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Mohamed Lahby *Editor*

Innovative Educational Assessment with Generative AI: Opportunities, Challenges, and Practical Case Studies

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Preface

The development of advanced Generative AI tools, such as ChatGPT, Gemini, DeepSeek, and LLaMA, is revolutionizing academic institutions worldwide, transforming the ways knowledge is accessed, produced, and assessed. The emergence of these technologies is paving the way for radical changes in higher education by providing personalized support, improving accessibility, and offering innovative ways for students and educators to interact with information and learning materials. These technologies not only facilitate more personalized and effective learning experiences but also provide innovative assessment techniques that offer deeper insights into student performance and progress.

This book explores the transformative potential of Generative AI in reshaping educational assessment. It provides a platform for the academic community to share cutting-edge research and innovative ideas on the integration of Generative AI in academic evaluation. It also examines emerging trends in education driven by GenAI-powered content generation, with a particular focus on how student learning is assessed in diverse contexts. Readers will discover how these technologies are redefining assessment and feedback practices through personalized adaptive assessments, automated scoring, real-time feedback, and simulative evaluations.

This book comprises a total of 14 chapters, organized into three main parts. In the first part (Chapters "Generative AI in Adult Learning and Assessment: Navigating Ethics, Justice, and Regional Disparities in Southeast Asia"–"Privacy and Data Security in Generative AI Assessments") focuses on an overview of Generative AI in Educational Assessment. It covers both theoretical and practical aspects of Generative AI in education and examines ethical, sociological, and security issues related to AI-driven educational assessment.

Chapter "Generative AI in Adult Learning and Assessment: Navigating Ethics, Justice, and Regional Disparities in Southeast Asia", authored by Nurhayati et al., introduces an equity-driven framework for integrating Generative AI into adult learning assessments in Southeast Asia. The chapter emphasizes the importance of ethical governance, cultural inclusivity, and the need to address regional disparities in digital infrastructure and policy. Chapter "The Cultural Politics of 'Objectivity': A Sociological Critique of GenAI-Based Feedback Mechanisms in Educational Assessment", by Pratham Parekh, critically challenges the myth of objectivity in

GenAI-based feedback systems. Drawing from feminist epistemology and the sociology of education, Parekh highlights how these systems often reinforce dominant linguistic and cultural norms, thereby marginalizing diverse student expressions and constraining educators' pedagogical agency. In Chapter "Generative AI and Educational Assessment: A Bibliometric Mapping of Current Trends, Challenges, and Future Directions in the Era of Personalization", Muriira and Nallisamy present a bibliometric analysis of current trends and challenges in GenAI for educational assessment. Using co-citation and keyword mapping of over 1400 publications, they identify emerging themes such as adaptive learning, federated learning, and ethical concerns related to data privacy and algorithmic bias. Chapter "Privacy and Data Security in Generative AI Assessments", by Ghosh and Kundu, explores the privacy and data security implications of GenAI-driven assessments. The authors examine risks associated with data use in AI-generated testing environments and provide a comprehensive review of privacy-preserving techniques, including differential privacy, federated learning, and homomorphic encryption.

In the second part (Chapters "The Impact of Personalized Assessment Strategies on Student Outcomes: A Comprehensive Literature Review"–"Personalized Learning in Higher Education: The Impact of Generative AI on Deep Learning Project Performance") of this book focuses on the transformative role of Generative AI in personalizing learning and assessment within higher education. In Chapter "The Impact of Personalized Assessment Strategies on Student Outcomes: A Comprehensive Literature Review", Kausar et al. present a comprehensive literature review on personalized assessment strategies and their impact on student outcomes. The chapter highlights how adaptive technologies, formative feedback, and learning analytics can enhance academic achievement and learner motivation, while also noting the challenges of equitable implementation and effective instructional design. Chapter "AI-Driven Personalized Learning and Adaptive Assessment: Transforming Higher Education Pedagogy", by Adiyono et al., examines the use of AI-driven personalized learning and adaptive assessments to transform higher education pedagogy. The authors explore intelligent tutoring systems, automated feedback mechanisms, and learning analytics that support individualized learning paths, while also addressing ethical considerations and the evolving role of educators in AI-enhanced environments. In Chapter "Formative Assessment Using a Personalized Bot Developed and Equipped with Educator-Specific Data: System and Assessment Feedback Quality", Louatouate and Zeriouh focus on formative assessment enhanced by Generative AI. They introduce "Intellectus," a customized AI chatbot trained on specific course material to generate context-relevant feedback for students. Their experimental study highlights positive student perceptions regarding system quality and assessment feedback, underlining the potential for AI to support personalized formative assessment practices. Finally, Chapter "Personalized Learning in Higher Education: The Impact of Generative AI on Deep Learning Project Performance", by Benlakhdar et al., investigates the use of Generative AI tools in project-based learning, specifically in deep learning courses. The study demonstrates how AI-assisted development enhances student creativity, boosts productivity, and facilitates deeper understanding of complex programming tasks. The findings underscore

the potential of Generative AI to improve both project performance and student engagement in technical education.

Finally, the last part of the book (Chapters "Artificial Intelligence Supporting Formative Assessment a Case Study in the Tunisian University Context"–" What Are the Theological and Pedagogical Impacts of the Integration of Artificial Intelligence (AI) in Catholic Religious Education (RE)?") presents case studies and practical applications from various countries, all focused on assessments and Generative AI. In Chapter "Artificial Intelligence Supporting Formative Assessment a Case Study in the Tunisian University Context", Ben Nejma explores how Artificial Intelligence, particularly learning analytics and adaptive assessment, can enhance formative assessment in higher education. Drawing on a case study in Tunisia, the chapter demonstrates how AI tools can improve feedback quality, increase student engagement and autonomy, and assist instructors in providing real-time instructional adjustments, promoting more personalized and effective learning experiences. Chapter "Exploring Vietnamese Students' Perceptions of Wordtune as an AI-Based Writing Assistant", by Nguyen Huu Chanh, investigates Vietnamese students' perceptions of Wordtune, an AI-based writing assistant. The chapter analyzes the emotional, behavioral, and cognitive responses of students, highlighting the role of AI tools in fostering writing autonomy and boosting self-confidence, while also pointing out concerns related to proficiency levels and equitable access. In Chapter " Perceptions Toward Generative AI Among Filipino Pre- and In-Services Teachers: Implications for AI Use in Educational Assessment", Alieto et al. examine the perceptions of Filipino pre- and in-service teachers regarding Generative AI in education, with a particular focus on its role in assessment. The study reveals a balanced perspective: while teachers recognize the benefits of GenAI, they remain cautious about its potential risks. Chapter "From Chalkboards to Chatbots: The Role of Generative AI in Philippine Teacher Education Assessment", by Gamusa et al., examines how Generative AI is reshaping assessment in Philippine teacher education. The chapter provides insights into AI's role in designing and implementing personalized assessments, while also addressing ethical concerns such as bias, academic integrity, and cultural sensitivity. In Chapter "Enhancing Code Assessment and Feedback Generation with GenAI Agents", Ceh-Varela et al. present a case study on automated code assessment and feedback generation using GenAI agents in introductory programming courses. The chapter illustrates how GenAI tools can generate personalized feedback and relevant test cases, supporting student learning while reducing instructor workload. Finally, Chapter " What Are the Theological and Pedagogical Impacts of the Integration of Artificial Intelligence (AI) in Catholic Religious Education (RE)?", by Shanahan and Parker, explores the theological and pedagogical implications of AI integration in Catholic Religious Education. This chapter highlights the tensions between technological advancement and the foundational principles of faith formation.

As a final note, the editors would like to sincerely thank all the contributing authors for their insightful and engaging chapters. We also thank the reviewers for their valuable support and constructive feedback throughout this process. For transparency,

we confirm that no Generative AI tools were used to write this preface, except for basic spell-check functions, which may already rely on AI in today's digital world.

Finally, we want to take this opportunity to express our sincere thanks to the contributors to this volume and the reviewers for their outstanding efforts in reviewing and providing interesting feedback to the authors of the chapters. The editors would like to thank Mr. Thomas Ditzinger (Series Editor-in-Chief) and Mr. Ram Prasad Chandrasekar (Springer Project Coordinator), for the editorial assistance and support to produce this important scientific work. Without this collective effort, this book would not have been possible to be completed.

Casablanca, Morocco Mohamed Lahby

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About the Editor

Prof. Mohamed Lahby is an Associate Professor at the Higher Normal School (ENS), University Hassan II of Casablanca, Morocco. He is also the Director of the Mathematics, Artificial Intelligence, and Digital Learning Laboratory (MIND-LAB). Since 2022, he has been recognized as a Senior Member of the IEEE. Prof. Lahby obtained his Ph.D. in Computer Science in 2013 from the Faculty of Sciences and Technology of Mohammedia, University Hassan II of Casablanca. His research interests include wireless communication and networking, mobility management, QoS/QoE, the Internet of Things, smart cities, optimization, and machine learning. He has authored or co-authored more than 60 publications and has edited 10 books. He has actively participated in numerous international conferences and serves as a reviewer for several journals, including *Ad Hoc Networks, Applied Computing and Informatics*, and the *International Journal of Disaster Risk Reduction.* Prof. Lahby has also chaired several international workshops and special sessions, such as MLNGSN'19, CSPSC'19, MLNGSN'20, MLNGSN'21, AI2SC'20, WCTCP'20, CIOT'22, ISGTA'23, and ISGAIE'2025.

Generative AI in Educational Assessment—An Overview

Generative AI in Adult Learning and Assessment: Navigating Ethics, Justice, and Regional Disparities in Southeast Asia

Sri Nurhayati, Fatima Zahra Lotfi, Taufikin Taufikin, and Ahmad Wahyu Hidayat

Abstract The emergence of Generative Artificial Intelligence (GenAI) technologies is transforming the epistemological and operational foundations of educational assessment, particularly within adult learning contexts. This chapter explores the pedagogical, ethical, and infrastructural implications of integrating GenAI into adult education systems across Southeast Asia. Drawing on contemporary theoretical frameworks—ranging from andragogy and transformative learning to critical digital pedagogy—it critically examines how GenAI reshapes assessment logics, redistributes epistemic authority, and reconfigures learner agency. Through a contextual lens, the chapter interrogates regional disparities in policy governance, digital infrastructure, educator readiness, and cultural alignment. Five interrelated domains are analyzed: governance fragmentation, infrastructural inequalities, programmatic integration, digital literacy and ethics, and strategies for inclusive innovation. While GenAI holds potential to enhance personalization, adaptivity, and reflective assessment practices, its effective implementation demands a paradigm shift in both pedagogy and policy. The chapter advocates for an ethically grounded, equity-driven, and context-responsive approach to AI adoption—one that foregrounds human-centered learning and regional diversity. Ultimately, it positions GenAI not as a panacea, but as a sociotechnical mediator whose impact must be shaped by inclusive governance, critical pedagogy, and participatory educational design.

Equity by Design: Repositioning GenAI for Just and Reflective Adult Assessment.

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1 Introduction

The global proliferation of generative artificial intelligence (GenAI) across educational landscapes signifies a paradigmatic transformation in the architecture of knowledge production, dissemination, and assessment. GenAI encompasses systems engineered to autonomously generate novel content—ranging from textual and visual artifacts to executable code and multimedia compositions—through pattern recognition derived from extensive data corpora. As these technologies permeate pedagogical ecosystems, they foreground the potential to facilitate hyper-personalized, adaptive, and multimodal learning trajectories. Beyond merely enhancing instruction, GenAI reconfigures the foundational logics of feedback mechanisms, assessment frameworks, and curricular architectures. Simultaneously, its integration surfaces intricate ethical, technical, and epistemological challenges necessitating deliberate scrutiny and systemic foresight [1, 2].

Among GenAI's most salient affordances is its capacity to scaffold individualized learning pathways. Platforms such as ChatGPT and GPT-4 Vision operationalize real-time content modulation and multimodal feedback, enabling learners to engage with educational material in contextually responsive and self-paced modalities [3, 4]. Within adult education—where learners navigate intersecting demands of employment, caregiving, and civic engagement—this personalization transcends convenience, becoming a pedagogical imperative. It underpins self-directed learning and cultivates learner autonomy, intrinsic motivation, and metacognitive engagement [5].

Concurrently, GenAI facilitates a radical reorientation of curricular design and resource generation. By automating the creation of pedagogical assets—including but not limited to instructional modules, simulation environments, and assessment instruments—educators can iterate more responsively to learner diversity and socioeconomic contingencies [6, 7]. This agility is especially critical in lifelong learning systems, where educational provision must remain aligned with the evolving exigencies of labor markets and demographic fluidity. Additionally, GenAI drives the development of intelligent tutoring systems and algorithmically adaptive learning environments, capable of tracking learner trajectories, forecasting disengagement, and proposing targeted pedagogical interventions [8, 9].

Yet, these innovations are inextricably entangled with structural and ethical complexities. Persistent issues surrounding algorithmic opacity, data surveillance, representational bias, and the instrumentalization of learner data provoke critical concerns regarding the democratic integrity of GenAI applications. The imperative for transparent governance architectures, ethical AI fluency, and inclusivity-by-design frameworks has never been more pronounced [10, 11]. Parallel to these systemic concerns is the pedagogical dilemma faced by educators who are often

compelled to adopt AI technologies absent sufficient epistemic preparation, technical support, or institutional infrastructure—a condition that risks performative implementation and pedagogical dissonance [12].

These tensions crystallize most acutely within the domain of educational assessment. Assessment, particularly in adult education and lifelong learning, is not merely an evaluative endpoint but a constitutive process underpinning learner motivation, reflective praxis, and continuous intellectual development. Adult learners enter educational spaces with heterogeneous biographies, aspirations, and epistemic orientations; thus, assessment must be enacted as an inclusive, flexible, and authentic engagement that foregrounds growth, cultivates self-awareness, and provides actionable feedback [13, 14].

The exigencies of the COVID-19 pandemic catalyzed an accelerated migration toward digital pedagogies, consequently destabilizing conventional assessment paradigms in both formal and non-formal adult learning contexts. The emergent assessment ecologies—encompassing AI-enhanced feedback loops, digital credentialing systems, and micro-certifications—seek to capture learner competencies with greater granularity and relevance to socio-professional contexts [15, 16]. However, these developments also illuminate systemic disparities in access, digital fluency, and institutional readiness [17, 18].

As educational institutions and frameworks increasingly integrate GenAI-driven innovations, it is imperative that these technologies are deployed through a critical, equity-oriented lens. The mere incorporation of AI tools is insufficient; their design and implementation must be guided by principles that enhance equity, foster learner agency, and preserve the humanistic values of education. This chapter undertakes a conceptual and contextual inquiry into the multilayered challenges associated with embedding GenAI in adult educational assessment. It interrogates the question: In what ways can GenAI be ethically and pedagogically harnessed to fortify, rather than fragment, the integrity and inclusiveness of adult learning ecologies?

This chapter is organized as follows. Section 2 conceptualizes the intersection of GenAI and adult assessment practices. Section 3 identifies critical implementation challenges including ethical dilemmas, fairness, and institutional readiness. Section 4 presents contextual illustrations from Southeast Asia. Section 5 synthesizes regional strategies for inclusive innovation.

2 Mapping the Conceptual Terrain: GenAI Meets Adult Assessment

Generative Artificial Intelligence (GenAI) represents a significant epistemological and technological rupture within the evolution of educational assessment. Positioned at the intersection of algorithmic creativity and pedagogical utility, GenAI refers to a class of machine learning systems—often large language or multimodal models—that can autonomously generate original outputs including text, images, simulations,

and complex educational artifacts in response to user inputs. Within educational contexts, GenAI is increasingly mobilized to perform functions that extend beyond traditional automation, such as the dynamic generation of quizzes, formative feedback, essay scaffolds, and even interpretive assessments [19, 20]. These affordances suggest not merely incremental efficiency gains but signal a paradigmatic rearticulation of how learning, cognition, and evidence of understanding are elicited and validated.

Current theoretical framings locate GenAI within a continuum of transformative assessment logics that seek to subvert reductive, summative paradigms in favor of more reflexive, processual, and situated models. Among the most notable conceptual contributions is the "Against, Avoid, Adopt, and Explore" (AAAE) framework, which offers a nuanced pedagogical taxonomy for AI integration that resists binary techno-deterministic discourse [21]. These frameworks illuminate the multifaceted implications of GenAI, not as a neutral instructional add-on but as a sociotechnical artifact that co-constructs learning environments, mediates power relations, and reframes epistemic authority in assessment practices [22, 23].

GenAI's alignment with learner-centered pedagogies is operationalized through its capacity for fine-grained personalization and adaptivity. By leveraging natural language processing, machine learning, and user-specific data, GenAI systems such as ChatGPT or GPT-based educational platforms can modulate language complexity, thematic framing, and assessment feedback according to the learner's prior knowledge, emotional state, and metacognitive profile [24, 25]. This level of adaptivity supports differentiated instruction and cultivates learner autonomy, reflective practice, and cognitive agency—cornerstones of 21st-century educational paradigms [26]. From the educator's perspective, GenAI redistributes labor by enabling a shift from routine evaluation to relational, formative dialogue, thereby repositioning the teacher as a critical mediator rather than a mechanistic assessor [27].

Despite its transformative potential, GenAI introduces complex ethical, epistemic, and ontological tensions. Concerns surrounding academic integrity—particularly the displacement of original thought through overreliance on AI-generated content—raise profound questions about authorship, creativity, and critical engagement [11, 28]. Additionally, algorithmic bias, opaque decision-making, data surveillance, and the commodification of learner data constitute enduring risks that are exacerbated in structurally marginalized or under-resourced educational ecosystems [21, 29]. These dynamics necessitate a reorientation of AI adoption from one of mere access to one of epistemic justice.

Learner attitudes toward GenAI further reflect ambivalence and tension. While some students appreciate the affordances of efficiency, accessibility, and clarity, others perceive a decline in critical thinking demands and a potential erosion of deep learning practices [30, 31]. These dissonances underscore the need for pedagogical strategies that intentionally scaffold learners' ethical and critical engagement with GenAI, enabling them to both leverage its affordances and resist its limitations.

In light of these layered complexities, scholars have increasingly called for a tripartite response: (1) the development of theoretically grounded and empirically validated frameworks for GenAI-informed assessment; (2) the institutionalization

of ethical policies and governance mechanisms; and (3) the integration of human-centered design principles that prioritize equity, inclusivity, and pedagogical coherence [19, 32]. The promise of GenAI in educational assessment is not located in its technological novelty alone, but in its potential to actualize more just, dialogic, and reflective learning systems. Realizing this promise requires critical, theory-informed, and contextually responsive engagement from educators, designers, and policy actors alike.

2.1 Core Principles of Assessment in Adult and Lifelong Learning

Assessment within adult and lifelong learning occupies a distinct epistemological terrain, characterized by its responsiveness to the diverse biographies, sociocultural contexts, and learning objectives of adult learners. In contrast to the rigid, standardized assessment architectures prevalent in compulsory schooling, assessment in adult education is underpinned by the principles of andragogy, critical pedagogy, and humanistic learning theory. These principles prioritize authenticity, contextual relevance, and learner agency—hallmarks of educational praxis that aim not only to measure but to transform [33–35].

Rather than functioning as an instrument of classification or credentialism, assessment in adult education is multifaceted—serving diagnostic, formative, developmental, and emancipatory functions. Diagnostic and programmatic assessments are deployed to recognize informal and experiential knowledge, surface learning needs, and align learners with appropriate educational pathways. These assessments often fulfill broader institutional mandates related to access, certification, and accountability while simultaneously operating as dialogical tools that facilitate learner self-awareness and educational planning [36].

What distinguishes adult assessment practices is their inherent heterogeneity and adaptability. Educators are expected to mobilize an array of assessment modalities—including formative, summative, authentic, and performance-based approaches—tailored to learners' professional trajectories, civic roles, and personal development goals [37, 38]. The inclusion of scenario-based tasks, simulations, portfolios, and community-engaged assessments enables the embedding of evaluative activities within real-world contexts, thereby reinforcing relevance, engagement, and meaning-making.

The theoretical scaffolding of adult assessment is fundamentally reflective and metacognitive. Drawing from andragogical assumptions that foreground self-direction, life experience, and intrinsic motivation, assessment in this domain must foster learner reflection, critical consciousness, and the capacity to regulate one's own learning [39]. Accordingly, reflective journals, structured self-assessment instruments, peer evaluation processes, and dialogic feedback loops are integral not only to evaluating performance but to cultivating agency and epistemic ownership [37].

Digital assessment technologies have further diversified and deepened these practices. Platforms that enable asynchronous interaction, adaptive assessment, and multimodal expression align with the temporal, cognitive, and affective complexities of adult learners—particularly those negotiating educational engagement alongside professional and familial obligations [40, 41]. These tools also facilitate formative data analytics, personalized learning trajectories, and learner-driven feedback mechanisms that are congruent with the pedagogical commitments of lifelong learning.

However, the implementation of such expansive and humanistic assessment strategies is often constrained by structural and institutional logics of accountability. In systems governed by funder-driven performance metrics and standardized reporting requirements, educators may experience tension between honoring learners' situated needs and fulfilling externally imposed quantification imperatives [36, 42]. Moreover, the dominance of audit cultures in education reinforces reductive conceptualizations of learning that privilege surface-level outcomes over deep, sustained engagement. Navigating this tension requires sophisticated pedagogical judgment and political acumen. Adult educators must not only possess a repertoire of assessment design skills but also be adept in negotiating institutional pressures, advocating for equity-oriented practices, and sustaining professional communities of praxis that resist technocratic reductionism [37].

At a macro level, assessment systems in adult education must enact a delicate synthesis of formative and summative objectives. They must be capable of meeting immediate instructional needs while supporting learners' long-term intellectual, civic, and professional development [43]. At a micro level, assessment must remain responsive to learner agency and oriented toward social transformation. In this light, assessment is not merely a pedagogical act but an ethical and political intervention—essential to the cultivation of critically engaged, resilient, and self-determined adult learners [44].

2.2 The Convergence of GenAI and Adult Assessment Paradigms

The integration of Generative Artificial Intelligence (GenAI) into adult education assessment marks a pivotal shift in both pedagogical design and technological mediation. GenAI's affordances—personalization, adaptivity, and process-based feedback—align closely with foundational principles of adult learning, such as autonomy, relevance, and critical reflection [45, 46]. These tools enable real-time scaffolding and diagnostic insight, offering new possibilities for responsive and learner-centered assessment practices.

However, this convergence is fraught with contradictions. While GenAI supports differentiated assessment pathways, it may simultaneously obscure epistemic nuance through opaque algorithms and decontextualized outputs. Automated evaluation,

when uncritically deployed, risks displacing dialogic and narrative-based assessment approaches central to emancipatory adult learning traditions. Moreover, passive consumption of AI-generated feedback can undercut learner agency unless intentionally counterbalanced by pedagogical strategies that promote co-construction and critical engagement. Equity concerns further complicate this landscape. Uneven access to digital infrastructure and professional development constrains the meaningful adoption of GenAI in under-resourced settings, perpetuating existing educational disparities. Thus, a critical reimagining of GenAI-mediated assessment is essential—one that emphasizes transparency, cultural responsiveness, and ethical alignment. To realize the transformative potential of GenAI in adult assessment, institutions must embed these technologies within frameworks that center justice, learner agency, and pedagogical integrity. Such integration requires not only technological sophistication but also a commitment to sustained dialogue, capacity building, and inclusive innovation.

This chapter adopts a critical-conceptual approach to interrogate the convergence between GenAI and adult educational assessment. Rather than engaging in an empirical or systematic review, the analysis is anchored in a synthesis of contemporary theoretical perspectives from adult learning, educational assessment, and AI ethics. Central to this framing is the premise that GenAI, as a sociotechnical system, is not merely a pedagogical tool but an epistemic actor that reconfigures what is assessed, how, and by whom.

The chapter draws on three key conceptual lenses. First, andragogy provides a foundation for understanding the unique assessment needs of adult learners—emphasizing autonomy, experience-based learning, and contextual relevance. Second, transformative learning theory offers a framework for assessing deeper cognitive and affective shifts enabled (or constrained) by AI-mediated feedback and reflection. Third, the chapter engages with critical digital pedagogy and posthumanist perspectives, which challenge technocentric narratives and foreground issues of agency, ethics, and relationality in AI-integrated learning systems. This conceptual triangulation enables the chapter to go beyond instrumentalist framings of GenAI. Instead, it positions AI as embedded within broader systems of power, discourse, and educational governance. The goal is not to celebrate or reject GenAI, but to map its implications across pedagogical, ethical, and structural dimensions of assessment in adult learning. In doing so, the chapter contributes to emerging scholarship that reframes educational technology as a site of critical inquiry. It invites educators, designers, and policymakers to consider how GenAI might be harnessed to support inclusive, reflective, and justice-oriented assessment practices—while remaining vigilant to its risks and unintended consequences in diverse adult learning ecologies.

3 Critical Issues in Implementing GenAI in Adult Assessment

3.1 Ethical Challenges in GenAI-Based Assessment

The integration of generative artificial intelligence (GenAI) into educational assessment frameworks introduces a constellation of intricate ethical, pedagogical, and epistemological considerations that interrogate the foundations of integrity, reliability, and justice in adult learning contexts. These concerns are particularly amplified in adult education settings, where the pedagogical architecture emphasizes formative, learner-centered, and competency-driven evaluation mechanisms.

One of the most urgent and widely discussed dilemmas pertains to the erosion of academic integrity. The capacity of GenAI systems to autonomously generate coherent, persuasive, and grammatically refined responses has facilitated instances where learners submit AI-generated content as original academic work [47, 48]. Such practices compromise the legitimacy of traditional assessment artifacts—including essays, analytical reports, and open-book tasks—by decoupling demonstrated performance from authentic learner cognition. Consequently, the credibility of academic credentials and the epistemic trust placed in evaluation systems are significantly undermined [49, 50].

Closely associated with integrity is the challenge of ensuring assessment reliability in AI-mediated contexts. Although GenAI presents new possibilities for delivering automated formative feedback and scalable assessment, it remains susceptible to producing "hallucinations"—outputs that are either factually erroneous or epistemically misleading [29]. Moreover, the variability in AI-generated responses to identical or similar prompts introduces inconsistency in evaluative outcomes, necessitating the integration of rigorous rubrics and sustained human moderation to uphold reliability standards [27, 51].

These operational vulnerabilities are further magnified by unresolved ethical issues, especially concerning data governance. GenAI platforms frequently operate through opaque data collection and processing systems, often without securing explicit informed consent from learners. This raises fundamental concerns related to data privacy, digital surveillance, and institutional responsibility [52]. In the absence of transparent, enforceable ethical frameworks, educational institutions risk institutionalizing algorithmic opacity and procedural injustice within their assessment regimes [53, 54].

A critical pedagogical limitation of GenAI lies in its constrained capacity to evaluate higher-order thinking, including originality, ethical reasoning, and creative problem-solving. Most GenAI applications are structurally designed to respond to fixed prompts, thereby reinforcing shallow cognitive engagement and limiting opportunities for intellectual exploration [55]. Addressing this limitation demands a paradigmatic pedagogical shift—from static, product-oriented assessments toward dynamic, process-driven evaluation models that privilege critical inquiry, contextual adaptation, and learner reflexivity.

Intersecting with these ethical and cognitive limitations are structural concerns involving fairness, transparency, and algorithmic bias. Fairness, in the context of GenAI-assisted assessment, must be reconceptualized beyond procedural neutrality to include epistemic equity—how algorithms represent and interact with diverse learner identities. Datasets used to train GenAI models frequently reproduce historical exclusions and sociocultural hierarchies, resulting in biased outputs that marginalize underrepresented populations [56, 57]. These distortions are not merely technical anomalies; they represent profound failures of inclusivity and epistemic justice.

Additionally, the increasing ubiquity of AI-generated submissions complicates long-standing norms of authorship and intellectual accountability. When students rely on GenAI to produce written assessments, they disengage from cognitive and reflective dimensions of learning, thereby weakening the scholarly value of assessment and intensifying asymmetries in educational attainment [58, 59]. These practices challenge the ontological purpose of assessment—as a space of learner transformation—and risk conflating technical automation with genuine academic achievement.

The issue of transparency remains unresolved in many GenAI implementations. The black-box nature of most AI systems—whereby decision-making processes remain inaccessible to users—obstructs learners' ability to interrogate, interpret, or contest the rationale behind evaluative feedback [60]. This lack of explainability poses a direct threat to procedural fairness and learner agency, particularly when AI-driven decisions have material consequences for academic progression [61]. Finally, the deeply embedded nature of algorithmic bias exacerbates the ethical terrain. Homogeneous training data and reductionist algorithmic design often yield outputs that misrepresent or erase non-normative cultural perspectives, reinforcing stereotypes and excluding minority epistemologies [62]. Such distortions compromise both the validity and the inclusiveness of assessment practices, alienating learners who do not conform to the implicit norms embedded in algorithmic logic. Wwhile GenAI offers transformative affordances for enhancing scale, personalization, and feedback in assessment, its deployment within adult education systems must be approached with critical vigilance. Addressing the complex entanglement of academic integrity, reliability, fairness, transparency, and bias requires a multi-layered response: one that is ethically anchored, pedagogically robust, and systemically reflexive. Only through such a principled and nuanced approach can GenAI be aligned with the emancipatory aspirations of adult learning and the broader project of educational justice.

3.2 Institutional and Pedagogical Responses

Addressing these multifaceted challenges requires proactive institutional and pedagogical interventions. First, the development of robust ethical frameworks is imperative. These frameworks must articulate core principles—fairness, transparency, accountability, and inclusivity—and guide the implementation of GenAI within

learning and assessment systems. Such frameworks should not be abstract declarations but operationalized through institutional policy, instructional design, and learner engagement protocols [63, 64]. Second, interdisciplinary governance structures are essential. Educational institutions must foster collaborations between technologists, educators, legal scholars, and ethicists to co-develop policies and practices that are contextually grounded and pedagogically responsive [57]. This approach guards against the imposition of technological logics that marginalize educational priorities. Third, fostering AI literacy as a foundational competence is critical. Faculty and learners alike must possess not only technical fluency but also critical understanding of AI systems' implications. Institutionalized AI literacy programs—integrated into curricula and supported by training and professional development—can enable informed, ethical, and reflexive engagement with GenAI tools [62, 63]. Finally, GenAI integration must be subjected to continuous, participatory evaluation. Adaptive assessment frameworks should incorporate stakeholder feedback, empirical monitoring, and iterative refinement [64]. By embedding ethical reflexivity and policy responsiveness into their assessment ecosystems, institutions can position GenAI not merely as a disruptive innovation but as a means to advance inclusive, dialogic, and critically informed adult learning.

3.3 Pedagogical Reorientation and Faculty Development Needs

The assimilation of generative AI technologies into educational assessment systems necessitates a paradigmatic shift in pedagogical thinking and faculty readiness. Conventional models—anchored in product-oriented and summative approaches—are increasingly insufficient in an era where AI can automate content generation and simulate cognitive outputs. In response, assessment must be reimagined as a process-driven, dialogic, and learner-centered endeavor, wherein cognitive depth, authenticity, and ethical engagement are foregrounded [29, 49]. This transformation requires educators to develop competencies in designing assessments that transcend mere recall and reproduction, focusing instead on evaluating complex constructs such as moral reasoning, critical inquiry, and adaptive problem-solving—domains that AI currently struggles to appraise with fidelity [50, 55]. Educators must shift from static rubrics to fluid, process-sensitive evaluative frameworks that emphasize reflection, synthesis, and meaning-making.

Achieving this vision hinges upon robust faculty development initiatives. Professional learning ecosystems must equip educators with AI literacy, an understanding of algorithmic affordances and limitations, and the pedagogical acumen to ethically embed GenAI into assessment without diminishing humanistic values. As Sağin et al. [65] assert, the future of AI in education depends not only on technical proficiency but also on educators' epistemic agency and ethical reflexivity. Training should extend

beyond technical workshops to include interdisciplinary collaboration, critical pedagogy, and scenario-based simulations tailored to varied educational contexts. Absent such development, the integration of GenAI risks exacerbating epistemic inequalities and reinforcing shallow forms of engagement. Institutions, therefore, bear a strategic responsibility to foster a culture of sustained pedagogical innovation that positions educators as critical mediators between algorithmic tools and transformative learning processes.

3.4 Stakeholder Engagement and Co-creation of Responsible AI Practices

Embedding GenAI into assessment infrastructures demands inclusive, iterative engagement with diverse stakeholders—faculty, students, administrators, technologists, and policymakers. Ethical and pedagogically coherent AI integration cannot be realized through top-down directives alone; rather, it necessitates dialogical co-construction processes that reflect the pluralistic realities of educational environments [49, 50, 66]. Resistance to AI often stems not merely from technical apprehension, but from a perceived lack of autonomy and shared ownership in shaping implementation frameworks. Pit et al. [67] underscore how institutional inertia and vague policy guidance contribute to faculty ambivalence and student mistrust. Consequently, institutional legitimacy hinges on transparency, participatory governance, and the articulation of clear, context-sensitive policies.

Equally vital is the codification of robust policy instruments: usage protocols, data ethics guidelines, and appeal mechanisms co-authored by stakeholders. These instruments must align with educational justice principles and ensure that GenAI deployment sustains, rather than supplants, pedagogical integrity [52, 53]. Student agency, too, must be elevated from passive recipient to active co-designer. Institutions should institutionalize mechanisms for capturing learner perspectives in GenAI design, testing, and evaluation. Doing so enhances relevance, ensures accessibility, and empowers students as digital citizens within AI-mediated ecosystems. Stakeholder engagement must be reframed as a foundational pillar of AI ethics in education. Through shared inquiry, negotiated norms, and sustained collaboration, institutions can reposition GenAI from a disruptive innovation to a collective enterprise in fostering equity-oriented, trust-based, and human-centered assessment practices.

4 Contextual Illustration—Southeast Asia's Adult Education Landscape

4.1 Regional Policy Landscape and Governance Challenges

The integration of artificial intelligence (AI) into educational systems across Southeast Asia is taking place within a fragmented and inconsistent policy landscape. This fragmentation reflects broader regional disparities in political priorities, institutional capacities, and levels of technological preparedness. Unlike more unified regional blocs such as the European Union, ASEAN has yet to establish a cohesive governance framework that provides clear ethical and regulatory guidelines for AI deployment in education [68, 69]. In the absence of such a framework, national approaches vary significantly. Singapore and Malaysia, for instance, have embedded AI into their strategic development plans with a strong emphasis on innovation and competitiveness. In contrast, countries such as Cambodia, Laos, and Myanmar remain in the early stages of digital policy formation, focusing primarily on basic ICT infrastructure and human capital development [69, 70].

This policy divergence is further compounded by political heterogeneity within the region. In decentralized systems such as Indonesia, inconsistencies between national and subnational governance structures often create policy disconnects that impede effective implementation [71]. Such vertical misalignments can result in the superficial adoption of AI technologies without accompanying pedagogical reform, ultimately limiting the transformative potential of these tools in adult education. Moreover, several lower-income ASEAN member states face systemic challenges in public administration, including limited institutional capacity and weak regulatory enforcement—factors that significantly constrain the development of robust and forward-looking AI governance frameworks [72].

Adding to these complexities are emerging ideological tensions between technocratic approaches to AI and the need for inclusive, human-centered educational models. While some governments view AI adoption primarily through the lens of economic modernization and digital competitiveness, ethical concerns and pedagogical values are often underrepresented in policy discourse. This imbalance risks reducing AI to a technocratic instrument rather than positioning it as a transformative force for lifelong learning and empowerment in adult education. Finally, the lack of regional policy harmonization not only impedes collaborative knowledge exchange but also limits the ability to scale best practices across borders. In the absence of institutionalized mechanisms for coordination and standard-setting, Southeast Asia remains vulnerable to uneven AI diffusion and deepening digital inequities. Addressing these challenges requires a renewed emphasis on regional cooperation—anchored in shared ethical commitments and pedagogical goals—to ensure that AI governance in adult education advances both innovation and equity across the region.

4.2 Infrastructure, Access, and the Digital Divide

The integration of AI into adult education across Southeast Asia is inextricably linked to the region's persistent infrastructural disparities and widening digital divide. While urban centers in countries such as Singapore and Malaysia have witnessed significant advances in digital infrastructure, large swaths of the region—particularly rural and remote areas in Cambodia, Laos, and Myanmar—continue to struggle with inadequate connectivity, limited access to devices, and a lack of technical support [70, 73]. This uneven distribution of digital infrastructure severely constrains the potential for equitable AI adoption, particularly in adult education programs that serve marginalized populations.

These infrastructural gaps are not solely technological in nature; they are also deeply embedded in socioeconomic inequalities. Income-based disparities remain a critical barrier to digital access, with individuals from lower-income households far less likely to benefit from AI-enabled educational tools [74]. Moreover, digital access is shaped by intersecting factors such as gender, geography, and age—resulting in multi-layered exclusion for women, older adults, and rural learners [75–78]. In many under-resourced communities, the scarcity of internet bandwidth, inconsistent electricity supply, and high costs of digital devices collectively undermine efforts to scale AI-based learning initiatives. These structural constraints are further aggravated by weak institutional support and the absence of localized digital infrastructure, particularly in community-based adult education centers. Without targeted investments, such disparities risk entrenching existing educational inequalities rather than alleviating them.

Teacher readiness is also a critical factor shaping the digital divide in adult learning contexts. Many educators across Southeast Asia—especially those serving in non-formal or rural education systems—have limited exposure to digital pedagogies and often lack the technical confidence to integrate AI tools into their instructional practices [79, 80]. Even when infrastructure is present, its effective utilization depends on educators' digital literacy and the presence of ongoing institutional support. To address these multifaceted challenges, bridging the digital divide must be prioritized not only as a matter of technological investment but also as a systemic educational imperative. Comprehensive strategies should encompass infrastructure development, context-sensitive digital content, and localized support ecosystems. Moreover, regional cooperation could facilitate knowledge-sharing and resource mobilization to support less-developed ASEAN member states in building resilient digital learning environments. Without a concerted effort to address infrastructural and access disparities, the promise of AI in adult education will remain largely aspirational for millions of learners across Southeast Asia.

4.3 Integration of AI in Adult Education Programs

The integration of artificial intelligence into adult education programs across Southeast Asia is emerging as a strategic response to the region's evolving economic demands and the growing need for lifelong learning. AI technologies offer a pathway toward more personalized, responsive, and scalable learning systems, yet their successful adoption hinges on a nuanced understanding of adult learners' unique needs, sociocultural contexts, and institutional constraints [72, 81]. One of the most salient innovations in this domain is the use of AI-driven assessment tools. These technologies are capable of adapting to individual learning trajectories, offering differentiated feedback, and aligning evaluations with learners' cognitive profiles and real-world skillsets [82, 83]. In adult education settings, where learner heterogeneity is particularly pronounced, AI-enhanced assessments can support more equitable and learner-centered outcomes. The application of these tools has also contributed to improved management and monitoring in adult learning programs, allowing for data-driven decision-making and more precise instructional interventions [84]. Beyond assessment, AI is reshaping the landscape of digital pedagogy through the development of intelligent tutoring systems, adaptive learning platforms, and multilingual content delivery. These technologies have become especially critical in post-pandemic contexts, where online and hybrid modalities dominate the delivery of adult education [85]. They offer opportunities to simulate work-based scenarios, support flexible learning schedules, and align content with labor market trends—key elements in making adult education both relevant and sustainable.

However, effective integration requires more than technological insertion. Many AI tools lack cultural and linguistic responsiveness, often reflecting design logics from Western contexts that do not align with Southeast Asian educational values and vernacular pedagogies [86]. When these tools are not adapted to local realities, they risk alienating learners and undermining traditional knowledge systems. Customization is, therefore, not a technical afterthought but a pedagogical necessity. Moreover, the success of AI integration depends heavily on the readiness and support systems surrounding educators. Adult learning facilitators must be equipped with not only technical competencies but also critical understanding of AI's role within andragogical frameworks. Unfortunately, in much of Southeast Asia, professional development opportunities in this area remain limited, especially outside urban centers [80, 86]. To bridge these gaps, forward-looking initiatives such as the GenAI Adult Learning Ecology (GenAI-ALE) framework have been proposed, emphasizing the convergence of curriculum redesign, ethical governance, and digital equity [87]. Such frameworks highlight the importance of integrating AI in ways that advance human-centered learning rather than merely automate existing instructional tasks. The integration of AI into adult education programs holds great promise, but its realization requires a culturally grounded, educator-enabled, and learner-responsive approach. When grounded in contextually relevant design and supported by inclusive institutional ecosystems, AI can enhance the flexibility, inclusivity, and effectiveness of adult learning across Southeast Asia.

4.4 GenAI in Southeast Asia: Advancing Assessment Practices Through Emerging Pedagogical Integration

The deployment of Generative Artificial Intelligence (GenAI) within adult educational assessment regimes across Southeast Asia reflects a regionally differentiated yet accelerating trend in technology-mediated pedagogical reform. Among the nations studied, Thailand and Indonesia demonstrate more pronounced experimentation with GenAI in formal assessment, especially in language education, while Malaysia has embarked on systemic AI integration across broader educational and policy domains. In contrast, Vietnam and Singapore, despite their technological advancements, remain underrepresented in the extant literature concerning GenAI-enabled assessment.

Thailand has emerged as a locus of innovation in utilizing GenAI for Automated Writing Evaluation (AWE), particularly within English as a Foreign Language (EFL) instruction. Research indicates that GenAI applications facilitate rubric-based formative feedback, supporting enhanced consistency, scalability, and responsiveness in language assessment tasks [88]. Pedagogical actors in Krabi Province report generally favorable perceptions of GenAI, especially its capacity to offer real-time feedback. However, critiques persist, particularly regarding reduced interpersonal interaction and potential informational inaccuracies [89]. National momentum is also evident in the proliferation of workshops and institutional seminars that explore GenAI's pedagogical affordances, signaling a structured, policy-informed enthusiasm [90].

Indonesia is widely recognized as a regional frontrunner in GenAI adoption, particularly within tertiary education. Empirical studies highlight diverse use cases, from AI-assisted formative writing evaluations to personalized academic support systems. While educators and learners alike affirm the benefits of improved academic productivity and learner engagement, concerns endure regarding ethical integrity, overreliance, and the erosion of critical thinking [91–93]. University students frequently report using GenAI to structure arguments and overcome cognitive inertia during writing tasks, although they also acknowledge challenges such as linguistic inaccuracies and the risk of uncritical automation [94].

Malaysia presents a distinctive case where direct application of GenAI in assessment remains emergent, yet the broader ecosystem demonstrates readiness for high-stakes algorithmic deployment. Notably, national initiatives have implemented AI—including GenAI—within public health infrastructure, as evidenced by its role in cancer screening protocols [95]. Within higher education, GenAI is gradually being associated with increased personalization, dynamic feedback, and process-oriented assessment design. Nonetheless, critical concerns surrounding AI-induced bias and breaches of academic integrity have prompted calls for governance mechanisms to regulate AI integration in pedagogical contexts [96, 97].

Vietnam and Singapore, although frequently lauded for their digital infrastructure and policy sophistication, remain peripheral in current academic discourse on GenAI-enabled assessment. Vietnam's literature emphasizes the importance of aligning

student attitudes, digital ethics, and institutional policy to create a fertile environment for GenAI adoption in education [98]. Singapore, despite its global leadership in EdTech investments, has not yielded accessible empirical accounts detailing the deployment of GenAI for assessment purposes within its academic systems. This evidentiary gap underscores the need for further empirical inquiry into both nations' educational AI practices.

Across national contexts, several thematic concerns surface. GenAI's affordances—such as real-time adaptive feedback and scalable personalization—render it a compelling tool in writing-intensive disciplines and asynchronous learning environments. Nevertheless, scholars caution against pedagogical displacement and epistemic dependency, highlighting the attenuation of higher-order reasoning skills and the reproduction of algorithmic bias [99–101]. These insights necessitate a pedagogical reorientation grounded in ethical foresight, human-centered instructional design, and institutional AI literacy. The evolving trajectory of GenAI adoption for educational assessment in Southeast Asia reveals both promise and precarity. While Thailand and Indonesia provide instructive case studies of grassroots and institutional uptake, Malaysia's infrastructural maturity suggests scalability potential. Vietnam and Singapore remain comparatively underexplored. Future research must prioritize longitudinal analyses and cross-national comparisons, aimed at delineating policy frameworks and pedagogical models that embed GenAI within ethically robust, culturally responsive, and epistemologically inclusive assessment ecosystems.

4.5 Digital Literacy, Ethics, and Cultural Relevance

As Southeast Asia accelerates its adoption of digital and AI-based tools in adult education, the imperative for cultivating digital literacy and embedding ethical, culturally grounded practices has never been more urgent. Digital inclusion is not merely a matter of infrastructure or access; it encompasses the competencies, values, and contextual sensitivities that enable adults to participate meaningfully and responsibly in digitally mediated learning ecosystems [102, 103].

A core issue remains the foundational gap in digital literacy among adult learners, particularly in low- and middle-income communities. Many adults lack the formal education needed to support basic literacy, let alone navigate algorithmic systems or data-driven feedback mechanisms [104]. This challenge is compounded by the absence of sustained digital skills training embedded within national adult education systems. Moreover, even when such programs exist, they often fail to account for learners' everyday realities, cultural practices, and vernacular languages—rendering digital literacy efforts ineffective or alienating [86, 105].

Ethical concerns also play a pivotal role in shaping how AI is received and implemented in adult education. The use of algorithmic systems in assessment and instruction raises significant questions about transparency, fairness, and the preservation of learner agency [106, 107]. In particular, fears around surveillance, dehumanization, and data misuse may erode trust in educational institutions, especially in

contexts where governance mechanisms are weak or opaque. This is especially critical in Southeast Asia, where uneven digital policy landscapes exacerbate risks of algorithmic harm and widen power asymmetries between institutions and learners [108].

Cultural relevance is equally crucial. AI systems that fail to align with local pedagogical traditions, indigenous knowledge systems, or religious and linguistic diversity are less likely to succeed. For example, tools designed in Global North contexts may lack sensitivity to Southeast Asia's pluralistic educational cultures, undermining learner engagement and perpetuating a form of digital colonialism [86, 109]. In response, scholars have called for the co-design of AI tools in partnership with local educators, communities, and learners—a strategy that fosters ownership, contextual fit, and ethical resilience.

Addressing digital literacy and ethical concerns also demands intergenerational and gender-sensitive approaches. Older adults and women in many Southeast Asian contexts face specific barriers to digital engagement, shaped by historical marginalization and social norms [75, 76]. Therefore, inclusive strategies must go beyond generic training and engage with the socio-political dynamics that shape digital participation. Building ethical and culturally relevant AI ecosystems in adult education requires more than deploying advanced technologies. It necessitates a reconfiguration of educational practices that center equity, trust, and local knowledge. A critical, inclusive, and context-aware approach to digital literacy can transform AI from a potential threat to a powerful enabler of lifelong learning and democratic participation across Southeast Asia.

4.6 Regional Strategies for Inclusive and Sustainable Innovation

In response to the multifaceted challenges posed by AI adoption in adult education, Southeast Asia is gradually embracing strategic frameworks that emphasize inclusivity, sustainability, and regional cohesion. However, the translation of these principles into actionable policy and pedagogical practice remains uneven. Bridging this gap requires both top-down alignment and bottom-up innovation, grounded in local realities and guided by shared ethical commitments.

A foundational strategy is the establishment of a cohesive regional governance architecture. While the ASEAN region has made strides in digital connectivity and education initiatives, it has yet to operationalize a unified AI policy for education that balances human capital development with ethical AI deployment. Scholars advocate for an ASEAN-wide framework that integrates data protection, algorithmic accountability, and cross-border educational collaboration [68, 69]. Such a framework would enable knowledge-sharing among member states, standardize quality benchmarks, and provide technical guidance for countries with less-developed AI ecosystems. Parallel to policy harmonization, regional investment in ICT infrastructure remains