

From Alignment to Implementation: Governing AI Literacy as a Coordinated National Capability in Progressive GULF Education Systems

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Abstract

Artificial intelligence literacy has become a strategic priority for education systems preparing learners for workforce participation, civic engagement, and responsible interaction with emerging technologies. In progressive to moderate GULF countries, enabling conditions are increasingly in place to support large-scale adoption, including digital infrastructure, policy direction, quality assurance systems, and post-pandemic digital maturity. The policy opportunity lies in strengthening alignment across these elements to enable consistent, scalable implementation. This article argues that AI literacy can be governed as a coordinated national capability through alignment across policy, educator competency, institutional readiness, and monitoring systems. Drawing on regional findings and contemporary literature, the analysis identifies priorities for system development, including coordinated governance across government institutions, unified educator competency frameworks, and national monitoring mechanisms. The article proposes a governance architecture that integrates central direction with institutional execution through tiered competencies, readiness assessment, and phased implementation, supporting sustained, system-wide capability development across diverse education contexts.

Keywords: AI literacy; educator competency; AI governance; institutional readiness; monitoring and evaluation; K-12; higher education; GULF education systems

Introduction

Artificial intelligence has transitioned from a specialized technical domain into a foundational layer of contemporary education systems. Learners engage with AI through adaptive learning platforms, generative tools, intelligent tutoring systems, translation technologies, and algorithm-driven recommendation engines. Educators interact with AI through learning analytics, automated assessment systems, content generation tools, and administrative decision-support platforms. These developments position AI literacy as a core capability required for meaningful participation in education, professional environments, and broader civic contexts (Chiu et al., 2024; Zhou et al., 2025; Wu & Huang, 2026).

AI literacy extends beyond the scope of traditional digital literacy. While digital literacy emphasizes access, communication, and information evaluation, AI literacy introduces additional competencies related to algorithmic reasoning, data interpretation, model limitations, bias recognition, account-

ability, and ethical use (Lan et al., 2025; Tenberga & Daniela, 2024; Ma et al., 2025). This distinction carries significant policy implications. Education systems that position AI literacy as a simple extension of digital skills risk under-specifying the depth and complexity of competencies required for responsible and effective engagement with AI systems (Chiu et al., 2024; Chee et al., 2025).

The growing body of literature conceptualizes AI literacy as a multidimensional construct integrating cognitive, technical, ethical, and social dimensions. These dimensions include knowledge of AI concepts, the ability to critically evaluate AI outputs, awareness of ethical implications, and the capacity to apply AI tools appropriately within domain-specific contexts (Zhou et al., 2025; Lan et al., 2025; Asghar et al., 2025). In K-12 education, AI literacy is often framed through foundational understanding, age-appropriate conceptual progression, and ethical awareness (Casal-Otero et al., 2023; Mannila et al., 2025; Yang et al., 2026). In higher education, AI literacy expands to include disciplinary application, research integration, and professional competency in AI-enabled environments (Chiu, 2025; Sun et al., 2026; Wu & Huang, 2026).

Empirical research demonstrates that AI literacy is associated with a range of educational outcomes. Studies have identified relationships between AI literacy and student self-efficacy, academic performance, creativity, and career readiness (Chun et al., 2025; Skalka et al., 2025; Wang, 2026). Additional research highlights the role of AI literacy in shaping learners' attitudes toward technology, influencing their willingness to engage with AI systems and pursue AI-related career pathways (Zhang et al., 2025). These findings reinforce the importance of AI literacy as a foundational educational objective rather than a supplementary skill set.

Despite increasing recognition of its importance, the implementation of AI literacy across education systems remains uneven. Variability in curriculum design, educator readiness, institutional support, and policy direction contributes to differentiated levels of adoption (Darmawan et al., 2024; Ngoveni, 2025; Özüdoğru & Durak, 2025). Research consistently identifies educator capacity as a central factor influencing the effectiveness of AI literacy integration. Educators often demonstrate positive attitudes toward AI while lacking the pedagogical knowledge, technical confidence, and ethical guidance required for meaningful classroom application (Tagare et al., 2025; Tang & Zhang, 2025).

Progressive to moderate GULF countries refer to education systems that demonstrate sustained investment in digital transformation, structured governance frameworks, and active integration of emerging technologies within policy and practice; examples include the United Arab Emirates, Saudi Arabia, Qatar, Jordan, and Bahrain, where coordinated efforts toward AI adoption and education modernization are evident. Progressive to moderate GULF countries provide a compelling context for examining AI literacy as a national capability. Investments in digital transformation, education reform, and emerging technologies have established strong enabling conditions for AI integration. These systems are characterized by advanced digital infrastructure, centralized policy direction, structured quality assurance mechanisms, and increasing institutional digital maturity. The acceleration of digital adoption following the COVID-19 pandemic has further strengthened the technological readiness of education systems across the region (Rahman et al., 2025; Karroum & Elshaiekh, 2023).

Within this context, AI literacy initiatives are emerging across both K-12 and higher education sectors. Institutions are incorporating AI tools into teaching and learning, developing new courses, and exploring innovative pedagogical approaches. At the same time, national strategies emphasize the importance of preparing learners for knowledge-based economies and future labor markets shaped by automation and artificial intelligence. These developments create a strong foundation for scaling AI literacy across education systems.

Current implementation patterns indicate that these enabling conditions are advancing in parallel. Policy frameworks, institutional initiatives, professional development efforts, and technological adoption are progressing simultaneously but without full alignment. This pattern reflects a stage of system development in which innovation is present but coordination mechanisms are still evolving. The result is variation in implementation across institutions, sectors, and regions, highlighting the need for structured alignment to support scalability and consistency.

A systems perspective provides a useful framework for understanding this dynamic. AI literacy development depends on the interaction of multiple components, including governance structures, educator capability, institutional readiness, technological infrastructure, and monitoring systems. Sociotechnical systems theory suggests that performance outcomes are shaped by the alignment of these components rather than by the strength of any single element (Pasupuleti et al., 2026; Benayoune et al., 2026). In the context of AI literacy, this implies that infrastructure and policy direction must be complemented by coordinated implementation and accountability mechanisms.

Governance structures play a central role in enabling this alignment. Education systems in progressive GULF contexts typically involve multiple government institutions with distinct regulatory mandates. These institutions oversee curriculum standards, accreditation processes, inspection frameworks, and institutional performance. While this structure supports specialization and oversight, it also requires coordination to ensure consistency in policy interpretation and implementation. Research on AI adoption highlights the importance of policy clarity, institutional support, and governance alignment in facilitating scalable integration (Benayoune et al., 2026; Rahman et al., 2025).

Educator competency represents a critical bridge between policy and practice. Competency frameworks define the knowledge, skills, and dispositions required for effective implementation. They provide structure for professional development, guide instructional practice, and establish benchmarks for evaluation. The absence of unified competency frameworks contributes to variation in educator readiness and limits the effectiveness of AI literacy initiatives (Chee et al., 2025; Sattelman & Pawlowski, 2025). Research emphasizes the need for structured, sustained professional development models that support progression from foundational awareness to advanced pedagogical integration (Geletu & Mihiretie, 2024; Tenberga & Daniela, 2024).

Monitoring and evaluation systems are equally important. Measurement frameworks enable education systems to assess progress, identify disparities, and support continuous improvement. Existing research highlights the challenges associated with AI literacy assessment, including the lack of standardized instruments and the complexity of measuring multidimensional competencies (Markus et al., 2025; Kang & Park, 2026). Without coordinated monitoring systems, implementation remains difficult to evaluate at scale.

Equity considerations further underscore the importance of coordinated implementation. AI literacy has the potential to enhance educational outcomes, but it may also reinforce existing disparities if access, support, and resources are unevenly distributed. Studies on digital transformation and AI adoption emphasize the risk of widening educational inequalities in the absence of targeted interventions (Assefa, 2025; Cao et al., 2025; George-Reyes & López-Caudana, 2026). Inclusive design and equitable access must therefore be integral components of AI literacy policy.

This article adopts a systems-level approach to AI literacy development in progressive GULF education systems. It examines how AI literacy can be governed as a coordinated national capability, how educator competency frameworks support scalable implementation, and what system-level mechanisms are required to enable sustained progress. The analysis integrates regional insights with contemporary literature to identify key priorities for policy and practice.

The contribution of this article is threefold. First, it positions AI literacy as a form of national educational infrastructure, emphasizing the need for coordinated governance and system alignment. Second, it connects educator competency development to broader institutional and policy frameworks, highlighting its role in enabling implementation. Third, it proposes a policy architecture that integrates governance, competency frameworks, readiness assessment, and monitoring systems to support scalable, sustainable AI literacy development across diverse education contexts.

Conceptualizing AI Literacy as a National Capability

Artificial intelligence literacy is increasingly positioned as a foundational capability within contemporary education systems, reflecting its relevance to workforce participation, civic engagement, and responsible interaction with emerging technologies. Current scholarship consistently defines AI literacy as a multidimensional construct that integrates knowledge, skills, attitudes, ethical awareness,

and the capacity for critical evaluation (Chiu et al., 2024; Lan et al., 2025; Zhou et al., 2025; Al-Abdullatif, 2025). This multidimensionality is central to policy design, as it requires education systems to move beyond narrow technical definitions toward comprehensive competency models that reflect real-world application and societal impact.

Within K–12 education, AI literacy is typically conceptualized through developmental progression. Early stages emphasize foundational understanding of AI concepts, recognition of system functionality, and awareness of human–machine interaction. As learners progress, competencies expand to include critical evaluation, ethical reasoning, and the ability to engage with AI in more complex contexts (Casal-Otero et al., 2023; Mannila et al., 2025; Yang et al., 2026). This progression reflects the need to align cognitive development with increasing levels of technological complexity, ensuring that learners build both conceptual understanding and applied capability over time.

In higher education, AI literacy extends into disciplinary and professional domains. Students are expected to apply AI tools within specific fields, integrate AI into research processes, and demonstrate readiness for AI-enabled workplaces (Chiu, 2025; Sun et al., 2026; Wu & Huang, 2026). This shift introduces additional requirements related to domain-specific application, interdisciplinary collaboration, and ethical decision-making in complex environments. As a result, AI literacy in higher education is not confined to technical proficiency but includes the capacity to critically evaluate AI outputs, assess risks, and apply AI responsibly within professional contexts.

Across both educational levels, AI literacy requires the integration of conceptual understanding and applied competence. Learners must understand how AI systems function, including data dependencies, algorithmic processes, and limitations, while also applying this knowledge in authentic contexts. This dual requirement distinguishes AI literacy from other forms of digital competence. It also reinforces the importance of instructional design approaches that combine theory with practice, enabling learners to engage with AI in meaningful and contextually relevant ways (Ma et al., 2025; Tagare et al., 2025).

Educators play a central role in facilitating this integration. Their responsibilities extend beyond content delivery to include instructional design, tool selection, ethical guidance, and assessment adaptation. Effective AI literacy implementation therefore depends on educator capacity to translate conceptual frameworks into classroom practice. Research indicates that educators require structured support to develop these competencies, particularly in areas such as ethical reasoning, bias recognition, and the evaluation of AI-generated outputs (Tang & Zhang, 2025; Sattelmaier & Pawlowski, 2025). Without this support, implementation may remain limited to surface-level tool usage rather than deeper pedagogical integration.

Empirical evidence demonstrates that AI literacy contributes to a range of positive educational outcomes. Studies have identified associations between AI literacy and academic performance, self-efficacy, creativity, and problem-solving ability (Chun et al., 2025; Skalka et al., 2025; Wang, 2026). Additional research highlights the influence of AI literacy on student attitudes toward technology, including increased confidence and interest in AI-related careers (Zhang et al., 2025). These findings support the positioning of AI literacy as a strategic priority within education systems, particularly in contexts seeking to align education with knowledge-based economic development.

The transition from AI literacy as an educational concept to AI literacy as a national capability requires a shift in perspective. A national capability is characterized by coordinated structures, shared standards, and measurable outcomes across the education system. It is not defined by isolated institutional initiatives but by the ability of the system as a whole to develop and sustain capability at scale. This distinction is critical for policy development, as it highlights the need for alignment across governance, curriculum, educator development, and evaluation mechanisms.

In progressive to moderate GULF education systems, the conditions for developing AI literacy as a national capability are increasingly present. Investments in digital infrastructure, centralized policy direction, and quality assurance frameworks provide a strong foundation for implementation. However, the advancement of these elements in parallel creates a need for structured alignment to ensure that they function as an integrated system. This alignment supports consistency in expectations, comparability of outcomes,

and scalability of implementation.

Conceptualizing AI literacy as a national capability introduces several implications for system design. First, it requires the establishment of shared definitions and competency frameworks that can be applied across educational levels. These frameworks provide a common language for educators, institutions, and policymakers, enabling coordinated implementation. Second, it requires the development of structured implementation pathways that support progression from initial adoption to sustained integration. Third, it requires the integration of monitoring and evaluation systems that enable education systems to assess progress and support continuous improvement.

This capability-based perspective also emphasizes the importance of coherence across educational transitions. Learners move from K–12 to higher education and into the workforce, carrying their competencies with them. AI literacy frameworks must therefore support continuity, ensuring that competencies developed at one stage are reinforced and expanded at subsequent stages. Research on AI literacy progression highlights the importance of this continuity in supporting long-term capability development (Yang et al., 2026).

Equity considerations are central to the development of AI literacy as a national capability. Access to technology, educator support, and institutional resources varies across contexts. Without coordinated implementation, these differences can influence the distribution of opportunities and outcomes. Inclusive design principles, targeted support mechanisms, and equitable access to resources are therefore essential components of system-wide AI literacy development (Assefa, 2025; Cao et al., 2025).

The conceptualization of AI literacy as a national capability also aligns with broader trends in education policy. Education systems are increasingly expected to prepare learners for dynamic, technology-driven environments. This requires the integration of emerging competencies into curriculum, pedagogy, and assessment. AI literacy represents a key component of this integration, linking educational outcomes to workforce readiness and societal participation.

In summary, AI literacy can be understood as a coordinated capability that emerges from the alignment of knowledge, skills, ethics, and application within a structured system. Its development depends on the interaction of multiple components, including educator capacity, institutional readiness, governance structures, and monitoring systems. In progressive to moderate GULF education systems, the current stage of development presents an opportunity to strengthen alignment across these components, enabling the transition from parallel initiatives to a coherent, system-wide capability.

Educator Competency as the Implementation Bridge

Educators function as the primary mechanism through which AI literacy is translated from policy intent into classroom and institutional practice. While policy frameworks, infrastructure, and digital tools establish enabling conditions, implementation ultimately depends on educator capacity to interpret, apply, and sustain AI-integrated teaching and learning. Research consistently identifies educator readiness as a critical determinant of effective AI adoption, with evidence showing that confidence, pedagogical understanding, and perceived relevance directly influence implementation outcomes (Darmawan et al., 2024; Ngoveni, 2025; Özüdoğru & Durak, 2025). Within progressive to moderate GULF education systems, this positions educator competency not as a supporting factor, but as the central bridge between system design and operational execution.

Current system development indicates a clear opportunity to strengthen alignment through the establishment of unified educator competency frameworks. In the absence of shared frameworks, professional development pathways tend to vary across institutions, resulting in differences in implementation depth, instructional quality, and student experience. These variations are not indicative of a lack of institutional effort, but rather reflect the absence of coordinated structures that define expectations and guide practice. Establishing a common competency architecture enables education systems to move from parallel capacity-building efforts toward a more coherent and scalable model of implementation.

Competency frameworks provide the structural foundation required for this transition. At a system level, they define the knowledge, skills, and dispositions educators are expected to develop in relation to AI literacy. They also establish progression pathways that sup-

port movement from foundational awareness to advanced pedagogical integration, and they provide evaluation criteria that enable consistent assessment of educator capability. These components are essential for aligning teacher preparation, in-service professional development, institutional expectations, and quality assurance processes.

Existing research demonstrates that educator competency frameworks for AI literacy vary significantly across contexts, reflecting differences in educational priorities, technological maturity, and policy direction (Chee et al., 2025; Sattelmaier & Pawlowski, 2025). Some frameworks emphasize technical understanding, focusing on computational concepts and system functionality. Others prioritize ethical reasoning, human-centered design, or interdisciplinary application. This variation offers valuable insights for framework development, but it also highlights the need for coordinated models that balance standardization with contextual flexibility. In progressive GULF systems, a unified framework can provide consistency in expectations while allowing institutions to adapt implementation to their specific contexts.

A coordinated competency framework should incorporate multiple dimensions of educator capability. Foundational competencies include understanding AI concepts, recognizing system limitations, and applying basic tools within instructional settings. Intermediate competencies involve integrating AI into curriculum design, adapting assessment practices, and guiding students in critical evaluation of AI outputs. Advanced competencies extend to leadership roles, including mentoring peers, contributing to institutional policy development, and supporting system-level implementation. This tiered structure enables progression while supporting differentiation across educator roles and experience levels.

Professional development models must align with this progression. Evidence from teacher development research indicates that sustained, structured approaches are more effective than isolated training sessions in building long-term capability (Geletu & Mihiretie, 2024). In the context of AI literacy, this requires a shift toward professional learning models that include diagnostic assessment, applied practice, peer collaboration, and continuous support. Diagnostic tools allow educators to identify their current competency levels and engage in targeted development pathways. Applied practice ensures that learning is connected to classroom implementation, while ongoing support mechanisms, such as coaching and communities of practice, reinforce sustained engagement (Tenberga & Daniela, 2024).

The integration of AI into professional development also presents opportunities for adaptive learning. AI-enabled systems can support personalized training pathways, provide real-time feedback, and identify areas for improvement. However, the use of AI in professional development must be aligned with governance and ethical standards to ensure transparency, data protection, and appropriate use. These considerations reinforce the need for competency frameworks that include both technical and ethical dimensions of AI literacy.

Ethical competency is a central component of educator readiness. As AI systems increasingly influence learning processes, assessment practices, and student data, educators must be equipped to address issues related to bias, fairness, accountability, and privacy. Research on AI ethics in education emphasizes the importance of integrating ethical reasoning into both teacher preparation and professional development (Hillis et al., 2026; Tagare et al., 2025). Educators must be able to evaluate AI-generated outputs, identify potential biases, and guide students in responsible use. This extends beyond compliance to include the development of critical awareness and professional judgment.

Ethical competency also intersects with inclusion and accessibility. AI systems can support differentiated learning and enhance access for diverse student populations, including People of Determination. At the same time, they may introduce risks related to representation, bias, and unequal access. Educators must therefore be prepared to use AI in ways that support inclusive practice while mitigating potential risks. This requires both technical understanding and a strong grounding in ethical and pedagogical principles.

The role of educator competency extends beyond individual practice to institutional and system-level outcomes. Institutions with higher levels of educator readiness are better positioned to integrate AI into curriculum, align assessment practices, and support student development. At a system level, coordinated competency frameworks enable comparability across institutions, support quality

assurance processes, and inform policy development. This alignment strengthens the overall capacity of the education system to implement AI literacy in a consistent and scalable manner.

In progressive to moderate GULF education systems, the development of educator competency frameworks represents a strategic opportunity to strengthen implementation. Existing investments in infrastructure and policy provide a strong foundation, but their impact depends on the ability of educators to translate these into practice. A coordinated approach to competency development supports this translation by providing clear expectations, structured pathways, and mechanisms for evaluation.

Educator competency can therefore be understood as the operational core of AI literacy implementation. It connects system-level policy with classroom-level practice, enabling the transition from conceptual frameworks to applied learning experiences. Strengthening this bridge requires alignment across teacher preparation, professional development, institutional support, and governance structures. When these elements are coordinated, educator competency becomes a driver of system-wide capability rather than a point of variation.

In summary, educators are central to the successful implementation of AI literacy. Their capacity determines how effectively policy is translated into practice and how consistently AI literacy is integrated across education systems. A coordinated competency framework, supported by structured professional development and embedded ethical guidance, provides the foundation for scalable and sustainable implementation. Within progressive GULF contexts, this approach enables the transition from differentiated institutional practices to a coherent, system-wide model of AI literacy development.

Governance Alignment and Policy Coordination

AI literacy implementation is strengthened through coordinated governance across government institutions. Education systems in progressive to moderate GULF countries typically operate through multiple regulatory and oversight bodies with distinct mandates across K–12 and higher education. These institutions are responsible for curriculum standards, accreditation, quality assurance, and institutional performance. Coordination across these entities is therefore central to ensuring that AI literacy develops as a coherent, system-wide capability rather than as a set of parallel initiatives.

Governance alignment supports three core outcomes: consistency in institutional policy, clarity in system expectations, and comparability of implementation outcomes. Where alignment is present, institutions operate within a shared framework that guides decision-making related to curriculum integration, educator development, assessment practices, and the use of AI-enabled technologies. This shared framework reduces ambiguity and enables institutions to focus on implementation rather than interpretation. Research on AI adoption in education consistently highlights the importance of policy clarity and institutional support in enabling scalable and sustainable integration (Benayoune et al., 2026; Rahman et al., 2025).

Current system dynamics across progressive GULF contexts indicate that AI-related policy development is advancing across multiple domains, including digital transformation strategies, innovation agendas, and education reform initiatives. These developments reflect strong institutional commitment and capacity. At the same time, the presence of multiple governance actors creates variation in how policies are interpreted and implemented across institutions. This variation is a natural feature of complex education systems and reflects differences in institutional context, readiness, and priorities. It also highlights the importance of strengthening coordination mechanisms to support alignment without limiting flexibility.

Strengthening governance alignment involves the development of shared reference points that guide implementation across institutions. These reference points include common definitions of AI literacy, agreed competency frameworks, policy guidance on ethical and responsible use, and aligned expectations for curriculum and assessment integration. When these elements are coordinated at the system level, institutions are able to implement AI literacy in ways that are both contextually relevant and aligned with national priorities. This alignment supports consistency in institutional policy while preserving the capacity for local adaptation.

Clarity in expectations is a critical component of effective governance. Education systems that provide clear guidance on AI use, educator responsibilities, and institutional accountability enable more confident and consistent implementation. Clarity reduces uncertainty for educators and institutional leaders, allowing them to integrate AI into teaching and learning with a clear understanding of system expectations. It also supports alignment between different levels of the education system, ensuring that K–12 and higher education institutions operate within compatible frameworks. Research indicates that such clarity is particularly important in emerging technology contexts, where rapid development can outpace policy formation (Rahman et al., 2025).

Comparability of outcomes is another key benefit of governance alignment. When institutions operate within shared frameworks, it becomes possible to assess implementation across the system using common indicators. This supports monitoring and evaluation processes, enabling education systems to identify areas of strength, address gaps, and support continuous improvement. Without comparable data, it is difficult to evaluate progress or ensure that AI literacy is being implemented equitably across institutions. Studies on institutional readiness and AI adoption emphasize the importance of aligned governance structures in enabling meaningful evaluation and evidence-based decision-making (Benayoune et al., 2026; Pasupuleti et al., 2026).

A balanced governance model is required to achieve these outcomes. Such a model combines central direction with institutional flexibility. Central direction provides the structure necessary for alignment, including standards, accountability mechanisms, and system-level guidance. This may include national competency frameworks, ethical guidelines, and monitoring frameworks that establish clear expectations for AI literacy implementation. Institutional flexibility allows schools and universities to adapt these frameworks to their specific contexts, including differences in curriculum, student populations, and available resources.

This balance between alignment and flexibility supports both coherence and innovation. Centralized standards ensure that all institutions work toward shared objectives, while decentralized implementation allows for experimentation and contextual adaptation. Research on education reform and technology integration highlights the effectiveness of governance models that combine these elements, enabling systems to scale innovation while maintaining quality and consistency (Kathala & Palakurthi, 2025; Somabut et al., 2025).

Governance alignment also plays a role in managing risk. AI technologies introduce considerations related to data protection, bias, transparency, and accountability. Coordinated policy guidance enables institutions to address these considerations in a consistent manner, reducing the risk of fragmented or incomplete approaches. Ethical governance frameworks provide guidance on responsible use, supporting educators and institutions in making informed decisions about AI integration (Hillis et al., 2026; Ma et al., 2025).

In progressive to moderate GULF education systems, the development of coordinated governance structures represents a strategic opportunity to strengthen AI literacy implementation. Existing investments in digital infrastructure and policy provide a strong foundation. Aligning these elements through shared standards, clear expectations, and coordinated monitoring enables the transition from parallel development to integrated system capability.

The role of government institutions in this process is to facilitate alignment rather than prescribe uniformity. By establishing common frameworks and supporting institutional implementation, governance structures can enable consistent outcomes while respecting contextual differences. This approach supports scalability, ensuring that AI literacy can be implemented across diverse institutions without compromising quality or relevance.

In summary, governance alignment is a central component of AI literacy as a national capability. It enables consistency in policy, clarity in expectations, and comparability of outcomes across the education system. A balanced model that combines central direction with institutional flexibility provides the foundation for scalable and sustainable implementation. Within progressive GULF contexts, strengthening governance coordination supports the transition from emerging initiatives to a coherent, system-wide approach to AI literacy development.

Readiness, Measurement, and Monitoring

System-wide development of AI literacy depends on the establishment of structured readiness, measurement, and monitoring systems that enable coordinated implementation across institutions. While policy direction, infrastructure, and educator competency provide foundational elements, sustained progress requires mechanisms that assess capability, track implementation, and support continuous improvement. Measurement frameworks serve as a central component of this process by aligning institutional practices with system-level expectations and enabling evidence-based decision-making.

Readiness in the context of AI literacy refers to the capacity of institutions to implement AI-related competencies effectively within teaching, learning, and governance structures. This includes the availability of trained educators, the integration of AI into curriculum and assessment, the presence of institutional policies for ethical and responsible use, and access to appropriate technological infrastructure. Readiness is not uniform across institutions. Variation reflects differences in resources, leadership, institutional priorities, and existing levels of digital maturity. Structured readiness assessment enables systems to identify these differences and design targeted support mechanisms.

Measurement frameworks provide the tools required to operationalize readiness and track progress. Current research highlights the importance of multidimensional assessment approaches that capture the complexity of AI literacy. These approaches move beyond single-indicator measures to include cognitive, technical, ethical, and application-based dimensions (Kang & Park, 2026; Markus et al., 2025). Multidimensional tools allow education systems to assess not only whether AI literacy is present, but also the depth and quality of its implementation across different domains.

Developmentally appropriate evaluation is particularly important in the context of AI literacy. Learner competencies evolve across educational stages, requiring assessment tools that reflect age-specific expectations and cognitive development. Research on early-stage AI literacy emphasizes the need for assessment frameworks that are sensitive to developmental progression and capable of capturing incremental learning (Miao & Zhang, 2025). This principle extends to educator evaluation, where competency expectations should align with experience levels and professional roles.

Educator-focused measurement also plays a critical role in system readiness. Self-assessment and diagnostic tools enable educators to evaluate their current competencies and identify areas for development. These tools support personalized professional learning pathways and provide institutions with aggregated data on educator readiness (Tenberga & Daniela, 2024). When integrated into professional development systems, diagnostic assessments facilitate targeted interventions that strengthen overall implementation capacity.

A national readiness assessment tool provides a structured mechanism for aligning institutions with system-level expectations. Such a tool evaluates institutional capability across key domains, including governance, educator capacity, curriculum integration, infrastructure, and ethical practices. By applying consistent criteria, readiness assessments enable institutions to identify their current position and develop targeted strategies for improvement. This approach supports differentiated implementation, allowing institutions to progress at appropriate rates while maintaining alignment with national priorities.

The use of readiness assessments also supports strategic planning at the system level. Aggregated data from institutional assessments can inform policy development, resource allocation, and capacity-building initiatives. Education systems can identify common challenges, prioritize areas for intervention, and monitor progress over time. This data-driven approach enhances the effectiveness of policy implementation and supports continuous system improvement.

Monitoring systems extend the role of measurement by providing ongoing evaluation of implementation. Effective monitoring frameworks include both compliance indicators and improvement indicators. Compliance indicators assess whether institutions have established the necessary structures, policies, and processes for AI literacy implementation. These may include the presence of competency frameworks, professional development programs, ethical guidelines, and approved technology use policies. Improvement indi-

cators assess the extent to which AI literacy is being integrated into practice, including educator competency progression, curriculum application, and student engagement.

The integration of both types of indicators ensures a balanced approach to monitoring. Compliance indicators provide accountability, ensuring that institutions meet baseline requirements. Improvement indicators support development by capturing progress and identifying areas for further enhancement. Together, these indicators enable a comprehensive understanding of system performance and support informed decision-making.

Equity considerations must be embedded within readiness, measurement, and monitoring frameworks to ensure inclusive implementation. AI literacy initiatives have the potential to enhance learning opportunities, but disparities in access, resources, and support can influence outcomes across institutions and student populations. Research on digital transformation highlights the importance of addressing these disparities through targeted interventions and inclusive design (Assefa, 2025; Cao et al., 2025). Monitoring systems should therefore include indicators related to access, participation, and outcomes for diverse learner groups, including People of Determination and students in varying institutional contexts.

Equity-focused measurement enables education systems to identify gaps and implement corrective actions. For example, institutions with limited access to technology or lower levels of educator readiness may require additional support through targeted funding, professional development, or resource allocation. By incorporating equity indicators into monitoring frameworks, systems can ensure that AI literacy development contributes to inclusive educational outcomes rather than reinforcing existing disparities.

The integration of readiness, measurement, and monitoring systems also supports alignment across educational levels. Data collected from K-12 and higher education institutions can be used to track learner progression, identify transition points, and ensure continuity in competency development. This alignment is essential for establishing AI literacy as a coherent national capability, as it enables education systems to support learners throughout their educational journeys.

Technological advancements provide additional opportunities for enhancing measurement and monitoring processes. AI-enabled analytics can support real-time data collection, pattern identification, and predictive modeling. These tools can provide insights into implementation trends, educator engagement, and student outcomes. However, the use of such technologies must be guided by clear governance frameworks to ensure data privacy, transparency, and ethical use.

In progressive to moderate GULF education systems, the development of structured readiness, measurement, and monitoring frameworks represents a critical step in advancing AI literacy. Existing investments in infrastructure and policy provide a strong foundation. The introduction of coordinated measurement systems enables these investments to be translated into measurable outcomes. By aligning institutional practices with system-level expectations, measurement frameworks support consistency, scalability, and continuous improvement.

In summary, readiness, measurement, and monitoring systems are essential components of AI literacy as a national capability. They provide the mechanisms through which implementation is assessed, progress is tracked, and improvements are guided. A coordinated approach that integrates multidimensional assessment, developmentally appropriate evaluation, educator diagnostics, and equity-focused monitoring supports the transition from isolated initiatives to a coherent, system-wide model of AI literacy development.

Cultural Grounding and Contextual Relevance

AI literacy frameworks require alignment with regional context to ensure relevance, adoption, and sustained implementation. While global models provide useful structural guidance, their direct application without adaptation may limit effectiveness. In progressive to moderate GULF education systems, AI literacy development must be situated within local cultural, linguistic, institutional, and policy environments to support meaningful integration across educational settings.

Contextual relevance begins with alignment to national education priorities and workforce objectives. Education systems in the region are increasingly oriented toward knowledge-based economic development, digital transformation, and innovation. AI literacy contributes directly to these priorities by equipping learners with competencies required for emerging labor markets. Aligning AI literacy frameworks with national development goals strengthens policy coherence and reinforces the role of education in supporting broader socio-economic outcomes (Asghar et al., 2025).

Language and accessibility are central considerations in contextualizing AI literacy. Progressive GULF education systems operate within multilingual environments where both Arabic and English function as primary languages of instruction. AI tools and learning resources must therefore support bilingual engagement to ensure equitable access and comprehension. Research on AI literacy emphasizes the importance of inclusive design, particularly in diverse linguistic contexts where language accessibility can influence learner outcomes and engagement (Cao et al., 2025). The integration of Arabic-language AI tools and resources supports both accessibility and cultural relevance, enabling learners to engage with AI concepts in familiar linguistic frameworks.

Cultural alignment also extends to ethical considerations. AI literacy includes competencies related to responsible use, bias awareness, and accountability. These competencies must be grounded in locally relevant ethical frameworks that reflect societal values and norms. Research on AI ethics in education highlights the importance of contextualizing ethical principles to ensure they resonate with learners and educators (Hillis et al., 2026). In GULF contexts, this includes aligning AI use with cultural expectations related to privacy, representation, and community responsibility. Embedding these considerations within AI literacy frameworks strengthens both relevance and adoption.

Inclusion is a critical component of contextual relevance. AI literacy initiatives must account for diverse learner needs, including People of Determination and students with varying levels of access to technology. AI systems have the potential to support personalized learning and improve accessibility through adaptive tools, speech recognition, and assistive technologies. At the same time, disparities in access and digital infrastructure can influence the distribution of these benefits. Research on digital equity underscores the importance of designing AI literacy frameworks that address access, support differentiated learning, and ensure inclusive participation (Assefa, 2025). Embedding inclusion within system design supports equitable outcomes across institutions and learner groups.

Institutional context also shapes the implementation of AI literacy. Schools and universities differ in terms of resources, governance structures, curriculum models, and levels of digital maturity. A contextually grounded approach recognizes these differences and allows institutions to adapt implementation within a shared framework. This aligns with research on technology integration, which emphasizes the importance of balancing standardization with local flexibility to support effective adoption (Somabut et al., 2025). In practice, this means that while core competencies and expectations remain consistent, the pathways through which institutions achieve these outcomes may vary.

Educator engagement is strengthened when AI literacy frameworks reflect classroom realities. Teachers are more likely to adopt AI-integrated practices when resources, examples, and training materials are relevant to their instructional context. This includes the use of locally relevant case studies, examples drawn from regional industries, and applications that reflect the lived experiences of learners. Research on educator adoption highlights the role of contextual relevance in supporting confidence and sustained implementation (Tang & Zhang, 2025). Professional development that incorporates local context enhances both understanding and applicability.

Curriculum integration provides another avenue for contextual alignment. AI literacy can be embedded within existing subject areas, enabling learners to apply AI concepts within disciplines such as science, mathematics, humanities, and vocational education. This interdisciplinary approach supports the development of transferable skills while maintaining alignment with existing curriculum structures. Research indicates that embedding AI within subject-based learning enhances relevance and supports deeper understanding (Li et al., 2025). In GULF contexts, this approach can be aligned with national curriculum standards and educational priorities.

Contextual relevance also supports continuity across educational transitions. Learners progress from K-12 to higher education and into the workforce, carrying their competencies across these stages. AI literacy frameworks that are aligned across levels support

this progression by ensuring that competencies developed in earlier stages are reinforced and expanded in later contexts (Yang et al., 2026). This continuity is essential for establishing AI literacy as a sustained capability rather than a discrete learning experience.

The integration of contextual considerations does not reduce the importance of global alignment. Instead, it enables education systems to adapt international frameworks in ways that support local relevance while maintaining coherence with global standards. This balance supports both comparability and flexibility, allowing systems to participate in global knowledge exchange while addressing local needs.

In progressive to moderate GULF education systems, contextual grounding represents a strategic enabler of AI literacy implementation. Existing investments in infrastructure and policy provide a strong foundation. Aligning these investments with cultural, linguistic, and institutional contexts enhances their impact and supports sustained adoption. By embedding contextual relevance within governance, curriculum, and professional development, education systems can ensure that AI literacy is both meaningful and scalable.

In summary, cultural grounding and contextual relevance are essential components of AI literacy as a national capability. They ensure that frameworks are aligned with local priorities, accessible to diverse learners, and adaptable to institutional contexts. A contextually informed approach supports effective implementation, strengthens educator engagement, and contributes to equitable and sustainable AI literacy development across progressive GULF education systems.

Toward a Coordinated Governance Architecture

A coordinated governance model includes:

Central Coordination Mechanism

A cross-sector body to align standards, policy, and implementation.

Educator Competency Framework

Tiered progression from awareness to leadership.

Institutional Readiness Assessment

Evaluation across governance, people, curriculum, infrastructure, and ethics.

Phased Implementation Model

- Early-stage pilots.
- Capacity building.
- System-wide integration.

This structure supports scalable, sustainable implementation.

Discussion

AI literacy development in progressive to moderate GULF education systems reflects a clear transition from exploratory adoption toward structured, system-level implementation. Early-stage efforts have focused on integrating tools, piloting initiatives, and building awareness among educators and institutions. These efforts have established a strong foundation. The current phase requires consolidation and alignment to ensure that AI literacy evolves as a coordinated capability rather than a collection of parallel initiatives. The central challenge is not access to technology, which is increasingly available across institutions, but the alignment of governance structures, educator capability, institutional processes, and monitoring systems.

A sociotechnical perspective provides a useful framework for understanding this transition. Sociotechnical systems theory emphasizes that outcomes are determined by the interaction between technological infrastructure and social components, including people, processes, and governance structures. In the context of AI literacy, technological readiness alone is insufficient. Effective implementation depends on how technology is integrated into institutional practices, how educators apply it within pedagogical contexts, and how governance structures guide and monitor its use (Pasupuleti et al., 2026; Benayoune et al., 2026). This perspective shifts the focus from individual interventions to system design, emphasizing the need for coordinated development across multiple dimensions.

Governance alignment emerges as a central requirement within this framework. Education systems in progressive GULF contexts are characterized by multiple government institutions with distinct regulatory mandates. These institutions provide oversight for curriculum, accreditation, and institutional performance. While this structure supports specialization, it also requires coordination to ensure consistency in policy interpretation and implementation. Research on AI adoption highlights the importance of clear governance structures in enabling effective integration by reducing ambiguity and supporting institutional decision-making (Rahman et al., 2025). Strengthening coordination across these entities enables a shared understanding of AI literacy objectives and supports consistent implementation across institutions.

Educator competency frameworks function as a critical translation mechanism between policy and practice. Policy frameworks establish expectations, but their impact depends on how effectively they are interpreted and applied by educators. Without structured competency frameworks, variation in implementation is likely to persist, as educators rely on individual interpretation and available resources. Research indicates that competency frameworks provide clarity, guide professional development, and establish benchmarks for evaluation, supporting more consistent implementation (Chee et al., 2025; Sattelmaier & Pawlowski, 2025). In progressive GULF systems, the development of unified competency frameworks represents a key step in aligning workforce capability with system-level objectives.

The role of professional development within this context is significant. Sustained, structured professional learning models have been shown to support educator capacity more effectively than isolated training sessions (Geletu & Mihiretie, 2024). AI literacy requires ongoing development that integrates conceptual understanding with practical application. This includes opportunities for educators to engage in applied practice, receive feedback, and participate in collaborative learning environments. When aligned with competency frameworks, professional development becomes a mechanism for building system-wide capability rather than a series of disconnected initiatives.

Measurement and monitoring systems provide the accountability structures necessary to support this development. These systems define what is measured, how progress is tracked, and how outcomes are evaluated. In the context of AI literacy, multidimensional assessment tools are required to capture the complexity of competencies, including technical understanding, ethical awareness, and application skills (Kang & Park, 2026; Markus et al., 2025). Developmentally appropriate evaluation frameworks further ensure that assessment aligns with learner progression (Miao & Zhang, 2025). Without coordinated measurement systems, it is difficult to assess implementation at scale or ensure comparability across institutions.

Monitoring systems also support continuous improvement by providing data that informs decision-making. Institutions can use this data to identify strengths, address gaps, and refine implementation strategies. At the system level, aggregated data enables policymakers to assess overall progress, allocate resources, and support targeted interventions. Research on institutional readiness emphasizes the importance of data-driven approaches in supporting effective implementation and scaling innovation (Pasupuleti et al., 2026).

Equity considerations remain central to AI literacy development. While AI has the potential to enhance learning outcomes and support personalized education, disparities in access, resources, and educator capacity can influence implementation outcomes. Without coordinated approaches, these disparities may result in uneven access to AI literacy across institutions and learner groups. Research on digital transformation highlights the importance of inclusive design and targeted support in addressing such disparities (Assefa, 2025; Cao et al., 2025). Embedding equity within governance and monitoring frameworks ensures that AI literacy contributes to inclusive educational outcomes.

Coordinated implementation provides a mechanism for mitigating disparities. By establishing shared standards, providing targeted support, and monitoring outcomes, education systems can ensure that all institutions have the opportunity to develop AI literacy capabilities. This approach supports both equity and quality, ensuring that learners across diverse contexts have access to consistent educational opportunities.

The framing of AI literacy as national educational infrastructure provides an important conceptual shift. Infrastructure is typically associated with physical and technological systems, but in this context, it extends to include governance structures, competency frameworks, and monitoring mechanisms. This broader definition emphasizes the role of systems in enabling capability development. It also reinforces the importance of alignment, as infrastructure must function cohesively to support effective implementation.

Viewing AI literacy as infrastructure also highlights the importance of sustainability. Infrastructure is designed to support long-term functionality rather than short-term initiatives. Applying this perspective to AI literacy encourages the development of systems that can adapt to technological change while maintaining consistent standards and practices. This includes the integration of AI literacy into curriculum frameworks, professional development systems, and institutional processes.

The transition from exploratory adoption to structured implementation reflects a broader trend in education systems responding to emerging technologies. Initial phases are often characterized by experimentation and localized innovation. As systems mature, the focus shifts toward standardization, scalability, and accountability. In progressive GULF contexts, this transition is supported by existing strengths in governance, infrastructure, and policy direction. The challenge is to align these strengths within a coordinated framework that supports system-wide capability.

The integration of governance, educator competency, measurement, and equity within a single framework supports this transition. Each component addresses a specific aspect of implementation, but their combined effect enables coherence across the system. Governance provides direction, competency frameworks build workforce capacity, measurement systems ensure accountability, and equity considerations guide inclusive practice. Together, these elements create a foundation for sustainable AI literacy development.

In summary, AI literacy development in progressive to moderate GULF education systems is entering a phase of structured implementation that requires alignment across system components. A sociotechnical perspective highlights the importance of integrating governance, workforce capability, institutional processes, and technology. Educator competency frameworks translate policy into practice, while measurement systems support accountability and continuous improvement. Equity considerations ensure inclusive outcomes. Framing AI literacy as national educational infrastructure provides a coherent approach to system design, supporting scalability, sustainability, and alignment with broader educational and national priorities.

Conclusion

AI literacy represents a strategic capability for education systems in progressive to moderate GULF countries, with direct implications for workforce readiness, civic participation, and responsible engagement with emerging technologies. Strong enabling conditions are already established across many systems, including digital infrastructure, policy direction, and institutional commitment to innovation. The next phase of development requires structured alignment across these elements to support consistent and scalable implementation. This transition reflects a shift from early-stage adoption toward coordinated, system-level capability.

A coherent pathway for advancing AI literacy is defined through the integration of four core components: a coordinated governance model, a unified educator competency framework, a structured readiness assessment system, and a phased implementation approach. Governance alignment enables clarity in expectations and consistency in institutional policy, while competency frameworks provide the structure necessary to develop educator capacity. Readiness assessment tools support differentiated implementation by identifying institutional capability levels and informing targeted interventions. Phased implementation models facilitate scalability by allowing systems to progress from pilot initiatives to full integration in a structured and iterative manner.

The emphasis of AI literacy development is therefore shifting from isolated innovation toward system capability. While early initiatives have demonstrated the potential of AI integration in education, sustained impact depends on the ability to embed these practices within governance structures, professional development systems, and institutional processes. Research on AI adoption and institutional readiness underscores the importance of coordinated approaches in achieving scalable and sustainable outcomes (Benayoune et al., 2026; Pasupuleti et al., 2026). This reinforces the need for alignment across policy, practice, and evaluation mechanisms.

Equity remains a central consideration in this transition. Coordinated implementation enables education systems to address disparities in access, resources, and educator capacity, ensuring that AI literacy contributes to inclusive outcomes across diverse institutions and learner populations (Assefa, 2025). Embedding equity within governance and monitoring frameworks supports balanced development and mitigates the risk of uneven implementation.

In summary, AI literacy in progressive GULF education systems is entering a phase defined by alignment, integration, and accountability. A coordinated governance architecture, supported by structured competency development and robust monitoring systems, provides the foundation for scalable progress. This approach positions AI literacy as a sustainable, system-wide capability aligned with national development priorities and responsive to the evolving demands of education and the workforce.