nodrus in Palestine, UNESCO's Gaza Virtual Campus (enabling 20,000 students to resume studies), and Sudan's regional digital transformation partnerships demonstrate that modular, partnership-based strategies can preserve learning (Yalla Nodrus, 2026; UNESCO, 2026; SUNA, 2026).

Data governance remains a region-wide vulnerability. Student data privacy frameworks are nascent or absent in most Arab states, and commercial platform deployment has outpaced accountability mechanisms. ALECSO's Charter on AI Ethics (2025) establishes regional principles on data protection and algorithmic transparency, but translation into national implementation frameworks remains limited.

Teacher capacity remains the region's most persistent implementation bottleneck, as identified in the 2015 ALECSO-ITU baseline and confirmed in 2026. Large-scale AI deployment without commensurate teacher preparation risks surface-level compliance rather than genuine pedagogical transformation. The following matrix consolidates this picture across the three regional clusters.

Synthesized Regional Profile

The following profile synthesizes the regional Smart Education assessment across the three groupings, drawing on the evidence reviewed (Huang et al., 2024; UNESCO-ICHEI & ALECSO, 2023; UNESCWA, 2024; Amu & Schmitt, 2026).

Table 3.1 Key strengths for Smart Education implementation in SSA

Regional Cluster	Smart Education Status	Key Evidence Signals	Primary Risk
High-income GCC states	Consolidating to advanced	UAE AI curriculum K-12 as part of national AI strategy (UAE Government, n.d.); Saudi Arabia national AI curriculum reaching six million students and OERx platform (Saudi Press Agency, 2025; National eLearning Center, 2025a); Qatar National Education Strategy 2024-2030 embedding digital pedagogy and AI literacy (Ministry of Education and Higher Education Qatar, 2024); GCC e-learning standards and regional cooperation frameworks (Arab Bureau of Education for the Gulf States, 2023a, 2023b)	Infrastructure and policy investment ahead of pedagogical transformation, teacher AI capacity, and learner data governance
Active digital-transition countries	Developing	Digital transformation strategies in higher education across Algeria, Egypt, Jordan, Morocco, and Tunisia (UNESCO-ICHEI & ALECSO, 2023); expanding hybrid and online learning modalities; growing Arabic-medium open learning demand with over 10 million registered learners on Edraak (Edraak, 2026)	Policy fragmentation, uneven teacher readiness, weak OER licensing frameworks, and nascent data governance
Conflict-affected and fragile states	Nascent to disrupted	At least 30 million children out of school across 12 MENA countries, including 16.5 million in Sudan and 645,000 in Gaza (UNICEF MENA, 2025); mobile internet usage gap of around 51 per cent of the MENA population (GSMA, 2025); OER as a practical modality for crisis-resilient learning continuity (Khribi, 2022); emerging crisis-resilient digital learning initiatives including Yalla Nodrus in Palestine and the UNESCO Gaza Virtual Campus (Yalla Nodrus, 2026; UNESCO, 2026)	Smart Education must be humanitarian, resilient, modular, and where necessary offline-capable; innovation-first framing is inappropriate in these contexts

Table 3.2 Synthesized Regional Profile: Arab Smart Education, 2026

Dimension	Arab Region: 2026 Assessment
Overall Maturity	Bifurcated. GCC states: consolidating to advanced. Active digital transition countries: developing. Conflict-affected and low-income states: nascent to disrupted.
Defining Strengths	(1) Growing national commitment to AI and digital education, illustrated by AI curricula in the UAE and Saudi Arabia, national education strategies in Qatar, and expanding digital transformation programs across active-transition countries including Algeria, Egypt, Jordan, Morocco, and Tunisia. (2) ALECSO's sustained pan-Arab Smart Education institutional portfolio. (3) Expanding open and Arabic-medium digital learning ecosystems demonstrating scalable demand.
Critical Gaps	(1) Teacher digital and AI pedagogical capacity: the region's most persistent implementation bottleneck. (2) Data governance and AI ethics frameworks: absent or nascent across most Arab states. (3) Equity across conflict-affected contexts, rural communities, and learners with disabilities: structural and severe.
Dominant Characteristic	Investment-rich in ambition and, in several contexts, in resources, yet equity and accessibility fractured and implementation-uneven in outcomes.

> "Unlike digital education focusing on online delivery modalities, or digital transformation aiming at digitally reshaping institutional systems, Smart Education integrates both into a continuously adaptive educational ecosystem, a distinction that is particularly consequential for the Arab region given the urgency and complexity of its educational transformation imperative."

Status Assessment: The Saudi Arabia Case Study

Rationale for Selection and Evidence Base

Saudi Arabia is selected as the case study for three reasons. First, it offers an ambitious, well-documented national Smart Education transformation with publicly available evidence for applying the Key Indicators framework (Huang et al., 2024). Second, its scale illustrates nationally coordinated transformation: over 26,000 schools, a national assessment reaching 1.5 million students annually, and a K-12 AI literacy curriculum from 2025–2026 (Saudi Press Agency, 2025; EDT & Partners, 2025; World Bank, 2025a). Third, its inclusion in the 2015 ALECSO-ITU baseline enables a longitudinal perspective over more than a decade. The case study draws on Ministry of Education and ETEC documents, Vision 2030, academic literature (2015–2026), World Bank reports, and EdTech sector analyses to assess all ten indicators across K-12, higher education, and TVET.

Performative Features Assessment (PF1-PF5)

The five Performative Features are assessed below against publicly available evidence from Saudi Arabia's education system, drawing on national policy documentation, institutional reports, and sector analyses published between 2015 and 2026.

PF1: Student-Centered Teaching

Saudi Arabia's progress on student-centered teaching is real but uneven. At the policy level, through Vision 2030, the learner is repositioned as an active participant in knowledge construction, shifting the stated ambition of the system away from rote-based delivery toward competency-driven, inquiry-oriented pedagogy (EDT & Partners, 2025). In higher education, several institutions have adopted active learning classroom designs, project-based curricula, and AI-assisted feedback tools that begin to operationalize this ambition. At K-12 level, however, the gap between policy intent and classroom practice remains the system's most visible tension: infrastructure investment has outpaced pedagogical transformation, and teacher-directed instruction remains the dominant mode in many schools, particularly outside major urban centres. The introduction of the national AI literacy curriculum across all K-12 grade levels from 2025–2026 represents a significant opportunity to embed inquiry-based approaches at scale, but its pedagogical impact will depend on how teachers are prepared to deliver it, an issue addressed under CF3 below.

PF2: Holistic Learning Assessment

Assessment reform is a leading indicator of whether Smart Education is changing pedagogy or merely digitizing existing routines, and Saudi Arabia has made meaningful progress on this front. The national assessment architecture, anchored by ETEC and reaching 1.5 million students annually (World Bank, 2025a), has progressively incorporated competency-based elements alongside more traditional summative measures. The Online Learning Evaluation Framework (OLEF), developed through the National eLearning Center (NeLC), provides a structured institutional basis for evaluating learning quality in digital environments (UNESCO-ICHEI & ALECSO, 2023). In higher education, learning analytics platforms and AI-assisted formative feedback tools are being adopted at a growing number of institutions, with Saudi Electronic University and King Saud University among the more advanced examples. Additionally, Saudi Arabia's participation in the OECD's PISA in 2018 and 2022 has further complemented these domestic efforts by providing an international benchmark for its assessment reforms. The critical gap is at K-12 level, where AI-enabled formative assessment remains limited in reach and where the alignment between the new AI curriculum and existing assessment frameworks is still being developed.

PF3: Smart Learning Environment

This is Saudi Arabia's strongest performance indicator and the dimension where investment is most visible and most documented. The national smart classroom programme has made large-scale investments in equipped learning spaces across the K-12 system, supported by high-speed connectivity, cloud infrastructure, and integrated learning management systems (EDT & Partners, 2025). In higher education, Saudi Electronic University operates on a 100 per cent blended learning model with full broadband access, cloud-based tools, virtual laboratories, and smart campus infrastructure, reflecting a broader transformation of Saudi higher education through technology-enhanced and open learning modalities (Faridi & Ebad, 2018), while King Saud University has deployed a comprehensive suite of platforms including Blackboard, Zoom, Teams, and Webex across its faculties (UNESCO-ICHEI & ALECSO, 2023). The OERx platform, operated by NeLC, provides an open national repository of digitally accessible learning resources supporting both formal and informal learning (National eLearning Center, 2025a). Intra-national variation is nonetheless significant: infrastructure quality in rural and underserved regions lags behind major urban centres, and TVET institutions have generally seen slower smart environment investment than either K-12 or higher education.

PF4: School Organizational Leadership

Saudi Arabia has constructed one of the Arab region's most documented multi-agency governance architectures for Smart Education, with the Ministry of Education, ETEC, SDAIA, MCIT, and NeLC each playing defined roles in a coordinated national framework that gives Smart Education sustained institutional support and cross-sector coherence (Saudi Press Agency, 2025; EDT & Partners, 2025; UNESCO-ICHEI & ALECSO, 2023). Vision 2030 provides an overarching strategic scaffolding, ensuring that Smart Education investment is positioned as a national priority rather than a sectoral initiative. Leadership development has also received institutional attention: Oxford Business Group (2026) reports that 40,000 school principals are currently engaged in structured leadership development programmes alongside 200,000 teachers in professional training. The gap in this indicator is one of translation: strong national governance does not automatically produce school-level instructional leadership, and the evidence on whether institutional coordination is driving classroom-level pedagogical change remains limited.

PF5: Educational Equity

Equity is the most complex and contested of the five Performative features in the Saudi context. On access and participation, the system has achieved near-universal K-12 enrolment and has made significant investments in digital infrastructure that extend connectivity to a wide range of geographic contexts. Gender equity in higher education enrolment has improved substantially, consistent with a broader regional trend in which six Arab countries now meet or exceed the world average for gender parity in tertiary enrolment (World Bank, 2024; Arab Barometer, 2025). However, equity for learners with disabilities remains an area where policy commitment has yet to translate into systemic provision: assistive technology integration in mainstream schools is uneven, and accessible digital content remains the exception rather than the norm across most public education platforms. Socioeconomic and geographic variation within the Kingdom also means that the smart learning environment gains documented at PF3 are not uniformly distributed, with rural and lower-income communities experiencing meaningfully different conditions from those in major urban and economically advanced regions (World Bank, 2025a).

Constructive Features Assessment (CF1-CF5)

The five Constructive Features are assessed below using the same evidence base and analytical structure applied above.

CF1: School Cultural Development

Saudi Arabia's school cultural development in the context of Smart Education is at an early but accelerating stage. The national AI literacy curriculum introduced from 2025–2026 (see PF1) represents a significant institutional step toward normalizing digital and AI competencies as expected learning outcomes across the school system, a shift that carries cultural weight beyond curriculum reform: it signals to teachers, students, and communities that AI literacy is a core educational expectation rather than a specialist or elective pursuit. The Arab Code Week initiative, coordinated regionally by ALECSO and implemented across all 22 Member States including Saudi Arabia, has contributed to normalizing computational thinking as a school-level cultural value. At the higher education level, several universities have established innovation hubs, maker spaces, and AI research centres that are beginning to shape an institutional culture oriented toward experimentation and digital fluency. The gap in this indicator is one of depth rather than direction: cultural transformation in education moves more slowly than curriculum reform or infrastructure deployment, and learner agency, critical thinking, and community engagement with Smart Education remain areas where evidence of systemic change is limited.

CF2: Data Security and Governance

Data governance is one of Saudi Arabia's two most critical constructive gaps, and the one where the distance between national ambition and operational practice is most pronounced. At the national level, SDAIA provides an institutional framework for AI governance and data regulation that is more developed than in most Arab states, and Saudi Arabia's participation in global AI governance conversations reflects genuine policy engagement with these issues (EDT & Partners, 2025). Saudi Arabia has relatively advanced national data and AI governance architecture compared with many regional peers, including the Personal Data Protection Law and SDAIA AI ethics principles, but publicly available education-specific learner data governance guidance remains underdeveloped, particularly for learning analytics, LMS data, AI-assisted assessment, and commercial EdTech procurement. The rapid deployment of commercial EdTech platforms across the K-12 and higher education systems has outpaced the development of the accountability mechanisms needed to ensure that learner data is handled responsibly. The ALECSO Charter on Artificial Intelligence Ethics (ALECSO, 2025) establishes relevant regional principles on data protection and algorithmic transparency, but its translation into binding national education-sector frameworks remains the critical next step for Saudi Arabia as for most Arab states.

CF3: Teacher Capacity Building

Teacher capacity represents Saudi Arabia's most consequential constructive gap, not in terms of training scale, which is substantial, but in terms of the depth and nature of pedagogical transformation that AI-enhanced teaching requires. The system has made real progress in structured professional development: NeLC offers certified micro-credential programmes across four competency tracks, covering eLearning leadership, content development, online teaching and training, and technical support, making Saudi Arabia one of only a small number of Arab countries with a nationally coordinated teacher certification architecture for digital teaching (UNESCO-ICHEI & ALECSO, 2023). As noted under PF4, Oxford Business Group (2026) reports that 200,000 teachers are currently engaged in professional training programmes; the gap at CF3 is therefore qualitative rather than quantitative. Existing programmes have focused primarily on platform competency and digital tool use rather than on the deeper pedagogical transformation that AI-enhanced teaching requires. The capacity to design AI-integrated learning experiences, use data analytics for formative pedagogy, and develop culturally responsive AI-assisted instruction remains unevenly distributed and inadequately supported across the system. This gap between digital tool familiarity and genuine AI pedagogical capacity is the single most important factor limiting Saudi Arabia's progress from infrastructure-strong to learning-outcome-strong Smart Education.

CF4: Sustainable Education Reform

Policy sustainability is one of Saudi Arabia's defining constructive assets and the indicator where its regional exemplar status is most clearly earned. Vision 2030 provides a long-term strategic framework that positions education transformation as a national development imperative with sustained political commitment and multi-year budgetary support (EDT & Partners,2025; World Bank,2025a). The institutional architecture supporting Smart Education, spanning NeLC, ETEC, SDAIA, and the Ministry of Education, has remained stable and has deepened its coordination over time rather than fragmenting across electoral or administrative cycles, a pattern that distinguishes Saudi Arabia from many other Arab states where smart education initiatives have been vulnerable to policy discontinuity. The 20th board meeting of the GCC eLearning Committee, which addressed AI strategic direction across Member States, further demonstrates Saudi Arabia's active role in embedding its national reforms within a broader regional sustainability framework (National eLearning Center, 2025b). The risk for this indicator is one that affects all long-horizon reform programmes: sustainability depends ultimately on measurable learning outcome improvement, and the evidence base connecting Saudi Arabia's substantial infrastructure and governance investment to student learning gains remains an area requiring stronger longitudinal documentation.

CF5: Cross-Sector Collaboration

Cross-sector collaboration is Saudi Arabia's second defining constructive asset alongside policy sustainability. Unlike other regions where cross-sector collaboration tends to emphasize school-family-community (including EdTech companies and the labour market/industries) partnerships, the Arab world—and Saudi Arabia in particular—has concentrated its efforts on coordination between government agencies, reflecting a top-down institutional approach to education reform. The multi-agency governance architecture coordinating the Ministry of Education, ETEC, SDAIA, MCIT, and NeLC represents a level of institutional coherence that is relatively uncommon in the Arab region and that has enabled the national AI curriculum, smart classroom programme, and OER infrastructure to be developed and deployed at scale rather than remaining isolated pilot initiatives (Saudi Press Agency, 2025; National eLearning Center, 2025b). NeLC, established in 2018 as the national competent authority for all e-education and training, plays a particularly important coordinating role, investing in AI and data analytics in alignment with the national mandate and providing a single institutional home for quality standards, teacher certification, and OER development (UNESCO-ICHEI & ALECSO, 2023). The gap in this indicator is one of transparency and impact measurement: while the architecture of cross-sector collaboration is well documented, the evidence on how effectively coordination translates into interoperable systems, shared data standards, and measurable learning impact across institutions and sectors remains limited and warrants stronger public accountability frameworks.

Synthesis: Strengths, Gaps, and Trajectory

The following matrix summarizes the ten-indicator assessment before the synthesis that follows.

Table 3.3 Saudi Arabia: Key Indicators of Smart Education Assessment, 2026

Indicator	Assessment	Key Evidence	Critical Gaps
PF1: Student-Centered Teaching	Emerging to moderate	Competency-driven curriculum reform; active learning adoption in higher education (EDT & Partners, 2025); National AI literacy curriculum 2025-2026 (Saudi Press Agency, 2025)	Infrastructure ahead of classroom pedagogical transformation
PF2: Holistic Learning Assessment	Moderate to strong	ETEC national assessment; OLEF framework through NeLC (UNESCO-ICHEI & ALECSO, 2023) reaching 1.5 million students annually (World Bank, 2025a)	AI-enabled formative assessment limited at K-12 level
PF3: Smart Learning Environment	Strong	large-scale smart classroom investments; OERx platform; 100% blended learning at Saudi Electronic University (National eLearning Center, 2025a; EDT & Partners, 2025)	Uneven infrastructure across rural regions and TVET

Indicator	Assessment	Key Evidence	Critical Gaps
PF4: School Organizational Leadership	Strong	Multi-agency architecture: MoE, ETEC, SDAIA, MCIT, NeLC; 40,000 principals in leadership development (Oxford Business Group, 2026)	National coordination not yet translating to school-level instructional change
PF5: Educational Equity	Moderate	Near-universal K-12 enrolment; gender parity improving (Arab Barometer, 2025; World Bank, 2024)	Disability access, rural connectivity, and differentiated learner support uneven
CF1: School Cultural Development	Emerging	National AI curriculum normalizing AI literacy as mainstream school expectation (Saudi Press Agency, 2025);	Learner agency and community engagement with Smart Education limited
CF2: Data Security and Governance	Emerging to moderate	Personal Data Protection Law and SDAIA AI ethics principles (EDT & Partners, 2025);	No publicly documented education-specific learner data protection framework
CF3: Teacher Capacity Building	Critical gap	NeLC micro-credentials across four tracks; 200,000 teachers in training (UNESCO-ICHEI & ALECSO, 2023; Oxford Business Group, 2026)	Qualitative gap between digital tool familiarity and genuine AI-integrated pedagogical capacity, despite substantial training scale
CF4: Sustainable Education Reform	Strong	Vision 2030; Human Capability Development Program; stable multi-agency architecture (EDT & Partners, 2025; World Bank, 2025a); GCC eLearning Committee AI strategic direction (National eLearning Center, 2025b)	Sustainability depends on measurable learning outcome evidence
CF5: Cross-Sector Collaboration	Strong	NeLC as national competent authority; coordinated MoE, ETEC, SDAIA, MCIT deployment; GCC eLearning Committee AI strategic direction (National eLearning Center, 2025b; Saudi Press Agency, 2025)	Coordination not yet translated into interoperable systems and shared data standards

Saudi Arabia exemplifies both the ambition and the limits of infrastructure-first Smart Education reform. Three defining assets emerge: PF3 (Smart Learning Environment) is the strongest, with large-scale infrastructure and OERx; CF4 (Policy Sustainability) is secured through Vision 2030; and CF5 (Cross-Sector Collaboration) operates through coordinated government agencies (NeLC, ETEC, SDAIA, MCIT, MoE) enabling national-scale deployment.

Three critical gaps persist: CF3 (Teacher Capacity) is the most consequential—digital familiarity has not translated into AI-integrated pedagogy; CF2 (Data Governance) is nascent, with commercial EdTech outpacing accountability; and PF1 (Student-Centered Teaching) remains policy aspiration rather than classroom reality. Evidence linking investments to learning outcomes remains limited—an accountability gap requiring longitudinal evaluation.

Saudi Arabia has moved through infrastructure and governance phases; the next phase requires qualitative shifts in classroom practice, teacher agency, and learning outcome measurement. The UAE and Qatar share similar trajectories but differ in scale and instruments. Three transferable lessons for the Arab region: cross-sector governance coherence is a prerequisite; teacher capacity must be the primary implementation variable from the outset; and data governance must be developed in parallel with platform deployment.

Future Directions and Recommendations

Probable, Possible, and Preferable Futures

Probable Futures (2026–2030): If Current Trends Continue

GCC Smart Education consolidation deepens, but the gap between infrastructure investment and genuine pedagogical transformation widens rather than closes, as technology deployment continues to outpace teacher preparation and learner data governance.

The 'intelligent divide' accelerates, with lower-income Arab states and conflict-affected systems falling further behind advanced GCC contexts as commercial AI deployment expands without commensurate investment in equity, accessibility, and crisis-resilient learning architectures.

GenAI adoption in Arab higher education advances ahead of institutional policy and academic integrity frameworks, creating accountability gaps that institutions are only beginning to address (Miao et al., 2023; Bozkurt, 2023).

Arabic AI tools improve in Modern Standard Arabic coverage, yet gaps in culturally aligned educational content, advanced reasoning, and dialectal Arabic persist, maintaining a structural disadvantage for Arabic-medium learners in AI-enhanced education.

Possible Futures (2026–2035): Beyond Current Expectations

A pan-Arab Smart Education data commons enables cross-border learning analytics, OER interoperability, and mutual credential recognition under a regionally brokered governance framework.

Arabic-first AI foundational models begin to reshape language-inclusive personalized learning at regional scale, enabling genuine Arabic-medium Smart Education.

Countries emerging from conflict begin to apply Smart Education frameworks for inclusive learning recovery, with digital tools helping displaced learners reconnect with formal education.

South-South investment and technology transfer within the Arab region begin to compress intra-regional disparities, with wealthier states co-investing in digital infrastructure across lower-income Member States.

The ALECSO Charter on AI Ethics (2025) moves from regional normative adoption to national-level implementation across Member States, with national-level adoption frameworks and cross-border data protection principles beginning to position the Arab region as a more active contributor to global AI governance.

Preferable Futures (Towards 2050): The Arab Smart Education We AIm to Create

Every Arab learner, regardless of geography, gender, disability, socioeconomic status, or conflict context, has equitable and meaningful access to quality Smart Education.

Arabic is a first-class language of AI-powered learning, with culturally grounded and pedagogically sophisticated tools serving learners across all 22 Member States.

Teacher agency is at the centre of Arab Smart Education, with educators leading AI-enhanced pedagogical innovation supported by strong professional communities and lifelong learning systems.

Education systems are resilient to conflict, displacement, and climate disruption through flexible, modular, and where necessary offline-capable smart learning architectures.

High-quality Arabic OER, culturally grounded, accessibility-compliant, and enriched through AI-enabled production, translation, localization, and adaptation tools, are available across all 22 Member States, operationalizing the vision of the UNESCO Dubai Declaration on OER, as a foundation of equitable Arab Smart Education (UNESCO, 2024).

Learner data across Arab education systems is governed by national and regional frameworks grounded in the ALECSO Charter on AI Ethics (ALECSO, 2025), ensuring transparent, accountable, and rights-respecting use of student data as a foundational condition of trustworthy Smart Education.

The Arab region is an active contributor to global Smart Education knowledge, technology, and policy, not merely a recipient of frameworks developed elsewhere.

Strategic Priorities for SDG 4 Acceleration

Equity and Accessibility by Design: Embed inclusive, gender-responsive, disability-accessible, and conflict-resilient Smart Education architectures in all national strategies and regional cooperation frameworks, making equity a design criterion from the outset rather than a retrofit, in pursuit of the SDG 4 commitment to inclusive and equitable quality education for all.

Arabic AI for Education: Invest regionally in Arabic natural language processing, large language models, culturally grounded AI learning tools, and expansive Arabic OER ecosystems harnessing GenAI, making Arabic a first-class language of smart learning rather than a secondary consideration in globally deployed AI systems.

Teacher Transformation at Scale: Implement systematic, sustained, and contextually adapted digital and AI professional development as the region's most urgent Smart Education investment, addressing the bottleneck that has persisted since the 2015 regional baseline.

Data Governance and AI Ethics Leadership: Disseminate, adopt, and implement the ALECSO Charter on AI Ethics (ALECSO, 2025) at national level across all Member States, translating its principles on data protection, algorithmic transparency, and ethical AI use in education into binding institutional frameworks before deployment outpaces accountability further.

South-South Collaboration and Knowledge Transfer: Drawing on GSENet, ALECSO, and intra-regional partnerships, advance Smart Education knowledge exchange, shared Arabic AI tool development, and co-investment in digital infrastructure across lower-income Member States.

Recommendations for Policymakers, Educational Leaders, and Practitioners

For Policymakers

1.Implement and build national frameworks aligned with the ALECSO Charter on AI Ethics (ALECSO, 2025), establishing binding timelines for adoption, developing enforcement mechanisms, and prioritizing learner data protection as a foundational educational right across all 22 Member States.

2. Commit to universal and affordable broadband connectivity as an education right, including in conflict-affected zones.

3. Integrate conflict-responsive and displacement-resilient Smart Education continuity plans into all national education sector plans, drawing on established good practices from humanitarian education contexts.

4. Mandate gender-inclusive and disability-accessible design standards for all publicly funded edtech platforms, with enforcement mechanisms and regular accessibility auditing built into procurement processes.

5. Establish a regional Arab Smart ducation observatory, coordinated through ALECSO and connected to GSENet (GSENet, 2023), to monitor indicators on AI readiness, teacher capacity, learner data governance, OER maturity, accessibility, Arabic digital content, and crisis-resilient learning continuity across all 22 Member States, providing the evidence base that regional cooperation and national accountability frameworks currently lack (Huang et al., 2024; ALECSO, 2025; ALECSO & ITU, 2015).

For Educational Leaders

6.Build teacher-led AI integration communities of practice with structured time, peer coaching, and institutional recognition, reframing AI as a pedagogical partner rather than an administrative efficiency tool.

7.Implement smart campus and digital inclusion strategies co-designed with disability communities from the outset, treating Universal Design for Learning as a system-wide commitment rather than a specialist accommodation, and ensuring every new platform and digital resource meets accessibility standards before deployment rather than as an afterthought.

8.Establish institutional governance structures with clear accountability for student data protection, transparent criteria for AI tool procurement and deployment, and sustained investment in the professional capacity of platform administrators, learning analytics teams, and digital infrastructure staff.

For Practitioners

9.Develop culturally responsive approaches to GenAI use in Arabic-medium classrooms, treating AI as a pedagogical complement rather than a knowledge substitute, and building student AI literacy and critical evaluation skills explicitly.

10. Anchor Smart Education programmes in community-based digital literacy initiatives that engage parents, local leaders, and civil society, particularly in rural, underserved, and conflict-affected communities where institutional reach is limited and community trust is essential for adoption.

Methodological Note

This chapter employs a critical synthesis methodology combining five complementary approaches. Documentary analysis forms the primary evidence base, drawing on national policy documents, ALECSO frameworks, international organization reports (UNESCO, World Bank, UNESCWA, UNDP, UNICEF, ILO, ITU), peer-reviewed literature (2015 - 2026), and EdTech sector analyses.

The Key Indicators of Smart Education framework (Huang et al., 2024) provides the analytical structure for the regional scan and case study, ensuring comparability with the other regional chapters. A longitudinal perspective is enabled by two baselines: the ALECSO-ITU smart learning survey (2015) across all 22 Arab Member States, and the UNESCO-ICHEI & ALECSO (2023) report on higher education digital transformation across ten Arab countries.

Practitioner knowledge – grounded in over two decades of engagement in educational technology across the Arab region – informs analytical judgments. Roy Amara's three-scenario futures framework (Amara, 1981) structures the forward-looking analysis in Section 3.

The analysis acknowledges limitations: country-level variation within each grouping is considerable, and the evidence base is stronger for GCC states than for active-transition or conflict-affected contexts, reflecting disparities in publicly available data across the region.

References

ALECSO & ITU. (2015). Guidelines for formulating national strategies on smart learning in Arab countries. Arab League Educational, Cultural and Scientific Organization and International Telecommunication Union.

ALECSO. (2025). ALECSO Charter on Artificial Intelligence Ethics. Arab League Educational, Cultural and Scientific Organization. ISBN: 978-9973-15-464-4. https://alecso.org/publications/uploads/2025/08/etic.pdf

Amara, R. (1981). The futures field: Searching for definitions and boundaries. The Futurist, 15(1), 25–29.

Amu, E., & Schmitt, L. (2026). AI in education in MENA: Snapshot of the landscape and emerging opportunities. EdTech Hub. https://doi.org/10.53832/edtechhub.1166. Available at https://docs.edtechhub.org/lib/EPJAMMH9.

Arab Barometer. (2025). Education and working women in MENA. https://www.arabbarometer.org/2025/03/education-and-working-women-in-mena/

Arab Bureau of Education for the Gulf States. (2023a). E-teaching and e-learning: Global and Gulf experiences (Part 1). https://abegs.org/publications/2930

Arab Bureau of Education for the Gulf States. (2023b). E-teaching and e-learning: Standards and guides (Part 2). https://abegs.org/publications/2929

Belhadj, H., Khribi, M. K., & Mansour, C. (2026). Towards responsible licensing of AI-generated open educational resources in engineering education. Proceedings of the IEEE Global Engineering Education Conference (EDUCON 2026). (in press).

Bozkurt, A. (2023). Unleashing the potential of generative AI, conversational agents and chatbots in educational praxis: A systematic review and bibliometric analysis of GenAI in education. Open Praxis, 15(4), 261–270. https://doi.org/10.55982/openpraxis.15.4.609

Demir, K. A. (2021). Smart Education framework. Smart Learning Environments, 8, Article 29. https://doi.org/10.1186/s40561-021-00170-x

Edraak. (2026). Edraak in 2025: Ten million learners and a lasting impact [Annual Impact Report]. Queen Rania Foundation. https://blog.edraak.org/edraak-in-2025-ten-million-learners-and-a-lasting-impact/

EDT & Partners. (2025). Education as the engine of Saudi Vision 2030. The EDiT Journal. https://theedit.edtpartners.com/education-as-the-engine-of-saudi-vision-2030/

Faridi, M. R., & Ebad, R. (2018). Transformation of higher education sector through massive open online courses in Saudi Arabia. Problems and Perspectives in Management, 16(2), 220–231.

https://doi.org/10.21511/ppm.16(2).2018.20

Global Business Outlook. (2025). Saudi Vision 2030: Through curriculum change, Kingdom embraces AI future. https://globalbusinessoutlook.com/technology/saudi-vision-through-curriculum-change-kingdom-embraces-ai-future/

GSENet. (2023). GSENet Beijing Declaration on Smart Education Strategies. Beijing Normal University and GSENet Founding Partners.

GSMA. (2025). The mobile economy Middle East and North Africa 2025. GSMA Intelligence. https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-economy/mena/

Huang, R. H., Liu, D. J., Kanwar, A. S., Zhan, T., Yang, J. F., Zhuang, R. X., Liu, M. Y., Adarkwah, M., & Li, Z. S. (2024). Global understanding of Smart Education in the context of digital transformation. Open Praxis, 16(4), 663–676. https://doi.org/10.55982/openpraxis.16.4.761

Huang, R. H., Liu, D. J., Kanwar, A. S., Zhan, T., & Yang, J. F. (2025). 2025 GSENet annual report: Smart Education in the age of AI. Figshare. https://figshare.com/articles/online_resource/2025_GSENet_Annual_Report_Smart_Education_in_the_Age_of_AI/29923658

ILO. (2025). Navigating the digital and artificial intelligence revolution in Arab labour markets: Trends, challenges and opportunities. International Labour Office. https://doi.org/10.54394/OYOA8722

Jemni, M., & Khribi, M. K. (2017a). The ALECSO smart learning framework. In E. Popescu, Kinshuk, M. K. Khribi, R. Huang, M. Jemni, N.-S. Chen, & D. G. Sampson (Eds.), Innovations in smart learning. Lecture Notes in Educational Technology. Springer. https://doi.org/10.1007/978-981-10-2419-1_14

Khribi, M. K. (2022). Open educational resources guide to ensure the continuity of education and learning during emergencies and crises. Arab Plan for Education in Emergencies and Crises. ALECSO.

Khribi, M. K., Othman, A., & Al-Sinani, A. (2022). Toward closing the training and knowledge gap in ICT accessibility and inclusive design harnessing open educational resources. Proceedings of the 2022 International Conference on Advanced Learning Technologies (ICALT 2022), 289–291. https://doi.org/10.1109/ICALT55010.2022.00093

Khribi, M. K., Belhadj, H., Tlili, A., Sellami, A., & Jemni, M. (2026). Open educational resources in the Gulf Cooperation Council (GCC) countries: An integrated systematic review. Open Praxis, 18(2), 324–346. https://doi.org/10.55982/openpraxis.18.2.1186

Miao, F., Giannini, S., & Holmes, W. (2023). Guidance for generative AI in education and research. UNESCO.

Ministry of Education and Higher Education Qatar. (2024). Qatar National Education Strategy 2024–2030. https://www.edu.gov.qa/en/Strategy

National eLearning Center. (2025a). OERx Open Educational Resources Platform. https://oerx.nelc.gov.sa/

National eLearning Center. (2025b). 20th board meeting of the GCC eLearning Committee discusses AI strategic direction. https://nelc.gov.sa/en/media-center/news/3186

Oxford Business Group. (2026). New higher education facilities improve Saudi Arabia's competitiveness https://oxfordbusinessgroup.com/reports/saudi-arabia/2025-report/education-training/prime-expansion-the-establishment-of-new-educational-facilities-aim-to-raise-the-competitiveness-of-universities-and-offer-more-diverse-learning-overview/

Saudi Press Agency. (2025, August 24). More than six million general school students in Saudi Arabia to study AI curriculum. https://www.spa.gov.sa/en/N2384135

SUNA. (2026). Higher education minister: Regional partnerships to enhance digital transformation and research development in Sudan. Sudan News Agency. https://suna.sd/posts/higher-education-minister-regional-partnerships-to-enhance-digital-transformation-and-research-development-in-sudan

UAE Government. (n.d.). UAE strategy for artificial intelligence. The Official Portal of the UAE Government. https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/strategies-plans-and-visions/government-services-and-digital-transformation/uae-strategy-for-artificial-intelligence

UNDP & Mohammed bin Rashid Al Maktoum Knowledge Foundation. (2025). Global Knowledge Index 2025. United Nations Development Programme. https://www.undp.org/arab-states/publications/global-knowledge-index-2025.

UNDP Arab States. (2025). Youth leading local change: Global impact. https://www.undp.org/arab-states/stories/youth-leading-local-change-global-impact-celebrating-2025-international-youth-day

UNESCO. (2024). Dubai Declaration on Open Educational Resources (OER): Digital public goods and emerging technologies for equitable and inclusive access to knowledge. UNESCO.

UNESCO. (2026). Sustaining higher education amid crisis: UNESCO's support in Gaza. https://www.unesco.org/en/articles/sustaining-higher-education-amid-crisis-unescos-support-gaza

UNESCO-ICHEI & ALECSO. (2023). Research report on digital transformation of higher education teaching and learning in the Arab region. UNESCO International Centre for Higher Education Innovation.

UNICEF MENA. (2025). At least 30 million children out of school in the Middle East and North Africa. https://www.unicef.org/mena/press-releases/least-30-million-children-out-school-middle-east-and-north-africa

UNESCWA. (2024). Artificial intelligence futures for the Arab region. United Nations Economic and Social Commission for Western Asia.

World Bank. (2024). Gulf economic update, fall 2023: Structural reforms and shifting social norms to increase women's labor force participation. http://hdl.handle.net/10986/40880

World Bank. (2025a). Improving education in Saudi Arabia through evaluation and assessment. https://blogs.worldbank.org/en/arabvoices/improving-education-in-saudi-arabia-through-evaluation-and-assessment

World Bank. (2025b). Population, total: Arab World. World Development Indicators. https://data.worldbank.org/indicator/SP.POP.TOTL?locations=1A

World Bank MENA. (2024). Level up MENA: How digital education and skills are powering the next generation of jobs. https://blogs.worldbank.org/en/arabvoices/level-up-mena-how-digital-education-and-skills-are-powering-the-next-generation-of-jobs

Yalla Nodrus. (2026). About us. https://yallanodrus.org/about-us

Zeng, H., Miao, M., & Qin, Z. (Coords.). (2023). Synthesis report of the Global Smart Education Conference 2023: Education transformation and data governance. Beijing Normal University and UNESCO IITE.

4

Chapter 4

Mapping the Current Status of Smart Education: a Regional Analysis of Asia

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Chapter 4 Mapping the Current Status of Smart Education: a Regional Analysis of Asia

Introduction

Home to more than half the world's student population, Asia is the most educationally diverse continent: a 90% average school attendance rate exists alongside an estimated 25 million children unable to access primary education (ADB, 2011). Asia contains countries that lead global rankings and systems, infrastructure approaching universal connectivity and contexts with unreliable electricity, reform ambitions of extraordinary scale alongside implementation conditions of constraint. This range is the chapter's central analytical challenge.

This chapter assesses the current state of Smart Education across Asia using the ten primary indicators of the Huang et al. (2024) framework; five Performative Features describing what Smart Education looks like in practice, and five Constructive Features describing the conditions that enable or constrain it. To account for Asia's diversity, the analysis is organised around four system archetypes; high-capacity technology-led, large-scale uneven implementation, policy-aspirational but infrastructure-constrained, and fragile and crisis-exposed; examined through what has been gained, what is being reshaped, and what is at risk in each. This responds to the GSE 2026 report's core objectives while allowing comparison across similar conditions rather than a flat inventory that conceals Asia's diversity. The Philippines, selected for its shared characteristics across several archetypes, is then examined as a country-level indicator assessment testing the regional patterns established above.

The analysis draws on national policy documents, regional and international reports, academic research, and the author's primary research with the Philippines' Department of Education. The chapter closes with future scenarios and practical recommendations for policymakers and practitioners.

The four archetypes used to organise the regional analysis are analytical constructs developed inductively from the literature by identifying recurrent patterns in how systems combine policy architecture, infrastructure, institutional capacity, and crisis exposure (ADB, 2023; Rahman & Freeman, 2025). Countries were selected as illustrations of each pattern rather than nationally representative cases. The chapter draws primarily on evidence from Southeast and South Asia, where data availability is strongest, complemented with examples from East Asia and Central Asia where comparable evidence exists. West Asia and the Arab region are addressed in a dedicated chapter of this report. China's internal diversity means it spans multiple archetypes and is set aside here for dedicated treatment; its coastal provinces appear in Section 2 solely as an illustration of the intra-regional range this chapter maps. Throughout the chapter, conflict and climate emergencies are treated as cross-cutting conditions that shape what is achievable across all four system types.

> "Asia's defining strength is its policy momentum, investment scale, and capacity for adaptive innovation under disruption; visible in platforms reaching hundreds of millions of learners and in the parallel education systems civil society has built where the state cannot or will not provide. Its critical gaps are equally consistent: teacher capacity is structurally underfunded relative to platform investment in every system examined; infrastructure inequality is entrenched both between and within countries; and governance and data security frameworks lag the pace of technological change."

The Asian Context: Diversity is an Analytical Starting Point

Asia's Smart Education landscape is characterised by stark diversity, both between countries and within them. China alone illustrates the scale of this intra-regional range: Beijing, Shanghai, Jiangsu, Zhejiang rank in PISA 2022 at or near the global top alongside Singapore (OECD, 2023), yet substantial urban-rural gaps in digital access, skills development, and education quality leave rural students at significantly greater risk of falling behind (Shen et al., 2025), compounded by the hukou household registration system, which ties education services to residency status and creates a two-track system for migrant children (Luo et al., 2025). China's internal diversity, spanning multiple archetypes in miniature, is the diversity this chapter maps across the region as a whole.

The Asian Development Bank's Digital Education Readiness Framework (DERF), applied across ten developing member countries, quantifies this variation across the wider region and finds it equally stark. Internet penetration falls below 50% in five of those countries: Bangladesh, the Kyrgyz Republic, Mongolia, Pakistan, and the Philippines (ADB, 2023, p. 5). Rural electricity access illustrates the range more starkly: while nine of the ten countries assessed achieve between 90% and 100% coverage, Pakistan stands as a significant outlier, with 41.3% of rural households without electricity (ADB, 2023, p. 5). These figures sit alongside Japan, Singapore, and South Korea's near-universal connectivity (ITU, 2024), illustrating the scale of intra-regional distance that this analysis must account for.

Beyond what the DERF data captures, Kazakhstan and Uzbekistan illustrate an emerging Central Asian trajectory: literacy rates above 99% coexist with weak PISA 2022 outcomes (36% of Kazakhstani students reaching functional reading proficiency against an OECD average of 74%; Uzbekistan ranked 78th of 81 countries) (OECD, 2023). Both are investing heavily in AI-integrated teacher training — Kazakhstan through aiming to reach 252,000 teachers by 2025; Uzbekistan through targeting all 19,500 computer science teachers nationally (Government of Kazakhstan, 2024; UNESCO-ICHEI, 2025; Government of Uzbekistan, 2021; New Uzbekistan University, 2026) but implementation gaps persist in remote areas despite the investment. Central Asia's trajectory sits beyond this chapter's depth of examination, but represents a recognisable variant of the same tension this chapter traces throughout the region: ambition outpacing implementation capacity.

Across Asia's diversity, climate emergency and conflict are cross-cutting conditions that shape what is achievable at every tier of the system. Asia holds 11 of the 20 most climate-vulnerable countries in the world, and in 2024 alone, South Asia, East Asia and the Pacific together accounted for over 178 million of the 242 million students globally whose schooling was disrupted by climate hazards (UNICEF, 2025). Global conflicts doubled between 2019 and 2024, and in the most severely affected systems, technology has become a tool for maintaining educational continuity rather than advancing it, a distinction that shapes how the framework applies across archetypes (Rahman & Freeman, 2025).

Regional Patterns: Asia Across Four System Archetypes

Asia's diversity shapes what Smart Education means in practice, and can be best understood through four main archetypes: 1) high-capacity, technology-led systems, 2) large-scale, uneven implementation systems, 3) policy-aspirational but infrastructure-constrained systems, and 4) fragile and crisis-exposed systems.

Table 4.1 maps each archetype to the Smart Education indicator framework, showing where each system type demonstrates strength and where gaps are most persistent. The archetype definitions were derived inductively from a synthesis of ADB Digital Education Readiness Framework data, UNESCO GEM regional background papers, and the academic literature on EdTech adoption across Asia. Across these sources, four distinct combinations of performative Feature achievement and Constructive Feature development recurred consistently, producing different Smart Education challenges and trajectories. The indicator profiles in Table 4.1 reflect conditions consistently observed across multiple independent sources covering each country grouping, rather than claims about either country individually:

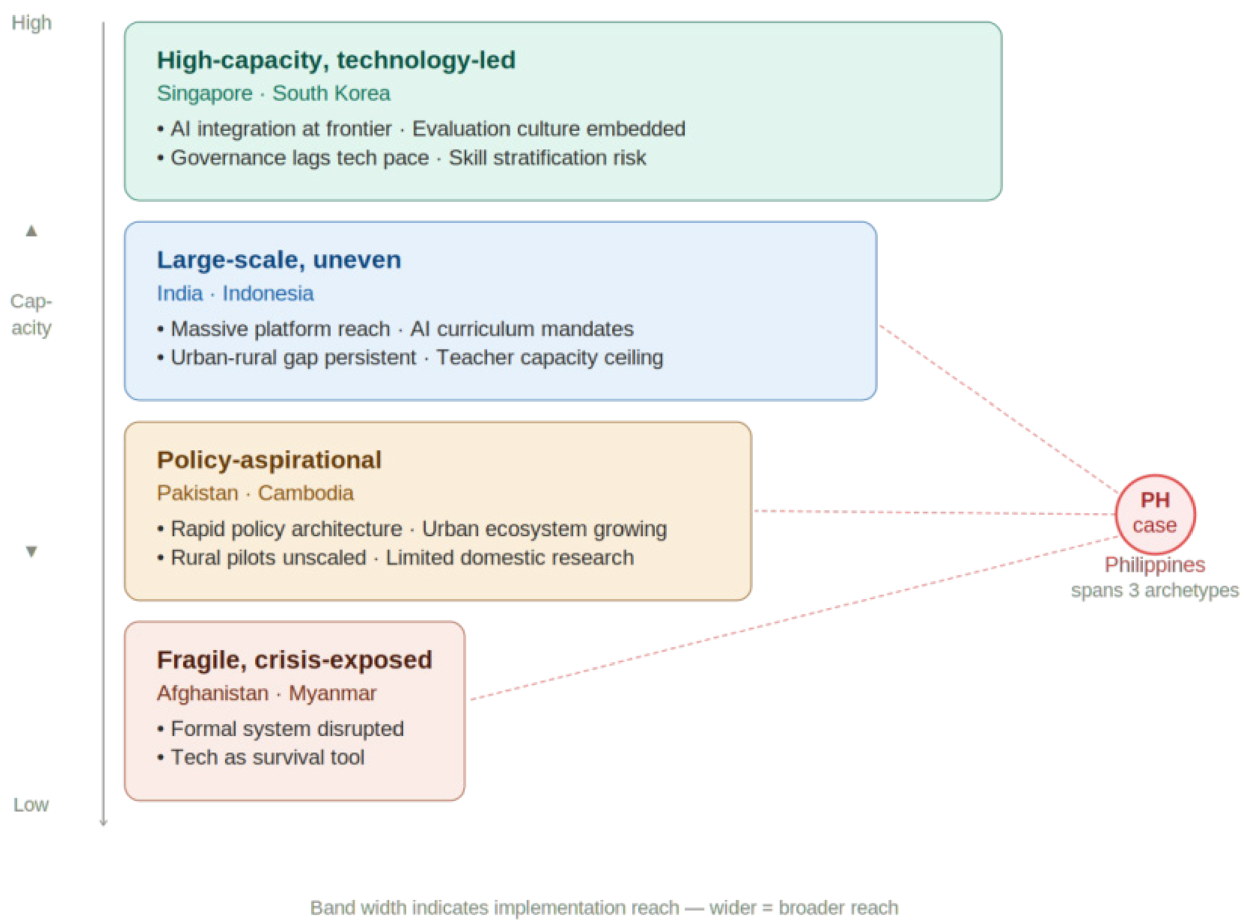
Table 4.1 Archetype definitions mapped to Smart Education indicators

Archetype	Illustrative Cases	Performative Features	Constructive Features
High-capacity, technology-led	Singapore, South Korea	Smart learning environments near-universal; student-centred teaching embedded; holistic assessment systems established; educational equity gaps narrow and actively monitored; school organisational leadership strong	Data security and governance developing; sustainable education reform across multiple policy iterations; school cultural development active; cross-sector collaboration institutionalised; teacher capacity building sustained over decades
Large-scale, uneven	India, Indonesia	Smart learning environments strong nationally but highly uneven sub-nationally; student-centred teaching advancing through curriculum reform; educational equity the defining performance gap between national averages and peripheral populations	Sustainable education reform and cross-sector collaboration strong at national level; teacher capacity building the binding constraint on progress; data security and governance fragmented across geographies and levels of government
Policy-aspirational	Pakistan, Cambodia	Smart learning environments established in urban contexts, severely constrained rurally; student-centred teaching aspirational in policy, inconsistent in practice; educational equity the most acute performance gap	Sustainable education reform framework present but implementation capacity lagging ambition; teacher capacity building and data security and governance the most underdeveloped enablers; cross-sector collaboration donor-dependent and externally resourced

Archetype	Illustrative Cases	Performative Features	Constructive Features
Fragile, crisis-exposed	Afghanistan, Myanmar	Smart learning environments severely disrupted or absent; school organisational leadership compromised or operating in exile; student-centred teaching contingent on civil society provision rather than formal system	All constructive features operating outside normal conditions; school cultural development and cross-sector collaboration improvised through non-state actors; data security and governance absent

Countries were selected as illustrations of each pattern based on the strength of available evidence and their geographic and contextual diversity across South, Southeast, Central, and East Asia. Figure 1 visualises the archetypes by system capacity and implementation reach:

Figure 4.1 Smart Education in Asia Across Four Archetypes



This section examines each archetype through illustrative country cases drawn from across Asia, mapped along three dimensions: what has been gained from Smart Education development; what is being reshaped by digital transformation; and what is at risk where governance, equity, or capacity have not kept pace. The mapping is not a comparative assessment but reflects on the variety of approaches and lessons learned in implementing Smart Education systems.

High-Capacity, Technology-Led Systems

South Korea and Singapore are among the highest-performing education systems in the world. In PISA 2022, Singapore led global rankings in mathematics, reading, and science; South Korea maintained above-average performance across all three domains through the COVID-19 period (OECD, 2023). Both systems are characterised by near-universal school connectivity, sustained high public investment in education, strong institutional capacity for curriculum design and teacher development, and decades of iterative, evidence-informed policy revision. These are the foundational prerequisites that distinguish high-capacity systems: not merely that technology is present, but that the governance, human capital, and institutional infrastructure required to deploy it purposefully have been built over time.

Both systems arrived at this point through sustained commitment over decades; South Korea's Cyber Home Learning System, piloted in 2004, established digital learning infrastructure at national scale; its Digital-based Education Innovation Plan (2023) represents the third major iteration of national digital education policy, now encompassing AI-embedded textbooks and a commitment to train 300,000 teachers by 2026. Singapore's first ICT Masterplan dates to 1997 and its current Educational Technology Plan, now in its fourth iteration, provides a ten-year vision to 2030 (Ministry of Education Singapore, 2023; UNESCO & CEI, 2023).

What both systems have gained is most visible in the maturity of their professional learning ecosystems and, particularly in Singapore, the development of evaluation as a governance principle. South Korea's EdTech Software Laboratory, established in 2021, moved from top-down procurement towards school-industry collaboration in regional hubs where teachers, students, and technology developers co-design solutions (Seo, 2023). The Jeeshik Samter peer knowledge-sharing service, introduced in July 2020, replaced supplier-centred government training with voluntary, teacher-to-teacher, real-time video learning (Seo, 2023). In Singapore, the Student Learning Space, operational since 2018, provides curriculum-aligned resources with an Adaptive Learning System delivering personalised learning pathways and documented improvements in competencies and motivation among low-progress learners. Singapore's governance model builds evaluation upstream where government support tends to follow demonstrated school-level evidence, with the system generating continuous performance data that feeds iterative development (Zhao & Wang, 2026).

What is being reshaped in both systems is the teacher's role as personalised learning deepens at scale: from knowledge deliverer to learning mentor, coach, and socio-emotional leader. South Korea's 2023 Digital-based Education Innovation Plan introduced AI-embedded digital textbooks from 2025, with USD 260 million earmarked for professional development and a commitment to train 300,000 teachers by 2026 (Yang & Yi, 2025). Singapore's National Artificial Intelligence Strategy 2.0 embeds AI ethics frameworks for education alongside continued platform development (UNESCO & CEI, 2023).

What is at risk in high-capacity systems is the governance gap that opens when technology adoption outpaces the institutional conditions required to sustain it. South Korea's 2025 experience illustrates this: fewer than 30% of elementary schools were using AI textbooks by March, and after complaints about factual inaccuracies, privacy, and teacher workload, the government stripped them of official status that August, a sign of accountability functioning, but also of scaling ahead of the evidence base (UNESCO GEM, 2025; Gezen, 2025). Singapore's risk is structurally similar but earlier-stage: data governance under the Personal Data Protection Act of 2012 lags emerging technology adoption, particularly software developed outside Singapore's jurisdiction, and few systematic methods exist to measure students' digital competence, meaning personalised learning gains may be difficult to verify and skill stratification may be widening without visibility (Zhao & Wang, 2026). For high-capacity systems, the frontier risk is whether evaluation culture, regulatory frameworks, and public trust can keep pace with AI integration.

Large-Scale, Uneven Implementation Systems

India and Indonesia show what Smart Education looks like at the largest scales of implementation: strong national ambition and real platform-level gains, alongside sharply uneven reach. Both countries have the policy architecture and government commitment in place; the gap is in the capacity to deliver consistently, especially to learners furthest from urban centres (ADB, 2023).

What both systems have gained is most visible at the platform level. India's Digital Infrastructure for Knowledge Sharing (DIKSHA), a federated platform aggregating e-content, teacher training resources, and assessments across 36 states and Union Territories in over 30 languages, is the primary digital vehicle for the National Education Policy 2020; reaching approximately 180 million students and seven million teachers, with 70% rural penetration (Maruwada, 2023). Indonesia's Merdeka Belajar reform has produced two complementary platforms: Platform Merdeka Mengajar, a teacher enablement platform that by 2023 reached two million users with over 80% of principals and 70% of teachers engaging in its training features (UNESCO & SEAMEOLEC, 2023; Wang et al., 2023), and Rapor Pendidikan, a school performance dashboard adopted by 95% of Indonesia's K-12 schools by October 2023 (Wang et al., 2023). Yet platform reach and learning outcomes are not the same thing: Indonesia's PISA 2022 mathematics score of 366, against an OECD average of 472, is a gap equivalent to roughly three and a half years of schooling (UNESCO & SEAMEOLEC, 2023; Wang et al., 2023).

What is being reshaped in both systems is the relationship between curriculum and technology, and through it the role of the teacher. India's National Education Policy 2020 reorients schooling toward foundational literacy and competency-based, multilingual learning, with DIKSHA as its vehicle; from 2026-27, AI and computational thinking become compulsory from Class 3 upward, requiring training of over 10 million teachers against a backdrop where only 58% of schools have functional computers (Government of India, 2025). Indonesia's Ministerial Regulation No. 13/2025 makes a parallel move, introducing AI and coding from Grade 5 upward conditional on infrastructure readiness, while the Kurikulum Merdeka shifts from prescriptive content toward competency-based, student-centred learning with technology as a targeted enabler rather than full digitisation. Both reforms share the same logic: technology as the lever for deeper pedagogical transformation. In both systems, teacher preparedness is a constraint; training remains fragmented and concentrated in cities, with many Indonesian teachers reporting limited digital literacy even as student familiarity with AI tools has reached 83.6% nationally (Haetami, 2025).

Policy-Aspirational, Infrastructure-Constrained Systems

Pakistan and Cambodia show policy ambition, and increasingly investment, outpacing what either country's evidence base can support.

The two arrive here from different governance structures. Pakistan, the world's most climate-vulnerable country, faces a learning crisis compounded by recurring climate emergencies (Hayat, Mazari & Aslam, 2025); its system, devolved to the provinces under the 18th Constitutional Amendment, leaves provinces running separate strategies with limited information-sharing, and donors and government alike continue scaling interventions regardless of evidence. Cambodia's more centralised environment doesn't resolve this: fragmentation across departments and unevaluated donor-funded projects are documented constraints on EdTech scaling regardless of governance structure (Curtiss Wyss & Olsen, 2026). Cambodia brings stronger connectivity, with cellular networks covering 100% of the population and 92% of households owning a mobile phone (ITU, 2024), underpinning a 2025 investment surge including the World Bank's $100 million Basic Education Improvement Project and a UNICEF-backed teacher development platform (Thinley et al., 2024; World Bank, 2025).

What both systems have gained is real, if narrow, evidence of what works. A Bahawalnagar RCT found a WhatsApp-based Teaching at the Right Level intervention improved Pakistani students' English and Urdu scores by 0.56 SD (Adil et al., 2022), and the Targeted Instruction Programme in Islamabad and KP shows gains are achievable where institutional support and connectivity align (Harvard Kennedy School CID, 2023). In Cambodia, the most rigorous published evaluation available, a Learning Generation Initiative pilot across nine schools in Phnom Penh and Kandal Province, found High Touch High Tech produced 0.36 SD math gains over eight months (Learning Generation Initiative, 2026).

Both systems are reshaping what EdTech is for, increasingly through informal platforms attractive for being cheap and fast rather than evaluated. In Pakistan, WhatsApp has become the primary informal learning channel, the most feasible way to scale across provincial boundaries during climate emergencies (Hayat, Mazari & Aslam, 2025). In Cambodia, Telegram plays the same role, used nationally during closures and adopted specifically to reach ethnic-minority students in multilingual schools (IIEP-UNESCO, 2020; Sam, 2023). Cambodia's Minister of Education has framed AI as compensating for the teacher shortage noted above, rather than enhancing learning (Kiripost, 2025).

What is at risk follows directly from that same evidence gap: access, language, and outcome problems concentrated where investment and evidence are thinnest. In Pakistan, only 33% of households have internet access and 12% own a computer (Zubairi et al., 2022); evidence comes almost entirely from better-resourced pockets like Islamabad, with a systematic review finding just 71 eligible studies nationally, none controlled or at scale (Baloch & Taddese, 2020). Interventions default to English and Urdu, with almost no coverage in Punjabi, Balochi, or Saraiki (Zubairi et al., 2022). In Cambodia, only 32% have basic digital access and 22% of schools have functional computers (UNESCO, 2024c; UNESCO GEM & SEAMEO, 2023). Evidence again clusters narrowly in Phnom Penh and Kandal, with no comparably rigorous evaluation for what's being scaled nationally. SEA-PLM 2024 found Cambodia's lowest-band Grade 5 students falling from 47% to 37% in reading and 36% to 20% in math since 2019, a rare regional improvement, but one that still leaves 81% of Grade 6 students short of proficiency in mathematics or Khmer (UNICEF & SEAMEO, 2024; World Bank, 2025). Ethnic minorities whose first language is neither Khmer nor English face disadvantages that Telegram outreach has only begun to address.

In both countries, investment is scaling faster than the evidence that would justify it, and effectiveness is best understood where internationally funded research has reached, least where the need is greatest.

Fragile and Crisis-Exposed Systems

Afghanistan and Myanmar occupy a distinct position in this analysis. In both, the prerequisites that make Smart Education possible: stable governance, functioning infrastructure, safe schools, a legitimate ministry of education; have been disrupted. The framework applies differently here: what has been gained is measured against the alternative of no education at all; what is being reshaped is the relationship between the state and education provision itself; and what is at risk is the sustainability of the improvised systems filling the gap.

What both systems have gained is the partial maintenance of learning continuity through technology in conditions designed to foreclose it.

In Afghanistan, an estimated 2.2 million girls are out of education following the Taliban's return to power in 2021 (UNICEF & UNESCO, 2025); technology has become the primary educational corridor for excluded learners, with Lapis Group's Senf programme and the Eagle Online Academy expanding across all 34 provinces to graduate over 2,000 women and girls (Lapis Group, n.d.), and UNESCO delivering radio-based literacy programmes across five provinces (Barnes et al., 2025). In Myanmar, following the February 2021 coup, the National Unity Government's Ministry of Education responded to junta control of formal institutions by building a parallel system that by October 2021 counted 235 of the country's 297 universities and 279 of 330 township education boards among its affiliates, since conducting its own matriculation examinations in resistance-held areas (Faxon et al., 2023; Radio Free Asia, 2024). Civil society has built further infrastructure beyond this parallel state: Burma Academy offers free offline-capable mobile courses and has piloted Raspberry Pi devices where the internet is shut down entirely, while ethnic resistance organisations sustain multilingual education rejecting the junta's monolingual model, part of a wider non-state response that now reaches over 890,000 of Myanmar's 13 million learners (UNICEF Myanmar, 2025).

What is being reshaped is the channel through which support reaches learners: donors now route funding through civil society, resistance organisations, and diaspora networks rather than state ministries, out of necessity rather than choice (Auh & Kim, 2025). However, what is at risk is the fragility of the funding sustaining these systems and the lack of evidence to guide effective use. Donors cannot work through state channels in either country: programmes therefore run through civil society and humanitarian channels structurally vulnerable to geopolitical shifts. In early 2025, the United States suspended over $560 million in Afghanistan aid, ending USAID-funded girls' education programmes and closing the IRC's community-based programmes for nearly 300,000 children (Refugees International, 2026; IRC, 2025); in Myanmar, USAID's termination of the Diversity and Inclusion Scholarship Program withdrew $45 million from over 400 students (Amnesty International, 2025; Aung Thet Paing Hmue, 2025). Barnes et al. (2025) review found critically thin evidence of EdTech effectiveness in emergencies generally.

Regional Synthesis and Profile

Several conditions cut across all four archetypes in ways that the archetype analysis alone cannot fully capture.

Connectivity inequality remains structural rather than incidental, present even in large-scale systems with significant platform investment. Indonesia's 95% school adoption of Rapor Pendidikan coexists with eastern Papua and Maluku, where over three-quarters of schools lack connectivity (UNESCO & SEAMOLEC, 2023); India's DIKSHA reaches 180 million users while only 18% of rural schools had internet access as of 2023 (UDISE+, 2023); Cambodia's 100% cellular coverage coexists with schools in Oddar Meanchey where no household owns a computer (UNESCO GEM & SEAMEO, 2023). National adoption statistics mask this, reflecting capital-city conditions rather than the depth of the gap at the periphery.

Teacher readiness is the binding constraint regardless of system sophistication: South Korea's AI textbook rollback, Indonesia's Kurikulum Merdeka gaps, Pakistan's unscaled pilots, and Cambodia's digital divide all trace back to teachers not yet equipped for what reform requires (Seo, 2023; Haetami, 2025; Mazari et al., 2023; UNESCO GEM & SEAMEO, 2023), and development is consistently underfunded relative to platform and device investment. SEAMEO's Southeast Asia Teachers Professional Development (TPD) analysis across nine countries finds a significant policy-practice gap despite formalised frameworks: cascade training dilutes quality, nearly one-third of teachers lack confidence with digital tools, and heavy workloads reduce participation (SEAMEO & FIT-ED, 2026). SEA-PLM confirms the pattern in outcomes: regional minimum proficiency in mathematics improved from 56% to 67% of Grade 5 students between 2019 and 2024, but only 53% reached minimum reading proficiency (UNICEF & SEAMEO, 2024).

Governance and evaluation capacity lag technology adoption across the spectrum. A 2026 Brookings Institution study of government EdTech decision-making helps explain why: decisions are shaped more by political motivation and short-term feasibility than by sustainability or evidence, with decision-makers accepting donor-funded projects and free corporate tools without evaluating fit against national strategy or long-term sustainability (Curtiss Wyss & Olsen, 2026). The lag runs from Singapore's acknowledged regulatory gap to Cambodia's reliance on commercial platforms with no educational data framework (UNESCO & SEAMEO, 2023) to Myanmar, where digital learning itself carries surveillance risk (Auh & Kim, 2025); South Korea scaled its AI textbook programme before the evidence base could sustain it (Gezen, 2025), and a 2025 EdTech Hub review found critically thin evidence of EdTech effectiveness in emergencies globally (Barnes et al., 2025).

Conflict and crisis form a cross-cutting condition no archetype is insulated from. Asia is home to the most climate-vulnerable countries, and with the Pacific accounts for over 178 million of the 242 million students globally whose schooling was disrupted by climate hazards (UNICEF, 2025). Direct conflict has foreclosed formal education in Afghanistan and Myanmar, but effects reach further: fuel shortages cascading from conflict in the Middle East have caused school closures elsewhere. (Rahman & Freeman, 2025). As conflicts multiply and humanitarian funding fails to keep pace, EdTech is increasingly deployed as a cost-efficiency mechanism rather than a learning tool (Rahman & Freeman, 2025).

Mapped against the ten indicators, smart learning environments and educational equity show the widest variation: the gap between Metro Manila's 68.7% household internet access and BARMM's 27.7% (PSA, 2025) illustrates in one country what the archetypes reveal at continental scale. Student-centred teaching and holistic assessment show gains in high-capacity and large-scale systems but remain aspirational elsewhere, though TVET points to where this is shifting: South Korea's advanced TVET digitalisation has become a benchmarking model for ASEAN counterparts (ILO, 2024), Cambodia's TVET 1.5M programme has expanded vocational enrolment nationally (Khmer Times, 2026), and the Philippines' Commission on Higher Education established a national micro-credentials framework in 2025 (CHED, 2025).

School organisational leadership shows persistent gaps, with governance fragmentation and principal shortages documented in the Philippines (DepEd, 2025) and echoed in regional TPD findings above. Sustainable education reform shows the strongest variation of any constructive feature, built over decades in high-capacity systems and lost entirely in fragile ones; cross-sector collaboration ranges similarly, from Singapore's institutionalised public-private ecosystem to Myanmar's improvised civil society architecture.

Overall maturity: Asia spans the full maturity spectrum simultaneously, from nascent in Afghanistan and Myanmar to advanced in Singapore and South Korea. East Asia anchors the high-capacity end, though open AI governance questions in South Korea and Singapore show system capacity alone doesn't guarantee consolidated maturity. Southeast Asia spans the widest internal range of any sub-region, constrained above all by teacher capacity. South Asia is predominantly developing, India's platform scale coexisting with deep rural connectivity gaps. Central Asia is nascent in some countries, accelerating in others. China complicates any regional reading further: its coastal provinces perform at high-capacity levels on PISA 2022 while rural and western provinces show large-scale-uneven characteristics (Shen et al., 2025). Asia's centre of gravity is best characterised as developing.

Defining strengths: sustainable education reform in high-capacity and large-scale systems; smart learning environments, where national platform reach represents real infrastructure achievement despite last-mile equity gaps; and cross-sector collaboration, from institutionalised to improvised.

Critical gaps: teacher capacity building, underdeveloped across every archetype; educational equity, where intra-national variation rivals inter-national variation; and data security and governance, lagging technology adoption from the region's most advanced systems to its most fragile.

Dominant characteristic: policy-ambitious but implementation-uneven. The continent invests at scale in Smart Education infrastructure while teacher capacity, evidence culture, and governance frameworks struggle to keep pace.

The Philippines: Indicator-Level Assessment

The Philippines offers a country-level test of the regional patterns established above. A middle-income archipelagic state of over 7,600 islands with 27 million children in public schools (National Mapping and Resource Information Authority, 2016), it is actively pursuing a national Smart Education agenda through DepEd's Presidential Digitalisation Blueprint while contending with a severe learning crisis, acute infrastructure inequality, recurring climate disruption, and sub-national conflict (DepEd, 2025). The distance between Smart Education in Metro Manila and BARMM is, in microcosm, the distance between Singapore and Cambodia at the regional level.

The assessment examines the Philippines against all ten indicators of the Huang et al. (2024) framework; five Performative Features and five constructive features; addressed in five thematic clusters, each covering two indicators, with attention to current state, evidence, and the key variations that reveal where Smart Education is working and where it is not.

Cluster 1: Learning outcomes and student-centred teaching (PF1: Student-Centred Teaching; PF2: Holistic Learning Assessment)

The starting point for any assessment of Smart Education in the Philippines is the depth of the learning crisis the system is trying to address. The Quality Basic Education Development Plan 2025-2035 diagnoses a system where 91% of ten-year-olds cannot read and understand short, age-appropriate texts, with weak foundations from the start: pre-kindergarten enrolment sat at just 20% in 2022, alongside high rates of childhood stunting (DepEd, 2025). EDCOM II's 2026 report documents a proficiency collapse; 30.5% of Grade 3 learners meet proficiency standards, dropping sharply to 0.4% by Grade 12, and identifies mass promotion as a systemic practice that obscures this, with students advancing without demonstrating competency (EDCOM II, 2026). In PISA 2022, the Philippines scored 355 in mathematics and 347 in reading, 77th of 81 countries, with only 8% of 15-year-olds reaching minimum reading proficiency (OECD, 2023). SEA-PLM (2024) confirms socioeconomic status remains the strongest predictor of achievement across Southeast Asia, with gaps equivalent to up to two years of schooling; contextualising the Philippines' intra-national variation as regional rather than country-specific (UNICEF & SEAMEO, 2024).

Assessment reform is underway: the MATATAG curriculum (2023) shifts toward foundational literacy and numeracy, and the Comprehensive Rapid Literacy Assessment offers a more granular picture of learning levels, but the link between assessment data and instructional practice remains weak (EDCOM II, 2026). Mazari et al.'s forthcoming study finds that completion of learning materials during closures does not verify learning quality; proxy completion by parents and siblings is widespread, and real verification only happens face-to-face on return. The GSMA's 2024 Future of Learning report finds no uniform monitoring and evaluation process for EdTech initiatives nationally (GSMA, 2024), a gap DepEd is addressing through the forthcoming EdTech Omnibus Policy, developed with EdTech Hub using a Do-Measure-Learn approach to map assumptions and define indicators (Afzal & Donato, 2026).

Cluster 2: Infrastructure, connectivity and educational equity (PF3: Smart Learning Environment; PF5: Educational Equity)

The infrastructure picture is one of ambitious targets set against a still-fragmented reality. As of 2024, only 48.8% of Philippine households had internet access at home, up from 17.7% in 2019, with BARMM recording the lowest rate of any region at 27.7% against the National Capital Region's 68.7% (PSA, 2025); remote, least-populated areas have made only one-third the connectivity progress of urban centres over the past decade (GSMA, 2026).

The digital divide is acute. BARMM has the country's lowest upper secondary completion rate at 30% (UNESCO, 2023b) alongside its lowest internet access. The government has identified 8,013 barangays without elementary schools, mostly in Geographically Isolated and Disadvantaged Areas (GIDA), and eight municipalities without secondary schools in conflict-affected Basilan, Maguindanao, and Palawan (Basic Education Development Plan, 2022); the GIDA Schools Act, passed on third reading in March 2026, seeks to institutionalise targeted support (EDCOM II, 2026). A parallel BARMM-level measure, the Inclusive Digital Education Act, was introduced to the Bangsamoro Parliament in April 2026, proposing a dedicated Bangsamoro Learning Management System and prioritising GIDA, indigenous, and conflict-affected learners specifically (Bangsamoro Parliament, 2026). The accumulated classroom deficit grew to 165,000 over the last decade, with centralised procurement building fewer than 10,000 classrooms annually in recent years (DepEd, 2025).

Climate vulnerability compounds these gaps structurally. Climate hazards affected 93% of Philippine schools between 2009 and 2019, and in 2023-24 alone nearly a third of the academic year was lost (UNICEF, 2025). EdTech Hub's study finds 75% of learners in Leyte have no home internet, making printed modular learning the near-universal default during suspensions; dependent on printing budgets calibrated for normal operations rather than emergencies (Mazari et al., forthcoming).

Cluster 3: Leadership, governance and data security (PF4: School Organisational Leadership; CF2: Data Security and Governance)

The Presidential Digitalisation Blueprint, the Education Centre for AI Research (E-CAIR), a SEAMEO INNOTECH-DepEd partnership launched in February 2025, and the forthcoming EdTech Omnibus Policy developed by DepEd's Bureau of Learning and Delivery represent national governance ambition (SEAMEO INNOTECH, 2025; Afzal & Donato, 2026). The Omnibus Policy aims to align EdTech procurement with foundational learning priorities and make budget allocations evidence-informed rather than device-centric; stress-testing of its Digital Maturity Assessment tool in Nueva Ecija and Rizal found digital maturity depends as much on teacher capability and pedagogical confidence as on infrastructure (Afzal & Donato, 2026). Tools under development include those for student health monitoring, among others (SEAMEO INNOTECH, 2025). Yet school-level leadership capacity remains underdeveloped: EDCOM II finds a shortage of principals in more than half of public schools. (EDCOM II, 2026; DepEd, 2025).

Data governance is a structural weakness. The Philippines enacted its Data Privacy Act in 2012 and the E-Governance Act more recently, but nearly four decades have passed without right-to-information legislation, leaving data disclosure to executive discretion; government platforms remain fragmented with no consistent interoperability framework, and criminal penalties under the Data Privacy Act have made officials risk-averse about sharing data across agencies (Disini, 2026). In education specifically, damage and needs reports filed through DepEd's Incident

Management Reporting System (IMRS) flow from schools to the central office without divisional verification, producing mismatched resource allocation (Mazari et al., forthcoming). DepEd's Indigenous Peoples Education programme, tracking 1.6 million IP learners, illustrates the fragmentation acutely: inter-agency data sharing is blocked by misapplied privacy rules, ethnicity lists are inconsistent across agencies, and the first disaggregation of National Achievement Test data for IP learners only happened in 2024 (Victor, 2025).

Cluster 4: Teacher capacity and school cultural development (CF3: Teacher Capacity Building; CF1: School Cultural Development)

Teacher capacity is the most consequential constraint on Smart Education in the Philippines. EDCOM II finds that 62% of high school teachers teach subjects outside their college major, a gap that may affect teaching quality (EDCOM II, 2026). Pizarro, Caballes and Vianzon (2024), studying 225 elementary teachers across four Bataan schools, found significant digital literacy disparities across teachers, ICT coordinators, and principals, with a substantial relationship between teachers' digital literacy and overall performance. GSMA (2024) identifies inadequate teacher capacity building as the key barrier to EdTech adoption at scale, with teachers reverting to traditional tools when digital approaches prove difficult. Mazari et al.'s forthcoming study finds a statistically significant relationship between training frequency and preparedness for climate-related learning continuity, yet only 58.3% of teachers engage in preparation activities at least once a term, and 28.4% cite stress and fatigue as a barrier. These challenges match regional TPD@Scale findings: cascade training dilutes quality at scale, heavy workloads reduce participation, and the time-on-task policy; six hours of daily teaching, two hours for everything else; makes sustained professional learning structurally difficult (SEAMEO & FIT-ED, 2026).

School cultural development is shaped by the archipelago's extraordinary linguistic diversity. Mother tongue-based multilingual education, introduced in 2010, expanded data infrastructure for tracking IP learners, though enrolment has declined substantially, raising retention and data-quality questions (Victor, 2025). Digital literacy is embedded in the K-12 curriculum and DepEd's 2025 International Day of Education foregrounded ethical AI use, but the gap between policy aspiration and classroom reality remains wide where most teachers lack subject-area qualifications and digital competency disparities are significant (EDCOM II, 2026; Pizarro et al., 2024).

Cluster 5: Sustainable reform and cross-sector collaboration (CF4: Sustainable Education Reform; CF5: Cross-Sector Collaboration)

EDCOM II's National Education Plan and its QBEDP 2025-2035 represent the most ambitious reform commitment in decades, a ten-year plan targeting global competitiveness by 2035, with digitalisation one of three strategic levers alongside decentralisation and public-private partnership.

DepEd received PHP 9.43 billion for digitalisation in 2024, a 60.6% increase, and the National Digital Connectivity Plan, approved January 2026, targets universal internet access for public schools by 2028 (DICT, 2026). External investment signals continued commitment: a proposed USD 150 million World Bank loan targets K-10 learning recovery (World Bank, 2024), and the Philippines is among eligible beneficiaries of a new ADB–IFFEd partnership unlocking at least USD 500 million in concessional education funding regionally (ADB, 2024).

The sustainability considerations are critical. Budgets are calibrated for normal operations such as school supplies, utilities, communication, training, and minor repairs, with no provision for emergency printing or alternative delivery (Ochada & Gempes, 2018). In practice, funding gaps are structurally embedded: EDCOM II found that 30% to 70% of school operating budgets go to utility bills alone, per-learner allocations have declined in real terms from PHP 150 in 2024 to PHP 137 in 2025, and local government units contribute just 6% of total public education spending despite decentralisation being a named strategic lever (EDCOM II, 2026; UNESCO GEM, 2026).

Cross-sector collaboration is most visible at the national governance level: the E-CAIR partnership between SEAMEO INNOTECH and DepEd, the Digital Bayanihan connectivity programme, and the DepEd-EdTech Hub collaboration; which supported the Omnibus Policy's evidence framework and Digital Maturity Assessment tool; reflect a multi-stakeholder architecture moving beyond procurement toward co-designed reform (SEAMEO INNOTECH, 2025; Afzal & Donato, 2026; DepEd, 2025). A contrast in sub-national implementation exists: Valenzuela's own multi-channel ecosystem, including a dedicated worktext, local broadcast partnerships, and a supporting city ordinance, shows what sustained local investment can produce. But this is a single city government's achievement that depends on institutional capacity and years of consistent local funding (Mazari et al., forthcoming).

Table 4.2 below indicates that the Philippines has established important foundations for Smart Education development, but its transformation from digitalisation toward intelligent and inclusive learning remains constrained by institutional and implementation challenges. Among the Performative Features, student-centred teaching, smart learning environments, and school leadership demonstrate moderate progress, supported by curriculum reform, digital platforms, and national digital strategies. However, personalised learning, data-driven assessment, and equitable access remain limited due to persistent learning gaps, infrastructure disparities, and uneven technology integration. Regarding Constructive Features, the Philippines shows strengths in cross-sector collaboration and policy commitment, while cultural responsiveness, data governance, and sustainable reform mechanisms continue to develop. Teacher capacity remains the most significant constraint, as gaps in digital competence and pedagogical integration limit the effective use of Smart Education tools. Overall, the Philippines case reflects a transitional stage in which policy ambition and collaborative ecosystems provide strong momentum, but long-term transformation depends on strengthening teacher capability, improving educational equity, and developing more integrated governance and implementation systems

Table 4.2 Assessment of Constructive Features (CF) and Performative Features (PF) of Smart Education in the Philippines

Indicator	New Level	Rationale
PF1: Student-centred Teaching	Weak	The Philippines has introduced curriculum reforms, digital learning initiatives, and EdTech-supported teaching approaches. However, smart technologies are still primarily used for instructional support rather than enabling personalised, adaptive, and learner-driven learning. Persistent learning gaps and limited digital integration constrain the full implementation of student-centred Smart Education.
PF2: Holistic Learning Assessment	Weak	Although assessment reforms such as the Comprehensive Rapid Literacy Assessment have been introduced, the use of assessment data to inform teaching remains limited. AI-enabled learning analytics, formative assessment, and personalised feedback systems are still at an early stage, while monitoring and evaluation mechanisms for EdTech initiatives continue to develop.

Indicator	New Level	Rationale
PF3: Smart Learning Environment	Weak	National policies have expanded digital infrastructure, connectivity programmes, learning platforms, and device distribution. However, considerable disparities in infrastructure, internet access, and device availability between urban and remote areas continue to limit the development of an inclusive smart learning environment.
PF4: School Organisational Leadership	Moderate	The Philippines has established important governance mechanisms, including the Presidential Digitalisation Blueprint, E-CAIR, and the forthcoming EdTech Omnibus Policy, demonstrating growing institutional commitment. Nevertheless, uneven school leadership capacity and implementation challenges continue to affect policy execution.
PF5: Educational Equity	Weak	Digital inequality remains a major challenge. Regional disparities in connectivity, educational resources, and socioeconomic conditions continue to limit equitable access to Smart Education, particularly in geographically isolated and conflict-affected areas.
CF1: School Cultural Development	Weak	The education system promotes cultural and linguistic diversity through mother tongue-based multilingual education and Indigenous Peoples Education initiatives. However, culturally responsive digital learning resources and community engagement remain uneven across regions.
CF2: Data Security and Governance	Weak	The Philippines has established important legal foundations, including the Data Privacy Act and broader digital governance policies. However, education data governance remains fragmented, with continuing challenges in interoperability, data sharing, and ethical management of learner information.
CF3: Teacher Capacity Building	Weak	Despite expanding professional development and digital literacy programmes, substantial gaps remain in teachers' digital competence, pedagogical integration of technology, and confidence in using Smart Education tools. Teacher capacity continues to be a major constraint on digital transformation.
CF4: Sustainable Education Reform	Moderate	Smart Education has been embedded within long-term national strategies, including the Quality Basic Education Development Plan 2025–2035. Although government investment and international partnerships support implementation, long-term sustainability remains constrained by funding, maintenance, and implementation capacity.

Indicator	New Level	Rationale
CF5: Cross-Sector Collaboration	Strong	The Philippines has established a comparatively mature collaborative ecosystem involving government agencies, international organisations, regional institutions, academia, and technology partners. Partnerships led by DepEd, SEAMEO INNOTECH, EdTech Hub, and other stakeholders have significantly supported policy development, research, and implementation, although collaboration at the local level remains uneven.

Futures and Recommendations

TAmara's (1981) three futures framework — probable (likely if current trends continue), possible (achievable outside current trajectories), and preferable (what we want, and the conditions required) — structures Asia's Smart Education trajectories. The most consequential variables shaping those futures are not technological but institutional, political, and climatic.

For high-capacity systems like Singapore and South Korea, the probable future is continued frontier leadership but a widening gap with the rest of the region, as the governance challenges visible in South Korea's AI textbook rollback recur in more acute forms. The possible future is governance maturity becoming a regional resource: open platforms, transferable frameworks, South-South technical assistance. The preferable future asks whether these systems can reorient their ambitions toward regional equity.

For large-scale uneven systems like India and Indonesia, the probable future is incremental with connectivity gains masking deep structural inequality. The possible future is the federated models pioneered by DIKSHA and Platform Merdeka Mengajar adopted at subnational scale, with teacher development funded at the level platforms currently receive.

For policy-aspirational systems like Pakistan and Cambodia, the probable future is continued ambitious strategy production with limited reach, as infrastructure inequality, governance fragmentation, and donor-dependent pilots remain unresolved. The possible future is urban EdTech ecosystems reaching underserved populations through evidence and equity design rather than market extension. The preferable future is a design philosophy starting from the most constrained learner.

For fragile and crisis-exposed systems like Afghanistan and Myanmar, the probable future is continued deterioration as crisis-response remains the dominant delivery mode well beyond 2030. The possible future, conditional on political change, recognises that parallel systems built by civil society and resistance organisations contain institutional knowledge worth preserving. The preferable future requires conflict-sensitive frameworks, recognition of non-state credentials, and sustained investment in the organisations keeping learning alive in conditions designed to foreclose it

Figure 4.2 Three Futures Framework Applied to Smart Education in Asia

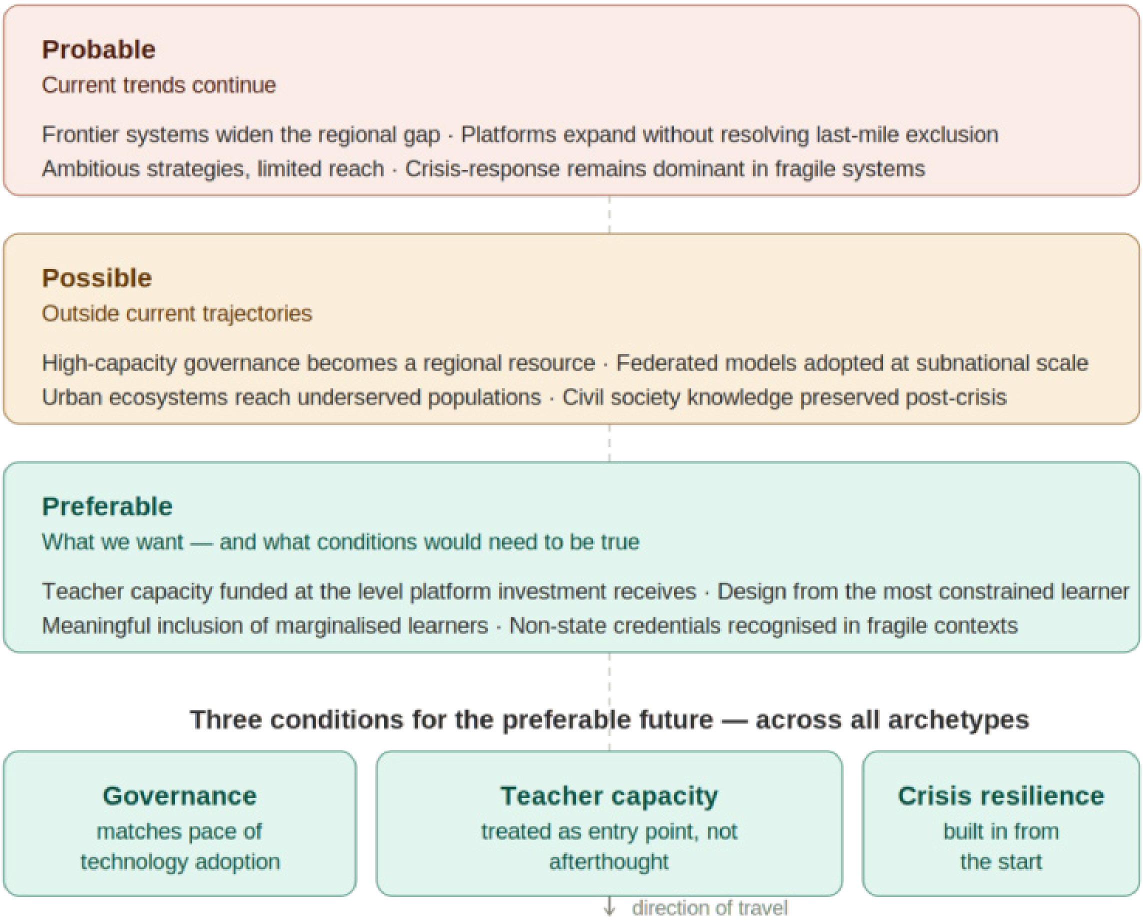


Figure 2: Amara's three futures framework — Asia's smart education synthesis

What unites these four preferable futures is a single shift: from treating governance, teacher capacity, and crisis resilience as afterthoughts to treating them as prerequisites, funded and designed for from the start.

Lessons and Recommendations

The evidence examined in this chapter produces recommendations that are practical and addressed to three distinct audiences.

For policymakers, the most consistent finding across archetypes is that teacher capacity is the binding constraint at every tier, and consistently underfunded relative to platform and device investment. The recommendations: treat teacher development as a prerequisite for technology adoption rather than a concurrent activity; design infrastructure for disruption resilience, not only steady-state conditions; and ensure equity frameworks explicitly address the conflict-affected and displaced learners named throughout this chapter, who remain the least visible in national data.

For practitioners and school leaders, the evidence converges on one practical principle: multimodal, low-dependency approaches should be the default in fragile and infrastructure-constrained contexts; printed modules, radio, and offline-capable platforms are the realistic foundation for more sophisticated modalities, not inferior alternatives. Community-level investment, as Valenzuela's ecosystem demonstrated above, produces more durable outcomes than centralised procurement alone.

For those applying the framework itself, the recommendation is contextual: the ten indicators produce meaningful diagnosis only when applied against the structural conditions systems actually operate in. Smart learning environments means something categorically different in Singapore than in Afghanistan, and treating both as points on a single maturity spectrum risks rendering the most constrained systems invisible. Future cycles should incorporate fragility, crisis exposure, infrastructure inequality, and governance fragmentation as contextual variables, since the framework's diagnostic value depends on reflecting the conditions systems face, not only the outcomes they achieve.

Conclusion

The evidence examined in this chapter resists a single regional narrative. Singapore's AI governance challenge and Afghanistan's educational survival are different problems, shaped by categorically different conditions the Philippines' indicator mapping has made concrete within one country. These are not gaps to be closed by better technology deployment. They are structural conditions that determine what technology can and cannot do.

The chapter's contribution is to insist that the framework's diagnostic value depends on the conditions under which it is applied. Evaluation capacity, crisis resilience, and teacher preparedness are prerequisites for Smart Education, not its by-products.

Author's note on AI use

The author used Claude (Anthropic) to assist with literature searching and source identification, structuring data into the archetype framework and indicator clusters, citation verification, producing the diagrams in Figures 4.1 and 4.2, and revising prose across sections of this chapter. All analytical judgements, the selection and weighting of evidence, the archetype framework's design, the country case study selection, and the conclusions drawn are the original work of the author, who reviewed, fact-checked, and takes full responsibility for all content in this chapter.

References

Adil, F., Nazir, R., & Akhtar, M. (2022). Investigating the impact on learning outcomes through the use of EdTech during COVID-19: Evidence from an RCT in the Punjab province of Pakistan. Frontiers in Education, 7, 993265. https://doi.org/10.3389/feduc.2022.993265

Afzal, N., & Donato, J. (2026). Designing EdTech for foundational literacy and numeracy: Insights from the Philippines' EdTech Omnibus Policy. EdTech Hub. https://edtechhub.org/2026/03/30/designing-edtech-for-foundational-literacy-and-numeracy-insights-from-the-philippines-edtech-omnibus-policy/

Amara, R. (1981). The futures field: Searching for definitions and boundaries. The Futurist, 15(1), 25–29.

Amnesty International. (2025, May 8). Myanmar: Life-saving education funding must be restored following USAID cuts. https://www.amnesty.org/en/latest/news/2025/05/myanmar-life-saving-education-funding-must-be-restored-following-usaid-cuts/

Asian Development Bank. (2011). Making the grade: Analyzing the state of education across Asia, from grade school to trade school. Asian Development Bank. https://www.adb.org/sites/default/files/publication/29072/devasia10.pdf

Asian Development Bank. (2023). Toward mature digital education ecosystems: The Digital Education Readiness Framework. Asian Development Bank. https://www.adb.org/publications/toward-mature-digital-education-ecosystems

Asian Development Bank. (2024, September 26). New ADB–IFFEd partnership to unlock $500 million in concessional education financing in Asia and Pacific. ADB. https://www.adb.org/news/new-adb-iffed-partnership-unlock-500-million-concessional-education-financing-asia-and-pacific

Auh, Y., & Kim, C. (2025). Educational fragmentation in Myanmar: Governance shifts, conflict, and the digital divide. Pedagogical Research, 10(4), em0248. https://doi.org/10.29333/pr/17054

Aung Thet Paing Hmue. (2025, August 21). Education in uncertainty: Innovation amid Myanmar's conflict. SRIc Insights, Shwetaungthagathu Reform Initiative Centre. https://www.eurasiareview.com/26092025-education-in-uncertainty-innovation-amid-myanmars-conflict-analysis/

Baloch, I., Taddese, A. (2020). EdTech in Pakistan: A Rapid Scan https://docs.edtechhub.org/lib/FIQDEKCI

Bangsamoro Parliament. (2026, April 28). BARMM eyes wider access to digital education through new learning framework bill. https://parliament.bangsamoro.gov.ph/2026/04/28/barmm-eyes-wider-access-to-digital-education-through-new-learning-framework-bill/

Barnes, K., Ramesh Vasudevan, S., & Flam, R. (2025). EdTech for education in emergencies: A rapid evidence review. EdTech Hub. https://docs.edtechhub.org/lib/BIUPGP3C/download/W5EXUDXY

Commission on Higher Education, Philippines. (2025). CHED Memorandum Order No. 1, Series of 2025: Guidelines for micro-credential development, approval and recognition in higher education. CHED. https://legacy.ched.gov.ph/2025-ched-memorandum-orders/

Curtiss Wyss, M., & Olsen, B. (2026). From access to impact: Government decisionmaking and scaling of EdTech in South and Southeast Asia. Brookings Institution/Asian Development Bank. https://www.brookings.edu/wp-content/uploads/2026/07/Millions-Learning-ADB-Report_Final.pdf

Department of Education, Philippines. (2022). Basic Education Development Plan 2022–2030. DepEd. https://www.globalpartnership.org/library/basic-education-development-plan-2030-philippines

Department of Education, Philippines. (2025). Quality Basic Education Development Plan 2025-2035. DepEd. https://www.deped.gov.ph/wp-content/uploads/Quality-Basic-Education-Development-Plan-QBEDP-2025-to-2035-29-July-2025.pdf

Department of Information and Communications Technology, Philippines. (2026). National Digital Connectivity Plan. DICT. https://cms-cdn.e.gov.ph/DICT/pdf/LATEST%20PUBLICATION%20NDCP_bda86f60-7dd4-4cf9-be58-c25275508074.pdf

Department of School Education and Literacy, Government of India. (2025). AI and computational thinking curriculum: Stakeholder consultation. Press Information Bureau. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2184211

Disini, J. J. (2026, April 6). Missed opportunities in Philippine data governance. InsiderPH. https://insiderph.com/insider-view-missed-opportunities-in-ph-data-governance

EDCOM II. (2026). Turning point: A decade of necessary reforms. Second Congressional Commission on Education. https://edcom2.gov.ph

Faxon, H., Kintzi, K., Tran, V., Wine, K. Z., & Htut, S. Y. (2023, May 30). Matriculating amid Myanmar's conflict. New Mandala. https://www.newmandala.org/matriculating-amid-myanmars-conflict/

Gezen, Z. (2025, June 16). South Korea slows down on AI education. Friedrich Naumann Foundation.

https://www.freiheit.org/north-and-south-korea/south-korea-slows-down-ai-education

Government of the Republic of Kazakhstan. (2024). Concept for the development of artificial intelligence for 2024–2029. Government of Kazakhstan.

Government of Uzbekistan. (2021). Resolution No. PP-4996: On measures to create conditions for the accelerated implementation of artificial intelligence technologies.

GSMA. (2024). The future of learning: The impact of EdTech on learning outcomes in the Philippines. GSMA. https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/wp-content/uploads/2024/11/TheFutureofLearning_TheImpactofEdTech.pdf

GSMA. (2026). Accelerating 5G and 5G-Advanced in Philippines: A roadmap for success. GSMA. https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2026/02/GSMA_Accelerating-5G-and-5G-Advanced-in-Philippines.pdf

Haetami. (2025). AI-driven educational transformation in Indonesia: From learning personalization to institutional management. Al-Ishlah: Jurnal Pendidikan, 17(2), 1819-1832.

Harvard Kennedy School Centre for International Development. (2023). Empowering educators: Early lessons from an EdTech-enabled targeted instruction programme. https://www.hks.harvard.edu/centers/cid/voices/empowering-educators-early-lessons-edtech-enabled-targeted-instruction-program

Hayat, A., Mazari, H., & Aslam, N. (2025). Pakistan climate policy brief. EdTech Hub. https://docs.edtechhub.org/lib/QGDI4RK2/download/VYF9N9RF

Huang, R. H., Liu, D. J., Kanwar, A. S., Zhan, T., Yang, J. F., Zhuang, R. X., Liu, M. Y., Adarkwah, M., & Li, Z. S. (2024). Global understanding of Smart Education in the context of digital transformation. Global Smart Education Network and Smart Learning Institute of Beijing Normal University.

International Labour Organization. (2024, April 18). Korea showcases TVET digitalization to South-East Asian counterparts. ILO. https://www.ilo.org/resource/news/korea-showcases-tvet-digitalization-south-east-asian-counterparts

International Rescue Committee. (2025, April 25). U.S. aid cuts are impacting millions of Afghans. IRC. https://www.rescue.org/article/us-aid-cuts-are-impacting-millions-afghans

International Telecommunication Union. (2024). World telecommunication/ICT indicators database. https://datahub.itu.int

Khmer Times. (2026, June 8). Over 270,000 enrolled in TVET scheme ahead of National Skills Day. Khmer Times. https://www.khmertimeskh.com/501915223/over-270000-enrolled-in-tvet-scheme-ahead-of-national-skills-day/

Kiripost. (2025). Is Cambodia ready to integrate AI in education? https://kiripost.com/stories/is-cambodia-ready-to-integrate-ai-in-education

Lapis Group. (n.d.). Senf distance learning programme. https://lapis-group.com

Learning Generation Initiative. (2026). High Touch High Tech in action: Strengthening teaching and learning in Cambodia through personalised, adaptive approaches. Education Development Center. https://learninggeneration.org/wp-content/uploads/2026/02/HTHT_Cambodia.pdf

Luo, Y., et al. (2025). When education policy drives migration: The impact of reform allowing migrants to take the local Gaokao on children's migration. International Journal of Educational Development. https://www.sciencedirect.com/science/article/abs/pii/S1049007825001198

Maruwada, S. (2023, March 27). Digital public goods for education: The Indian experience. Carnegie Endowment for International Peace. https://carnegieendowment.org/research/2023/03/digital-public-goods-for-education-the-indian-experience

Mazari, H., D'Rozario, J., Donato, J., & Swindell, A. (forthcoming). Learning continuity in emergencies: A case study of climate-related school closures in the Philippines. EdTech Hub.

Mazari, H., et al. (2023). National Distance Education Strategy: Pakistan. EdTech Hub. https://edtechhub.org/2023/09/27/connecting-edtech-investment-with-education-needs-lessons-from-pakistans-national-distance-education-strategy/

Ministry of Education Singapore. (2023). EdTech Masterplan 2030. https://www.moe.gov.sg/education-in-sg/educational-technology-journey/edtech-masterplan

National Mapping and Resource Information Authority. (2016). Philippine islands count updated to 7,641. NAMRIA, Department of Environment and Natural Resources.

New Uzbekistan University. (2026). New Uzbekistan University to lead nationwide AI education reform. https://newuu.uz/en/news/new-uzbekistan-university-to-lead-nationwide-ai-education-reform

Ochada, N. R. C., & Gempes, G. P. (2018). The realities of Maintenance and Other Operating Expenses (MOOE) allocation in basic education system: Unheard voices of public school teachers. International Journal of Scientific & Technology Research, 7(4).

OECD. (2023). PISA 2022 results (Volume I): The state of learning and equity in education. OECD Publishing. https://www.oecd.org/en/publications/pisa-2022-results-volume-i_53f23881-en.html

Philippine Statistics Authority. (2025). 2024 National Information and Communications Technology Household Survey (NICTHS). PSA & DICT. https://psa.gov.ph/statistics/nicths/node/1684077807

Pizarro, M. D., Caballes, D. G., & Vianzon, J. R. (2024). Digital literacy of elementary teachers and its relation to performing their various school roles amidst COVID-19 pandemic. Journal of Interdisciplinary Perspectives, 2(2). https://ejournals.ph/article.php?id=22459

Radio Free Asia. (2024, December 12). In divided Myanmar, graduates of a parallel education system struggle for recognition. https://www.rfa.org/english/myanmar/2024/12/12/myanmar-nug-university-12122024/

Rahman, A., & Freeman, A. (2025). Education in conflict and crisis in 2035: Twelve trends and five scenarios for how the future might unfold [Technical Report]. EdTech Hub. https://doi.org/10.53832/edtechhub.1126

Refugees International. (2026, January 29). "No one cares about us anymore": How U.S. aid cuts have intensified the crisis for women and girls in Afghanistan. https://www.refugeesinternational.org/reports-briefs/no-one-cares-about-us-anymore/

Sam, S. (2023, April 27). Unlocking the potential of a digital education at MLE schools. UNICEF Cambodia. https://www.unicef.org/cambodia/stories/unlocking-potential-digital-education-mle-schools

SEAMEO & FIT-ED. (2026). An analysis of teacher professional development systems in Southeast Asia: Regional report. SEAMEO Secretariat and Foundation for Information Technology Education and Development. https://elibrary.seameo.org/viewdetail/content/3827

SEAMEO INNOTECH. (2025, February 21). SEAMEO INNOTECH joins forces with DepEd to revolutionize Philippine education through AI. https://www.seameo-innotech.org/seameo-innotech-joins-forces-with-deped-to-revolutionize-philippine-education-through-ai/

Seo, J. (2023). Digital transformation of education: The case of South Korea [Background paper prepared for the Global Education Monitoring Report 2023]. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000387833

Shen, X., et al. (2025). Cloud for Youth: An implementation research of cloud-based solutions for bridging the digital divide in rural China. British Journal of Educational Technology. https://bera-journals.onlinelibrary.wiley.com/doi/10.1111/bjet.70037

Thinley, S., Hayat, A., Thang, S., Mazari, H. (2024). EdTech in Cambodia: A Rapid Scan. EdTech Hub. https://docs.edtechhub.org/lib/Z7XKA7E8/download/7E2W97HI/Thinley%20et%20al.%20-%202024%20-%20EdTech%20in%20Cambodia%20A%20Rapid%20Scan.pdf

UDISE+. (2023). Unified District Information System for Education Plus 2022-23. Ministry of Education, India. https://udiseplus.gov.in

UNESCO & CEI. (2023). Technology in education: A case study on Singapore [Background paper prepared for the Global Education Monitoring Report 2023]. UNESCO.

UNESCO & SEAMEOLEC (2023). Technology in education: A case study on Indonesia [Background paper prepared for the Global Education Monitoring Report 2023]. UNESCO.

UNESCO GEM (2025). AI textbooks to arrive in Korea -- the good, the bad, and the ugly. https://world-education-blog.org/2025/01/03/ai-textbooks-to-arrive-in-korea-the-good-the-bad-and-the-ugly/

UNESCO GEM and SEAMEO. (2023). Technology in education: A case study on Cambodia [Background paper prepared for the Global Education Monitoring Report 2023]. UNESCO. ED/GEMR/MRT/2023/SA/P1/05

UNESCO GEM. (2026). Philippines country case study. UNESCO. https://www.unesco.org/gem-report/en/2026-gem-report-country-case-studies/philippines

UNESCO International Centre for Higher Education Innovation. (2025, November 21). ICHEI courses empower 324,000 teachers in Kazakhstan with AI. UNESCO-ICHEI. https://en.ichei.org/en/news/information/1962.html

UNESCO. (2020). Cambodia: Digital education is here to stay. IIEP-UNESCO. https://www.iiep.unesco.org/en/articles/cambodia-digital-education-here-stay

UNESCO. (2024). Cambodia launches its first competency framework on Digital, Media and Information Literacy. UNESCO. https://www.unesco.org/en/articles/cambodia-launches-its-first-competency-framework-digital-media-and-information-literacy-empower

UNICEF & SEAMEO. (2024). SEA-PLM 2024 main regional report: Children's learning in 6 Southeast Asian countries. UNICEF & SEAMEO-SEA-PLM Secretariat. https://www.seaplm.org/index.php/sea-plm-2024/regional-results-2024

UNICEF & UNESCO. (2025). Afghanistan education situation report 2025. https://articles.unesco.org/sites/default/files/medias/fichiers/2025/10/Afghanistan%20Education%20Situation%20Report%202025.pdf

UNICEF Myanmar. (2025). Learning. UNICEF. https://www.unicef.org/myanmar/Learning

UNICEF. (2025). Learning interrupted: Global snapshot of climate-related school disruptions in 2024. UNICEF. https://www.unicef.org/reports/learning-interrupted-global-snapshot-2024

Victor, M. L. (2025). Towards inclusion of indigenous peoples in education planning: Viable practices and challenges [Presentation]. Department of Education, Philippines/World Bank. https://thedocs.worldbank.org/en/doc/80eb3648451121814942b7ccaba8c782-0090012025/original/Day-2-DepEd-Ma-Lourie-Victor.pdf

Wang, C., Aburizaiza, H., Abutaleb, K., Ameen, N., & Barrett, M. (2023). Technology-driven education reform in Indonesia. https://repositori.kemendikdasmen.go.id/30538/1/Indonesias-K-12-Education-Quality-Improvement-English-05122023.pdf

World Bank. (2024). Philippines: Project for learning upgrade support (P503991). World Bank. https://documents1.worldbank.org/curated/en/099110424010085064/pdf/P50399112f46b90218eff15af37de4ba38.pdf

World Bank. (2025). The World Bank Cambodia Basic Education Improvement Project (P508313): Program document. World Bank. https://documents1.worldbank.org/curated/en/099011325044024749/pdf/P508313-a9c132f6-8cea-46e7-8380-d3eeccafc798.pdf

Yang, H. M., & Yi, J. Y. (2025, March 18). Implementing EdTech at scale: 3 lessons from Korea for digital transformation. Inter-American Development Bank. https://www.iadb.org/en/blog/education/implementing-edtech-scale-3-lessons-korea-digital-transformation

Zhao, H., & Wang, Q. (2026). Use of AI in Singapore education. In Handbook of Asian educational innovation. Springer. https://link.springer.com/rwe/10.1007/978-981-96-3901-4_5-2

Zubairi, A., Khalayleh, A., Baloch, I., Mazari, H., Kaye, T., & Groeneveld, C. (2022). Pakistan digital learning landscape analysis. EdTech Hub, UNICEF. https://doi.org/10.53832/edtechhub.0093

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Chapter 5

Future Pathways for Smart Education in Europe: from Emerging Trends to Strategic Action

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Chapter 5 Future Pathways for Smart Education in Europe: from Emerging Trends to Strategic Action

Introduction

This chapter examines how AI is transforming education in Europe and what these developments imply for the future of Smart Education. It presents the current state of AI adoption, analyses emerging practices across educational sectors, and explores future pathways for integrating AI into learning ecosystems. Europe's response is shaped by a strong commitment to human-centred, trustworthy, and inclusive AI, reflected in a growing body of policies, institutional strategies, and practical initiatives.

The chapter is organised into three parts. Section 1 presents a regional profile of Smart Education in Europe, examining the current state of AI adoption, its benefits, structural implications, risks, and overall maturity. Section 2 analyses illustrative case studies from institutions, schools, and national systems, identifying emerging good practices and interpreting them through the Smart Education indicator framework. Section 3 explores future developments through probable, possible, and preferred scenarios and formulates policy recommendations for advancing human-centred AI ecosystems in education.

Regional Profile and Status

Current status

Smart Education in Europe is evolving rapidly as part of the wider digital transformation of society, driven by Artificial Intelligence (AI), and particularly GenAI tools such as ChatGPT. European education is increasingly using AI tools to improve teaching and learning, assessment, and administration, while trying to ensure that these technologies are used safely, ethically, and effectively.

At the same time, AI adoption remains highly uneven across Europe. Differences in infrastructure, digital readiness, institutional capacity, and policy implementation mean that some countries and institutions are progressing quickly, while others are still at an early stage of exploration. As a result, Europe presents a mixed picture: strong innovation exists alongside significant variation in implementation and maturity.

Higher education

Across Europe, universities are increasingly exploring the use of AI in teaching, learning, assessment, and administrative processes. Interest in AI has grown rapidly since the emergence of GenAI tools, with many institutions investigating how these technologies can improve student engagement, learning outcomes, and institutional efficiency (EUA, 2026).

However, the adoption of AI across European higher education remains uneven. The landscape is characterised by disparate initiatives and varying levels of maturity with no common approach to implementation. While some institutions have advanced AI strategies and practices, others are still in an exploratory phase. These differences are largely influenced by variations in digital infrastructure, institutional capacity and governance readiness (Stracke et al., 2024).

Evidence from the ADMIT project by EADTU, involving institutions in 11 European countries, confirms this diversity. While some universities have integrated AI into course and curriculum design, assessment, and institutional strategies, many remain at an early stage where AI use is largely experimental and driven by individual staff initiatives or small pilot projects (Koçdar et al., 2024). Structured training, institutional policies, and organisation-wide strategies are often still limited.

The ADMIT literature review (October 2024–July 2025) indicates that higher education is rapidly transitioning from experimental to routine use of GenAI. Whereas AI use was still tentative before 2025, now studies show everyday integration. At the same time, concerns about academic integrity and critical thinking have intensified, as increasing evidence suggests that excessive reliance on AI may undermine independent learning and require institutions to redesign assessment approaches. Despite AI's potential to improve inclusion, issues of accessibility, bias, and the digital divide remain largely underexplored, with only modest progress reported. Meanwhile, universities are gradually replacing AI bans with formal policies and guidelines, but these responses are often inconsistent, reactive, and rarely co-designed with students and staff (Bektik et al., 2025).

A wider sector analysis reflects also the gap between growing interest and systematic implementation. Many universities are developing AI guidelines and governance frameworks, but their focus often remains on regulatory compliance, ethics, and risk management rather than full pedagogical integration (EUA, 2026). The classification of education as a high-risk sector under the EU AI Act has increased universities' awareness of the need for robust governance, transparency, accountability, and risk management when implementing AI in education (European Union, 2024).

Overall, the European higher education landscape is dynamic but fragmented. While frontrunner institutions have already embedded a structured and institution-wide integration of AI, many universities are still moving from exploration and experimentation towards more coherent and systematic implementation. Throughout this transition phase, institutions are addressing main pedagogical, ethical, and regulatory challenges.

School education (primary and secondary levels)

The variability in primary and secondary education reflects many of the trends observed in higher education. While most European countries consider AI a strategic priority, implementation remains uneven and is often limited to pilot initiatives rather than system-wide adoption

Evidence from European Schoolnet's 2025 analysis of 23 education systems confirms this uneven landscape. Although nearly all countries have identified AI as a strategic priority, only a limited number have progressed to applying AI in key areas such as assessment. Some education systems have already integrated AI literacy into curricula and launched structured pilots, whereas others are still at an exploratory stage. Across Europe, strong emphasis is placed on the responsible use of AI, including student safety, data protection, ethical considerations, and the mitigation of potential risks associated with AI technologies (European Schoolnet, 2025).

Teacher capacity is widely recognised as a key enabler of successful AI integration. Consequently, many policies focus on equipping teachers and school leaders with the skills, knowledge, and guidance needed for translating policy ambition into classroom practice. As a result, the European school landscape can be characterised by high levels of ambition combined with gradual and carefully managed implementation, where innovation is balanced with attention to educational quality, inclusion, and equity (European Schoolnet, 2025; Villar-Onrubia et al., 2025).

Insights from the European Commission's Joint Research Centre (JRC) further reinforce this picture. GenAI is increasingly influencing classroom practices by supporting personalised learning, learner engagement, and innovative teaching approaches. At the same time, important challenges remain, including concerns about bias, misinformation, ethical concerns, and uneven levels of preparedness among schools (Villar-Onrubia et al., 2025).

A key conclusion of the JRC analysis is that existing approaches to digital competence are no longer sufficient. The report calls for a redefinition of AI literacy that integrates technical understanding of AI with critical, ethical, and pedagogical dimensions. The JRC highlights that AI is beginning to reshape how learners access, interpret, and apply information, thereby influencing cognitive processes and patterns of learning. While this creates new opportunities for more deeper, personalised and inclusive learning, strengthening educator capacity and embedding human-centred and responsible AI use are identified as essential conditions for ensuring that GenAI contributes positively to education systems rather than reinforcing existing inequalities.

To support this transition at system level, the European Commission and OECD have developed the AI Literacy (AILit) Framework for primary and secondary education, providing guidance on when and how AI should be used in educational contexts, as well as when its use should be limited. By offering practical learning scenarios and a clear progression model, the framework supports schools in embedding AI literacy across subjects and preparing learners for higher education and employment (European Commission & OECD, 2026).

Lifelong learning and adult education

AI is increasingly reshaping lifelong learning and workforce development across Europe. European policies recognise lifelong learning as essential for responding to digital transformation, AI-driven labour market change, and evolving skills requirements. The Digital Education Action Plan and the European Skills Agenda emphasises reskilling, upskilling, micro-credentials, and lifelong learning as key mechanisms for strengthening Europe's competitiveness in a digital economy (European Commission, 2020a; European Commission, 2020b).

These ambitions are reinforced through the Digital Europe Programme, which invests more than €8.1 billion in AI, cybersecurity, advanced digital skills, and technology adoption (European Commission, 2026d). However successfully adopting AI means not only investing in technology but also in educational systems capable to promote AI literacy, ethical awareness and lifelong learning.

Likewise, the State of the Digital Decade 2025 report points out that digital skills, infrastructure and inclusive access are key enablers of Europe's digital future and Smart Education environment Collectively, these developments are a signal that digital readiness and human capacity are core foundations to ensure AI-driven transformation (European Commission, 2026c).

Despite strong policy support, important challenges remain. Many adults still lack basic digital skills, and participation in lifelong learning varies across regions and socio-economic groups. Consequently, AI-driven transformation may widen inequalities if access to learning opportunities remains uneven (Council of the European Union, 2023).

Frameworks such as DigComp 3.0 and the EU AI Act increasingly position AI literacy as a key competence for employability, active citizenship, and lifelong learning (JRC, 2026; European Union, 2024). At the same time, the European Agenda for Adult Learning stresses the importance of accessible and inclusive learning opportunities, particularly for disadvantaged groups (Council of the European Union, 2021, 2023).

Evidence from Cedefop indicates that a growing share of the European workforce is already using AI, increasing the need for continuous upskilling and reskilling throughout working life (Cedefop, 2025a). Promising developments include digital credentials, skills intelligence systems, workplace learning, lifelong guidance, and targeted support for low-skilled adults (Cedefop, 2023; Cedefop, 2026a). Looking ahead, AI is expected to enable more personalised, flexible, and learner-centred lifelong learning ecosystems that strengthen the alignment between education and labour market needs (Cedefop, 2025b).

Potential Benefits of AI in Education (What May Be Gained)

The integration of AI into education already offers important benefits across all educational sectors. AI supports the development of more accessible, personalised, and adaptive learning environments. In schools, intelligent tutoring systems and GenAI tools enable differentiated instruction and greater learner engagement. In higher education, AI is increasingly used to support student-centred learning design, critical thinking, and metacognitive skills. In lifelong learning, AI-powered platforms provide flexible and self-paced learning opportunities aligned with the diverse needs of adult learners (European Commission, 2020; Villar-Onrubia et al., 2025).

AI also has significant potential to expand equitable access to education. Open learning platforms, micro-credentials, and digital learning systems enable broader participation, particularly for non-traditional learners and adults seeking reskilling opportunities. European policy frameworks position lifelong learning and AI literacy as important mechanisms for reducing skills gaps and promoting social inclusion (Council of the European Union, 2021; European Commission, 2020).

In addition, AI contributes to a stronger alignment between education and labour market needs. Evidence from Cedefop shows that AI is reshaping workplace practices and skill requirements, increasing demand for both advanced and transversal competences such as digital literacy, critical thinking, and adaptability. In response, education systems are increasingly integrating AI literacy and labour-market-relevant competences into curricula and training pathways (Cedefop, 2025a).

Finally, AI can improve efficiency by supporting administrative tasks, data analysis, and learning support functions, allowing educators to dedicate more time to teaching, mentoring, and student development.

Structural Transformations (What may be Reshaped)

Beyond incremental change, AI is driving structural transformation within education systems.

Course and curriculum design is increasingly incorporating AI literacy as a core competence. integrating technical, critical and ethical dimensions of AI such as the AI Literacy (AILit) framework (OECD & European Commission, 2026). Not only generic, but also discipline-specific AI competences are integrated in course and curriculum design to enable professional and responsible use of AI in future practice.

Assessment practices are being reconsidered. AI challenges traditional assessment models based on knowledge reproduction, leading institutions—particularly in higher education—to explore new forms of evaluation incorporating higher-order skills such as critical reflection, problem-solving, knowledge production and contextual applications. (EUA, 2026; Koçdar et al., 2024).

AI supports blended and online learning models that facilitate flexible lifelong learning pathways. Education is increasingly shaped by broader ecosystems involving education providers, industry and community organisations, often through micro-credentials and other flexible learning opportunities. This reflects a growing shift towards multi-stakeholder Smart Education ecosystems (Cedefop, 2023).

These developments suggest that AI is not simply introducing new tools into existing systems. Rather, it is reshaping the structure and organisation of education itself.

What may be at risk

Despite its potential benefits and transformations, AI also presents significant risks that require careful management.

A major concern is fairness and bias. AI systems used in education may reinforce existing inequalities when they rely on biased data or poorly designed algorithms. This risk is particularly significant where AI implementation is still experimental and governance frameworks are not yet fully developed (Villar-Onrubia et al., 2025).

Closely related are challenges concerning data privacy and protection. The increasing reliance on learner data in AI-driven systems raises concerns regarding data security, ownership, and ethical use. While EU frameworks such as the GDPR and AI Act provide strong regulatory safeguards, institutional capacity to implement these requirements varies significantly across systems.

Issues of the accountability and transparency are also critical. As AI tools are increasingly used, questions arise regarding responsibility for outcomes, the explainability of AI decisions, and the role of human oversight. The classification of education as a high-risk sector under the AI Act reflects these concerns and underscores the need for robust governance mechanisms.

Trust is equally important. Many educators and learners express concerns about over-reliance on AI, the accuracy of AI-generated information, and the impact of AI on academic integrity. Without sufficient guidance, support, and training, these concerns may reduce willingness to adopt AI-based approaches.

Addressing these challenges requires strong governance frameworks and effective institutional leadership.

Maturity, Strengths, and Challenges of Smart Education in Europe

The Smart Education ecosystem in Europe can best be described as moving from development towards consolidation. Awareness of AI is high, policy frameworks are well established, and innovation is widespread. However, implementation remains uneven across countries, sectors, and institutions. Higher education is moving toward more structured and embedded AI adoption, whereas school education and lifelong learning are still in a phase of experimentation and gradual scaling. This indicates that Europe has moved beyond the initial exploratory stage but has not yet reached full systemic maturity.

Several strengths are clearly visible. Europe has made considerable progress in learner-centred teaching (PF1), with AI increasingly supporting personalised and adaptive learning. Strong policy leadership (PF4) provides a clear strategic direction, supported by robust European policy frameworks such as the Digital Education Action Plan, the AI Act, and ethical guidelines for AI in education. Investment in teacher development (CF3) is recognised as essential for implementation.

At the same time, important challenges remain. Access to digital infrastructure and high-quality learning environments (PF3) remains unequal. AI-supported assessment practices (PF2) are still developing and require further work to ensure fairness, transparency, and reliability. Concerns regarding privacy, bias, accountability, and trust (CF2) continue to require attention.

This characterisation reflects a strong foundation for Smart Education in a region where strategic vision, ethical awareness, and policy coherence are well advanced, but where translating these ambitions into consistent, large-scale educational practices remains an ongoing challenge. The next phase of development will depend on strengthening institutional capacity in terms of infrastructure and AI enhanced teaching and learning, accelerating implementation at course and curriculum level, and ensuring that innovation is accompanied by inclusive, equitable, and trustworthy governance mechanisms.

> "The next stage of Smart Education requires moving beyond experimentation toward system-wide, human-centred AI integration that combines pedagogical innovation with robust governance, teacher capacity, equity, and trustworthy AI ecosystems."

In-Depth Case Studievs

This section analyses selected examples of AI integration in European education. The cases illustrate regional trends, innovations, challenges, and effective practices across higher education, school education, and national systems, interpreted through the Smart Education indicator framework.

Examples of good practice

Good practices demonstrate how AI is being integrated at institutional, sectoral, and national levels. Together, they show at each level the importance of governance, ethical implementation, AI literacy, pedagogical design, and teacher development.

Higher education

KU Leuven (Belgium)

KU Leuven represents one of Europe's most comprehensive institutional responses to GenAI. Following the emergence of ChatGPT, the university established an interdisciplinary working group that developed university-wide guidelines for students, teaching staff, researchers, and support services, supported by Leuven.AI, KU Leuven's multidisciplinary AI institute (Leuven.AI, 2025; KU Leuven, 2026).

Its AI strategy is built around five principles: respect legal frameworks, take responsibility for your input and your output, remain critical, be transparent about your use, and choose the right tool for the right task. The guidelines are updated regularly and have become a reference for other institutions (KU Leuven, 2026).

At course and programme level, learning goals are reviewed to ensure they remain aligned with developments in the professional field. Existing goals may be revised and new ones added. In some cases, students also need to learn without using GenAI, for example when developing foundational skills or knowledge, or when GenAI is unavailable or inappropriate. Teaching staff therefore design future-oriented learning activities that incorporate AI, such as analysing and correcting AI-generated data, while also preserving activities without AI to support deep knowledge acquisition (KU Leuven Learning Lab, 2026).

The university complements governance with extensive capacity-building initiatives. Its "AI Bootcamp" provides foundational AI knowledge to all students and staff, while seminars, digital resources, and collaboration with Leuven.AI and the Flemish AI Academy (VAIA, 2026) support continuous professional development. The KU Leuven case illustrates how governance, training, and innovation can be integrated into a system-wide institutional strategy (KU Leuven, 2026).

Open and Distance Teaching Universities: Universitat Oberta de Catalunya (UOC) and UniDistance Suisse

Open universities increasingly use AI to scale personalised learning, automate learner support, and enhance online delivery. Core applications include AI-assisted course design, adaptive learning environments, AI tutoring, predictive analytics, and automated assessment and feedback (EADTU, 2025).

The Universitat Oberta de Catalunya (UOC) aims to become an AI-native university through its uoc.Ωmega initiative, embedding AI across teaching, learning, student services, research, and administration (UOC, 2026). The initiative supports personalised learning pathways, learner support, and AI competence development while maintaining commitments to quality assurance, inclusion, and responsible AI use. As a fully online university serving large and diverse learner populations, UOC illustrates how open universities can serve as laboratories for scalable AI innovation while maintaining a strong commitment to learner-centred pedagogy, quality assurance, and inclusion.

Similarly, UniDistance Suisse provides practical pedagogical guidance for educators. Its ChatGPT guide focuses on three principles: understanding AI capabilities and limitations, integrating AI pedagogically to support learning processes, and redesigning assessment to ensure fairness and robustness. It positions AI as a complement rather than a replacement for teaching and learning and emphasises transparency and responsible use (UniDistance Suisse, 2024). Concrete examples include using AI tools to support instructional design and shifting traditional assessment practices toward formats requiring reflection, critical thinking and contextualization (Jullien et al., 2025). Importantly, the guide is designed as a living document, evolving alongside technological advancements and ensuring ongoing institutional support.

Together, these examples demonstrate how higher education institutions are moving beyond isolated AI experiments towards institution-wide integration supported by governance, professional development, and pedagogical innovation.

School education

At school level, a diverse range of innovative practices illustrates how AI can be applied in concrete classroom contexts to enhance learning, inclusion, and skills development.

De Wereldreiziger (Belgium)

In Belgium, the primary school De Wereldreiziger (Antwerp) demonstrates how AI tools can support highly diverse, multilingual classrooms. With more than 70 languages spoken among pupils, the school faces significant challenges in ensuring equal learning opportunities. AI-powered applications such as reading and language tools (e.g. Microsoft Reading Progress and Immersive Reader) are used to provide individualised feedback on reading performance, including pronunciation, speed, and comprehension. These tools allow pupils to practise at their own pace while enabling teachers to monitor progress and identify learning gaps more efficiently. Evidence shows that such applications can accelerate learning progress and improve motivation, helping pupils overcome language barriers and develop foundational skills more effectively (Welsch, 2025; VRT NWS, 2023).

Generation AI (Finland)

In Finland, initiatives such as the Generation AI project illustrate a different but complementary approach, focusing on learning about AI rather than only learning with AI. The project delivers free and open educational resources(OER)for learning about AI at K-12. Tools are developed in a Finnish national strategic research program called Generation AI (2022-2028). Pupils design and experiment with simple AI applications, such as image classifiers or rule-based exercises, enabling them to understand how algorithms work and to reflect critically on bias and limitations. This hands-on approach fosters creativity, critical thinking, and a deeper understanding of how algorithms work, strengthening their AI literacy (Kahila, 2024; Vartiainen, 2024).

European Projects

European projects further illustrate how AI can be integrated systematically into education systems. Each of them covers multiple partner institutions European-wide.

AI4EDU (Conversational AI Assistant for teaching and learning) develops conversational AI assistants such as Study Buddy interacting with students in natural language (text and voice) as a mentor, tutor and test facilitator; and Teacher Mate, assisting teachers with instructional design and monitoring student progress, generating and administering assessments (AI4EDU Consortium, 2024).

AI4T (Artificial Intelligence for and by Teachers) focuses on teacher professional development through MOOCs, toolkits, and collaborative learning communities. The project helps teachers integrate AI responsibly and effectively into classroom practice. By developing context-specific applications, AI4T contributes to the professionalisation of AI use in schools and supports teachers in navigating both opportunities and risks associated with AI (AI4T Project, 2024).

AI4STEM (AI for STEM Education) and AIware (Software for All and by All) support the integration of AI into school education through curriculum frameworks, learning resources, and practical classroom applications. AI4STEM targets learners aged 8–16 and combines AI, Internet of Things (IoT), programming, and STEM education through hands-on projects. AIware focuses on secondary education and provides AI curriculum models, competency frameworks, certification schemes, and policy guidelines to support the systematic adoption of AI in schools (AISTEM Consortium, 2023; AIware Consortium, 2023).

Together, these examples demonstrate that AI in school education is developing along multiple complementary pathways: personalisation and inclusion (e.g. De Wereldreiziger); AI literacy and active learning (e.g. Generation AI); systemic innovation and scalability (e.g. AI4EDU, AI4T).

Lifelong learning

A representative example of AI-enabled lifelong learning is Germany's AI Campus (KI-Campus), a national digital learning platform that provides free online courses, micro-credentials, and AI literacy programmes for learners, professionals, companies, and public administrations. The platform supports continuous upskilling and reskilling in areas such as GenAI, machine learning, and AI governance, illustrating how AI can enable flexible, personalised, and scalable lifelong learning pathways aligned with emerging labour market needs (Stifterverband, 2026).

A second example is the Flanders AI Academy (VAIA), a lifelong learning initiative within the Flemish AI policy programme. VAIA brings together universities, universities of applied sciences, training providers and employer organisations to strengthen AI literacy and AI skills among professionals. Through a free online platform, it offers access to more than 1,500 AI courses from over 500 providers, By matching learners, employers, and training providers, VAIA makes lifelong learning on AI more accessible for the workforce in an increasingly AI-driven economy (VAIA, 2026).

National strategies

Finland: AI in education and national strategy

Finland is widely recognised as a leading example of systemic AI integration in education, characterised by a strong focus on AI literacy and inclusivity. Its national strategy promotes broad access to AI knowledge, aiming to prepare all citizens for participation in a digital society.

A flagship initiative is the Elements of AI free online courses, developed by the University of Helsinki and Reaktor, which provides free and accessible AI education at scale. With over one million participants globally, it demonstrates how AI literacy initiatives can support lifelong learning and workforce development (University of Helsinki & Reaktor, 2025).

Finland's approach reflects a coherent national ecosystem. AI competences are integrated across curricula, teacher education, and higher education. National policy frameworks such as Work in the Age of Artificial Intelligence emphasise skills development, innovation, and ethical AI use. Recent guidelines provide legal and pedagogical support for educational institutions (Ministry of Economic Affairs and Employment of Finland, 2019).

Germany

Germany's national AI strategy places education and skills development at the centre of its digital transformation agenda. The strategy promotes the integration of AI and digital skills across all levels of education. Key priorities include teacher training, AI research, interdisciplinary collaboration, and links between education, industry, and society. Governance is structured through cooperation between federal ministries and of the 16 federal states (the Länder), combining national frameworks with regional implementation. Policy instruments such as the AI Strategy, AI Action Plan, and Digital Strategy provide long-term direction and funding (BMBF, German Federal Government, 2018–2023).

The AI Campus initiative illustrates how policy is translated into practice through digital learning ecosystems and open educational resources (Stifterverband. (2026).

Overall, both Finland and Germany demonstrate how national leadership, curriculum development, teacher capacity building, and ethical governance can support systematic AI integration.

A detailed comparative overview of national and European AI-in-education strategies is provided in Appendix A Table 5.1.

AI integration in a Smart Education indicator perspective

The integration of AI across European education systems reveals a multi-level transformation towards Smart Education, spanning both higher education and school-level contexts. While institutional and national case studies demonstrate strong innovation and experimentation, the analysis shows varying degrees of maturity across the Performative Features (PF) and Constructive Features (CF) (Huang et al., 2024).

Performative Features (PF): the "What" of Smart Education

PF1: Student-centred teaching

Across both higher education and school systems, student-centred teaching (PF1) emerges as the most advanced dimension of AI integration. In higher education, institutions such as KU Leuven and UniDistance Suisse, promote the critical and responsible use of GenAI, positioning tools like ChatGPT as supports for reflection, idea generation, and autonomous learning. At school level, similar patterns are visible, though often through more experiential and exploratory approaches. For example, in Finland, pupils participate in hands-on AI design activities, while in Belgium AI applications support multilingual learners through personalised instruction. EU initiatives such as the Artificial Intelligence for Education project (AI4EDU) further extend student agency by enabling self-paced learning through conversational AI tools such as Study Buddy. National systems such as Finland and Germany reinforce this approach by embedding AI literacy, critical thinking, and problem-solving into curricula, ensuring students develop the capacity to engage actively with digital technologies. Taken together, these developments illustrate a strong and consistent shift toward learner-driven pedagogies across all levels of education.

PF2: Holistic learning assessment

In contrast, holistic learning assessment (PF2) represents an area of transition rather than consolidation. In higher education, the emergence of GenAI has already triggered substantial reform. KU Leuven and UniDistance are actively redesigning assessment models to prioritise higher-order competences such as critical reflection, contextual reasoning, and ethical judgement, moving beyond traditional knowledge reproduction. At school level, similar changes are emerging but remain less mature. AI tools such as the Teacher Workmate in AI4EDU support formative assessment, while applications like Reading Progress enable continuous monitoring of student performance. However, these practices are still largely experimental, and traditional assessment models remain dominant in most school systems. National systems such as Finland and Germany align assessment frameworks with competencies relevant to the digital age.

PF3: Smart learning environments

The development of smart learning environments (PF3) shows strong progress across both sectors, although with differences in scale and integration. Higher education institutions such as KU Leuven have developed comprehensive digital ecosystems, including AI platforms, training programmes, and learning resources that support both staff and students. UniDistance contributes through structured guidance for educators. At school level, AI-enabled learning environments are increasingly visible through adaptive learning platforms, chatbots, and digital assistants. Nevertheless, implementation remains uneven, particularly at school level, where infrastructure and capacity constraints limit large-scale deployment. National initiatives such as Finland's Elements of AI platform extend access to digital learning environments to broader society. Germany complements this with large-scale investments in infrastructure, including research centres and the AI Campus.

PF4: Organizational leadership

The role of organizational leadership (PF4) is central to explaining these differences in maturity. In higher education, institutions such as KU Leuven demonstrate strong leadership through structured governance mechanisms, including interdisciplinary working groups and regularly updated AI guidelines. UniDistance similarly provides clear pedagogical guidance, translating emerging technologies into actionable strategies for educators. At school level, leadership is more variable. While countries such as Finland demonstrate strong system-level governance, many school systems rely on project-based innovation, often driven by EU-funded initiatives such as AI4EDU, AI4STEM, and AIware. As a result, leadership capacity remains uneven, particularly at the institutional level. At national level, Finland and Germany illustrate coherent policy-driven leadership, supported by curriculum alignment and inter-ministerial coordination.

PF5: Educational equity

Across both sectors, educational equity (PF5) emerges as a key priority, although with significant variation in implementation. In higher education, Finland's commitment to AI literacy for all and Germany's focus on inclusion highlight efforts to ensure broad access to AI-related competences. Institutions such as KU Leuven contribute by offering widely accessible training opportunities, while UniDistance emphasises fairness in assessment design. At school level, equity gains are particularly visible in targeted initiatives. The Belgian case demonstrates how AI can address linguistic diversity and support disadvantaged learners, while adaptive learning platforms and AI-supported tools provide personalised support for students with different needs. However, despite these promising examples, equitable access remains uneven, as it depends heavily on infrastructure, resources, and institutional readiness.

Constructive Features (CF): the "How" and Enablers

CF1: Cultural development

At the level of enabling conditions, cultural development (CF1) shows strong convergence across education levels. In higher education, institutions such as KU Leuven and UniDistance promote cultures of responsible and transparent AI use, encouraging critical reflection among both staff and students. At school level, this cultural transformation is particularly visible in practices that combine learning with ethical reflection. Finnish initiatives integrate discussions on bias and societal impact, while early childhood projects introduce children to AI through inquiry-based exploration. Overall, both sectors are moving toward a shared model of human-centred, ethically grounded digital education. National systems such as Finland and Germany embed ethical awareness and digital literacy within broader educational frameworks.

CF2): Data security and governance

In contrast, data security and governance (CF2) remain areas of uneven development. Higher education institutions demonstrate stronger alignment with regulatory frameworks such as the EU AI Act and GDPR, with explicit guidance on transparency, accountability, and ethical use. KU Leuven, for example, integrates legal and ethical considerations into institutional policies. At school level, however, governance practices are less mature. While awareness of ethical and legal issues is increasing, most initiatives remain focused on pedagogical innovation rather than operationalising governance frameworks. This creates a gap between policy requirements and institutional capacity. This can be overcome by national systems providing structured governance models.

CF3: Teacher capacity building

Teacher capacity building (CF3) stands out as the most critical enabler across both sectors. In higher education, institutions such as KU Leuven offer structured professional development through bootcamps, workshops, and ongoing training programmes, while UniDistance provides continuously updated guidance for educators. At school level, EU-funded projects play a central role. Initiatives such as AI4T, Generation AI, and AI4STEM provide teachers with practical tools, open resources, and training opportunities to integrate AI into classroom practice. Despite strong progress at project and institutional level, scaling these efforts to entire systems remains a key challenge. National systems reinforce this through formal integration of AI into teacher education and professional development.

CF4: Sustainable education reform

The dimension of sustainable education reform (CF4) shows moderate but increasing progress. In higher education, institutions such as KU Leuven demonstrate long-term integration of AI into teaching and research, supported by iterative policy development. UniDistance contributes through dynamic, evolving guidance resources. At school level, sustainability is more dependent on project-based innovation, although national systems such as Finland show strong alignment between curriculum, teacher training, and policy. EU-funded initiatives provide frameworks and models for scaling, but long-term sustainability remains contingent on funding continuity and systemic integration. Finland and Germany link AI in education to broader societal and economic strategies, ensuring policy coherence and long-term investment.

CF5: Cross-sector collaboration

Finally, cross-sector collaboration (CF5) is a strong and growing feature of AI integration across both levels. In higher education, institutions collaborate with industry, research centres, and public authorities, as illustrated by KU Leuven's partnerships with Leuven.AI and the Flemish AI Academy. Recently, the Flemish government provided funding to universities to develop AI in schools nation-wide. At school level, collaboration is largely project-driven, with initiatives such as AI4EDU involving multi-country partnerships across Europe. These collaborations facilitate knowledge exchange and innovation. National systems such as Finland and Germany foster collaboration through coordinated innovation ecosystems.

Overall synthesis

Taken together, the analysis reveals a consistent pattern across education levels. The strongest progress is observed in student-centred teaching (PF1), smart learning environments (PF3), and teacher capacity building (CF3). At the same time, assessment systems (PF2) and organisational leadership (PF4) are undergoing gradual but incomplete transformation. The most significant challenges remain in data governance (CF2), educational equity at system level (PF5), and the scaling and sustainability of reforms (CF4).

AI integration in European education is advancing most rapidly at the level of pedagogical innovation, while systemic transformation remains uneven. The evidence suggests that the full realisation of Smart Education requires a more integrated approach that combines innovation in teaching and learning with robust governance, sustained investment, and coordinated implementation across education systems.

Future Directions and Actionable Recommendations

Across European education systems, AI is expected to evolve from today's fragmented and exploratory "messy muddle" towards more structured institutional and system-wide integration. Universities, schools, and training providers are increasingly experimenting with AI while addressing important pedagogical, ethical, and governance challenges, reflecting a sector that is still in transition rather than one that has reached maturity (EUA, 2026).

Looking ahead, new AI technologies are likely to further expand AI's educational potential. In the future, even more advanced AI systems may provide stronger support for teaching and learning, particularly in the development of advanced academic and professional AI competences, intelligent tutoring, and collaborative learning and knowledge creation. Rather than replacing educators, these developments are expected to strengthen human-AI partnerships, leveraging AI to support learning while maintaining the indispensable contribution of educators in providing professional expertise, instructional leadership, pedagogical judgment, and ethical accountability (OECD, 2026).

This section will distinguish between probable developments, which point to gradual and incremental integration, possible scenarios, which explore more transformative but uncertain innovations alongside significant risks, and preferred futures, which outline a strategic, human-centred direction for aligning AI with educational values.

Finally, the actionable recommendations address system and institutionallevel conditions that are essential for the successful implementation of these pedagogical approaches.

Probable futures — Gradual Integration

Incremental Course and Curriculum Adaptation

The most probable future is characterised by the gradual integration of AI into existing institutional frameworks. Across Europe, institutions are prioritising transversal AI literacy, ethics, and responsible AI use, while discipline-specific curriculum reform progresses more slowly due to the complexity of revising courses and professional competency frameworks (Raes, 2025; Villar-Onrubia et al., 2025). AI is therefore likely to be introduced first as a transversal competence across institutions before becoming embedded in disciplinary and professional practice in fields such as healthcare, engineering, journalism, accounting, translation, and teacher education. Initiatives such as the University of Helsinki's Elements of AI illustrate this focus on broad AI literacy as a foundation for future curriculum transformation (University of Helsinki & Reaktor, 2025).

AI Tutors for Personalised Learning

A second probable development is the growing use of AI-supported tutoring systems that enable personalised learning pathways. These systems are expected to evolve beyond simple answer-generation tools and provide more targeted learning support through formative assessment and adaptive feedback, based on AI-patterns found in learning analytics. They can significantly enhance personalisation by identifying learning gaps, suggesting timely interventions and by helping learners progress at their own pace. As such, they represent an important step towards more student-centred, data-informed, and adaptive learning environments (EADTU, 2025b).

AI-Supported Collaboration Within Existing Learning Designs

A third development concerns AI-supported collaborative learning within existing pedagogical models. Educational institutions are increasingly exploring how AI can facilitate peer feedback, collaborative writing, shared problem-solving, and structured classroom discussions. In this scenario, AI primarily acts as a facilitator that supports organisation, communication, and dialogue, while teachers remain responsible for orchestrating collaborative learning processes. Evidence suggests that AI can strengthen collaborative activities, but the Joint Research Centre (JRC) also warns that excessive individual reliance on AI may reduce interaction with peers and teachers if pedagogical guidance is lacking (Villar-Onrubia et al., 2025). Initiatives such as the Virtual International Collaboration (VIS) network demonstrate how AI-enhanced digital environments can support collaboration and intercultural learning across institutions and countries.

Possible Futures — Extended Innovation Scenarios

Embedded AI-Driven Course and Curriculum Transformation

A more transformative future emerges if AI becomes deeply embedded in disciplinary knowledge and professional practice. In this scenario, AI becomes an integral component of curriculum design. Learning objectives, disciplinary content, teaching approaches, and assessment methods are redesigned around human–AI collaboration in the discipline. Students would not only master disciplinary knowledge but also work effectively with intelligent systems within their discipline, apply AI in professional contexts and learn how to critically evaluate AI-generated processes and outputs.

Such transformation will fundamentally alter education. Domain-specific AI competence becomes a core element of academic and professional expertise rather than merely a transversal competence. Engineering programmes may focus on AI-supported design and modelling, legal education may integrate AI-enhanced jurisprudence analysis, and language programmes may emphasise collaboration with advanced translation and communication systems. Initiatives at institutions such as Karolinska Institutet (Sweden), Erasmus MC (Netherlands), and Charité Berlin (Germany) illustrate how AI-assisted diagnostics and medical imaging are already stimulating discussions about future medical competencies and curriculum redesign (Izquierdo-Condoy, 2026; van Sassen, 2025; Charité, 2025).

This aligns also with evidence by the European Commission's JRC, highlighting the need to redefine AI literacy in secondary schools in relation to the subject area and each discipline. AI may redefine pedagogical approaches across diverse subjects in humanities as well as in STEM subjects (JRC, Vilar Onrubia, 2025).

AI Tutors as Learning Companions

A second possible future is the evolution of AI tutors into advanced learning companions that support learners through structured learning activities based on their prior knowledge and learning progress. Drawing on learning analytics, Vygotsky's zone of proximal development and evidence-based design approaches such as the 4C/ID instructional design model, these systems offer learning activities aligned with learners' prior knowledge, scaffold learning, and manage cognitive load (Vygotsky, 1978; Van Merriënboer, 2024). In this scenario, the AI-tutor moves beyond delivering feedback and becomes an active guide in disciplinary thinking and problem solving.

The AI tutor becomes really a companion when it opens a conversation with the learner, reflecting conversational theories of learning (Laurillard, 2002; Pask, 1975), encouraging reflection, self-explanation, deeper engagement with subject matter, critical thinking and metacognition. The tutor no longer simply recommends exercises or provides feedback but is an active guide through disciplinary thinking processes. Evidence suggests that pedagogically designed AI tutors have the potential to strengthen conceptual understanding, critical thinking, and deeper learning outcomes.

Although developed outside Europe, Khanmigo is increasingly being explored in European pilot projects because of its use of Socratic questioning and guided reasoning rather than direct answer generation. Such initiatives illustrate a possible future in which AI tutors function as learning companions and reasoning partners rather than information providers (Khan Academy, 2026).

AI as an Intelligent Facilitator of Collaborative Learning

A third scenario involves AI becoming an intelligent facilitator of collaborative learning and knowledge creation. In this role, AI becomes an intelligent facilitator of dialogue, collective inquiry, collaborative problem-solving by helping learners formulate questions, challenge assumptions, identify misconceptions, and explore alternative perspectives. AI thus acts a mediating agent within learning communities, that strengthens teamwork, interdisciplinary collaboration, and collective knowledge construction.

The European Commission Universities Initiative (ECIU) currently connects hundreds of institutions across Europe through transnational educational collaboration. These alliances increasingly experiment with virtual collaboration spaces, digital teamwork, challenge-based learning, and shared learning environments that can serve as platforms for AI-supported collaborative learning (European Commission, 2026b; EUA, 2024). The ECIU promotes challenge-based learning in which multinational student teams work collaboratively on real-world challenges in partnership with companies and public organisations (ECIU, 2025).

Preferable futures: Human-Centred AI Learning Ecosystems

In the preferred future, AI is embedded within human-centred learning ecosystems in which technology strengthens rather than replaces the core functions of education. Evidence increasingly points to hybrid human-AI models as the most effective approach, combining the scalability and adaptability of AI with the pedagogical expertise, judgement, and responsibility of educators. AI becomes an important enabler of personalised learning, collaborative knowledge creation, and lifelong learning, while teachers remain responsible for direct instruction, curriculum interpretation, pedagogical judgement, assessment, learner motivation, ethical development, mentoring, and community building. AI therefore augments rather than replaces the teaching function (Córdova-Esparza, 2025).

AI-supported Course and Curriculum Renewal

Within course and curriculum development, AI supports strategic curriculum renewal by helping educators identify emerging competences, generate resources, design authentic learning tasks, and embed AI-related skills within disciplinary and professional programmes. However, educational goals, curriculum priorities, content selection, and the development of deep disciplinary understanding remain the responsibility of teachers and curriculum developers. AI supports curriculum innovation, but professional educators remain the architects of educational design and instructional decision-making (Villar-Onrubia et al., 2025).

AI Tutors as an Immersive Learning Guide

In intelligent tutoring, AI evolves into an evidence-informed learning guide that combines conversational AI, learning analytics, and adaptive learning design. These systems support personalised learning pathways, adaptive feedback, formative assessment, self-regulation, and metacognitive development (Laurillard, 2002; Van Merriënboer et al., 2024; OECD, 2026).

AI can explain concepts, generate examples, provide additional practice opportunities, monitor progress, and identify learning difficulties, but it cannot assume responsibility for instructional decisions or learning outcomes. Teachers remain responsible for instruction, expert modelling, diagnosing misconceptions, pedagogical judgement, assessment decisions, and determining the appropriate level of guidance. AI strengthens instructional capacity, while teachers remain the primary instructional leaders.

Emerging European initiatives, including adaptive learning research at the Open University of the Netherlands and EADTU's vision of AI-supported learner-centred education, demonstrate how AI tutoring can be embedded within broader pedagogical frameworks (EADTU, 2025b).

AI-supported collaborative learning communities connected with broader ecosystems

Another distinctive feature of this future is the emergence of AI-supported collaborative learning communities connected with broader ecosystems. AI strengthens dialogue, teamwork, peer learning, and collective knowledge construction within learning communities. At the same time, AI helps connect learners with expertise, resources, and learning opportunities across institutional and geographical boundaries, enabling more networked, collaborative, and lifelong forms of learning. In this vision, AI acts as a catalyst for collective intelligence by supporting knowledge sharing, co-creation, and participation in broader communities of practice (EADTU, 2025a).

However, the development of meaningful learning communities and their connection to broader learning ecosystems remains fundamentally dependent on human leadership and oversight. Teachers remain responsible for providing instructional leadership, disciplinary expertise, ethical oversight, and the social foundations that enable meaningful learning and knowledge creation (EADTU 2025a; AI2PI Erasmus+ Teacher Academy, 2025; OECD, 2026).

In summary, the preferred future is not an AI-driven education system but a human-guided AI ecosystem in which AI supports curriculum innovation, personalised learning, intelligent tutoring, and collaborative learning, while teachers remain central as instructional leaders, curriculum interpreters, pedagogical decision-makers, mentors, and guardians of educational quality and values (European Commission, 2026a; EUA, 2026).

Policy recommendations for advancing human-centered AI ecosystems in European education

System Level policies

Building Sovereign AI Ecosystems

The successful implementation of human-centred AI in education requires the development of sovereign European AI ecosystems that allow educational institutions to retain control over data, algorithms, and pedagogical design. This aligns with European priorities on digital sovereignty, trustworthy AI, and the protection of public values in education (European Commission, 2025; EUA, 2026). Governments should therefore invest in interoperable learning platforms, educational data spaces, open AI models, and robust governance frameworks that ensure transparency, privacy protection, accountability, and ethical AI use. Such investments support secure, scalable, and autonomous AI adoption while reducing dependence on commercial providers and is aligned with European democratic values and the public mission of education (European Commission, 2025; EUA, 2026).

Multilingual, AI-supported education systems

The creation of multilingual, AI-supported education systems represents another critical policy direction. AI-based translation technologies and adaptive content delivery can significantly reduce language barriers and broaden access to education across Europe, supporting the objectives of the European Education Area (European Commission, 2020). Integrating multilingual AI tools into learning platforms and assessment processes enhances participation for diverse learner populations and strengthens cross-border collaboration. These developments contribute directly to equity and inclusion while reinforcing the cultural and social dimension of learning, particularly in increasingly diverse and international learning environments. At school level, AI-supported multilingual tools contribute directly to equity and inclusion, supporting migrant and multilingual learners participate in diverse classroom set-ups and reducing the risk of early learning gaps.

Scaling AI-driven credentialing and lifelong learning systems

In parallel, there is a strong need to scale AI-driven credentialing and lifelong learning systems. European initiatives on micro-credentials and digital credentials demonstrate the potential for more flexible, modular, and personalised learning pathways (European Commission, 2022; Cedefop, 2026b). AI can enable learners to build individualised trajectories across formal, non-formal, and informal contexts and support continuous assessment and validation of learning outcomes. These developments directly contribute to student-centred learning and personalisation. They support sustainable reform by strengthening the alignment between education systems and labour market needs, while improving learner agency and employability.

In open and distance universities, the physical dimension of education is significantly reduced in favour of greater flexibility and personalisation, particularly to meet the diverse needs of lifelong learning students. This encourages these institutions to actively experiment with scalable AIbased solutions that can support large and heterogeneous learner populations. They are particularly important as testbeds for such innovation, given their strong focus on flexibility, personalisation, and lifelong learning (EADTU, 2025).

Institutional level: the development of fully hybrid institutions

Given the complementary roles of AI and educators, education systems should evolve towards fully hybrid institutions that integrate physical, digital, and AI-supported learning environments. Such institutions enable seamless transitions between online and face-to-face learning while leveraging AI not only for technological innovation but also to enhance learning quality, inclusion, personalised learning, and lifelong learning.

To realise these preferred AI-supported futures, a number of institutional enablers are required (see also: Laurillard, 2015):

1.Leadership support: institutional leaders provide the vision, strategy, resources, and teacher incentives needed to develop hybrid learning environments and encourage educational innovation.

2.Trustworthy AI governance: establish robust governance frameworks that ensure transparency, privacy protection, human oversight, academic integrity, inclusiveness, and ethical AI use.

3.Digital infrastructure: invest in interoperable learning environments that integrate AI tutoring, learning analytics, collaboration tools, and secure access to educational data across institutions and countries.

4.AI literacy and capacity building: strengthen AI literacy among educators and learners through continuous professional development and learning opportunities.

5.Shared resources and innovation networks: provide access toOER, AI-supported learning design tools, and collaborative (subject-related) networks to facilitate innovation and reduce development costs.

6.Curriculum integration: embed AI within disciplines and curricula by integrating AI-methods, tools, and competences into subject-specific learning processes and outcomes.

7.Authentic learning: align learning activities with real-world practice through AI-supported problem-solving, simulations, project work, and professional decision-making.

8.Pedagogically grounded AI tutors: implement AI tutors as companions that combine instructional design principles and conversational AI to support formative feedback, personalisation, self-reflection, critical thinking and metacognitive development while complementing the role of educators.

9.Collaborative learning ecosystems: promote interoperable AI-supported learning environments that foster dialogue, teamwork, peer learning, collective inquiry, knowledge co-creation, and collaboration across institutions, sectors, and countries.

10.Assessment innovation: redesign assessment systems to evaluate higher-order competences such as critical thinking, problem-solving, creativity, collaboration, and the responsible use of AI.

Continuous evaluation and research: invest in ongoing research and evaluation to generate evidence on effective AI design principles, implementation strategies, and educational outcomes, thereby informing policy and practice.

Conclusion

Europe has made substantial progress in adopting AI for education, supported by strong policy frameworks and growing institutional innovation, but implementation remains uneven across countries, sectors, and institutions.

The next stage of Smart Education requires moving beyond experimentation toward system-wide, human-centred AI integration that combines trustworthy AI ecosystems with pedagogical innovation, robust governance, teacher capacity, and equity.

The preferred future is not an AI-driven education system but a human-guided and interoperable AI ecosystem in which AI supports curriculum innovation, intelligent tutoring and personalisation, and interconnected collaborative learning, while teachers remain central as instructional leaders, curriculum interpreters, pedagogical decision-makers, mentors, and guardians of educational quality and values.

Achieving this vision requires sovereign European AI infrastructures, strong governance, hybrid learning institutions, teacher capacity building, multilingual learning environments, and flexible lifelong learning systems. The future of Smart Education therefore depends not only on technological innovation but on the ability of education systems to harness AI in ways that strengthen human agency and the public mission of education while remaining firmly aligned with European democratic and educational values (European Commission, 2025; EUA, 2026; OECD, 2026).

References

ADMIT. (2024–2026). Reports, ethical guidelines and tools on generative AI in higher education. Erasmus+ project by EADTU. https://admit.eadtu.eu

AI4EDU Consortium. (2024–2026). Conversational AI assistant for teaching and learning. https://ai4edu.eu

AI2PI (2025, AI Literacy for Europe's Teachers. Erasmus+ teacher Academy. https://www.ai2pi.eu

AI4T Project. (2024). Artificial intelligence for and by teachers (AI4T). https://www.ai4t.eu

AIware Consortium. (2023). AIware. https://aiwareproject.eu

AISTEM Consortium. (2023). Introducing the 5 big ideas in artificial intelligence using Internet of Things in STEM education. https://ai4stem.erasmusplus.website/data/files/AI4STEM_Project_Presentation_EN.pdf

Bektik, D., Edwards, C., Whitelock, D.& Antonaci, A.(2025). Use of LLM tools within higher education. ADMIT Erasmus+ project by EADTU. Zenodo.DOI: 10.5281/zenodo.17747509

BMBF (Federal Ministry of Education and Research). (2023). Artificial intelligence action plan. https://www.bmbf.de

Cedefop. (2023). The future of vocational education and training in Europe: Volume 4. Delivering lifelong learning. Publications Office of the European Union. https://doi.org/10.2801/726631

Cedefop. (2025a). Skills empower workers in the AI revolution: First findings from Cedefop's AI skills survey. https://www.cedefop.europa.eu/en/publications/9201

Cedefop. (2025b). Preparing for 2040: Four AI-powered scenarios for the future of continuing skills development. Publications Office of the European Union. http://data.europa.eu/doi/10.2801/2114554

Cedefop. (2026a). Adult learning: Empowering adults through upskilling and reskilling. https://www.cedefop.europa.eu/en/projects/adult-learning-empowering-adults-through-upskilling-and-reskilling

Cedefop. (2026b). Digital tools for the portability of learning outcomes and micro-credentials. https://www.cedefop.europa.eu/de/projects/digital-tools-portability-learning-outcomes/events

Charité – Universitätsmedizin Berlin. (2025). Institut für Künstliche Intelligenz in der Medizin. https://ikim.charite.de

Council of the European Union. (2021). Council resolution on a new European agenda for adult learning 2021–2030. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021G1214(01)

Council of the European Union. (2023). Council recommendation on improving the provision of digital skills and competences in education and training (C/2024/1030). https://eur-lex.europa.eu/eli/C/2024/1030/oj

Córdova-Esparza, D.-M. (2025). AI-powered educational agents: Opportunities, innovations, and ethical challenges. Information, 16(6), Article 469. https://doi.org/10.3390/info16060469

ECIU University. (2025). We actively drive innovation by connecting regions, research, and external stakeholders. https://www.eciu.eu

EADTU, European Association of Distance Teaching Universities. (2025a). The envisioning report for empowering universities 2025 (9th ed.). Zenodo. https://zenodo.org/records/15908735

EADTU, European Association of Distance Teaching Universities. (2025b). Personalisation of education: Enhancing equity, learner agency and academic success. Zenodo. https://doi.org/10.5281/zenodo.17279059

European Commission. (2020a). Digital education action plan 2021-2027. https://education.ec.europa.eu/focus-topics/digital-education/actions

European Commission. (2020b). European skills agenda for sustainable competitiveness, social fairness and resilience. https://employment-social-affairs.ec.europa.eu

European Commission. (2022). A European approach to micro-credentials for lifelong learning and employability. https://education.ec.europa.eu/education-levels/higher-education/micro-credentials

European Commission. (2025). State of the Digital Decade 2025 report: Keep building the EU's sovereignty and digital future. Directorate-General for Communications Networks, Content and Technology. https://digital-strategy.ec.europa.eu/en/library/state-digital-decade-2025-report

European Commission. (2026a). Guidelines on the ethical use of artificial intelligence and data in teaching and learning for educators (updated ed.). Publications Office of the European Union. https://doi.org/10.2766/9548952

European Commission. (2026b). European Universities alliances and their partners. https://education.ec.europa.eu/education-levels/higher-education/european-universities-initiative/map

European Commission. (2026c). State of the Digital Decade 2026 package. European Commission. https://digital-strategy.ec.europa.eu/en/policies/2026-state-digital-decade-package

European Commission. (2026d). The Digital Europe Programme (DIGITAL). Shaping Europe's Digital Future. https://digital-strategy.ec.europa.eu/en/activities/digital-programme

European Schoolnet. (2025). Artificial intelligence in school education: An overview of policy priorities and initiatives across 23 education systems. http://www.eun.org/documents/411753/12100059/Agile+collection+of+Information+vol.6-11.12.25_Updated.pdf/d0e683fa-7c71-4913-ae1d-69acbb12598b

European Union. (2024). Regulation (EU) 2024/1689 of the European Parliament and of the Council laying down harmonised rules on artificial intelligence (Artificial Intelligence Act). Official Journal of the European Union. https://eur-lex.europa.eu/eli/reg/2024/1689/oj/eng

European University Association. (2025). The role of universities in the European Union's ambitions for AI. https://eua.eu/publications/policy-input/the-role-of-universities-in-the-european-unions-ambitions-for-ai.html

European University Association. (2024). European University Alliances. https://www.eua.eu/our-work/topics/european-universities-alliances.html

European University Association. (2026). Adopting

AI that serves the needs and values of universities. https://www.eua.eu/publications/reports/adopting-ai-that-serves-the-needs-and-values-of-universities.html

Federal Government of Germany (BMBF). (2018–2023). Artificial intelligence. https://www.bmftr.bund.de/EN/Research/EmergingTechnologies/ArtificialIntelligence/artificialintelligence_node.html

Huang, R. H., Liu, D. J., Kanwar, A. S., Zhan, T., Yang, J. F., Zhuang, R. X., Liu, M. Y., Adarkwah, M., & Li, Z. S. (2024). Global understanding of Smart Education in the context of digital transformation. Global Smart Education Network & Smart Learning Institute of Beijing Normal University.

Izquierdo-Condoy, J. S., Arias-Intriago, M., Montero Corrales, L., & Ortiz-Prado, E. (2026). Artificial intelligence in medical education: Transformative potential, current applications, and future implications. JMIR Medical Education, 12, e77127. https://doi.org/10.2196/77127

Jullien, J.-M., Carbonel, H., Shylo, U., Gaillard, F., & Belardi, A. (2025). UseGenAI: A tool for transparent use of generative AI in learning activities and assessment. UniDistance Suisse. https://unidistance.ch/en/research/research-project/usegenai-ein-tool-fuer-den-transparenten-einsatz-von-genai-beim-lernen-und-bei-leistungsnachweisen

Kahila, J., Vartiainen, H., Tedre, M., Arkko, E., Lin, A., Pope, N., Jormanainen, I., & Valtonen, T. (2024). Pedagogical framework for cultivating children's data agency and creative abilities in the age of AI. Informatics in Education. https://doi.org/10.15388/infedu.2024.15

Khan Academy. (2026). Khanmigo for educators. https://www.khanacademy.org/khan-for-educators/khanmigo-for-educators

Koçdar, S., Uçar, H., Aydın, C. H., Uotinen, V., Waselius, T., & Antonaci, A. (2024). Report on trends in policies and practices on the use of LLMs and generative AI in higher education. ADMIT, Erasmus+ project by EADTU. Zenodo. https://doi.org/10.5281/zenodo.14501248

KU Leuven. (2026). Generative AI at KU Leuven: Guidelines for responsible use. https://www.kuleuven.be/english/genai

KU Leuven Learning Lab. (2026). Learning goals in times of GenAI. KU Leuven. https://www.kuleuven.be/english/apply/education/leuvenlearninglab/support/genai/teaching-design-and-evaluation

Laurillard, D. (2002). Rethinking university teaching: A conversational framework for the effective use of learning technologies. Routledge.

Laurillard, D. (2015). Thinking about blended learning: A paper for the Thinkers in Residence programme. In G. Van der Perre & J. Van Campenhout (Eds.), Higher education in the digital era: A thinking exercise. Royal Flemish Academy of Belgium for Science and the Arts. https://kvab.be/sites/default/rest/blobs/77/tw_blended-learning_en.pdf

Leuven.AI. (2025). AI education and research initiatives at KU Leuven. https://ai.kuleuven.be

Ministry of Economic Affairs and Employment of Finland. (2019). Leading the way into the age of artificial intelligence. https://ai-watch.ec.europa.eu/countries/finland/finland-ai-strategy-report_en

OECD. (2026). OECD digital education outlook 2026: Exploring effective uses of generative AI in education. OECD Publishing. https://doi.org/10.1787/062a7394-en

OECD & European Commission. (2026). Empowering learners for the age of AI: An AI literacy framework for primary and secondary education. OECD Publishing. https://doi.org/10.1787/65cd27d4-en

Pask, G. (1975). Conversation, cognition and learning: A cybernetic theory and methodology. Elsevier Scientific Publishing Company.

Pastor-Vargas, R., et al. (2025). Report on policies relating to the use of LLM tools within higher education. ADMIT, EADTU. https://doi.

org/10.5281/zenodo.17864908

Raes, A. (2025). Onderwijs van de toekomst: In synergie met AI? KU Leuven.

Stifterverband. (2026). AI Campus: The free learning platform for artificial intelligence. https://ki-campus.org/en

Stracke, C. M., Griffiths, D., Pappa, D., et al. (2024). Analysis of artificial intelligence policies for higher education in Europe: Country reports. Zenodo. https://doi.org/10.5281/zenodo.14811951

UniDistance Suisse. (2024). Guide on the use of ChatGPT for educators. https://unidistance.ch/en/edudl-resources/article-edudl/a-teachers-guide-to-chatgpt-and-remote-assessments

Universitat Oberta de Catalunya. (2026). UOC launches uoc.Ωmega to become an AI-native university. https://www.uoc.edu/en/news/2026/ai-native-university-uoc-omega-mission-uoc

University of Helsinki & Reaktor. (2025). Elements of AI. https://www.elementsofai.com

VAIA. (2026). Flemish AI Academy. Vlaamse AI Academie. https://www.vaia.be/en/about-vaia

Van Merriënboer, J. J. G., Kirschner, P. A., & Frèrejean, J. (2024). Ten steps to complex learning: A systematic approach to four-component instructional design (4th ed.). Taylor & Francis.

van Sassen, M. (2025). Enhancing learning and reducing workload with AI-driven personalized feedback in clinical reasoning education and case-based assessments of ErasmusArts 2030 curriculum. https://www.eur.nl/en/educational-innovation/news/enhancing-learning-and-reducing-workload-ai-driven-personalized-feedback-clinical-reasoning

Vartiainen, H., Kahila, J., Tedre, M., López-Pernas, S., & Pope, N. (2024). Enhancing children's understanding of algorithmic biases in and with text-to-image generative AI. New Media & Society. https://doi.org/10.1177/14614448241252820

Villar-Onrubia, D., Cachia, R., Rietz, C., Feltrero, R., Niemi, H., Hallissy, M., & Reuter, R. (2025). Generative artificial intelligence in secondary education: Uses and perceptions from the perspective of early adopters across five EU Member States (JRC144345). Publications Office of the European Union. https://doi.org/10.2760/8636621

VRT NWS. (2023). Basisschool De Wereldreiziger gebruikt AI om leesvaardigheid te verbeteren. https://www.vrt.be/vrtnws/nl/2023/04/19/basisschool-de-wereldreiziger-in-antwerpen-microsoft-apps/

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.

Welsch, C. (2025). In de klas de wereld verbinden: Hoe AI in een Belgische school grenzen verlegt. Microsoft. https://news.microsoft.com/source/emea/2025/02/in-de-klas-de-wereld-verbinden-hoe-ai-in-een-belgische-school-grenzen-verlegt/?lang=nl

Appendix A

To complement the case analyses, the Table 5.1 below provides a comparative overview of national and European approaches to AI in education. The table summarises key policy priorities, ethical principles, implementation measures, and financing mechanisms across selected European countries and the European Union. Although approaches differ in governance structures and investment levels, several common patterns emerge. Most countries emphasise AI literacy, teacher capacity building, curriculum integration, lifelong learning, and responsible AI use. Ethical principles such as transparency, human oversight, inclusion, and data protection are consistently reflected across national strategies, while implementation is supported through a combination of public investment, research funding, pilot projects, and public–private partnerships. The overview illustrates the growing convergence of European education systems around human-centred and trustworthy approaches to AI adoption.

Table 5.1 Summary of the EU Countries' approaches in relation to the regulations of the use of AI'

Country	AI in Education Strategy & Policy (Summary)	Ethical Approach	Actions	Financing Mechanisms
European Union (EU AI Act)	EU AI Act classifies education/vocational AI systems as 'high-risk' with strict oversight; GenAI requires transparency, labeling, and copyright compliance; promotes innovation via sandboxes; ensures human supervision.	Risk-based, transparency, human oversight, non-discrimination, data protection.	Classification of AI risk, mandatory transparency, labeling deepfakes, sandboxes for innovation.	EU regulatory framework; national implementation via compliance funding and sandboxes.
France	Human-centered approach; strong governance (Ministry of Education + DNE); promotion of Digital Educational Content (DEC); funding via Edu-Up and P2IA; teacher autonomy with vouchers; support for EdTech; data protection.	Human-centered, fairness, inclusiveness, data privacy, ethics-by-design.	DEC strategies (France 2030, 2023–27), teacher vouchers, public-private partnerships, training programs.	Edu-Up fund (€70k/ project), P2IA competitions, strong EdTech public funding (>45% companies).
Portugal	Education and skills central; AI and digital literacy from school to higher ed; MOOCs, summer schools, >20 graduate programs; universities to expand research; adaptive curricula; lifelong learning and reskilling.	Human-centered, inclusion, equity, responsible AI use.	MOOCs, AI clubs, summer schools, new degree programs, adaptive curricula, lifelong learning.	Government support for MOOCs, EU and national funding for programs, reskilling initiatives.

Country	AI in Education Strategy & Policy (Summary)	Ethical Approach	Actions	Financing Mechanisms
Austria	National AI strategy with 85-measure roadmap; €4.07bn investment; pilots in 100 schools; AI Literacy Landscape (350+ courses); strong governance (RTR Service Desk); focus on teacher training, equitable access, infrastructure.	Ethical oversight, teacher empowerment, equitable access, governance of bias.	Pilots in 100 schools, AI Literacy Landscape, RTR Service Desk, systemic governance.	€4.07bn roadmap investment, EU recovery and cohesion funds, national pilot funding.
Belgium	Federal + regional mix; Flanders (Smart Education @ Schools, i-Learn, DigiJump Action Plan); Wallonia (DigitalWallonia4.ai, TRAIL); Brussels (Innoviris funding); focus on AI literacy, curricula integration, lifelong learning.	Ethical use, inclusion, lifelong learning, data protection.	Regional initiatives (Smart Education, DigiJump, DigitalWallonia4.ai), higher ed integration, Innoviris support.	Regional and federal funding, Innoviris (Brussels), DigiJump Plan resources.
Germany	Education, research, and skills at the core; AI integrated across curricula; teacher training prioritized; AI research hubs and centers of excellence funded; ethical, inclusive approach; interministerial governance (BMBF + Länder).	Ethical, inclusive, democratic values, human rights focus.	Integration into curricula, creation of AI hubs, teacher training, and centers of excellence.	Federal and Länder funding, national research centers, university grants.
Finland	Global model; AI literacy for all (Elements of AI MOOC); integration into national curriculum; higher ed expands AI programs across disciplines; teacher training; ethical, human-centered AI adoption.	Human-centered, trust, inclusiveness, transparency.	Elements of AI MOOC, national curriculum integration, teacher training, higher ed programs.	Government funding for Elements of AI, partnerships with universities and industry.

Country	AI in Education Strategy & Policy (Summary)	Ethical Approach	Actions	Financing Mechanisms
Denmark	2024 strategy: three principles (responsible use, competitiveness, public sector leadership); four measures (AI Taskforce, AI in Society Center, Danish language models, open data); schools/universities benefit from resources & ethical frameworks.	Responsible use, accountability, transparency, ethical governance.	AI Taskforce, AI in Society Center, Danish language models, open-source text data.	Government funding, RTR AI Service Desk, national budget for AI infrastructures.
Hungary	National AI strategy: AI literacy, STEM, curriculum integration; teacher training and upskilling; creation of AI degree programs and research hubs; focus on lifelong learning, reskilling, ethical adoption, infrastructure investment.	Human-centric, ethical adoption, alignment with EU values.	Curriculum reform, teacher upskilling, AI research hubs, vocational training, reskilling programs.	Government funding for curricula reform, AI labs, PPPs, infrastructure investment.
Ireland	AI Strategy Refresh 2024: focus on skills, talent, and research; National AI Research Nexus; digital upskilling/reskilling (Skillnet, Springboard+); AI literacy and inclusion; ethical alignment with EU AI Act; female participation in digital.	Trustworthy AI, ethical and inclusive, aligned with EU AI Act.	Skillnet, Springboard+, apprenticeships, AI Research Nexus, female participation initiatives.	Skillnet Ireland, Springboard+, SFI Research Centres, apprenticeships, EU funds.
Lithuania	AI strategy 2019: skills, education, research as pillars; AI integrated into curricula; universities develop AI programs; workforce reskilling; teacher training; lifelong learning; ethical, human-centric adoption.	Human-centric, ethics in curricula, privacy protection.	Curriculum integration, AI programs at universities, lifelong learning initiatives, teacher training.	Government and EU funding for curricula, university programs, and infrastructure investment.

Country	AI in Education Strategy & Policy (Summary)	Ethical Approach	Actions	Financing Mechanisms
Luxembourg	AI 2030 strategy under digital sovereignty; promotes AI literacy, training, and sovereign infrastructures; universities supported with funding and collaboration; AI chatbot for education; ethical, transparent adoption; inclusive focus.	Human-centered, transparency, inclusiveness, accountability.	AI chatbot for education, digital infrastructures, university-industry collaboration, open data.	Government funding, sovereign infrastructures (MeluXina), EU partnerships.
Malta	AI strategy 2019: education and talent central; AI literacy at all levels; expand AI degrees, research, and partnerships; teacher training; lifelong learning; ethical, inclusive adoption; innovation ecosystems.	Ethical, human-centered, aligned with EU principles.	Embedding AI literacy in curricula, AI degree programs, teacher training, lifelong learning.	Government funding, industry partnerships, public grants, innovation ecosystems.
Netherlands	Government-wide vision on generative AI: focus on AI literacy for all; integration into curricula (technical, ethical, social aspects); teacher empowerment and training; interdisciplinary university research; transparency, human oversight, experimentation.	Transparency, accountability, human oversight, inclusivity.	AI literacy campaigns, teacher training, interdisciplinary research, transparent governance.	Government support for AI research and literacy, university funding, EU alignment.

Source: Pastor-Vargas et al. (2025), Report on policies relating to the use of LLM tools within higher education (Research Report No. 2.3), Zenodo, CC BY-SA 4.0.

6

Chapter 6

Artificial Intelligence and Smart Education in Latin America and the Caribbean: Regional Dynamics and System Transformation Through the Case of Rio De Janeiro

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Chapter 6 Artificial Intelligence and Smart Education in Latin America and the Caribbean: Regional Dynamics and System Transformation Through the Case of Rio De Janeiro

Introduction: AI and the Systemic Transformation of Education

Artificial Intelligence (AI) is increasingly reshaping the ways in which education systems are conceptualized, organized, and experienced. In contemporary educational contexts, AI should not be understood merely as a technological innovation, but as a structural force influencing curriculum design, pedagogical practices, assessment systems, and institutional governance. As Luckin et al. (2016) argue, AI enables adaptive, personalized, and data-informed learning processes, allowing education systems to respond more effectively to individual learner needs. Similarly, Holmes, Bialik, and Fadel (2019) emphasize that AI can transform both teaching and learning through intelligent tutoring systems, learning analytics, and new forms of assessment.

In Latin America and the Caribbean (LAC), this transformation unfolds unevenly. The region is characterized by structural inequalities, diverse institutional capacities, and heterogeneous policy trajectories. As a result, AI integration does not follow a unified pathway; rather, it reflects differentiated patterns of adoption shaped by governance capacity, digital infrastructure, and policy coherence (Ortiz et al., 2025).

This chapter therefore analyzes the current status of Smart Education in Latin America and the Caribbean through two complementary moves. The first is a regional analytical mapping structured through three lenses: what may be gained, what may be reshaped, and what may be at risk. The second is a system-level case study of the Ginásio Educacional Tecnológico (GET) model in the municipal network of Rio de Janeiro, Brazil. Together, these two levels of analysis connect macro-level regional dynamics with a concrete example of large-scale educational transformation.involving institutions in 11 European countries, confirms this diversity. While some universities have integrated AI into course and curriculum design, assessment, and institutional strategies, many remain at an early stage where AI use is largely experimental and driven by individual staff

> "A particularly significant insight derived from the table is the weak correlation between income level and educational AI maturity. Countries with similar economic classifications display very different levels of progress. This suggests that while material resources matter, they are insufficient to explain transformation. Governance quality, continuity of policy, institutional learning, and implementation capacity appear to be more decisive than income alone."

> "Latin America and the Caribbean cannot be described either as digitally stagnant or as uniformly advanced. Rather, the region presents a condition of: 'fragmented but accelerating transformation.'"

Regional Overview: Asymmetries, Trajectories, and Structural Conditions

The current landscape of AI in education across LAC is marked by deep asymmetries in policy design, institutional capacity, and levels of implementation. While a limited number of countries have advanced toward more systemic integration, many others remain at early or fragmented stages.

Three broad patterns can be identified across the region. First, system-driven models, such as Brazil, are characterized by large-scale public digital education ecosystems, national and subnational platform infrastructures, and more coordinated strategies for teacher development and digital curriculum integration. In Brazil, the National Digital Education Policy, established by Law No. 14,533/2023, integrates digital inclusion, school-based digital education, professional development, and research and innovation, while national connectivity programmes seek to expand the pedagogical use of digital technologies across public basic education (Brazil, 2023; Ministry of Education, n.d.). Second, policy-driven models, such as Chile and Costa Rica, explicitly connect AI, digital transformation, and human capital development through national strategies. Chile has translated its National Artificial Intelligence Policy into an inter-ministerial action plan that includes educational resources for teachers and students, AI-related teacher education, curriculum revision, and measures to strengthen digital and technological competencies (Ministry of Science, Technology, Knowledge and Innovation, 2021, 2024). In Central America, Costa Rica adopted its National Artificial Intelligence Strategy 2024–2027 as a framework for the ethical, safe, inclusive, and sustainable development and use of AI. The strategy gives particular emphasis to human capacities, infrastructure, and coordination among public institutions (Ministry of Science, Innovation, Technology and Telecommunications, 2024). Third, fragmented or emerging models, especially in parts of Central America and the Caribbean, rely primarily on pilot projects, externally supported training initiatives, or limited digital modernization programs.

These patterns reflect more than technological readiness. They also express broader differences in state capacity, policy continuity, coordination, and the existence of public digital ecosystems capable of sustaining innovation over time. In many countries in the region, the challenge is not only access to tools, but also the absence of integrated strategies that connect curriculum, teacher education, infrastructure, regulation, and institutional leadership.

This unevenness is also visible in how AI enters education systems. In some contexts, the entry point is pedagogical innovation; in others, it is digital administration, content platforms, teacher-support tools, or national discourse around competitiveness and future jobs. In the Caribbean, Jamaica has begun to incorporate AI and adaptive technologies into school curricula, teacher development, and workforce preparation. Government initiatives announced since 2024 also include the testing of AI tools intended to reduce part of the administrative workload faced by teachers (Jamaica Information Service, 2024; Jamaica Information Service, 2025). In still others, AI remains more aspirational than operational. These different entry points matter because they shape whether AI becomes a transformative element of educational ecosystems or remains a scattered and weakly institutionalized set of initiatives.

Analytical Lenses

What May Be Gained: opportunities and emerging benefits

The integration of artificial intelligence into education systems across Latin America and the Caribbean has begun to generate a set of significant, yet unevenly distributed, benefits, particularly in relation to personalization, efficiency, and system scalability.

One of the most transformative opportunities lies in the expansion of personalized and adaptive learning environments. AI-enabled systems allow for the continuous collection and analysis of learner data, supporting differentiated instruction and targeted interventions. In a region marked by profound educational inequalities, such capabilities offer the potential to address long-standing learning gaps by tailoring instruction to diverse learner profiles (Luckin et al., 2016; Holmes et al., 2019). Brazil's National Digital Education Policy (Law No. 14,533/2023) reflects this perspective by promoting the pedagogical use of digital technologies to support inclusion, equity, and learning opportunities that respond to different educational contexts (Brazil, 2023). Importantly, personalization in this context should not be interpreted simply as individualization, but as the systemic capacity of education systems to respond more dynamically to heterogeneous learning trajectories at scale.

AI also contributes to efficiency gains across multiple levels of the education system. At the classroom level, GenAI tools support lesson planning, feedback, and content creation, reducing administrative burdens on teachers and potentially freeing more time for pedagogical interaction (UNESCO, 2023). In Jamaica, government initiatives have begun testing AI tools designed to reduce part of teachers' administrative workload, allowing educators to devote more time to teaching and student support (Jamaica Information Service, 2025). At the system level, learning analytics can support data-informed decision-making, resource allocation, and the early identification of students at risk of disengagement or low performance (Pedro et al., 2019). In resource-constrained systems, such efficiency gains are particularly relevant, as they suggest the possibility of qualitative improvement without proportional increases in time or staffing.

A third area of potential gain relates to the development of future-oriented skills and competencies. AI-rich educational environments can promote digital literacy, computational thinking, problem-solving, creativity, and adaptability, skills that are increasingly central to debates on the future of work and lifelong learning (OECD, 2021). In several countries in the region, policy discourse has already begun to link digital education more explicitly to employability, innovation, and participation in digital economies. Chile's National Artificial Intelligence Policy and its Action Plan connect the development of AI-related competencies, digital skills, curriculum development, and teacher education to broader national goals for innovation and economic development (Ministry of Science, Technology, Knowledge and Innovation, 2024).

What May Be Reshaped: systemic and pedagogical transformation

Beyond incremental improvements, AI is contributing to a deeper reconfiguration of educational systems, affecting not only how teaching and learning occur, but also how education is organized, governed, and conceptualized.

At the pedagogical level, AI supports a shift toward more learner-centered, data-informed, and flexible models of instruction. Continuous assessment, adaptive feedback, and project-based learning environments increasingly blur the boundaries between teaching, learning, and evaluation. This transformation challenges traditional models of standardized instruction and requires a redefinition of the teacher's role, from knowledge transmitter to facilitator, designer, and mediator of learning processes. Uruguay's National Education Policy Plan 2025–2030 positions digital innovation as a strategic component of educational development and was developed in coordination with the Ceibal Centre, whose long-standing work in digital education and teacher professional development continues to support more learner-centered teaching practices across the public education system (Ministry of Education and Culture of Uruguay, 2026).

Curricula are also being reshaped. In Panama, the nationwide curriculum redesign led by the Ministry of Education integrates artificial intelligence, technology, socio-emotional competencies, and entrepreneurship into the national curriculum while supporting its implementation through collaboration with universities, educational networks, and large-scale professional development for teachers and school leaders (Ministry of Education of Panama, 2026). This reflects a broader reorientation of education toward skills and knowledge considered relevant for rapidly changing socio-economic contexts.

At the system level, governance structures are transforming. The Dominican Republic's National Digital Education Strategy illustrates this by integrating AI competencies within a comprehensive policy framework (Ministry of Education of the Dominican Republic, 2026a, 2026b).

Importantly, these reshaping processes are not uniform. They unfold unevenly across countries and within systems, reflecting differences in institutional capacity, policy coherence, and historical trajectories. As a result, the reconfiguration of education systems in the region should be understood as partial, uneven, and contested rather than linear or homogeneous.

What May Be at Risk: inequalities, governance gaps, and ethical tensions

The same processes that generate opportunities and transformation also introduce significant risks, many of which are particularly acute in the Latin American and Caribbean context.

A central concern relates to the potential amplification of existing inequalities. Access to digital infrastructure, connectivity, devices, and digital skills remains uneven across and within countries. In this context, the benefits of AI integration tend to concentrated in better-resourced schools and systems, while others remain excluded or only partially integrated. Rather than reducing inequality, AI may therefore reinforce existing disparities unless explicitly addressed through equity-oriented policies.

Brazil's National Digital Education Policy explicitly recognizes the reduction of digital inequalities as a prerequisite for the equitable integration of digital technologies into education, combining actions related to connectivity, infrastructure, digital literacy, and teacher development (Brazil, 2023).

A second major concern relates to data governance and ethical regulation. AI systems depend on the collection, analysis, and circulation of educational data, often including sensitive information about student learning, behavior, and performance. In many countries in the region, regulatory frameworks for privacy, algorithmic accountability, and platform governance remain weak or fragmented (UNESCO, 2023; Williamson, 2023). This creates risks related to surveillance, opacity, bias, and insufficient public oversight.

The growing role of global technology providers also raises questions of technological dependency and digital sovereignty (Benedikter & Cruz-Infante, 2026). In such cases, the governance of education reform may gradually shift away from public systems and toward external actors. Uruguay's long-standing public investment in the Ceibal ecosystem illustrates an alternative approach in which digital infrastructure, educational platforms, and innovation policies have been developed under sustained public leadership, strengthening national capacity for digital transformation in education (Ministry of Education and Culture of Uruguay, 2026).

There are also pedagogical risks. Over-reliance on AI systems may weaken critical engagement, reduce opportunities for deeper forms of knowledge construction, or encourage more superficial learning if not supported by strong pedagogical frameworks (Selwyn, 2019; Kasneci et al., 2023). In addition, the rapid pace of technological change may pressure systems into making high-stakes decisions in the absence of sufficient evidence or professional consensus.

Regional synthesis: structural patterns, comparative evidence, and systemic implications

The combined analysis of gains, reshaping processes, and risks reveals a region characterized not by uniform transformation, but by structured heterogeneity. This heterogeneity becomes more visible when the analytical insights developed in the previous sections are examined alongside comparative regional evidence.

To consolidate this interpretation, Table 6.1 provides a structured overview of AI adoption across countries in the region, combining sub-regional location, World Bank income levels, and qualitative assessments of AI-in-education maturity. Although the table does not aim at causal inference, it offers a comparative analytical lens through which regional variation can be interpreted more systematically.

Table 6.1 AI in Education in Latin America and the Caribbean: Comparative Overview

Country	Sub-region	Income Level	AI in Education Maturity	IITE Dimension	Notes
Brazil	South America	Upper middle	Strong	High	System-driven ecosystem
Chile	South America	High income	Strong	High	Policy-driven
Argentina	South America	Upper middle	Intermediate	Medium	Programmatic
Colombia	South America	Upper middle	Intermediate	Medium	Platform-based
Peru	South America	Upper middle	Emerging	Medium-Low	Transition
Ecuador	South America	Upper middle	Emerging	Medium-Low	Pedagogical
Paraguay	South America	Upper middle	Emerging	Low-Medium	Early-stage
Bolivia	South America	Lower middle	Low	Low	Limited evidence
Venezuela	South America	Lower middle	Low	Low	Limited evidence
Mexico	North America	Upper middle	Intermediate	Medium	Distributed
Costa Rica	Central America	Upper middle	Strong	Medium-High	Strategy-driven
Panama	Central America	Upper middle	Intermediate	Medium	Curriculum-based
Guatemala	Central America	Upper middle	Emerging	Low-Medium	Partial
Honduras	Central America	Lower middle	Low	Low	Limited evidence

Country	Sub-region	Income Level	AI in Education Maturity	IITE Dimension	Notes
El Salvador	Central America	Lower middle	Emerging	Low-Medium	Digital focus
Nicaragua	Central America	Lower middle	Low	Low	Limited evidence
Dominican Republic	Caribbean	Upper middle	Intermediate	Medium	Strategy-linked
Jamaica	Caribbean	Upper middle	Emerging	Medium-Low	Digital transition
Trinidad & Tobago	Caribbean	High income	Emerging	Medium	Training-based
Barbados	Caribbean	High income	Emerging	Medium-Low	Skills-oriented
Guyana	Caribbean	Upper middle	Emerging	Low-Medium	Pilot-based
Bahamas	Caribbean	High income	Low	Low	Limited evidence
Belize	Caribbean	Lower middle	Low	Low	Limited evidence
Suriname	Caribbean	Upper middle	Low	Low	Limited evidence
Saint Lucia	Caribbean	Upper middle	Emerging	Low-Medium	Early-stage
Grenada	Caribbean	Upper middle	Low	Low	Limited evidence

The comparative evidence reinforces three insights. *First*, there is no linear relationship between income and AI maturity; governance capacity is more decisive. *Second*, the region has multiple coexisting trajectories - from consolidated integration to incipient development. *Third*, fragmentation should be understood not as an exception, but as a defining regional condition. even in countries with higher levels of maturity, implementation remains uneven across territories, institutions, and social contexts.

The comparative patterns outlined above underscore the importance of moving beyond aggregate regional assessments to examine how Smart Education takes shape within specific systems. While cross-country analysis reveals the uneven geography of AI integration in education, it cannot fully capture how these dynamics are translated into institutional arrangements, pedagogical practice, and governance at the local level. In this respect, Brazil offers a particularly relevant context, not only because it stands out as one of the more system-driven environments in the region, but also because its internal diversity makes it possible to observe how national and subnational trajectories interact. Within this broader landscape, the municipal education system of Rio de Janeiro provides a compelling analytical lens. Its experience with the Ginásio Educacional Tecnológico (GET) model makes it possible to examine how the opportunities, transformations, and tensions identified at the regional level materialize in a large and unequal urban public system. The following section therefore turns to Rio de Janeiro not as an isolated example, but as a case through which broader regional dynamics can be observed in concrete form.

Case Study: The Ginásio Educacional Tecnológico (GET) in Rio de Janeiro

Introduction to the case and policy relevance

To complement the regional analysis and provide an evidence-based illustration of Smart Education in practice, this section examines the case of the Ginásio Educacional Tecnológico (GET) in the municipal education system of Rio de Janeiro.

The Rio de Janeiro case is particularly relevant for four reasons. First, it is embedded in one of the largest municipal school systems in the region, which gives the initiative strong policy relevance. Second, the GET model is not a standalone edtech project, but part of a broader reform agenda involving full-time schooling, curricular redesign, teacher education, and digital and media education. Third, the initiative has already undergone a process of institutional maturation, including normative consolidation and large-scale expansion. Fourth, it offers a particularly useful case for examining how Smart Education principles unfold under the constraints of an unequal urban context.

Official material shows the GET model is framed as a public policy combining pedagogical innovation, active learning, and technology-rich environments (Secretaria Municipal de Educação do Rio de Janeiro, 2026b). By March 2026, the network reached 300 GET schools serving approximately 125,000 students, with a target of 500 by 2028 (Secretaria Municipal de Educação do Rio de Janeiro, 2026c).

This expansion is not merely quantitative. It reflects a strategic attempt to position innovation as part of the municipal system's core educational model rather than as a marginal experiment. That distinction is important for Smart Education analysis, because one of the central questions in the field is whether digitally enabled innovation can be scaled and institutionalized without losing pedagogical coherence or reinforcing inequality. Rio de Janeiro offers a rare opportunity to examine this question empirically.

Institutional evolution: from experimental initiative to consolidated public policy

The institutional trajectory of the GET program is itself analytically revealing. The initiative was originally created in 2022 under the name Ginásio Experimental Tecnológico, through Decree No. 50.434, which established the program within the Municipal Secretariat of Education with the objective of promoting academic development, innovation in pedagogical approaches, and integral human development (Prefeitura da Cidade do Rio de Janeiro, 2022). At that stage, the experimental designation signaled a pilot logic: the municipality was testing a model that combined technology, innovation, and differentiated pedagogical approaches within selected full-time schools.

This status changed in 2024. Through Decree No. 53.939, the municipality formally altered the program's nomenclature from Ginásio Experimental Tecnológico to Ginásio Educacional Tecnológico, explicitly recognizing that the initiative was no longer in a pilot phase and required a name consistent with its level of institutional maturity (Prefeitura da Cidade do Rio de Janeiro, 2024). This regulatory change matters because it marks the passage from experimentation to consolidation. In policy terms, the shift signals that innovation has ceased to be a provisional exception and has become part of the system's official architecture.

The Secretariat's own public documentation confirms this evolution. The official GET webpage explains that the model began with five schools in 2022 and later expanded across the eleven Regional Education Coordinations of the city, with a long-term projection of 500 units by 2028 (Secretaria Municipal de Educação do Rio de Janeiro, 2026b). The 2025 case published by Todos Pela Educação also documents the rapid scaling of the model from five units in 2022 to 202 in 2024, presenting the Rio case as a national reference in the expansion of full-time schooling combined with pedagogical innovation (Todos Pela Educação, 2025). The later update from March 2026, marking the inauguration of the 300th GET, confirms that this trajectory of expansion continued and became a flagship element of the municipal reform agenda (Secretaria Municipal de Educação do Rio de Janeiro, 2026c).

The policy significance of this trajectory is considerable. Many digital education initiatives in Latin America remain confined to pilots, externally funded projects, or fragmented interventions that do not survive beyond a political cycle. By contrast, the GET program shows signs of institutional durability: it is regulated by decree, framed by guiding documents, embedded in curriculum and training structures, and publicly associated with municipal education strategy. From the perspective of Smart Education, this makes Rio de Janeiro not simply a case of innovation adoption, but a case of public policy institutionalization.

The pedagogical conception of the GET model

The GET model is based on premises including hands-on education, student-centred, interdisciplinary projects, intentional technology use, and continuous professional development (Secretaria Municipal de Educação do Rio de Janeiro, 2026a). The model moves away from transmissive schooling toward active and constructionist learning, drawing on Dewey, Freire, and Papert (Secretaria Municipal de Educação do Rio de Janeiro, 2026a)."

The model also emphasizes project-based and interdisciplinary learning. The Secretariat's experiential report states that the GET was designed to make schools more attractive and aligned with the realities of contemporary students, particularly in the final years of fundamental education, where disengagement, school delay, and poor learning outcomes are especially acute (Secretaria Municipal de Educação do Rio de Janeiro, 2026d). The response was to create a school model capable of integrating active methodologies, maker education, and the STEAM approach into a broader effort to make learning more relevant and effective.

More recent documents show that this pedagogical conception has evolved. The 2026 guiding document presents the model not only as STEAM-oriented, but as organized around STEAM+Cai, explicitly incorporating computation and artificial intelligence into the educational vision (Secretaria Municipal de Educação do Rio de Janeiro, 2026a). This is important because it indicates that the program is no longer limited to generic educational technology or digital culture, but is increasingly aligned with the policy and curricular agenda surrounding computation, AI, digital literacy, and media education.

Structure and enabling conditions: full-time schooling, collaboratories, actors, and governance

A central strength of the GET model is that its pedagogical ambitions are supported by a clear set of structural and organizational elements. The program is not defined only by discourse, but by concrete institutional arrangements intended to make innovation implementable at scale.

The first of these is its integration with the broader policy of full-time education. According to the Secretariat's experiential report, the GET model was conceived as part of the municipality's strategy to expand full-time schooling, which had reached 50% of the municipal network, with around 310,000 full-time enrollments, and 202 GET schools serving around 90,000 students at the time of the report (Secretaria Municipal de Educação do Rio de Janeiro, 2026d). The 2025 case study by Todos Pela Educação further shows that the expansion of full-time schooling in Rio was not accidental, but based on structured governance, territorial analysis, network reorganization, targeted infrastructure investment, and an explicit concern with equity (Todos Pela Educação, 2025). This matters because it means that the GET is not operating in isolation from time and space conditions: it is anchored in a school day and organizational form designed to make pedagogical transformation more feasible.

The second structural element is the collaboratory, described by the Secretariat as the heart of the GET model (Secretaria Municipal de Educação do Rio de Janeiro, 2026d). These are hybrid maker-oriented learning spaces equipped with a wide range of resources, including computers, robotics kits, virtual reality glasses, 3D printers, cutting tools, audiovisual kits, and even sewing machines (Secretaria Municipal de Educação do Rio de Janeiro, 2026a). The collaboratory is designed not simply as a laboratory or technology room, but as a pedagogical environment that supports collaboration, experimentation, interdisciplinary projects, and problem-solving rooted in local realities. The official webpage similarly presents the collaboratory as a space that invites the transformation of pedagogical routines and expands possibilities for collaborative education (Secretaria Municipal de Educação do Rio de Janeiro, 2026b).

The third structural element is the creation of specific actors and functions within the school. The Secretariat identifies two strategic profiles: the Professor do Projeto Integrador no Colaboratório (PIC) and the Professor Articulador (PA) (Secretaria Municipal de Educação do Rio de Janeiro, 2026a). The PIC is responsible for the curricular component linked to the collaboratory, while the PA acts as an ambassador of the GET conception inside the school, supporting colleagues in the use of equipment, active methodologies, and the integration of technology into broader curricular work (Secretaria Municipal de Educação do Rio de Janeiro, 2026a). This is a crucial feature from the perspective of system design: the municipality recognized that innovative environments do not function automatically and therefore created intermediary pedagogical roles to sustain implementation.

A fourth element is the training system. According to the documents, both PAs and PICs receive continuous training through the Secretariat, the Paulo Freire Teacher Training School, MultiRio, and external partners such as Columbia University and Stanford University (Secretaria Municipal de Educação do Rio de Janeiro, 2026d). The 2026 guidance document reinforces that training should address the pillars of the program, maker education, digital culture, computational thinking, and the intentional pedagogical use of technology, and can occur in face-to-face, online, and hybrid modalities (Secretaria Municipal de Educação do Rio de Janeiro, 2026a). Additional material submitted by the Secretariat indicates that the model includes more than 300 annual hours of training, representing a remarkable level of investment in professional development (Secretaria Municipal de Educação do Rio de Janeiro, 2026d). The program also provides structured pedagogical materials, including the GET na Prática notebooks and digital repositories of teacher-created sequences, designed to foster authorship and interdisciplinary planning (Secretaria Municipal de Educação do Rio de Janeiro, 2026d).

Finally, the GET is supported by a robust governance logic. The municipal case study published in 2025 explains that the broader expansion of full-time education in Rio was managed through a multi-level governance structure including executive, tactical, operational, and regional committees, integrating pedagogical, infrastructural, logistical, and financial decisions (Todos Pela Educação, 2025). The experiential report on the GET similarly notes that the conversion of schools into GET units follows defined stages, including school selection criteria, alignment with leadership teams, infrastructure reform, acquisition of equipment, teacher designation, and inauguration processes (Secretaria Municipal de Educação do Rio de Janeiro, 2026d). The guidance document also makes clear that the collaboratory should not be understood as the entirety of the model; rather, the GET is a whole-school pedagogical identity that must permeate the school beyond the dedicated space itself (Secretaria Municipal de Educação do Rio de Janeiro, 2026a).

Taken together, these elements, full-time schooling, collaboratories, dedicated actors, continuous training, and governance, constitute the enabling conditions that make the GET analytically important. They show that Smart Education, in this case, is being built not as a matter of devices alone, but as a combination of pedagogy, organization, curriculum, infrastructure, and administrative coordination.

Status assessment through the Smart Education indicator framework

Using the framework proposed by Huang et al. (2024), the Rio de Janeiro case can be analyzed across the ten primary indicators of Smart Education. The value of the case lies precisely in the fact that it allows us to see how these indicators interact in practice, rather than in isolation.

PF1: Student-centered teaching

The GET model strongly advances student-centered teaching. Official documents repeatedly emphasize student protagonism, hands-on learning, project-based methodologies, and real-world problem-solving (Secretaria Municipal de Educação do Rio de Janeiro, 2026a). The pedagogical core of the model is that students should investigate, create, collaborate, and produce rather than merely receive content. This is one of the clearest areas of alignment between the Rio case and Smart Education principles.

PF2: Holistic learning assessment

The GET model contains important elements that support more holistic assessment, especially through projects, integrated activities, and process-oriented pedagogical work. The official guidance notes that evaluation should value the construction process and the learning developed along the way, rather than only the final product (Secretaria Municipal de Educação do Rio de Janeiro, 2026a). This aligns with the move toward formative, competency-oriented assessment.

PF3: Smart learning environment

This is one of the strongest dimensions of the case. The collaboratories, the equipment lists, the dedicated curricular spaces, and the linkage between infrastructure and pedagogy together form a strong example of a Smart Learning Environment in public education (Secretaria Municipal de Educação do Rio de Janeiro, 2026a). The environment is not limited to connectivity or hardware; it is intentionally organized to enable interaction, experimentation, creation, and collaboration.

PF4: School organizational leadership

Leadership is a core variable in the GET model. The Secretariat's documents show that school management teams are deeply involved in school selection, implementation alignment, local governance, teacher designation, and the cultivation of the program's identity (Secretaria Municipal de Educação do Rio de Janeiro, 2026d). The 2026 guidance document also insists that the GET is not merely a room or a piece of equipment, but a whole-school pedagogical identity that must involve the entire community (Secretaria Municipal de Educação do Rio de Janeiro, 2026a). This suggests strong recognition of school leadership as an implementation driver. At the same time, because the model depends on local engagement, leadership variation likely affects outcomes considerably. PF4 can therefore be considered a strategically central and moderately strong indicator, but one that remains sensitive to school-level conditions.

PF5: Educational equity

Equity is both a motivation and a challenge in the Rio case. The Secretariat explicitly presents the GET model as a response to disengagement, learning gaps, age-grade distortion, absenteeism, and dropout, especially in the final years of elementary education (Secretaria Municipal de Educação do Rio de Janeiro, 2026d). The broader municipal strategy for full-time education also prioritizes vulnerable territories and uses territorial diagnostics to guide expansion (Todos Pela Educação, 2025). These are clear indications that equity is not absent from the policy logic.

CF1: School cultural development

The GET model invests heavily in school culture. The official discourse emphasizes innovation, collaboration, creativity, student agency, scientific thinking, experimentation, resilience, diversity, and future orientation (Secretaria Municipal de Educação do Rio de Janeiro, 2026a). The insistence that the whole school, and not only the collaboratory, must embody the GET conception shows that the municipality understands transformation as cultural, not merely instrumental. CF1 can therefore be assessed as a relative strength of the model, though naturally dependent on sustained institutional work.

CF2: Data security and governance

This is one of the weakest documented dimensions of the case. While the model clearly uses digital tools, data, platforms, and increasingly AI-related educational practices, the available official documentation provides limited explicit discussion of data governance, privacy protection, algorithmic accountability, or AI regulation at the level of the municipal school system. The broader normative context may be evolving, but within the case materials this dimension appears underdeveloped. CF2 represents a critical governance gap.

CF3: Teacher capacity building

Teacher capacity building is one of the clearest strengths of the model. The range of training, the dedicated roles of PA and PIC, the materials such as GET na Prática, and the partnerships with training institutions all indicate a structured and serious commitment to teacher development (Secretaria Municipal de Educação do Rio de Janeiro, 2026d). The supplementary material also reports more than 300 hours of annual training, which is unusually substantial in comparative terms (Secretaria Municipal de Educação do Rio de Janeiro, 2026d). CF3 is therefore strong in institutional design, but still uneven in realized capacity across the system.

CF4: Sustainable education reform

The Rio case displays several attributes of sustainability: formal decrees, long-term expansion targets, integration with broader municipal educational strategy, curricular embedding, training structures, and public communication around the model (Secretaria Municipal de Educação do Rio de Janeiro, 2026a; Todos Pela Educação, 2025). Few initiatives in the region show this degree of institutional layering. CF4 can therefore be assessed as relatively strong, though contingent on long-term continuity.

CF5: Cross-sector collaboration

The case shows strong evidence of cross-sector collaboration. The Secretariat works with MultiRio, universities, and external partners, and the founding decrees explicitly allow partnerships with other public agencies and private actors (Prefeitura da Cidade do Rio de Janeiro, 2022; Secretaria Municipal de Educação do Rio de Janeiro, 2026d). The role of outside expertise in training, content production, and pedagogical support is visible throughout the documentation. Rio's collaboration appears relatively structured. CF5 can be considered moderately strong.

Case synthesis: what the Rio de Janeiro experience reveals

The Rio de Janeiro principal strengths lie in the alignment between pedagogy and infrastructure, the creation of enabling institutional structures, the explicit investment in teacher development, and the ability to scale innovation across a large municipal network. Few cases in Latin America display such a combination of scale, policy continuity, curricular embedding, and organizational design. In that sense, Rio de Janeiro stands out not simply as a successful local initiative, but as a rare example of public-sector capacity to institutionalize educational innovation.

At the same time, the case also reveals the limits and tensions of Smart Education in unequal contexts. Data governance is less developed than pedagogical components, teacher engagement varies, and structural inequalities remain powerful.

This duality is precisely what makes the case analytically valuable. Rio de Janeiro does not escape the broader regional condition identified in Section 1; rather, it concentrates it in a more advanced form. It shows that acceleration is possible, that fragmentation can be partially overcome, and that Smart Education can be institutionalized. But it also confirms that such transformation depends on governance, public investment, teacher capacity, and sustained political commitment. Technology alone does not produce educational transformation. System design does.

Future Directions and Actionable Recommendations

The analysis developed in the previous sections points to a central conclusion: the trajectory of Artificial Intelligence in education in Latin America and the Caribbean remains fundamentally open. Rather than following a linear or technologically determined path, it is shaped by the dynamic interaction between institutional capacity, governance arrangements, and pedagogical choices. In this context, the distinction between probable, possible, and preferable futures provides a conceptual framework for interpreting not only where the region is heading, but also the range of directions it may still take.

Probable futures: accelerated but uneven expansion

From the perspective of probable futures, the most likely trajectory for the region is one of continued but uneven expansion of AI in education systems. The patterns identified in the regional analysis suggest that countries and systems with stronger governance capacity, more coherent policy frameworks, and more developed digital infrastructures will continue to deepen their integration of AI across pedagogical, administrative, and strategic domains.

This expansion is likely to occur through the consolidation of digital platforms, the increasing use of learning analytics and data-driven decision-making, and the gradual incorporation of AI into teaching and assessment practices. However, as the analysis in Section 3 indicates, this process is unlikely to be uniform. Instead, it will reinforce existing asymmetries, with more advanced systems moving toward deeper systemic integration, while others remain characterized by fragmented, pilot-based, or externally driven initiatives.

A defining feature of this probable trajectory is the growing gap between technological adoption and governance capacity. In many contexts, innovation is likely to outpace regulation, resulting in the expansion of AI-enabled practices without corresponding development in areas such as data protection, algorithmic transparency, and institutional accountability. This imbalance may generate new forms of systemic vulnerability, even as technological capabilities expand.

Possible futures: divergent pathways and systemic reconfiguration

While the probable future suggests continuity with current trends, a range of possible futures can be identified, reflecting different configurations of policy choices, institutional development, and socio-technical arrangements.

One possible trajectory is the emergence of more coherent Smart Education ecosystems, in which technology, pedagogy, and governance are aligned within a shared and strategically coordinated framework. In such contexts, AI would not function as an external layer added to existing systems, but as an integrated component of educational transformation, supporting new forms of curriculum design, teacher practice, and system governance.

A contrasting possibility is the increasing platformization of education systems. In this scenario, public education becomes progressively dependent on global technology providers for infrastructure, content, and analytics. While this may accelerate access to advanced tools and capabilities, it raises critical concerns regarding data sovereignty, public control, and the long-term autonomy of education systems. The risk is not only technological dependency, but also the gradual reconfiguration of educational governance according to logics that may not be fully aligned with public values.

A third possible trajectory involves partial or stalled integration. In such cases, AI becomes present within education systems but does not translate into systemic transformation. This may occur due to limitations in institutional capacity, discontinuities in policy, or resistance at the level of implementation. The result is a landscape in which AI exists, but its impact remains uneven, superficial, or disconnected from core pedagogical processes.

These alternative futures highlight that the trajectory of AI in education is not predetermined. It is contingent upon decisions made at multiple levels, including policy design, institutional leadership, and pedagogical practice.

Preferable futures: toward equitable, human-centered Smart Education

The notion of preferable futures introduces a normative dimension that is central to the argument of this chapter. If AI is to contribute meaningfully to the transformation of education systems in Latin America and the Caribbean, its development must be guided by explicit commitments to equity, public governance, and pedagogical integrity.

A preferable trajectory for the region would be one in which AI functions as a tool for strengthening public education systems rather than fragmenting them. This implies placing equity at the center of policy design, ensuring that technological innovation actively contributes to reducing, rather than reproducing, structural inequalities. It also requires sustained investment in infrastructure, connectivity, and digital inclusion, particularly in underserved communities.

Equally important is the centrality of teachers. As both the regional analysis and the Rio de Janeiro case study demonstrate, technological innovation does not translate into educational transformation without strong pedagogical mediation. Teachers must be supported not only in acquiring technical skills, but also in developing the pedagogical and critical capacities required to integrate AI meaningfully into teaching and learning processes.

A preferable future also depends on the development of robust governance frameworks. Issues such as data protection, algorithmic transparency, accountability, and ethical use cannot be treated as secondary or reactive concerns. They must be integrated into the design and implementation of Smart Education systems from the outset. In this sense, governance is not an external constraint on innovation, but a constitutive element of sustainable transformation.

Research agenda: advancing evidence on implementation and impact

The analysis developed in this chapter also points to a significant gap in the current knowledge base. Despite the growing presence of AI in education systems, there is still limited empirical evidence on how these technologies are implemented in practice and what effects they produce over time.

Addressing this gap requires a more systematic and regionally grounded research agenda. This includes implementation studies that examine how policies are translated into practice at the school level; longitudinal analyses that assess the long-term impact of AI on learning outcomes, equity, and system performance; and comparative research that identifies patterns and divergences across countries and contexts.

Monitoring and regional coordination: toward a shared analytical infrastructure

In parallel with the need for research, there is also a need for more structured mechanisms of monitoring and regional coordination. The heterogeneity identified throughout this chapter underscores the importance of developing shared analytical tools capable of tracking progress across different contexts.

The creation of common indicators, periodic assessment frameworks, and regional observatories could support more consistent monitoring of Smart Education development. Such mechanisms would not only facilitate comparative analysis, but also enable policy learning and knowledge exchange across countries.

Concluding perspective: governing transformation

The distinction between probable, possible, and preferable futures highlights that the trajectory of AI in education remains open. It will be shaped by how systems navigate the tensions between innovation and regulation, efficiency and equity, and global technological dynamics and local educational priorities.

In this sense, the central challenge is not technological, but institutional and political. The question is not whether AI will be used in education—it already is—but how it will be governed, for whom, and with what long-term implications.

Ultimately, this chapter has argued that Artificial Intelligence in education should not be understood as a technological layer added to existing systems, but as a catalyst for systemic transformation whose outcomes are contingent upon institutional conditions. The evidence from Latin America and the Caribbean shows that similar technologies can produce markedly different effects depending on how they are governed, implemented, and pedagogically mediated. The case of Rio de Janeiro reinforces this point by demonstrating both the potential for large-scale institutionalization and the persistent tensions that accompany it. Taken together, the regional analysis and the case study suggest that the future of Smart Education in the region will not be defined by technological innovation alone, but by the capacity of public education systems to align innovation with equity, governance, and pedagogical purpose. In this sense, the central question is not whether AI will transform education, but how—and under what conditions—that transformation will occur.

References

Benedikter, R., & Cruz-Infante, C. (2026). AI in Latin America: Attempts of regulating artificial intelligence within the geopolitical paradigm of active non-alignment. Journal of Transatlantic Studies.

Brazil. (2023). Lei nº 14.533, de 11 de janeiro de 2023. Institui a Política Nacional de Educação Digital (PNED).

Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial intelligence in education: Promises and implications for teaching and learning. Center for Curriculum Redesign.

Huang, R. H., Liu, D. J., Kanwar, A. S., Zhan, T., Yang, J. F., Zhuang, R. X., Liu, M. Y., Adarkwah, M., & Li, Z. S. (2024). Global understanding of Smart Education in the context of digital transformation. Global Smart Education Network and Smart Learning Institute of Beijing Normal University.

Jamaica Information Service. (2024). Government announces artificial intelligence initiatives for education.

Jamaica Information Service. (2025). AI tools to reduce teachers' administrative workload.

Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeiffer, F., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., … Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. Learning and Individual Differences, 103, 102274.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). Intelligence unleashed: An argument for AI in education. Pearson.

Ministry of Science, Innovation, Technology and Telecommunications. (2024). Estrategia Nacional de Inteligencia Artificial de Costa Rica.

Ministry of Education of Panama. (2026). Transformación curricular para la educación panameña.

Ministry of Education of the Dominican Republic. (2026a). Consejo Nacional de Educación aprueba Estrategia de Educación Digital y socializa propuesta para regular uso de celulares en las escuelas.

Ministry of Education of the Dominican Republic. (2026b). Estrategia Nacional de Educación Digital con énfasis en el Pensamiento Computacional y la Competencia en Inteligencia Artificial.

Ministry of Education and Culture of Uruguay. (2026). Plan Nacional de Política Educativa 2025–2030.

Ministry of Science, Technology, Knowledge and Innovation. (2021). Política Nacional de Inteligencia Artificial.

Ministry of Science, Technology, Knowledge and Innovation. (2024). Plan de Acción de la Política Nacional de Inteligencia Artificial.

Ministry of Education. (n.d.). Programa Educação Conectada.

OECD. (2021). AI and the future of skills. OECD Publishing.

Ortiz, E. A., Vergara, N. C., Pabón, T. F., & Gambi, G. D. N. (2025). AI and education: Building the future through digital transformation. Inter-American Development Bank.

Pedro, F., Subosa, M., Rivas, A., & Valverde, P. (2019). Artificial intelligence in education: Challenges and opportunities for sustainable development. UNESCO.

Prefeitura da Cidade do Rio de Janeiro. (2022). Decreto Rio nº 50.434, de 23 de março de 2022.

Prefeitura da Cidade do Rio de Janeiro. (2024). Decreto Rio nº 53.939, de 16 de fevereiro de 2024.

Secretaria Municipal de Educação do Rio de Janeiro. (2026a). Documento orientador dos Ginásios Educacionais Tecnológicos.

Secretaria Municipal de Educação do Rio de Janeiro. (2026b). GET: Ginásio Educacional Tecnológico.

Secretaria Municipal de Educação do Rio de Janeiro. (2026c). Prefeitura do Rio inaugura o 300º Ginásio Educacional Tecnológico da rede municipal de ensino.

Secretaria Municipal de Educação do Rio de Janeiro. (2026d). Relato da experiência: GET Ginásio Educacional Tecnológico. A escola do futuro é carioca!

Selwyn, N. (2019). Should robots replace teachers? AI and the future of education. Polity.

Todos Pela Educação. (2025). O caso do Rio de Janeiro (RJ): Inovação e expansão da educação integral na rede carioca.

UNESCO. (2023). Guidance for generative AI in education and research.

Williamson, B. (2023). Education and AI governance

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Chapter 7

Smart Education in the United States: Innovation, Ecosystems, and Global Implications

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Governance and Education System Structure

The structure of the U.S. education system fundamentally shapes how Smart Education develops and is experienced. Unlike many nations, the United States has no national ministry of education that directly governs schools or universities. Instead, authority is distributed across federal, state, and local levels, creating a decentralized system that encourages innovation while producing considerable variation in educational policy and practice. The landscape includes more than 4,000 degree-granting colleges and universities serving approximately 19 million students, making it the world's largest higher education system (National Center for Education Statistics [NCES], 2025).

At the federal level, influence is exerted through funding, research, and policy guidance rather than direct regulation. Recent federal initiatives have emphasized the responsible integration of artificial intelligence (AI), highlighting equity, transparency, privacy, and human oversight (U.S. Department of Education, 2023; White House Office of Science and Technology Policy, 2023). More recent federal initiatives have increasingly emphasized AI competitiveness, innovation, national infrastructure, public-private collaboration, and governance of advanced AI systems, reflecting the rapidly evolving U.S. policy landscape (White House, 2025). Together, these initiatives establish national priorities while leaving implementation decisions largely to states, districts, and institutions.

The technological environment further supports educational innovation. According to the International Telecommunication Union (ITU, 2025), approximately 97% of individuals in the United States use the Internet, providing the digital infrastructure necessary to support widespread adoption of online, hybrid, and AI-enabled learning. This environment is further strengthened by the presence of many of the world's leading educational technology and AI companies, whose platforms increasingly shape teaching, learning, assessment, and educational administration.

State and local systems therefore serve as the primary engines of Smart Education. Their autonomy enables rapid experimentation with emerging technologies but also contributes to uneven implementation. While some states, districts, and institutions have developed sophisticated digital ecosystems, others continue to face persistent challenges related to infrastructure, funding, educator capacity, and equitable access (OECD, 2021; UNESCO, 2023).

Higher education further amplifies this dynamic. Universities increasingly serve as laboratories for Smart Education, advancing interconnected innovations in digital learning environments, AI, data-informed decision-making, flexible learning models, and institutional transformation (EDUCAUSE, 2025; Abulibdeh et al., 2025). These developments reflect the broader characteristics of Smart Education described by Huang et al. (2024), while recent research shows that U.S. universities are increasingly adopting institution-wide strategies that integrate technological innovation with pedagogy, governance, and student support.

> The United States does not offer a singular vision of Smart Education. Rather, it functions as a living laboratory in which governments, schools, universities, technology companies, and professional communities continuously negotiate the future of learning. Its greatest strength is its capacity for innovation; its greatest challenge is ensuring that innovation remains equitable, coherent, and accountable. As such, the United States serves not as a blueprint to replicate, but as a critical reference point through which the possibilities and tensions of Smart Education are actively tested.

Smart Education in the United States

Smart Education in the United States represents one of the most dynamic and complex developments in global education. Unlike regions where Smart Education is guided by centralized policy and coordinated national strategies, the United States presents a distinct model characterized by decentralization, rapid innovation, institutional autonomy, and deep interaction between public institutions and private technology actors. This ecosystem enables the rapid development and adoption of AI-driven tools, including intelligent tutoring systems, adaptive learning platforms, and data-informed instructional environments, while also producing uneven implementation across systems and populations (Holmes et al., 2022; UNESCO, 2023).

In many global contexts, most notably China, Smart Education has been pursued through coordinated national strategies that align infrastructure, policy, and pedagogy at scale (Huang et al., 2024). The United States follows a different trajectory. This chapter argues that Smart Education in the United States is best understood as an innovation ecosystem rather than a centrally designed reform. Its strength lies in its capacity to generate, absorb, and scale innovation across a distributed system. At the same time, this model raises significant concerns about fragmentation, equity, data privacy, and public accountability. The U.S. case is therefore globally significant not because it offers a single model to replicate, but because it reveals how Smart Education develops when innovation is fast-moving, multi-actor, and only partially coordinated.

The chapter applies the framework articulated by Huang et al. (2024), examining Smart Education through three analytical lenses: what may be gained, what may be reshaped, and what may be at risk. Concrete examples from K–12 and higher education illustrate how AI-enabled tutoring systems, hybrid instructional models, university-level digital transformation, and private-sector platforms are changing teaching, learning, assessment, and institutional roles. An in-depth case study of the University of Michigan Center for Digital Curricula (UMCDC) and the Roadmap Platform provides empirical evidence of how deeply digital curriculum design can support both innovation and equity when implemented coherently. These developments also align with longstanding national calls for transformational approaches to STEM and digital learning in U.S. education (President's Council of Advisors on Science and Technology [PCAST], 2010).

Viewed through the three lenses of gains, reshaping, and risks, Smart Education in the United States can be characterized as an emerging-to-moderately mature innovation ecosystem: highly dynamic, rapidly adaptive, and globally influential, but unevenly governed and unequally distributed. Its primary strengths include rapid experimentation, strong cross-sector innovation, and evidence-based models such as the UMCDC Roadmap initiative. The sections that follow examine how this ecosystem operates in practice, the opportunities it creates, the risks it introduces, and the implications it holds for the future of Smart Education globally.

Smart Education in Practice: Gains, Reshaping, and Risks

Using the framework of Huang et al. (2024), Smart Education in the United States can be understood through three interrelated lenses: the gains it enables, the educational practices it reshapes, and the risks it introduces. In practice, these dimensions are deeply interdependent: advances in personalization are inseparable from increased collection of student data, and the transformation of teaching roles is tied to both the opportunities and limitations of AI systems.

The most visible gains are personalization, responsiveness, and expanded access to instructional support. AI technologies enable increasingly personalized learning experiences, while adaptive systems provide real-time feedback and data analytics support more informed instructional decision-making (Holmes et al., 2022; Luckin et al., 2016). At the same time, Smart Education is reshaping fundamental aspects of teaching and learning. The role of the teacher is evolving from primary knowledge provider to facilitator, mentor, and designer of learning experiences. Assessment practices are shifting toward more continuous and formative approaches (Hattie & Timperley, 2007).

However, these transformations are accompanied by significant risks. Equity remains a central concern, as disparities in access to technology and high-quality digital resources persist. Without intentional design and policy intervention, Smart Education may exacerbate existing inequalities (UNESCO, 2023). Data privacy and governance represent additional challenges. The increasing use of AI systems involves the collection and analysis of large volumes of student data, raising questions about consent, security, and appropriate use. In a decentralized system, establishing consistent standards and protections is particularly complex.

From a policy perspective, this suggests that effective governance must move beyond binary frameworks of adoption or resistance. Instead, it must engage with the dynamic interplay of benefits and risks, supporting innovation while actively mitigating unintended consequences. For practitioners, this means that Smart Education is not simply a matter of adopting new tools, but of developing the capacity to interpret and respond to complex, evolving systems. In this sense, the success of Smart Education depends not only on technological capability, but on the adaptive capacity of educators and institutions.

The Private Sector, Public Governance, and Platform Power

A defining feature of Smart Education in the United States is the central role of private-sector technology companies in shaping both the pace and direction of innovation. Unlike many global contexts where governments lead educational transformation, technology companies in the United States function as co-architects of educational change (Holmes et al., 2022; UNESCO, 2023).

Platform Adoption and the Privatization of Educational Infrastructure

Major technology firms, including Google, Microsoft, and emerging artificial intelligence developers, have introduced tools that are rapidly becoming embedded in educational practice. These include AI-powered writing assistants, coding environments, intelligent tutoring systems, and productivity platforms that augment both teaching and learning. In many cases, these tools enter classrooms informally, adopted by educators and students before institutional policies are fully established. As a result, practice often precedes governance, creating a pattern in which Smart Education evolves through use, adaptation, and iteration rather than through formal implementation frameworks.

At the same time, this model raises important concerns. The integration of privately developed technologies into public education systems introduces questions related to data ownership, commercial influence, and long-term sustainability. Without clear governance structures, there is a risk that educational priorities may become aligned with market incentives rather than pedagogical goals (Holmes et al., 2022; UNESCO, 2023). This pattern reflects a broader shift in the locus of educational innovation. Rather than originating within formal education systems, many of the most influential developments now emerge externally and are subsequently adapted for educational use. Schools and universities increasingly function as adopters, adapters, and mediators of technologies developed elsewhere.

This influence requires careful critique. Historical cases demonstrate that innovation alone does not produce transformation. The 2013 Los Angeles Unified School District $1.3 billion iPad rollout faltered because of inadequate infrastructure, insufficient teacher professional development, and unresolved software licensing issues (Lamb & Weiner, 2018). Likewise, governance challenges have also constrained educational innovation. The closure of the student data platform in Bloom in 2014, following widespread public concern over data privacy and transparency, illustrates how the absence of public trust and robust governance can undermine even technically ambitious initiatives (Krueger & Moore, 2015). Contemporary scholars argue that AI increasingly embeds critical educational functions, including assessment, feedback, and learning analytics, within proprietary, market-driven systems, raising concerns about the commercialization of public education and diminishing local accountability (Selwyn, 2022; Hillman & Couldry, 2025; Williamson et al., 2023).

The Policy–Innovation Interface: Governing AI in Education

Artificial intelligence illustrates the policy–innovation dynamic especially clearly. GenAI systems, AI-powered writing tools, and tutoring platforms have quickly become part of educational practice, shaping how students search for information, receive feedback, and engage with content. This has placed technology companies in a powerful position: their design decisions influence what forms of feedback students receive and what kinds of data are collected, even when public institutions remain responsible for educational goals and accountability.

Responses to GenAI across the United States have varied considerably. Some institutions quickly provided guidance for responsible use; others initially restricted tools such as ChatGPT over concerns about plagiarism and assessment validity; still others moved from prohibition toward guided integration as it became clear that GenAI could not be meaningfully excluded from learning environments. This variation reflects the decentralized nature of U.S. education and illustrates how Smart Education develops unevenly across institutions.

The growing public attention to AI has also brought technology leaders into direct conversation with policymakers. Congressional hearings involving major technology figures reflect the recognition that AI is no longer only a technical matter, but a social, economic, and ethical issue (UNESCO, 2023). These discussions shape the broader policy environment in which educational AI is understood and governed.

This creates a central paradox. The same private-sector dynamism that enables rapid innovation also creates governance challenges, raising questions about accountability: if an AI system influences student learning, who is responsible for its accuracy and fairness? The U.S. Department of Education has emphasized that AI should augment human judgment and be guided by equity, transparency, and effectiveness (U.S. Department of Education, 2023). International guidance similarly stresses that GenAI should protect learners, promote inclusion, and preserve human agency (UNESCO, 2023).

For global audiences, the U.S. experience offers an important lesson: Smart Education is not only a matter of technology adoption, but of negotiating relationships among markets, governments, institutions, and communities. The key question is not whether technology companies will influence education—they already do—but whether public institutions can shape that influence in ways that advance learning, equity, and human development. The most sustainable forms of Smart Education will require a balance between innovation and governance, private-sector capacity and public purpose.

Illustrative Examples of Smart Education in Practice

A defining strength of Smart Education in the United States lies not in uniform implementation, but in the breadth and diversity of its applications. These examples are best understood not as isolated innovations, but as indicators of broader systemic shifts. They reveal how Smart Education is being enacted across contexts, and what these implementations suggest about the evolving nature of teaching and learning. The examples below are not intended to represent a unified national strategy. Rather, they illustrate the varied ways Smart Education is emerging across the United States through local experimentation, institutional policy decisions, and platform adoption.

K–12 Education: Personalization, Agency, and the Reconfiguration of Time

AI-powered tutoring systems represent one of the most visible manifestations of Smart Education in U.S. K–12 contexts. Platforms such as Khan Academy's Khanmigo provide conversational, adaptive support that responds dynamically to student input, offering explanations, prompts, and feedback in real time (Luckin et al., 2016). The significance of these systems lies in how they redistribute instructional time and authority. Students are no longer entirely dependent on whole-class instruction to progress; instead, they can move through foundational content at their own pace. This creates space for teachers to focus on higher-order learning experiences, including discussion, inquiry, and application. In this sense, AI tutors do not replace teachers, they restructure the instructional ecosystem.

Institutional responses to GenAI in K–12 have varied considerably. Some districts and schools have moved proactively to provide guidance for responsible classroom use, emphasizing teacher oversight, academic integrity, and student AI literacy. Others initially restricted or blocked access to GenAI tools because of concerns about plagiarism, privacy, misinformation, and age-appropriate use. In several cases, early prohibitions were later reconsidered as educators recognized that AI tools were becoming embedded in students' everyday learning environments. This pattern illustrates a broader feature of Smart Education in the United States: implementation often begins through local judgment and institutional experimentation before broader policy consensus emerges.

Beyond individual tools, emerging school models are experimenting with hybrid structures that integrate AI-supported learning with human-led instruction. In some settings, students engage in AI-mediated learning for a portion of the day, focusing on literacy and numeracy, followed by collaborative, project-based learning facilitated by teachers. This reconfiguration signals a deeper transformation: Smart Education is not simply enhancing existing systems but reorganizing the temporal and pedagogical architecture of schooling.

These developments also signal a deeper epistemic shift. Traditionally, knowledge acquisition has been structured around standardized pacing and uniform instructional delivery. AI-enabled learning environments introduce the possibility of continuous differentiation, positioning knowledge not as a fixed sequence to be delivered, but as an adaptive pathway to be navigated. At the same time, this shift raises critical questions about the role of human judgment. While AI systems can optimize for efficiency and responsiveness, they cannot fully account for the social, emotional, and cultural dimensions of learning. Teachers therefore become essential as interpreters of context, ensuring that personalization does not come at the expense of relational and developmental aspects of education (Holmes et al., 2022; Luckin et al., 2016).

However, challenges remain. The quality and accuracy of AI-generated responses, the potential for over-reliance, and uneven access to devices or connectivity all raise concerns. In under-resourced contexts, limited access may restrict the benefits of personalization, reinforcing existing inequities. From a system perspective, these changes suggest that K–12 Smart Education is moving toward learning environments that are continuously responsive rather than periodically adjusted, with significant implications for curriculum design, assessment systems, and teacher preparation.

Higher Education: Innovation at Scale through Arizona State University (ASU)

In higher education, Smart Education in the United States is increasingly defined by institutions that integrate technological innovation with systemic redesign. Arizona State University (ASU) provides a particularly compelling example of how Smart Education can be implemented at scale while maintaining a focus on access, quality, and innovation. ASU has positioned itself as a leader in digital transformation through its deliberate strategy of integrating online learning, AI, adaptive technologies, and data-informed decision-making within an institution-wide innovation model (Educational Technology Cooperative, 2026; EDUCAUSE, 2025). The significance of ASU's approach lies in its integration of scale and personalization, traditionally seen as competing priorities. Through data-informed decision-making and cross-sector partnerships, ASU demonstrates how Smart Education can offer tailored support within large enrollment environments while expanding access for diverse learners.

ASU's partnerships with technology companies further illustrate the role of cross-sector collaboration. Collaborations with industry actors have enabled the development of new learning platforms and expanded access to online programs, reflecting a broader U.S. pattern in which universities and private companies co-develop solutions. ASU has also been at the forefront of rethinking access, leveraging technology to reach non-traditional learners and extending educational opportunities beyond traditional campus boundaries.

ASU's model also reflects a broader redefinition of the university as a platform organization—a networked system that integrates digital infrastructure, partnerships, and learner services across physical and virtual domains. By decoupling learning from place and time, ASU expands opportunities for working adults and geographically dispersed populations. However, this also introduces new dependencies on digital infrastructure and self-directed learning capacities, which may not be equally distributed.

A significant implication of Smart Education in higher education is the changing role of faculty. As AI systems increasingly support information retrieval, tutoring, and routine feedback, the value of faculty expertise shifts from the transmission of information toward the design of learning experiences. Faculty therefore become essential mediators between technological capability and human development.

Ultimately, ASU illustrates both the promise and the complexity of scaling Smart Education. It demonstrates how technology can expand access and personalization, while also highlighting challenges related to data governance, algorithmic transparency, and the sustainability of partnerships.

Platforms as Infrastructure: Copilot, Canvas, and Embedded AI

A defining characteristic of contemporary Smart Education in the United States is the increasing integration of AI into the digital platforms that educators and students already use. Rather than existing as standalone applications, AI capabilities are becoming embedded within learning management systems, productivity environments, and collaboration platforms. Tools such as Microsoft Copilot and AI-enabled learning management system features illustrate this trend, showing how AI is increasingly embedded within the everyday platforms through which educators plan instruction, communicate, generate feedback, and manage learning environments (Microsoft Education, 2024; Instructure, 2024).

Similarly, Canvas has introduced AI-enhanced features that support feedback generation, content creation, and instructional design. These developments reduce barriers to adoption because educators can access AI capabilities within familiar environments rather than learning entirely new systems.

The significance of these platforms extends beyond efficiency. As AI becomes embedded within everyday educational infrastructure, it increasingly shapes how teaching, learning, assessment, and communication occur. Smart Education therefore becomes less visible as a discrete innovation and more integrated as a routine component of educational practice. In higher education, institutions such as Arizona State University, the University of Michigan, and Vanderbilt University have developed guidance frameworks that encourage responsible AI use while emphasizing transparency, attribution, and human oversight. These approaches contrast with some early institutional responses that focused primarily on restriction or prohibition, illustrating the rapid evolution of thinking regarding GenAI in U.S. education.

At the same time, platform-level integration raises important questions regarding transparency, data governance, algorithmic influence, and institutional dependence on commercial technologies. These concerns reinforce the need for governance frameworks that balance innovation with accountability—a challenge that lies at the heart of Smart Education's development in the United States.

The Role of ISTE and Professional Ecosystems: Creating Coherence in a Distributed System

In a system as decentralized as that of the United States, coherence does not emerge from policy alone. It is constructed through professional communities and shared frameworks. Within this landscape, the International Society for Technology in Education (ISTE) plays a uniquely influential role, not as a governing authority, but as a norm-setting institution that shapes how educators understand and enact Smart Education.

The ISTE Standards have become one of the most widely adopted frameworks for digital-age learning, emphasizing agency, creativity, collaboration, and ethical engagement with technology (ISTE, 2021). Their significance lies in their ability to function as a common interpretive lens across diverse educational contexts. In the absence of centralized mandates, such shared frameworks provide continuity, enabling educators to align their practices with broader principles of Smart Education.

Importantly, ISTE's influence extends upstream into educator preparation. Increasingly, educator preparation programs (EPPs) and accreditation systems draw upon ISTE-aligned competencies to define readiness for teaching in digitally mediated environments. This integration reflects a growing recognition that Smart Education is not simply about access to tools, but about professional capacity to design, interpret, and ethically navigate technology-rich learning environments.

ISTE also operates as a connector across systems. Through partnerships with school systems, higher education institutions, and technology companies, it facilitates the translation of innovation into practice. In a context where private-sector actors play a major role, ISTE helps mediate this relationship, ensuring that technological possibilities are interpreted through pedagogical priorities. This role has become increasingly important in the era of GenAI. As educators navigate questions related to academic integrity, assessment design, and AI literacy, many have relied on professional communities, standards, and collaborative networks to develop practical approaches—bridging the gap between technological innovation and classroom implementation.

At a global level, ISTE's involvement in networks such as the Global Smart Education Network (GSENet) positions it as a bridge between regional innovation and international dialogue. Through these collaborations, U.S. experiences with AI, digital learning, educator preparation, and technology integration contribute to broader conversations about the future of Smart Education, while also benefiting from insights emerging from other regions of the world. This bidirectional exchange is critical in a rapidly evolving field, where no single system holds all answers. Through this engagement, ISTE contributes to the development of a shared global understanding of Smart Education, while maintaining sensitivity to contextual differences.

In this sense, ISTE contributes not by directing Smart Education, but by stabilizing and humanizing it, ensuring that rapid technological change remains anchored in professional judgment, ethical considerations, and learner-centered values.

The significance of ISTE becomes even more pronounced when considered in relation to quality assurance and system-level coherence. In the absence of centralized mandates, frameworks such as the ISTE Standards function as de facto quality benchmarks, informing how institutions define effective digital learning. This is particularly evident in educator preparation programs (EPPs), where alignment with ISTE standards increasingly signals readiness for teaching in technology-rich environments.

In this way, ISTE exemplifies how professional ecosystems can provide coherence in decentralized systems, not by imposing uniformity, but by cultivating shared principles, professional capacity, and ongoing dialogue. In a decentralized system, professional ecosystems may be among the most important mechanisms through which innovation becomes sustainable, scalable, and educationally meaningful (ISTE, 2021).

Case Study: UMCDC and the Roadmap Platform through the Smart Education Indicator Framework

The Roadmap initiative developed by the University of Michigan Center for Digital Curricula (UMCDC) represents one of the most fully realized examples of Smart Education in the United States. Its significance lies not only in its demonstrated impact, but in its ability to illustrate how Smart Education can function as a coherent, system-level intervention rather than a collection of disconnected tools.

Indicator Selection and Evidence Base

The University of Michigan Center for Digital Curricula (UMCDC) and its Roadmap Platform provide a compelling example of Smart Education implementation within the decentralized educational landscape of the United States. Unlike national-level Smart Education initiatives, the Roadmap model operates across district and school contexts characterized by local governance, institutional autonomy, and diverse implementation conditions. As such, it offers valuable insight into how Smart Education can emerge and scale within a distributed innovation ecosystem.

This case study applies the Smart Education Indicator Framework proposed by Huang et al. (2024) to assess the extent to which the Roadmap initiative embodies key dimensions of Smart Education. Because UMCDC is an institutional and district-level case rather than a national system, some indicators are evidenced more directly than others. The strongest evidence relates to Student-Centered teaching (PF1), Holistic Assessment (PF2), Smart Learning Environments (PF3), Educational Equity (PF5), Teacher Capacity Building (CF3), Sustainable Reform (CF4), and Cross-sector Collaboration (CF5). Together, these indicators demonstrate how deeply digital curriculum design can support measurable learning gains while advancing coherence across teaching, learning, assessment, and professional practice.

To preserve strict comparative alignment with the global report series format, this case study explicitly evaluates all ten primary indicators outlined in the national framework (Huang et al., 2024). However, because the Roadmap initiative operates at an institutional and district level rather than as a uniform national mandate, certain indicators are evidenced through different empirical depths. Primary indicators such as Student-Centered Teaching (PF1), Holistic Learning Assessment (PF2), and Educational Equity (PF5) serve as the structural anchors of this analysis because they are directly verified by the rigorous quantitative and qualitative baseline data from the Ypsilanti longitudinal study (Jaksa, et al., 2024). Conversely, broader systemic enablers like Data Security and Governance (CF2) and Sustainable Education Reform (CF4) are evaluated textually through an analysis of how the platform interacts dynamically with evolving state regulations and local district policies.

Performative Features (PF)

PF1: Student-Centered Teaching

At its core, the Roadmap Platform reshapes the instructional relationship between teacher, student, and content. Teachers transition from primary deliverers of instruction to designers and orchestrators of learning, using embedded data systems to monitor progress and respond in real time. This shift reflects a broader transformation within Smart Education, from teaching as transmission to teaching as adaptive, data-informed design.

For students, the platform enables a structured yet flexible learning experience. Multimodal resources, scaffolded pathways, collaborative tasks, and embedded supports create an environment in which learners engage with content in ways that align with their needs while remaining within a coherent instructional framework. This balance between agency and structure is critical because it ensures that personalization does not devolve into fragmentation. This balance aligns closely with classic models of self-regulated learning, which demonstrate that student autonomy is most effective when paired with structured, environmental scaffolding (Zimmerman, 2002).

Roadmaps organize learning around inquiry, creation, discussion, reflection, and authentic demonstrations of understanding. Teachers facilitate rather than direct learning, while students assume greater responsibility for navigating resources, monitoring progress, and engaging with meaningful tasks.

Implementation varies according to district capacity, teacher experience, and local instructional priorities. Nevertheless, the student-centered design principles remain consistent across settings.

PF2: Holistic Learning Assessment

Assessment within the Roadmap environment is formative, continuous, and integrated directly into the learning process. Rather than functioning primarily as a mechanism for accountability, assessment serves as a tool for feedback, reflection, and instructional adaptation.

Teachers can monitor student progress in real time, provide timely feedback, and adjust instruction based on learner needs. The empirical strength of the Roadmap initiative is reinforced by a recent peer-reviewed two-year longitudinal study conducted in Ypsilanti Community Schools, an historically underserved district in Michigan (Jaksa, et al., 2024).

The study followed 380 students across grades 3–5 and compared those whose teachers consistently implemented Roadmap-formatted curricula with those whose teachers did not. Using NWEA Reading Conditional Growth Percentiles as the primary outcome measure, students exposed to consistent Roadmap implementation achieved reading growth at the 46th percentile compared with the 20th percentile among their peers. This metric is particularly notable when contrasted with historical meta-analyses of general K–12 educational technology applications, which typically yield much lower median effect sizes in reading achievement (Cheung & Slavin, 2013). Furthermore, the cumulative growth observed over the two-year period validates the platform's capacity to optimize the formative feedback loops essential for deep cognitive processing (Hattie & Timperley, 2007).

Importantly, the longitudinal design revealed that impact accumulated over time. Students demonstrated approximately nine percentile points of additional growth during the first year of implementation, with the full twenty-six-point advantage emerging across two years of sustained use. These findings suggest that Smart Education interventions produce their strongest effects when implementation is sustained and systemically supported.

The strongest outcomes were associated with consistent implementation, indicating that instructional fidelity and teacher capacity significantly influence results.

PF3: Smart Learning Environment

The Roadmap Platform exemplifies a smart learning environment through its integration of curriculum, instructional resources, assessment tools, accessibility supports, and emerging AI capabilities.

Students access learning through a structured digital ecosystem that supports personalization, continuity, and differentiated instruction. More recently, artificial intelligence has become increasingly integrated into the Roadmap ecosystem through tools designed to support both teachers and learners.

VoiceBot and GraderBot provide illustrative examples. VoiceBot enables students to access written content through teacher-voiced audio support, while GraderBot assists teachers by generating structured feedback aligned to instructional criteria. Importantly, these tools function within pedagogical routines that preserve student engagement and teacher oversight.

For students who experience challenges with decoding and reading fluency, VoiceBot increases access to complex content while maintaining expectations for comprehension and critical thinking. Similarly, GraderBot supports iterative writing and revision processes by generating structured feedback that teachers review and mediate before it reaches students. In this way, AI serves not as a replacement for teaching but as a scaffold that expands instructional capacity while preserving human judgment.

Differences are primarily associated with infrastructure, device availability, and local implementation capacity rather than platform design.

PF4: School Organizational Leadership

Successful implementation depends upon leadership support, organizational commitment, and a shared instructional vision.

District leaders and school administrators play a critical role in creating conditions that support implementation, including professional learning opportunities, scheduling flexibility, resource allocation, and instructional coherence. Sustained implementation across multiple years demonstrates the importance of leadership in scaling innovation beyond isolated classrooms.

Implementation depth varies according to leadership priorities, organizational capacity, and local strategic planning.

PF5: Educational Equity

Educational equity is embedded within the design of the Roadmap model rather than treated as a secondary outcome.

The platform incorporates multimodal engagement, accessibility features, differentiated pathways, and embedded instructional supports intended to reduce barriers to participation. The Ypsilanti study is particularly significant because it was conducted in a district where more than half of students qualify for free or reduced-price meals.

The findings challenge assumptions that advanced digital learning models are effective only in well-resourced environments. Instead, they suggest that thoughtfully designed digital systems can support meaningful learning gains when implementation is coherent and sustained.

Although implementation conditions vary, the platform's design consistently prioritizes inclusive participation and equitable access to learning opportunities.

Constructive Features (CF)

CF1: School Cultural Development

The Roadmap model promotes collaboration, communication, reflection, and digital literacy as integral elements of learning.

Students engage in discussion, peer interaction, problem solving, and reflective activities that support both academic and social-emotional development. Digital tools are used not only to access information but also to foster participation and collaboration.

School culture remains influenced by local context, leadership, and instructional practices.

CF2: Data Security and Governance

Data privacy and governance remain important considerations within digital learning environments.

Roadmap implementation occurs within district and state frameworks governing student privacy, platform use, and digital security. Consistent with broader U.S. Smart Education trends, governance structures continue to evolve alongside technological innovation and AI adoption.

Requirements differ across states and districts due to the decentralized nature of U.S. educational governance.

CF3: Teacher Capacity Building

Professional learning is a foundational condition for successful implementation.

The Roadmap case underscores the centrality of teacher capacity. Effective implementation requires educators to interpret learning data, adapt instruction, facilitate student-centered learning, and integrate digital tools into pedagogically meaningful practice.

Teachers receive ongoing support related to curriculum design, digital pedagogy, assessment, and platform integration. The longitudinal findings suggest that impact increases as teachers gain greater fluency with the instructional model over time.

Teacher confidence, experience, and access to professional development influence implementation quality and student outcomes.

CF4: Sustainable Education Reform

The Roadmap initiative represents a sustained approach to educational transformation rather than a short-term technology intervention.

As the initiative evolves, attention increasingly shifts from implementation toward scalability. Expanding the model across contexts raises important questions regarding fidelity, adaptation, and sustainability. Which elements are essential? How can systems maintain coherence while responding to local needs?

The initiative's integration of curriculum, pedagogy, assessment, professional learning, and technology distinguishes it from many isolated digital interventions. Its two-year evidence base suggests that Smart Education reform becomes sustainable when innovation is embedded within instructional systems rather than layered onto them.

Long-term sustainability depends on leadership support, infrastructure, funding, and professional learning capacity.

CF5: Cross-Sector Collaboration

The Roadmap initiative reflects collaboration among researchers, educators, districts, schools, and technology developers.

UMCDC's work demonstrates how partnerships can support innovation, implementation, evaluation, and continuous improvement. The collaboration among researchers and practitioners contributed directly to the development, refinement, and validation of the model.

Partnership structures vary according to local capacity and organizational context.

Synthesis: What the UMCDC Case Reveals

Viewed through the Smart Education Indicator Framework, the UMCDC Roadmap initiative demonstrates how Smart Education can move beyond technology adoption toward systemic educational transformation. The strongest evidence appears in student-centered teaching, holistic assessment, smart learning environments, educational equity, teacher capacity building, sustainable reform, and cross-sector collaboration.

The case also provides important lessons regarding replication and system design. While digital platforms can be scaled, the conditions that support their effectiveness, including professional learning, leadership support, instructional coherence, and organizational commitment, are more difficult to reproduce. Smart Education is therefore not a product that can simply be implemented; it is a system that must be cultivated.

For global audiences, the significance of the Roadmap initiative is clear. It demonstrates that meaningful transformation occurs not through isolated technological interventions, but through sustained, coherent, and contextually responsive approaches that align curriculum, pedagogy, assessment, professional learning, and innovation over time. As such, it offers an important example of how Smart Education can advance both educational excellence and educational equity within complex educational systems.

Future Directions and Actionable Recommendations

As AI becomes increasingly embedded within educational systems, the future of Smart Education will be shaped not only by technological capabilities but also by the decisions educators, institutions, policymakers, and communities make regarding how those technologies are used. Looking beyond current conditions, three futures frameworks: probable, possible, and preferable futures, provide a useful lens through which to consider the next phase of Smart Education development in the United States.

Probable Futures: Accelerated Integration and Uneven Governance

If current trajectories continue, the United States is likely to remain one of the world's leading ecosystems for Smart Education innovation, exemplifying what Amara (1981) describes as a probable future. The immediate short-term (1–3 years) will be characterized by accelerated technology integration within a fragmented policy environment. AI-enabled systems will become increasingly embedded across K–12, higher education, and lifelong learning, with growing variation in state and local AI policies. Some jurisdictions are moving toward proactive AI literacy and responsible-use guidance, while others adopt more cautious approaches focused on privacy, academic integrity, and student protection (U.S. Department of Education, 2023; UNESCO, 2023).

GenAI is likely to become a routine component of educational practice. Students will increasingly interact with AI-supported systems while researching, writing, problem-solving, and receiving feedback. Teachers will use AI to support lesson design, curriculum development, assessment, communication, and instructional differentiation. Universities will continue integrating AI into student support services, advising systems, and learning environments. Rather than existing as standalone applications, AI capabilities will be embedded within learning management systems, productivity platforms, and assessment tools, becoming less visible as a discrete innovation and more integrated as an underlying layer within educational systems.

The role of educators will continue to evolve. As information retrieval and routine feedback become increasingly automated, teachers and faculty will function more as learning architects—designing learning experiences, facilitating inquiry, and supporting critical engagement with knowledge. At the institutional level, schools and universities are likely to become increasingly hybrid, with digital platforms supporting more flexible pathways between face-to-face, online, and AI-supported learning experiences. However, governance mechanisms will continue to develop more slowly than technological innovation, producing the defining U.S. pattern: rapid innovation accompanied by fragmented governance and variable access.

Possible Futures: New Learning Ecosystems and Emerging Challenges

Looking toward the medium-term horizon (3–7 years), several possible futures may emerge as systems transition from reactive tool adoption to deeper architectural reorganization (Amara, 1981). One possibility is the development of highly personalized learning ecosystems supported by intelligent tutoring systems, adaptive feedback environments, and AI-assisted learning companions. Such systems could provide individualized learning pathways at unprecedented scale, allowing students to receive support tailored to their needs, interests, and learning profiles.

Universities may increasingly evolve into networked Smart Education ecosystems that integrate formal education, workplace learning, professional development, and lifelong learning opportunities, blurring traditional boundaries between these domains. Institutions such as Arizona State University already demonstrate elements of this transformation through integrated digital learning environments, AI-supported teaching, industry partnerships, microcredentialing, and lifelong learning initiatives (Educational Technology Cooperative, 2026; EDUCAUSE, 2025).

At the same time, significant challenges may emerge. As AI becomes increasingly integrated into educational practice, traditional assumptions about authorship, assessment, and knowledge production may become more difficult to sustain. Distinguishing between human-generated and AI-assisted work will become increasingly challenging. Educational systems may therefore shift away from product-based assessment models toward process-oriented approaches that emphasize reasoning, reflection, collaboration, and authentic performance. Growing concerns regarding misinformation, algorithmic bias, surveillance, and data privacy may lead to more restrictive regulatory approaches and increased demands for transparency and public oversight. Another possible future involves increasing tension between innovation and regulation as policymakers face growing pressure to balance opportunities with concerns regarding student protection and democratic accountability.

Preferable Futures: Human-Centered and Equitable Smart Education

In the long-term (7–10+ years), a preferable future is one in which intelligent technologies strengthen human learning, inclusion, and opportunity. Smart Education remains fundamentally human-centered: teachers continue to occupy a central role, cultivating critical thinking, ethical reasoning, creativity, and civic responsibility. Schools and universities remain vital social, cultural, and civic spaces where learners develop identities and belonging. While digital technologies expand access and flexibility, they complement rather than replace the human dimensions of education.

A preferable future requires sustained attention to equity. Access to AI-supported learning should not depend upon geography, socioeconomic status, or institutional wealth. The United States has the opportunity to demonstrate that Smart Education can support both innovation and equity, but doing so requires investment not only in technology but also in professional learning, instructional design, digital infrastructure, and governance frameworks. The University of Michigan Center for Digital Curricula's (UMCDC) Roadmap initiative illustrates this vision by combining digital innovation with sustained teacher professional learning and evidence-based instructional design to improve learning outcomes in an historically underserved district (Jaksa et al., 2024). Building on this work, the emerging RoadmapBot pedagogy engine demonstrates how AI can apply evidence-based pedagogical frameworks to transform digitized curriculum into deeply digital learning experiences while preserving educator oversight and instructional quality. Above all, educational transformation must be recognized as a social, ethical, and cultural project grounded in public values, not a technological challenge alone.

Recommendations for Policymakers, Educational Leaders, and Teachers

Recommendations for Policymakers

1.Develop coherent AI governance frameworks that balance innovation with accountability.

2.Invest in equitable digital infrastructure and connectivity, particularly in underserved communities.

3.Support research examining the long-term effects of AI on learning, assessment, well-being, and educational equity.

4.Establish transparent standards for data privacy, algorithmic accountability, and responsible AI use.

5.Encourage cross-sector collaboration among educational institutions, researchers, technology providers, and community stakeholders.

Recommendations for Educational Leaders

1.Develop institution-wide strategies for responsible AI integration.

2.Invest in sustained professional learning focused on AI literacy, instructional design, and digital pedagogy.

3.Evaluate technologies based on educational value rather than novelty or market visibility.

4.Foster cultures of experimentation while maintaining clear ethical guidelines and governance structures.

5.Ensure that equity considerations remain central to technology adoption decisions.

Recommendations for Teachers and Practitioners

6.Develop AI literacy and critical digital competencies.

7.Use AI to enhance, rather than replace, meaningful learning experiences.

8. Prioritize student agency, creativity, reflection, and metacognitive development.

9.Design assessments that emphasize process, reasoning, and authentic performance.

10.Help learners critically evaluate AI-generated content and understand its limitations.

Concluding Reflection

The United States offers important lessons for the global Smart Education community, not as a singular model to emulate, but as a living example of how Smart Education develops within a highly decentralized, innovation-driven ecosystem.
One of the most important lessons is that Smart Education cannot be reduced to technology adoption alone. Meaningful transformation occurs when technology is integrated with pedagogy, professional learning, and sustained institutional support. The success of initiatives such as the UMCDC Roadmap Platform demonstrates that educational impact is produced not by technology itself, but by the coherence with which technology, curriculum, and teaching practices are aligned.

The U.S. experience also illuminates tensions likely to define the next generation of Smart Education worldwide: between innovation and regulation, personalization and privacy, efficiency and human connection, technological opportunity and educational equity. The future will depend not on eliminating these tensions, but on navigating them thoughtfully.

Looking toward 2030 and beyond, the most promising vision is one in which intelligent technologies strengthen rather than diminish human learning. In such a future, AI expands access to knowledge and enhances educational opportunity while preserving the central importance of teachers, communities, and educational institutions. The United States does not offer a singular vision of Smart Education, but a dynamic landscape that reveals how quickly education can transform when innovation is enabled, and how unevenly those transformations can unfold. It serves not as a blueprint, but as a critical reference point through which the future of education is being actively tested, contested, and reimagined.

References

Abulibdeh, A., Chatti, C. B., Alkhereibi, A., & El Menshawy, S. (2025). A scoping review of the strategic integration of artificial intelligence in higher education: Transforming university excellence themes and strategic planning in the digital era. European Journal of Education, 60(1), e12908. https://doi.org/10.1111/ejed.12908

Amara, R. (1981). The futures field: Searching for definitions and boundaries. The Futurist, 15(1), 25–29.

Cheung, A. C. K., & Slavin, R. E. (2013). The effectiveness of educational technology applications for enhancing reading achievement in K–12 classrooms: A meta-analysis. Educational Research Review, 9, 88–113. https://doi.org/10.1016/j.edurev.2013.01.001

Educational Technology Cooperative. (2026, May 6). Age of rapid change and implications for higher education: Institutional spotlights. ETC Journal. https://etcjournal.com/2026/05/06/age-of-rapid-change-and-implications-for-higher-education-may-2026/

EDUCAUSE. (2025). 2025 EDUCAUSE Horizon Report: Teaching and learning edition. https://library.educause.edu/-/media/files/library/2025/5/2025hrteachinglearning.pdf

Hattie, J., & Timperley, H. (2007). The power of feedback. Review of Educational Research, 77(1), 81–112. https://doi.org/10.3102/003465430298487

Hillman, V., & Couldry, N. (2025). Infantilising education through risk-averse educational technologies of calculability: A critical essay. British Journal of Sociology of Education, 46(2), 210–225. https://doi.org/10.1080/01425692.2025.2519485

Holmes, W., Bialik, M., & Fadel, C. (2022). Artificial intelligence in education: Promises and implications for teaching and learning (2nd ed.). Center for Curriculum Redesign. https://curriculumredesign.org/our-work/artificial-intelligence-in-education/

Huang, R. H., Liu, D. J., Kanwar, A. S., Zhan, T., Yang, J. F., Zhuang, R. X., Liu, M. Y., Adarkwah, M., & Li, Z. S. (2024). Global understanding of Smart Education in the context of digital transformation. Global Smart Education Network & Smart Learning Institute of Beijing Normal University.

Instructure. (2024). Canvas and AI: The future of teaching and learning. https://www.instructure.com/resources/ebooks/canvas-lms-built-whats-next

International Society for Technology in Education (ISTE). (2021). ISTE standards for educators. https://www.iste.org/standards

International Telecommunication Union. (2025). Facts and figures 2025. https://www.itu.int/itu-d/reports/statistics/facts-figures-2025/

Krueger, K. R., & Moore, B. (2015). Trust is needed to allay data privacy concerns. Phi Delta Kappan, 97(2), 80–83. https://doi.org/10.1177/0031721715610093

Lamb, A. J., & Weiner, J. M. (2018). Institutional factors in iPad rollout, adoption, and implementation: Isomorphism and the case of the

Los Angeles Unified School District's iPad initiative. International Journal of Education in Mathematics, Science and Technology, 6(2), 136–154. https://doi.org/10.18404/ijemst.408936

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). Intelligence unleashed: An argument for AI in education. Pearson.

Microsoft Education. (2024). Microsoft Copilot for education. https://education.microsoft.com/en-us/resource/9f7a4c0d

National Center for Education Statistics. (2025). Digest of Education Statistics 2024. U.S. Department of Education, Institute of Education Sciences. https://nces.ed.gov/programs/digest/

OECD. (2021). Digital education outlook 2021: Pushing the frontiers with artificial intelligence, blockchain and robots. OECD Publishing. https://doi.org/10.1787/589b283f-en

President's Council of Advisors on Science and Technology. (2010). Prepare and inspire: K–12 education in science, technology, engineering, and math (STEM) for America's future. Executive Office of the President. https://www.nitrd.gov/pubs/PCAST-NITRD-report-2010.pdf

Selwyn, N. (2022). Education and technology: Key issues and debates (3rd ed.). Bloomsbury Academic.

Tapp Jaksa, A., Lopez, C., Norris, C., Rodeffer, C., Simiao, G., Soloway, E., & Zachery-Ross, A. (2024). Using Roadmap-formatted curriculum in elementary school to improve NWEA reading growth. Journal of Interactive Learning Research, 35(4), 451–466. https://www.learntechlib.org/primary/p/225209/.

UNESCO. (2023). Guidance for generative AI in education and research. UNESCO. https://www.unesco.org/en/articles/guidance-generative-ai-education-and-research

U.S. Department of Education. (2023). Artificial intelligence and the future of teaching and learning: Insights and recommendations. https://tech.ed.gov/ai/

White House. (2025). Winning the AI race: America's AI Action Plan. Executive Office of the President. https://www.whitehouse.gov/wp-content/uploads/2025/07/Americas-AI-Action-Plan.pdf

White House Office of Science and Technology Policy. (2023). Blueprint for an AI Bill of Rights. https://www.whitehouse.gov/ostp/ai-bill-of-rights/

Williamson, B., Bayne, S., & Shea, M. (2023). The datafication of education: A critical introduction. Learning, Media and Technology, 48(1), 1–10. https://doi.org/10.1080/17439884.2023.2166133

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. Theory Into Practice, 41(2), 64–70. https://doi.org/10.1207/s15430421tip4102_2

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Chapter 8

Smart Education in the Pacific: Regional Pathways, Small-State Systems, a Case Study of Samoa

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Chapter 8 Smart Education in the Pacific: Regional Pathways, Small-State Systems, a Case Study of Samoa

Regional Context and Smart Education Development

Regional Context and System Characteristics

The Pacific region presents a distinctive context for the development of Smart Education. Comprising diverse island states across Polynesia, Melanesia, and Micronesia, the region is characterised by geographic dispersion, small populations, dispersed communities, and uneven access to educational resources. These structural conditions significantly influence how digital technologies are introduced, adapted, and sustained within education systems. Unlike large and highly connected education systems where digital transformation is often driven by technological innovation, Pacific countries must address additional challenges associated with distance, limited infrastructure, and resource constraints.

Within this context, Smart Education should not be understood merely as the introduction of digital tools into classrooms. Rather, it represents a broader transformation involving the interaction between technology, pedagogy, institutional governance, and human capability. For Pacific education systems, Smart Education requires approaches that are locally appropriate, socially inclusive, and culturally relevant. The effectiveness of digital transformation depends not only on technological availability but also on institutional readiness, teacher capacity, governance mechanisms, and sustainable implementation strategies (UNESCO, 2024).

Digital infrastructure remains one of the most significant factors shaping Smart Education development across the Pacific. Although connectivity has improved through investments in broadband networks and digital infrastructure, substantial disparities remain between countries, regions, and communities. The Pacific regional technology assessment highlights that many education systems continue to experience challenges related to internet reliability, device accessibility, technical support, and the affordability of digital services (UNESCO & COL, 2024). Similarly, the digital economy assessment for the Pacific identifies geographic isolation and high infrastructure costs as continuing barriers to digital inclusion (United Nations Conference on Trade and Development [UNCTAD], 2025).

As a result, Pacific countries have generally adopted adaptive and hybrid approaches rather than fully online transformation models. Digital learning initiatives frequently combine online platforms with offline resources, mobile technologies, radio, television, and other low-bandwidth solutions. These multimodal approaches have been particularly important in maintaining educational continuity during periods of disruption. For example, Commonwealth of Learning (COL, 2021) documented how Pacific education systems used flexible and multimodal strategies to respond to resilience challenges, demonstrating that effective Smart Education depends on the appropriate combination of technologies rather than technological complexity alone.

The development of education systems in the Pacific has also evolved through several stages. Earlier reforms focused primarily on expanding educational access, particularly for rural and geographically isolated communities. Subsequent reforms emphasised improving educational quality, relevance, and workforce preparation. More recently, education strategies have increasingly incorporated innovation, digital transformation, resilience, and inclusion as key priorities (Pacific Community [SPC], 2025a, 2025b).

Regional cooperation has been central to these developments. The Pacific Regional Education Framework (PacREF 2018–2030) provides a shared regional vision for improving educational quality, equity, and system capacity (SPC, 2024). Partnerships involving UNESCO, COL, the University of the South Pacific (USP), and other regional organisations have supported policy development, teacher capacity building, open learning initiatives, and knowledge exchange (UNESCO, 2025). Such collaboration is particularly important because many Pacific Small Island Developing States lack the scale and resources required to independently develop comprehensive digital education ecosystems.

Opportunities and Gains of Smart Education

Smart Education has created important opportunities for expanding educational access and improving learning flexibility across the Pacific. Technology-enabled learning (TEL) and Open, Distance and Flexible Learning (ODFL) approaches have enabled institutions to reach learners who face geographical barriers and strengthened opportunities for lifelong learning (Pacific Partnership for ODFL in the Pacific, 2024).

Higher education institutions have played a particularly important role in demonstrating the potential of digital transformation. The USP has developed regional approaches to blended and flexible learning, while institutions such as the National University of Samoa (NUS) have progressively expanded technology-supported teaching and learning environments. These developments illustrate how small-state universities can use digital technologies to overcome geographical limitations and extend educational participation.

Digital platforms and open educational resources (OER) have also contributed to improving access to learning materials. OER initiatives reduce dependence on costly educational resources while enabling institutions to adapt materials to local contexts (Butcher et al., 2023). In Samoa, OER development has increasingly focused on supporting STEM education and locally relevant learning resources (Chand, 2025). Such approaches are particularly valuable for Pacific systems where access to high-quality educational materials remains uneven.

Artificial intelligence (AI) represents a further emerging opportunity. AI-supported learner assistance systems, automated feedback mechanisms, and intelligent educational services may improve responsiveness and provide additional support in contexts where institutional resources are limited. However, AI adoption also requires careful consideration of pedagogical implications. Research has highlighted concerns regarding cognitive offloading and the possibility that excessive dependence on AI may reduce learners' independent thinking and problem-solving abilities. Therefore, AI should be integrated as a supportive tool within human-centred learning environments rather than replacing teacher guidance and learner agency.

Teacher capacity development remains another essential component of Smart Education transformation. Across the Pacific, professional development initiatives supported by regional organisations have focused on strengthening digital pedagogy, technology-enabled teaching, and flexible learning practices. These initiatives demonstrate that digital transformation depends not only on infrastructure investment but also on educators' ability to design meaningful learning experiences through technology (UNESCO & COL, 2024).

Emerging Challenges and Risks

Despite significant progress, Smart Education development in the Pacific continues to face structural challenges. Digital inequality remains one of the most important concerns. Differences in connectivity, device availability, and digital skills may reinforce existing educational inequalities, particularly among learners in remote communities and disadvantaged groups (UNICEF, 2022). Regional assessments continue to highlight uneven learning outcomes and persistent disparities in educational participation across Pacific countries (SPC, 2025a, 2025b).

Sustainability is another critical issue. Many digital education initiatives have been supported through external partnerships and development programmes. While such support has enabled important innovations, long-term impact depends on whether institutions can maintain infrastructure, provide technical support, and integrate digital initiatives into broader educational strategies. Sustainable Smart Education requires continuous investment in human capacity, institutional leadership, and system-level planning.

Governance challenges are also becoming increasingly important as digital platforms and AI applications expand. Education systems need stronger mechanisms for data protection, cybersecurity, ethical AI use, and responsible technology governance. These issues are particularly significant for small-state systems where institutional capacity may be limited and where external technologies are often adopted through partnerships.

Cultural relevance represents another essential consideration. Pacific societies possess diverse languages, traditions, and knowledge systems, and digital transformation must recognise these contexts. Technologies and educational resources that are not adapted to local realities may have limited educational value. Therefore, Smart Education development should support not only digital access but also cultural sustainability and local knowledge preservation.

Overall, Smart Education in the Pacific can be understood as an equity-driven adaptation process under structural constraints. The region's experience demonstrates that meaningful transformation does not depend solely on adopting advanced technologies, but on aligning technology with educational goals, institutional capacity, and community needs. Against this regional background, Samoa provides an important example of how a small island education system translates Smart Education ambitions into institutional practice.

> "The Pacific region presents a distinctive context for smart education. Scattered island nations suffer from remote geography, insufficient infrastructure and unequal educational resources. Smart Education here is not merely digital tools in classrooms, but a comprehensive transformation combining technology, teaching methods and local cultural demands."

Samoa Case Study

Case Selection and National Context

Samoa provides an important case for understanding how Smart Education develops within a small island state context. As one of the Pacific Island countries experiencing challenges related to geographic dispersion, limited infrastructure, and constrained institutional capacity, Samoa reflects many of the structural conditions influencing digital transformation across the region. At the same time, the country has demonstrated sustained commitment to education reform, digital development, and inclusive learning, making it a valuable example of how Smart Education can evolve through context-sensitive approaches.

Samoa's digital education development has been guided by national policy frameworks that position information and communication technologies (ICTs) as important instruments for improving educational quality, accessibility, and system resilience. The ICT in Education Policy 2018–2023 established strategic priorities for strengthening digital infrastructure, developing teacher capability, and integrating ICT into teaching and learning practices (Government of Samoa, 2018). More recently, the National Information and Communications Technology Policy 2025–2030 further emphasised digital transformation, connectivity improvement, and the development of digital capability across sectors, including education (Government of Samoa, 2025).

However, Samoa's Smart Education development must be understood within the realities of a small island education system. The country faces challenges associated with dispersed communities, infrastructure limitations, and uneven access to digital resources. While connectivity has improved substantially, differences remain between urban and rural areas, particularly regarding reliable internet access, device availability, and technical support (UNESCO, 2024).

Consequently, Samoa has adopted a gradual and adaptive approach to digital transformation. Rather than replacing traditional education systems with fully online models, the country has focused on integrating digital technologies into existing educational structures through blended learning, technology-enabled learning (TEL), open and flexible learning, and multimodal approaches. This strategy reflects the broader Pacific approach in which technology is used as an enabler of educational inclusion rather than as an objective in itself.

The National University of Samoa (NUS) represents a central institutional actor in this transformation. Through sustained development of TEL systems, Moodle-based learning environments, digital resources, and professional learning initiatives, NUS has gradually built institutional capacity for Smart Education. The university's experience demonstrates how small-state higher education institutions can leverage digital technologies while adapting implementation strategies to local conditions (Mow, 2025).

Institutional Development of Smart Education at NUS

NUS provides an important example of how Smart Education can develop through incremental institutional innovation. The university's TEL

NUS provides an important example of how Smart Education can develop through incremental institutional innovation. The university's TEL journey began with the recognition that digital technologies could expand educational access, improve teaching flexibility, and support learners who faced geographical and logistical barriers.

Early TEL initiatives focused on establishing digital learning infrastructure and supporting academic staff in adopting online teaching practices. Moodle was introduced as a core learning management platform, enabling lecturers to upload learning materials, organise online activities, communicate with students, and support blended delivery. The initial implementation process highlighted the importance of institutional readiness, teacher support, and continuous professional development rather than technology adoption alone (Mow, 2017).

Subsequent evaluations demonstrated that TEL implementation contributed to improved flexibility, learner engagement, and teaching capacity at NUS. The experience showed that technology-supported learning was particularly valuable for expanding educational opportunities in a small island context where geographical distance can limit participation in traditional face-to-face education (Mow, 2019).

More recently, NUS has continued to strengthen its TEL ecosystem by integrating digital platforms, OER, professional development mechanisms, and emerging AI applications. The university's TEL development illustrates a shift from technology adoption toward broader digital transformation, where technology is embedded within institutional strategies, teaching practices, and learner support systems.

A key feature of NUS's approach is the emphasis on institutional capacity building. Digital transformation has been supported through structures such as the Oloamanu Centre for Professional Development and Continuing Education (OCPDCE), which provides academic staff with support in instructional design, digital pedagogy, and flexible learning approaches. This reflects the understanding that sustainable Smart Education requires continuous development of human capability.

Performative Features (PF): The "What" of Smart Education in Samoa (with NUS as anchor)

PF1: Student-Centred Teaching

One of the most significant features of Samoa's Smart Education development is the movement toward more student-centred learning supported by digital technologies. At NUS, TEL has expanded opportunities for students to access learning resources, participate in online activities, and engage with instructors beyond traditional classroom settings.

Moodle serves as the foundation of this digital learning environment, supporting course delivery, resource sharing, assessment activities, and communication. Through TEL implementation, NUS has enabled greater flexibility for students, particularly those balancing study with employment, family responsibilities, or geographical constraints.

Digital technologies have also supported more interactive learning approaches. Online quizzes, multimedia resources, discussion forums, and collaborative activities have provided additional opportunities for learner engagement. These practices demonstrate a shift from technology as a content-delivery mechanism toward technology as a platform for interaction and learning participation.

However, student-centred Smart Education requires careful consideration of the relationship between technology and human learning. While digital tools can enhance flexibility and access, effective learning still depends on teacher guidance, meaningful interaction, and learner agency. This consideration has become particularly important with the emergence of AI-supported educational tools.

Research on AI and education has highlighted potential concerns regarding cognitive offloading, where learners may rely excessively on AI-generated responses rather than developing independent reasoning abilities. Therefore, AI adoption in Samoa should focus on enhancing learning processes while maintaining human-centred pedagogical principles.

PF2: Holistic Learning Assessment

AI represents an emerging dimension of Samoa's Smart Education development. Although AI adoption remains at an early stage compared with larger education systems, initiatives at NUS demonstrate the potential of AI to improve learner support and institutional responsiveness.

The AI-powered learner support initiative developed through COL provides an example of how AI can address practical challenges within small-state higher education systems. By providing automated assistance for common student enquiries, such systems can improve service efficiency and offer timely support to learners (Commonwealth of Learning, 2023).

For institutions with limited human resources, AI-supported services may provide valuable assistance in administrative and academic support functions. However, responsible implementation requires careful attention to accuracy, transparency, privacy, and human oversight. AI should complement rather than replace professional judgement and meaningful interaction between educators and learners.

The future development of AI in Samoa will therefore depend not only on technological availability but also on institutional governance, teacher AI literacy, and ethical frameworks. Building capacity among educators and administrators will be essential to ensure that AI contributes positively to educational quality and inclusion.

PF3: Smart Learning Environment

Samoa's smart learning environment demonstrates the importance of combining digital innovation with local adaptation. Rather than relying exclusively on high-bandwidth online solutions, Samoa has developed a hybrid ecosystem that integrates online platforms, offline resources, and locally relevant knowledge systems.

At the national level, initiatives such as the Samoa Knowledge Society Initiative (SKSI) and the Samoa Digital Library (SADIL) have supported the development and dissemination of digital knowledge resources. These platforms contribute to preserving local knowledge while improving access to educational materials (Mow, 2022; UNDP, 2022).

Open Educational Resources (OER) represent another important dimension of this development. OER enable institutions to reduce resource barriers, share educational materials, and adapt content according to local curriculum needs (Butcher et al., 2023). In Samoa, OER initiatives have also supported STEM education by expanding access to relevant learning resources (Chand, 2025).

These developments demonstrate that Smart Education in Samoa is not simply about introducing digital platforms. Instead, it involves building knowledge ecosystems where technology supports learning access, cultural relevance, and educational sustainability.

PF4: School Organizational Leadership

Leadership and governance have been central to Samoa's Smart Education development. The experience of NUS demonstrates that sustainable digital transformation requires more than the introduction of technological platforms; it requires institutional strategies, policy alignment, organisational support, and continuous capacity development.

At the institutional level, NUS has adopted a phased approach to technology-enabled learning development. Rather than implementing digital tools as isolated projects, the university has gradually integrated TEL into teaching practices, academic support structures, and institutional planning. This approach reflects the understanding that Smart Education is fundamentally an organisational transformation process involving people, systems, and practices.

The establishment of professional development mechanisms has been particularly important. Through the Oloamanu Centre for Professional Development and Continuing Education (OCPDCE), NUS has provided academic staff with support in instructional design, digital teaching strategies, and flexible learning approaches. Such institutional arrangements enable teachers to move beyond basic technology use toward more sophisticated integration of digital tools into curriculum and pedagogy.

At the national level, governance frameworks have provided strategic direction for digital education development. The ICT in Education Policy established priorities for technology integration, teacher development, and digital infrastructure improvement (Government of Samoa, 2018). More recently, the National ICT Policy 2025–2030 has strengthened the broader digital transformation agenda by emphasising connectivity, digital capability, and innovation (Government of Samoa, 2025).

However, expanding digital education also creates new governance requirements. As learning platforms, analytics systems, and AI-supported tools become increasingly embedded in education, institutions need stronger mechanisms for data protection, cybersecurity, and ethical technology governance. These issues are particularly important for small island systems where institutional resources may be limited and where digital services are often developed through external partnerships.

Samoa's experience suggests that effective Smart Education governance requires a balance between innovation and accountability. Institutions must create environments that encourage experimentation while ensuring that technologies are introduced responsibly and aligned with educational values.

PF5: Educational Equity

Educational equity represents one of the most important dimensions of Samoa's Smart Education development. For small island systems, digital technologies provide significant opportunities to reduce geographical barriers and expand access for learners who have historically experienced limited educational opportunities. However, technology alone does not automatically create equitable outcomes.

Samoa has implemented a range of initiatives aimed at improving digital inclusion. National ICT education programmes have focused on strengthening school connectivity, providing digital resources, and improving teachers' capacity to integrate technology into learning. The Ministry of Education, Sports and Culture's ICT initiatives have contributed to expanding access to digital learning environments across schools (Ministry of Education, Sport and Culture, 2021).

Infrastructure improvement has also been supported through initiatives such as school connectivity programmes and digital access projects. The Free and Secure Wi-Fi Project for Schools represents an important effort to improve access to online learning resources and strengthen digital participation among students (Ministry of Education and Culture, 2020).

At the same time, Samoa recognises that inclusion involves more than connectivity. Learners differ in terms of socioeconomic background, location, gender, disability, and digital capability. The Gender Achievement Gap Report highlights continuing inequalities affecting learner outcomes and reinforces the importance of targeted interventions to support disadvantaged groups (Ministry of Education, Sports and Culture, 2023).

Within higher education, NUS has incorporated Gender Equality, Disability and Social Inclusion (GEDSI) principles into institutional development. These approaches aim to ensure that digital transformation benefits diverse groups of learners rather than only those with greater access to technology.

The UNESCO-supported ICT in Education initiatives in Samoa further demonstrate the importance of combining infrastructure development with teacher support, curriculum adaptation, and inclusive practices (UNESCO, 2021, 2023). Such experiences highlight that digital equity requires a comprehensive approach involving technology access, learning support, and institutional commitment.

The assessment of Samoa's Smart Education performance features is summarised in Table 8.1. Overall, Samoa has established a relatively strong foundation in smart learning environments and educational leadership, while student-centred pedagogy, holistic assessment, and educational equity remain areas requiring further development to translate digital investments into more inclusive and effective learning outcomes.

Table 8.1 Assessment of Performative Features in Samoa's Smart Education Development

Indicator	Assessment	Critical Gap
PF1: Student-Centered Teaching	Moderate	Digital platforms and blended learning approaches are expanding, but technology adoption has not yet consistently translated into student-centred pedagogical transformation and AI-enhanced learning practices
PF2: Holistic Learning Assessment	Moderate	Platform-based formative assessment is developing, but AI-enabled assessment, learning analytics, and personalised feedback remain limited, particularly in school education

Indicator	Assessment	Critical Gap
PF3: Smart Learning Environment	Moderate	Hybrid learning environments and context-responsive solutions are well established, but connectivity reliability and digital access remain uneven across rural and outer-island communities
PF4: School Organizational Leadership	Strong	National and institutional leadership structures are relatively mature, but policy implementation and digital innovation capacity vary across schools
PF5: Educational Equity	Moderate	Targeted initiatives have improved access and inclusion, but disparities remain in rural connectivity, disability support, learner resources, and educational outcomes

Constructive Features (CF): The "How" and Enablers of Smart Education in Samoa (with NUS as anchor)

While the previous section examined the practical manifestations of Smart Education, constructive features refer to the deeper conditions that enable sustainable transformation. The Samoa case demonstrates that successful Smart Education depends on the interaction between cultural relevance, teacher capability, sustainability strategies, and collaborative partnerships.

CF1: School Cultural Development

Smart Education in Samoa demonstrates a strong emphasis on cultural relevance and localisation. At NUS, digital learning initiatives incorporate Samoan language, local knowledge, and context-specific content to ensure alignment with national culture and educational priorities (Mow, 2025). Similarly, national initiatives such as the Samoa Knowledge Society Initiative (SKSI), Samoa Digital Library (SADIL), and Samoa Systematic Synthetic Phonics programme support culturally grounded digital resources and curriculum-aligned learning materials. However, further efforts are needed to strengthen learner agency, community participation, and locally generated digital content (UNESCO &COL, 2024).

CF2: Data Security and Governance

Digital expansion has increased the importance of data governance and student privacy in Samoa's education system. Across the Pacific, governance frameworks remain uneven, with only four of fifteen education systems having education-specific data privacy laws (UNESCO & COL, 2024). In Samoa, student data privacy is currently addressed mainly through institutional cybersecurity measures, such as MESC's Free and Secure Wi-Fi for Schools initiative, rather than through a dedicated legal framework for education technology or student data protection (MESC, 2020; Education Profiles, 2025). At the institutional level, digital platforms such as Moodle and AI-supported learner helpdesk systems process student data to support learning and provide real-time assistance. While these technologies improve access and responsiveness, they also raise concerns regarding privacy, data security, and the ethical use of learner information (COL, 2023). Although national ICT policies emphasise cybersecurity and digital governance, implementation remains constrained by connectivity limitations, ageing infrastructure, and limited institutional capacity. Consequently, strengthening data governance, privacy protection, policy frameworks, and ethical AI practices will be essential to ensure the responsible and trustworthy development of Smart Education in Samoa (Government of Samoa, 2025; Education Profiles, 2025).

CF3: Teacher Capacity Building

Teacher capacity building is a key component of Smart Education development in Samoa.

Nationally, MESC integrates professional development with digital learning initiatives, and around 346 teachers have received training in open, distance and flexible learning (ODFL) through national and regional programmes (Pacific Partnership for ODFL in the Pacific, 2024). At NUS, professional development is supported through structured training in blended learning, instructional design, and digital pedagogy delivered by OCPDCE, reflecting the importance of pedagogically informed AI integration (Lodge & Loble, 2026). Pre-service teacher education is increasingly aligned with technology-enhanced learning (TEL), providing exposure to digital tools and blended learning, although programme-level integration remains uneven. For in-service teachers, capacity building has expanded beyond basic ICT skills to include AI- and STEM-related training, with approximately 80 teachers participating in specialised AI programmes and cascade training for TVET, demonstrating a gradual shift towards advanced digital competence and instructional innovation (UNESCO & Commonwealth of Learning, 2024).

CF4: Sustainable Education Reform

Sustainability remains a major challenge for Smart Education development in Samoa, as many ICT initiatives rely on external funding and short-term project support. At NUS, however, TEL has been implemented through a phased approach that integrates infrastructure, policy, and staff capacity building, embedding Moodle-based learning and OER systems within institutional practice rather than as stand-alone projects (Mow, 2025). This approach demonstrates that sustainable digital transformation depends on aligning technology adoption with institutional capacity and continuous professional development. Nevertheless, long-term sustainability remains constrained by limited funding, infrastructure, technical expertise, and maintenance capacity. These challenges underscore the importance of planning for ongoing costs, system maintenance, infrastructure upgrades, and institutional support to ensure the long-term viability of Smart Education in small island contexts.

CF5: Cross-Sector Collaboration

Smart Education development in Samoa relies on collaboration among government agencies, educational institutions, and international partners. These partnerships support policy development, technology implementation, and capacity building at both national and institutional levels (UNESCO &COL, 2024). Digital learning initiatives have expanded access to education through online and blended learning, with NUS enabling students to access courses and learning resources remotely, although connectivity challenges continue to limit equitable access in some areas. Collaboration with organisations such as COL and UNESCO further strengthens technology-enhanced learning (TEL), research, and knowledge sharing, providing technical expertise and international support for Samoa's ongoing Smart Education development (UNESCO &COL, 2024).

The assessment of Samoa’s constructive features and enabling conditions for Smart Education development is presented in Table 8.2. Overall, Samoa demonstrates strong collaborative and institutional foundations for sustainable Smart Education development; however, strengthening data governance, advancing teacher AI capabilities, and enhancing culturally responsive and inclusive practices remain critical to achieving long-term transformation.

Table 8.2 Assessment of Performative Features in Samoa's Smart Education Development

Indicator	Assessment	Critical Gap
CF1: School Cultural Development	Strong	Culturally relevant digital resources are emerging, but learner agency, community engagement, and locally generated digital content remain limited
CF2: Data Security & Governance	Weak	Digital governance mechanisms are developing, but Samoa lacks a dedicated education-specific learner data protection framework and comprehensive AI governance arrangements
CF3: Teacher Capacity Building	Strong	Professional development programmes have expanded digital skills, but a gap remains between technology familiarity and the ability to implement AI-integrated pedagogy and instructional redesign
CF4: Sustainable Education Reform	Moderate	TEL, OER, and blended learning have been increasingly institutionalised, although stronger evidence of long-term learning outcomes and system-level impact is needed
CF5: Cross-Sector Collaboration	Moderate	Partnerships among government, universities, and international organisations are well established, but interoperability, shared data standards, and integrated digital ecosystems remain underdeveloped

Future Directions

Probable Future: Adaptive and Context-Sensitive Digital Transformation

Based on the regional context and the Samoa case study, the future development of Smart Education in the Pacific is likely to follow a pathway of adaptive digital transformation rather than rapid technology replacement. Given the region's geographic characteristics, infrastructure limitations, and diverse educational contexts, future Smart Education systems will continue to prioritise flexible, inclusive, and sustainable approaches that align technological innovation with local realities.

Digital learning platforms, blended learning models, and open and flexible learning approaches are expected to become increasingly embedded within Pacific education systems. Institutions such as the National University of Samoa have demonstrated that technology-enabled learning can expand participation, improve learning flexibility, and strengthen institutional resilience when supported by appropriate governance and professional capacity.

However, future development will remain uneven. While some institutions and countries are moving toward more advanced digital ecosystems, others continue to face fundamental challenges related to connectivity, infrastructure maintenance, and digital capability. Regional evidence indicates that digital transformation in the Pacific must continue to address the structural inequalities that shape access to education and technology (UNESCO, 2024; Pacific Community [SPC], 2025b).

Therefore, the future of Smart Education in the Pacific is unlikely to be characterised by a single technological model. Instead, hybrid approaches combining online platforms, offline resources, mobile technologies, and face-to-face learning will remain essential. Such approaches are particularly appropriate for small island contexts because they balance innovation with affordability, accessibility, and sustainability.

Possible Futures: Emerging Opportunities for Transformation

First, regional cooperation is essential for advancing Smart Education across the Pacific, where limited resources and small education systems constrain the independent development of digital infrastructure and AI capacity. Frameworks such as the Pacific Regional Education Framework (PacREF) provide a foundation for collaboration in educational quality and system strengthening (Pacific Community [SPC], 2024). Future cooperation could focus on shared digital learning platforms, teacher professional development, open educational resources, and joint research. International organisations, including UNESCO, COL , and UNDP, have supported these efforts through policy advice, capacity building, and knowledge exchange, with increasing emphasis on strengthening local ownership and institutional capability (UNESCO, 2025). By promoting shared resources and expertise, regional collaboration can reduce duplication, improve efficiency, and enhance the long-term development of Smart Education across Pacific island countries.

Second, the NUS and COL AI-supported learner support initiative demonstrates how AI can improve institutional responsiveness and student support services (COL, 2023). However, AI adoption should follow a human-centred approach, ensuring that technology complements rather than replaces teachers and supports learners' independent thinking. Future AI development in Pacific education should emphasise human oversight, ethical governance, teacher AI literacy, and contextual adaptation to local educational needs. These principles align with international guidance that technology should serve educational objectives while protecting learner autonomy, privacy, and equitable access.

Third, OER provide an important pathway for improving educational access, sustainability, and curriculum innovation in the Pacific by enabling the sharing, adaptation, and reuse of learning materials. Samoa's digital knowledge platforms, including SKSI and SADIL, demonstrate the potential of digital ecosystems to preserve local knowledge while expanding access to resources (Mow, 2022; UNDP, 2022). OER development is particularly valuable for STEM education, where shared resources can help address limited access to specialised teaching materials and support regional collaboration (Chand, 2025). Therefore, OER strategies should be linked with professional development, local cultural contexts, and ongoing curriculum innovation.

Fourth, equity should remain central to future Smart Education development. Across the Pacific, disparities in educational participation and outcomes continue to affect remote communities, disadvantaged learners, and groups requiring additional support (SPC, 2025a, 2025b). Future strategies should adopt an inclusive-by-design approach by improving affordable connectivity, device access, digital literacy, accessible learning resources, and consideration of gender and disability needs. Samoa's GEDSI-oriented education planning demonstrates the importance of integrating inclusion principles into digital transformation to ensure that technology supports meaningful participation for diverse learners (Ministry of Education, Sports and Culture, 2023).

Preferable Future

Among different possible development pathways, the preferable future for Pacific Smart Education is one that combines technological innovation with human-centred, inclusive, and sustainable development principles.

First, technology should remain a means rather than an end. Digital platforms and AI systems should strengthen teacher capability, support learner engagement, and improve educational opportunities without reducing education to automated processes. Human relationships, cultural values, and professional judgement must remain central.

Second, sustainability should guide technology investment decisions. Smart Education initiatives should consider long-term maintenance, institutional capacity, and financial feasibility. For small island systems, affordable and adaptable solutions may provide greater value than technologically advanced but difficult-to-sustain models.

Third, digital transformation should strengthen rather than weaken cultural identity. Pacific education systems possess rich cultural traditions and knowledge resources. Smart Education should support the preservation and integration of these resources within contemporary learning environments.

Ultimately, the preferable future is not a fully digital education system, but an intelligent, flexible, and inclusive learning ecosystem where technology enhances human potential while remaining responsive to local contexts.

Actionable Recommendations

For Policymakers

Governments should strengthen national frameworks for digital education, including policies related to connectivity, data governance, cybersecurity, and responsible AI use. As digital platforms become increasingly embedded in education systems, clear regulatory approaches will be required to protect learners and maintain public trust (UNESCO & COL, 2024).

Investment strategies should also consider the full lifecycle of digital transformation. Funding should support not only infrastructure development but also teacher training, technical maintenance, evaluation mechanisms, and institutional capacity building.

Furthermore, policymakers should continue prioritising equity-oriented approaches to ensure that digital transformation benefits remote communities and disadvantaged learners rather than widening existing inequalities.

For Educational leaders (Institutions)

Educational institutions should integrate Smart Education into broader institutional strategies rather than treating digital initiatives as temporary projects. This requires strengthening governance structures, professional development systems, and quality assurance mechanisms.

Institutions should also develop flexible learning models combining online, offline, and face-to-face approaches. Such models are particularly suitable for Pacific contexts because they provide resilience while accommodating diverse learner needs.

Universities should further strengthen partnerships with regional and international organisations to expand research capacity, share resources, and develop locally relevant innovations.

For Practitioners (Teachers)

Teachers remain the key actors determining whether Smart Education achieves meaningful outcomes. Professional development should therefore move beyond technical training toward deeper capabilities in digital pedagogy, AI literacy, assessment innovation, and ethical technology use.

Educators should actively participate in developing and adapting digital resources to ensure cultural and pedagogical relevance. They should also maintain critical oversight of AI-supported learning processes to ensure that technology promotes creativity, critical thinking, and learner autonomy.

Conclusion

The findings of this chapter indicate that Smart Education in the Pacific is best understood as a process of context-sensitive and equity-driven adaptation, rather than rapid technological transformation. Progress is evident in expanded access, increased use of blended and flexible learning, and the gradual integration of digital and AI-supported tools across systems. However, these developments remain uneven and continue to be shaped by structural constraints, including limitations in infrastructure, governance capacity, and sustainability. The growing use of AI further underscores the need to balance efficiency with meaningful learning outcomes and strong teacher capacity (Lodge & Loble, 2026). Overall, the future development of Smart Education in the Pacific depends on achieving balance: balancing innovation with sustainability, technology with humanity, and global knowledge with local contexts. Samoa's experience demonstrates that meaningful transformation emerges not from adopting the most advanced technologies, but from creating education systems capable of adapting technologies to serve learners, communities, and societies.

References

Butcher, N., Zimmermann, A., Levey, L., & von Gogh, K. (2023). Open educational resources. In Global education monitoring report 2023. UNESCO.

Mow, C. I. (2017). Baseline study of technology-enabled learning at the National University of Samoa. National University of Samoa.

Mow, C. I. (2019). The impact of technology-enabled learning implementation at the National University of Samoa. Commonwealth of Learning / Samoa Digital Library.

Mow, C. I. (2022). The role of NUS in establishing the Samoa Knowledge Society Initiative (SKSI). Journal of Samoan Studies, 12(1).

Mow, C. I. (2025). Technology-enabled learning at the National University of Samoa. Commonwealth of Learning.

Chand, R. (2025). Open educational resources for STEM education in Samoa. Commonwealth of Learning.

Commonwealth of Learning. (2021). A multimodal education response to the resilience challenge in Tonga.

Commonwealth of Learning. (2023). Samoa pioneers AI-powered learner support.

Education Profiles. (2025). Samoa: Technology. https://education-profiles.org/oceania/samoa/~technology

Government of Samoa, Ministry of Education, Sports and Culture. (2018). ICT in education policy 2018–2023.

Government of Samoa. (2025). National information and communications technology policy 2025–2030.

Lodge, J. M., & Loble, L. (2026). Artificial intelligence, cognitive offloading and implications for education.

Ministry of Education and Culture. (2020). MESC's Free and Secure WiFi Project for Schools. Apia, Samoa.

Ministry of Education, Sport and Culture. (2021). Press Release: ICT in Education in Samoa. Apia, Samoa.

Ministry of Education, Sports and Culture. (2023). Samoa gender achievement gap report: An exploration of factors contributing to male students' underachievement.

Pacific Community (SPC). (2024). Pacific Regional Education Framework: Monitoring and evaluation progress report.

Pacific Community (SPC). (2025a). PILNA 2025: A regional picture of learning in the Pacific.

Pacific Community (SPC). (2025b). The status of Pacific education report 2024 (SOPER).

Pacific Partnership for ODFL in the Pacific. (2024). Country briefing: Samoa.

United Nations Conference on Trade and Development (UNCTAD). (2025). Digital economy report: Pacific edition.

United Nations Development Programme (UNDP). (2022). Samoa digital library (SADIL) and SKSI knowledge platform.

UNESCO. (2021). Promoting Information Communication Technologies in Education in Samoa. UNESCO Pacific Office, Apia.

UNESCO. (2023). ICT Shaping a New Way of Learning for Schools in Samoa. UNESCO Pacific Office, Apia.

UNESCO. (2024). Technology in education: Pacific regional report.

United Nations Educational, Scientific and Cultural Organization, & Commonwealth of Learning. (2024). Global education monitoring report 2024: Technology in education—A tool on whose terms? Pacific regional edition.

UNESCO. (2025). Regional collaboration strengthens education in Pacific Island countries.

UNICEF. (2022). Annual report 2022.

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9

Chapter 9

Global Synthesis and Future Directions: Different Realities, Lessons We Can Share

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Chapter 9 Global Synthesis and Future Directions: Different Realities, Lessons We Can Share

The seven regional reports reveal the diversity, richness and adaptability of Smart Education around the world. In one place, it means building a national platform that serves millions. In another, it means helping a learner continue during conflict, displacement or a power outage. Elsewhere, it means giving teachers better tools, helping adults return to learning, protecting learner data or making sure education remains available across islands and remote communities. These approaches are different because the circumstances are different. One is not automatically more advanced than another. That is what makes this report useful. It shows what each region is trying to solve, what it is learning and what others may learn from it. The ten Smart Learning indicators show more clearly where the regions differ, what appears to support progress and which problems remain unresolved across all regions. China's vision then takes the discussion into the future. It shows how AI may change teachers, classrooms, schools and learning centres, as well as how countries may work together. This gives us a way to look at both where Smart Education stands today and where it may be heading. Across the reports, the three lenses relating to the gains, the changes and the risks are closely connected. The same development can widen access, reshape education and create a new concern at the same time.

Where New Possibilities Are Opening

The clearest gain is that education is reaching people who were once harder to reach.

The Pacific faces a reality shaped by distance. Learners are spread across islands and communities where connectivity is uneven. Education systems are not waiting for perfect infrastructure. They are combining online learning with radio, mobile access, print and other forms of support. Regional cooperation and shared resources help smaller systems do more than they could do alone. The Pacific report describes an approach shaped by equity, culture and local conditions rather than by the urge to adopt the newest technology.

Sub Saharan Africa brings a different set of realities. The barriers are familiar and serious: electricity, connectivity, affordability, devices, teacher shortages and language. The report also describes what is being built: teacher development, digital skills, new curricula, local partnerships and African language technologies. It makes a basic point that is easy to overlook. A platform is not truly accessible when its language, examples or assumptions do not make sense to the learner.

The Arab region shows both the reach of national ambition and the importance of continuity. Some countries are investing heavily in artificial intelligence, national curricula, smart classrooms and Arabic language tools. Others are trying to keep education going in the middle of conflict and displacement. The same region therefore includes highly developed national initiatives, countries still building their approach and places where the immediate concern is keeping education available at all.

Asia shows what can happen when public policy, long term investment and very large education systems work together. National platforms can make courses, resources and teacher support available on a vast scale. The region also shows how technology can keep education moving during disruption. But large numbers do not tell the whole story. A platform may reach millions and still miss the learner who cannot connect, cannot follow the material or cannot get help before falling behind.

Europe brings strong work in policy, ethics, and responsible use. It also shows how artificial intelligence can support personalized learning, adult education and more flexible ways to gain and carry skills from one setting to another. The European report shows that institutions can test new tools while still asking difficult questions about data, accountability and educational purpose.

Latin America and the Caribbean show why lasting public capacity matters. The region is changing, but not evenly. Some projects remain scattered or temporary. Others have moved beyond pilots and become part of public education systems. The strongest examples connect technology with curriculum, teacher preparation, school organization and public policy. A project has a different value when it becomes part of everyday education rather than disappearing after the pilot ends.

The North American report focuses on the **United States** which has schools, colleges, universities, public agencies and private companies trying many approaches at once. This produces examples quickly and gives others a large testing ground. The useful part is not the pace alone. It is what these experiments reveal about learning, teaching and responsibility.

Canada, though not a separate chapter, brings another North American experience. Online and flexible learning have been used to reach people across enormous distances, in English and French, and in northern, rural, remote and Indigenous communities. Publicly supported institutions and services have an important part in making that possible.

Across the reports, education systems are becoming better at noticing when learners may need help. Data can show that someone has stopped participating or is falling behind. Artificial intelligence can offer another explanation, provide feedback or help a teacher prepare material. Flexible learning can make it easier for adults to return after years away. None of this comes from technology alone. It depends on teachers, institutions, language, culture and continuing support.

What the Ten Smart Education Indicators Reveal

The ten indicators fall into two groups: five that show what Smart Education looks like in practice and five that show whether the education system can support it.

The Performative Features, student centred teaching, holistic learning assessment, smart learning spaces, school organizational leadership and educational equity, show what Smart Education looks like in practice.

The Constructive Features, school cultural development, data security and governance, teacher capacity building, sustainable education reform and cross sector collaboration, show whether the conditions exist to support, govern and sustain that practice.

This difference is important. An education system may have advanced technology and smart learning spaces but lack the teachers, safeguards or institutional capacity needed to use them well. Another may have strong leadership and teacher development but continue to face major limits in connectivity, funding or access.

The results differ sharply from one region to another. The strongest results generally appear where institutions are well established, public investment continues, policies are clear and teachers receive sustained support. Progress is more uneven where systems face serious learning problems, weak infrastructure, teacher shortages, climate risks or dependence on short term external funding. These differences are real and deserve to be recognized. They are best understood in light of each region's circumstances, priorities and stage of development. Used this way, the indicators tell us what each region has built, what remains unfinished and what may account for the difference.

Regional Variations

Brazil shows what can happen when technology is connected with wider public education reform. Its technological school model includes 300 schools serving approximately 125,000 students, supported by extensive teacher preparation. Brazil records strong results across several Performative and Constructive Features, while its weak data governance assessment shows that innovation can move faster than the protections needed to govern it.

Europe's strengths include student centered teaching, smart learning spaces, teacher preparation, sustainable reform and cross sector collaboration. Its regulatory frameworks provide an important foundation, but implementation within schools and institutions remains incomplete.

Europe's strengths include student centered teaching, smart learning spaces, teacher preparation, sustainable reform and cross sector collaboration. Its regulatory frameworks provide an important foundation, but implementation within schools and institutions remains incomplete.

Kenya faces a difficult combination of infrastructure, teacher capacity and institutional constraints. Its experience shows that technology cannot by itself overcome shortages of prepared teachers, limited access to devices and weak institutional support.

The Philippines faces serious learning, infrastructure and equity challenges. Reported proficiency declines sharply between the early and final grades, while the difference in digital access between Metro Manila and the Bangsamoro Autonomous Region in Muslim Mindanao reaches 41 percentage points. At the same time, the Philippines demonstrates strength in cross sector collaboration, showing that limited results in one area can coexist with progress in another.

Samoa presents another mixed picture. It shows strength in leadership, school culture and teacher development, but only about half of primary schools have internet access. Offline technologies therefore remain important. Data governance and the long-term financing of reform continue to require attention.

Saudi Arabia demonstrates the effect of long-term national planning and public investment. Its results are strong in smart learning spaces, organizational leadership and sustainable reform. It has also trained teachers on a very large scale. The assessment nevertheless distinguishes between learning to operate platforms and being prepared to integrate artificial intelligence deeply into teaching, assessment and learner support.

The United States is strong in institutional capacity, professional networks, investment and extensive experimentation. Yet school organizational leadership, educational equity, and data security and governance remain uneven.

Each region shows a different mix of progress and constraint. A large, well-resourced system responds differently as compared to a small island state or a country still dealing with basic infrastructure and learning problems.

What Appears to Explain the Differences

One of the clearest differences is the ability of governments and institutions to turn policy into practice. Regions with stable institutions, continuing public investment and clear national strategies are generally better able to connect technology with curriculum, assessment, teacher preparation and institutional reform. But a strong policy does not guarantee strong implementation.

The United States and Europe have established laws and frameworks, yet both remain incomplete in translating data governance and accountability into consistent school level practice. Other regions are introducing platforms and data systems before education specific protections are fully in place. The real gap is between what policies promise and what schools, teachers and learners experience in practice.

Teacher preparation is just as important. A system may have connectivity, platforms, devices and a national strategy. If teachers are not prepared to integrate them into teaching, assessment and learner support, progress in the other indicators will have limited effect. Brazil's sustained teacher development illustrates the value of long term preparation. Saudi Arabia's experience shows that training large numbers of teachers does not by itself demonstrate deeper change in pedagogy.

Kenya and the Philippines show how skills gaps, shortages and teachers working outside their areas of preparation can limit implementation.

Training a teacher to operate a platform is not the same as preparing that teacher to decide when artificial intelligence adds value, when it may mislead a learner and when human judgement is required. Policy reaches learners through teachers.

Infrastructure still matters. Electricity, connectivity, devices, affordability and maintenance determine whether learners can participate consistently. National averages can also conceal large differences between urban and rural areas, wealthy and low income communities, and central and remote regions.

The Philippines' geographical digital divide, Kenya's inadequate access to devices and Samoa's limited school connectivity demonstrate how infrastructure continues to shape participation.

The reports also show that education systems do not always need to wait for ideal infrastructure. Radio, mobile access, print and offline resources can all form part of a serious Smart Education strategy. These are not necessarily signs that a system has failed to modernize. In some settings, they are the most dependable and appropriate ways to keep education available.

No region has fully solved the question of equity. Even systems with stronger overall results receive only moderate assessments in educational equity. Technology does not automatically overcome poverty, geography, disability, language, discrimination or unequal access to support. Reaching a learner and helping that person learn are not the same thing. Registration is easy to count. So are logins, completed tasks and platform use. Understanding is harder to measure. So are independence, confidence and what happens after a course ends.

Smart Education is best judged by how well learners can take part, receive help and make progress, as well as by how many people it reaches.

Data security and governance are the one area in which no region receives a strong assessment. Learners may not know how their information is used, how a recommendation was made or who is responsible for a decision. Biased data may repeat old inequalities. Commercial systems may become deeply embedded before institutions have agreed on clear rules. A system cannot be considered smart if nobody can explain what it is doing, review a decision or accept responsibility when it causes harm.

Collaboration also makes a difference. Governments, education institutions, technology providers, employers, community organizations and international partners increasingly work together. Collaboration can bring expertise, investment, speed and reach. It can also blur responsibility. The important question is not how many organizations are involved, but whether their responsibilities are clear, their systems work together and their efforts create lasting value for learners.

A pilot may succeed and still disappear when funding ends. A platform may lack the staff, maintenance or public commitment needed to keep it going. An institution may depend on a provider it does not control. A successful launch tells us very little about what will remain five years later. For a reform to last, it needs continuing funding, people who can run it, institutional responsibility, maintenance and honest evidence that it is improving learning.

One conclusion stands out. Technology does not drive educational transformation by itself. Education systems do.

What Is Changing Now

Smart Education is changing more than how education is delivered. Curriculum is changing. Learners are being asked to understand artificial intelligence, use it well and judge its output. Using a tool is one skill. Knowing when its answer is wrong, incomplete or unhelpful is another. The Sub Saharan Africa report makes this point with unusual force. It warns that learners may begin to hand too much of their thinking to artificial intelligence. It argues for education that protects questioning, reflection, local knowledge and the learner's ability to go beyond the answer on the screen. Europe reaches a similar conclusion from another direction. Its reports give more attention to reflection, problem solving and the use of artificial intelligence to support reasoning rather than replace it.

Learners will use these tools. The question is whether they still understand what they are doing, can explain it and can apply it elsewhere. Assessment is changing for the same reason. A polished answer no longer tells us as much as it once did. It may show strong understanding. t may also show that the learner used a powerful tool well. Educators are therefore paying more attention to how learners reached an answer, how they explain it, how they use it in a new situation and whether they can respond to questions about it.

The role of the teacher is changing too. Technology can provide information, suggestions and feedback. It still takes a person to judge whether the information is sound, whether it suits the learner and whether the learner is becoming more confident and independent. The teacher's role is not disappearing. It is becoming more demanding. Institutions are changing as well. Education now involves more technology companies, employers, public agencies and community organizations. That can bring knowledge, speed and investment. It can also blur responsibility. The purpose of all this change is education for all. It is to help learners remain curious, think critically, develop creativity, exercise judgement and keep learning throughout their lives. That is where the wider human value of Smart Education lies. Faster feedback, wider access and better information all have value. So do human judgement, trusted relationships, cultural relevance and the learner's own work of thinking.

Five Questions from the Learner's Point of View

The reports lead to five plain questions:

1. Can I take part and keep going?

2. Am I learning and thinking for myself?

3. Can I trust the people and technology supporting me?

4. Do I have different ways to learn, receive help and show what I know?

5. Will this learning help me move forward?

Infrastructure, investment and policy still matter. These questions tell us what they are supposed to accomplish.

The Strength of More Than One Approach

Smart Education's strength lies precisely in not relying on a single platform, form of delivery, language, kind of support or way for learners to demonstrate what they know. Learners live in different circumstances. Connectivity may be uneven. A format may not be accessible. A language may not reflect the learner's experience. Geography, cost, displacement or disruption may affect how learning continues. Smart Education takes different forms because people's lives are different. A strong system gives learners different workable ways to participate, receive support, continue learning and show what they know. The most advanced tool is not always the most useful one. A smart system uses the tools, people and support that allow learning to continue.

China's Vision for the Future of Education

China begins with a broad view of Smart Education. It extends beyond online delivery, digital platforms or individual AI applications. The regional reports and the ten indicators show where Smart Education stands today. China's vision looks ahead. In this vision, AI serves as a catalyst for wider changes in teaching, learning and the organization of education. China sets out this future through four connected parts.

1. Cultivating Future Teachers

The first focuses on teachers. AI supported systems would undertake repetitive tasks such as elements of lesson planning and grading. This would allow teachers to devote more time to mentorship, creativity and deeper educational interaction. Data informed teaching research systems would provide teachers with personalized feedback and support continuing improvement in their practice. Teachers would increasingly work as facilitators and innovators within a human and machine collaborative teaching environment. The teacher's role becomes even more important, with greater emphasis on mentorship, creativity and educational judgement.

2. Building Future Classrooms

The second focuses on classrooms. China envisages classrooms in which collaboration among teachers, students and machines becomes increasingly common. Artificial intelligence, big data and virtual simulation would be combined with modular courses, agile learning groups and open forms of assessment. The aim is to create immersive and interactive learning environments that connect the physical and digital worlds. Students would participate more actively in finding, applying and producing knowledge.

3. Creating Future Schools

The third focuses on future schools. Intelligent technologies would be integrated more deeply into school administration and governance. Data informed systems could support decisions about regional talent needs, university programmes, educational resources and demographic change. AI supported assessment could also provide a broader picture of student growth rather than relying only on examination results. The vision includes moral, intellectual, physical, aesthetic and labour education in this broader understanding of development.

4. Establishing Future Learning Centres

The fourth focuses on future learning centres. These centres would be student centred, interdisciplinary and digitally accessible. They would bring industry, education and research into closer contact. Learners could follow personalized pathways using resources such as MOOCs, virtual simulations, scenario based learning and project based learning. The wider aim is to make high quality learning more broadly available and support a society in which people can return to education throughout their lives. Each part supports the others. Teachers work differently, classrooms change, schools use information more extensively and learning becomes more flexible throughout life.

China's Call for Global Collaboration

China also presents the educational changes associated with AI as a matter for international cooperation.

Two lessons from China's experience have wider relevance. Digital education infrastructure can be treated as a public resource that widens access to quality learning. National planning can also leave room for schools and local communities to test and adapt new approaches.

China proposes cooperation in three areas.

Ensuring Equitable and Inclusive Access

China proposes sharing high quality educational resources through platforms such as the National Smart Education Platform. It also proposes skills training in developing countries and international efforts to narrow the digital divide. The test will be whether these resources are genuinely useful to learners working in different languages, cultures and levels of infrastructure.

Promoting Openness and Collaborative Innovation

The vision calls for joint research and practical cooperation in digital education technologies.

This includes open language datasets, shared resource repositories and collaboration in developing future oriented educational institutions. International cooperation is essential to address the technical, educational and ethical questions raised by AI.

Advancing AI Safety and Ethical Governance

The vision recognizes the risks associated with the AI divide, privacy, algorithmic bias and unequal access. It calls for international cooperation on AI safety standards and ethical guidelines, in line with the United Nations guidelines. This returns us to the weakness found across all ten indicators. Technology is advancing faster than many education systems can establish and apply effective rules. China's vision shows the scale of change that long term planning can make possible. Other governments and regions will bring their own priorities and circumstances to this international discussion.

Another Long Term Perspective from the Global South

The African Union's Agenda 2063 offers a different long term perspective. It presents a vision of an integrated, prosperous and peaceful Africa built through inclusive growth and sustainable development. Education, skills, science, technology and innovation form part of that wider ambition and of the development of human and social capacity across the continent. Agenda 2063 offers a broader development framework in which education, science and technology support Africa's long term future.

China's vision gives detailed attention to future teachers, classrooms, schools and learning centres. Agenda 2063 places education, science and innovation within a broader continental vision. They are different, but both look beyond the immediate adoption of another tool or platform.

Both ask what kind of society education should help build. Smart Education will not have one future. Regions will make different choices because their conditions and priorities are different.

GSENet's Continuing Role

GSENet will continue to build on the collective experience of its members, bringing more evidence and experience into the global discussion about Smart Education. It will help members compare not only which technologies are being adopted, but whether they are improving learning and what makes that improvement possible. It will bring together what regions are learning about teachers, language, infrastructure, public capacity, trust, assessment, equity and continuity. It can also give members a place to compare different visions of the future. GSENet's role is to help members see what each experience offers, what others may use and what must remain rooted in local circumstances.

There is no single path to Smart Education. A system working during conflict is responding to a different and equally important educational need. A small island state combining radio, print and online learning is following an approach suited to its learners and circumstances. They are dealing with different circumstances and making different choices. Comparing them helps us see what each experience adds. In the Pacific, flexibility and local fit are central. Sub Saharan Africa places language, culture and independent thought firmly in the discussion.

The Arab region shows national ambition alongside the daily work of keeping education available. Asia shows what public policy and scale can achieve, as well as what scale may overlook. Europe connects innovation with trust, responsibility and clear rules. The United States offers lessons from rapid and varied experimentation. Canada shows how geography, language, community and public support shape access to learning. Latin America and the Caribbean show why public institutions matter when an innovation is expected to last. The ten indicators show that governance, teacher preparation, infrastructure, equity, data protection, collaboration and long term support work best when developed together.

Taken as a whole, the report shows both the reach of Smart Education and the work that remains. It shows education becoming more available and adaptable. It also brings us back to the question that matters most:

Are learners understanding what they are studying, thinking for themselves and able to move forward? The answer will depend on how effectively each region connects technology with educational purpose, prepared teachers, clear responsibility, strong institutions and real support for learners. GSENet is well placed to keep that question at the centre of its members' work and to help turn it into clearer choices, stronger practice and better results for learners.

References

Ministry of Education of the People's Republic of China. (2025). White Paper on China's Smart Education.

African Union. (2013). Agenda 2063: The Africa We Want. African Union Commission.

Global Smart Education Network (GSENet)

Vision

To network with leading partners and diverse experts to promote better education for all.

Mission

To create a shared platform that connects organizations and institutions for intercultural dialogue, leveraging smart learing technologies to enhance educational excellence and innovation for all through research, policy development, and capacity building.

Smart Education AROUND THE WORLD

Education systems everywhere are asking the same urgent question: *How do we harness AI's potential while safeguarding what matters most?* This report answers that question—not from one perspective, but from seven distinct regional viewpoints, brought together through the collaborative efforts of GSENet partners worldwide.

While contexts differ significantly, four key messages emerge across all regions.

First, AI should strengthen rather than replace human judgement.

Second, equity remains the defining challenge of Smart Education.

Third, teachers' roles are evolving rapidly.

Fourth, governance has not kept pace with technological change.

While the report aligns with the Education 2030 Agenda, it recognises that emerging developments beyond 2030 will require education systems to respond to new challenges and opportunities by looking beyond immediate technological trends, towards long-term thinking about how education can be more equitable, resilient and responsive to the needs of all learners.

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