



Generative artificial intelligence in Ecuadorian education: Pedagogical transformation and cognitive development

Inteligencia artificial generativa en educación ecuatoriana: Transformación pedagógica y desarrollo cognitivo

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ABSTRACT

The integration of generative artificial intelligence into the Ecuadorian education system represents an opportunity to revolutionise teaching methodologies and enhance student cognitive development. Through a systematic review of specialist literature published between 2023 and 2025, this study examines the potential impact of these emerging technologies, analysing the opportunities, challenges and implications of their implementation. The results show that generative AI can personalise learning experiences, stimulate critical thinking and facilitate student-centred pedagogical approaches. However, risks associated with excessive technological dependence and the need for appropriate regulatory frameworks are identified. The METE-IAG model (Ecuadorian Model for Educational Transformation through Generative Artificial Intelligence) is proposed, structured around five interrelated dimensions: pedagogical, technological, cognitive, organisational, and ethical. This framework suggests a gradual implementation that combines teacher training, adequate technological infrastructure, and coherent educational policies to maximise benefits while minimising potential risks.

Descriptors: pedagogical transformation; cognitive development; educational technology. (Source: UNESCO Thesaurus).

RESUMEN

La integración de inteligencia artificial generativa en el sistema educativo ecuatoriano constituye una oportunidad para revolucionar las metodologías pedagógicas y potenciar el desarrollo cognitivo estudiantil. Mediante una revisión sistemática de literatura especializada publicada entre 2023 y 2025, este estudio examina el impacto potencial de estas tecnologías emergentes, analizando oportunidades, desafíos e implicaciones de su implementación. Los resultados demuestran que la IA generativa puede personalizar experiencias de aprendizaje, estimular el pensamiento crítico y facilitar enfoques pedagógicos centrados en el estudiante. No obstante, se identifican riesgos asociados con la dependencia tecnológica excesiva y la necesidad de marcos regulatorios apropiados. Se propone el modelo METE-IAG (Modelo Ecuatoriano de Transformación Educativa mediante Inteligencia Artificial Generativa), estructurado en cinco dimensiones interrelacionadas: pedagógica, tecnológica, cognitiva, organizacional y ética. Este marco sugiere una implementación gradual que combine capacitación docente, infraestructura tecnológica adecuada y políticas educativas coherentes para maximizar beneficios mientras se minimizan riesgos potenciales.

Descriptor: transformación pedagógica; desarrollo cognitivo; tecnología educativa. (Fuente: Tesauro UNESCO).

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Research articles



INTRODUCTION

The global educational landscape is undergoing an unprecedented technological revolution, with generative artificial intelligence emerging as a disruptive force capable of redefining traditional teaching and learning paradigms. In the Ecuadorian context, characterised by particular challenges in terms of educational equity, access to technological resources and teacher training, the strategic adoption of these tools represents both an extraordinary opportunity and a complex challenge that demands rigorous analysis and careful planning.

Over the last few decades, Ecuador has undergone significant transformations in its education system, driven by public policies aimed at improving educational quality and reducing socio-economic gaps. However, structural challenges remain that limit student learning potential, including predominantly traditional teaching methodologies, limited educational resources, and disparities in access to emerging technologies between different regions of the country.

The emergence of generative artificial intelligence in the global education sector has demonstrated significant transformative capabilities, from personalising learning to automating complex administrative processes. According to research by Bobula (2024), these technologies offer unique opportunities to address persistent educational challenges, but they also present risks that require careful consideration. Similarly, the work of Farrelly and Baker (2023) highlights that the successful implementation of generative AI in higher education requires holistic approaches that consider both pedagogical opportunities and ethical and practical implications.

The relevance of this research lies in the urgent need to develop conceptual frameworks and implementation strategies that enable the Ecuadorian education system to capitalise on the transformative potential of generative AI, while navigating the challenges inherent in its adoption. In particular, the study by Chaparro-Banegas et al. (2024) emphasises that the integration of these technologies requires a rethinking of traditional approaches to critical thinking and



educational assessment. Complementarily, Vieriu and Petrea (2025) stress that the impact of AI on student academic development depends significantly on how educational interventions are designed and implemented.

Furthermore, Bustard and Ghisoiu (2025) propose that the educational revolution through generative AI requires asynchronous approaches and innovative methodologies that transcend the limitations of conventional pedagogical models. This perspective is particularly relevant to the Ecuadorian context, where geographical and sociocultural diversity demands flexible and adaptable educational solutions.

Study objectives

The main objective of this study is to analyse the potential of generative artificial intelligence as a tool for pedagogical transformation in the Ecuadorian education system, identifying viable strategies for its effective implementation and evaluating its potential impact on student cognitive development. Specifically, it seeks to examine the opportunities and challenges associated with the integration of these technologies, develop a conceptual framework for their strategic adoption, and propose practical recommendations to maximise their positive educational impact.

Theoretical framework

The theoretical basis of this study is supported by a body of contemporary research that examines the intersections between generative artificial intelligence and education from multiple disciplinary perspectives. This conceptual framework integrates contributions from digital pedagogy, cognitive psychology, educational technology, and educational sciences, providing a solid foundation for critical analysis of the transformative implications of AI in educational contexts.

Bobula's (2024) research provides a comprehensive perspective on the challenges and opportunities presented by generative AI in higher education, identifying specific areas where these technologies can generate significant added value. His analysis reveals that successful implementation requires careful consideration of technical, pedagogical, and ethical factors, setting important



precedents for developing educational contexts such as Ecuador's. The research particularly highlights the need to develop digital teaching skills and appropriate regulatory frameworks to maximise potential benefits.

From an innovative pedagogical perspective, Bustard and Ghisoiu (2025) explore how the integration of generative AI can revolutionise education through asynchronous approaches that transcend traditional temporal and spatial limitations. Their work demonstrates that these technologies enable unprecedented personalisation of learning experiences, facilitating adaptation to different cognitive styles and learning rhythms. This perspective is particularly relevant for education systems with limited resources, where efficiency and scalability are priority considerations.

The work of Chaparro-Banegas et al. (2024) adds a critical dimension by examining how generative AI challenges traditional paradigms of critical thinking in education. Their research suggests that, far from replacing human cognitive abilities, these technologies can serve as catalysts for developing more sophisticated forms of analysis and critical reflection. This perspective refutes common concerns about technological dependence, proposing instead models of cognitive complementarity that enhance natural human capabilities.

In the specific field of marketing and business education, Ding et al. (2024) demonstrate practical applications of generative AI that can be extrapolated to other academic disciplines. Their work illustrates how these tools can transform traditional teaching methodologies, facilitating more interactive and contextually relevant learning experiences. The implications of their research extend beyond specific disciplines, suggesting general principles for the effective integration of AI in various academic fields.

In this vein, Farrelly and Baker (2023) contribute a holistic perspective that examines the systemic implications of generative AI in higher education, focusing on practical considerations for educational institutions. Their analysis ranges from technological infrastructure to required organisational changes, providing a valuable frame of reference for institutions considering the adoption of these



technologies. Particularly relevant is their focus on change management and academic staff training.

On the other hand, Gerlich (2025) brings an important sociological dimension by examining the impact of AI tools on the development of critical thinking and cognitive offloading. His work raises fundamental questions about how these technologies may affect human cognitive abilities in the long term, suggesting the need for balanced approaches that preserve and enhance essential cognitive skills while taking advantage of available technological benefits.

In this way, Gonsalves (2024) delves into the specific impact of generative AI on critical thinking, revisiting Bloom's taxonomy from a contemporary perspective. His work suggests that these technologies require a reconceptualisation of traditional cognitive levels, proposing updated frameworks that reflect the new realities of AI-assisted learning. This contribution is particularly valuable for the design of curricula and assessment strategies in modern educational contexts.

The contributions of Grewal et al. (2025) and Guha et al. (2023) examine specific applications of generative AI in higher education, providing empirical evidence on its effectiveness in different academic contexts. Their research demonstrates tangible benefits in terms of student engagement, learning personalisation, and teaching efficiency, setting important precedents for future implementations in diverse educational contexts.

Kshetri et al. (2024) offer a comprehensive perspective on the applications, opportunities, and challenges of generative AI, developing a comprehensive research agenda that encompasses multiple dimensions of analysis. Their work provides a robust conceptual framework for assessing the transformative potential of these technologies, including economic, social, and ethical considerations that are particularly relevant to developing contexts.

The research by Narang et al. (2025) explores the multifaceted role of generative AI in education, highlighting its versatility and adaptability to different pedagogical contexts. Their work demonstrates how these technologies can take on multiple



roles within the educational ecosystem, from teaching assistants to assessment tools, suggesting flexible approaches for their effective implementation.

Similarly, Patil (2024) contributes specialised perspectives on personalisation and optimisation of educational strategies through generative AI, providing valuable insights into how these technologies can be adapted to individual learning needs. Their research suggests concrete methodologies for implementing adaptive learning systems that respond dynamically to student needs.

Similarly, Singh and Huang (2025) examine the intersection between AI and creativity in educational contexts, demonstrating how these technologies can enhance creative abilities rather than limit them. Their work refutes common concerns about the standardisation of thinking, proposing instead models that use AI as a catalyst for innovation and creative expression.

Consequently, Vieriu and Petrea (2025) provide empirical evidence on the impact of AI on student academic development, offering quantitative data that supports hypotheses about the educational benefits of these technologies. Their research demonstrates measurable improvements in various indicators of academic performance, establishing a solid evidence base for arguments in favour of implementing AI in education.

Meanwhile, Zhai et al. (2024) contribute an important critical perspective through their systematic review of the effects of over-reliance on AI systems on student cognitive abilities. Their work identifies potential risks associated with the inappropriate use of these technologies, proposing strategies to maximise benefits while minimising negative consequences.

METHOD

A qualitative systematic review design oriented towards narrative synthesis was implemented, appropriate for examining complex and multidimensional phenomena such as the integration of generative AI in education. This approach allows for the analysis of diverse theoretical and empirical contributions,



facilitating the construction of a comprehensive understanding of the transformative implications of these technologies.

The methodological selection is justified by the emerging nature of the field of research, where limited empirical evidence requires approaches that allow for the integration of theoretical perspectives with preliminary results from experimental implementations. This design facilitates the identification of general principles applicable to the specific Ecuadorian context, considering the country's socio-economic, cultural, and technological particularities.

The study population comprises the body of contemporary academic research examining the intersection between generative artificial intelligence and education, published between 2023 and 2025. This time frame ensures the relevance of the results, considering the rapid evolution of AI technologies and their educational applications.

The sample analysed includes fifteen (15) specialised publications selected using specific criteria of theoretical and methodological relevance. The selected studies cover various disciplinary perspectives, including digital pedagogy, educational psychology, educational technology and applied computer science, providing a comprehensive basis for analysis.

The inclusion criteria considered: (1) direct thematic relevance to generative AI applications in education, (2) methodological quality demonstrated through peer review, (3) significant theoretical or empirical contributions to the field, (4) publication in indexed journals of recognised academic prestige, and (5) accessibility of the full text for detailed analysis.

The systematic review was conducted following established ethical principles for academic research, including appropriate recognition of intellectual contributions through accurate citation and faithful interpretation of original arguments. Analytical objectivity was maintained by avoiding confirmation bias and ensuring equitable representation of diverse perspectives.

Although this research does not directly involve human participants, ethical implications related to the proposed recommendations were considered,



particularly in terms of educational equity, technological access, and student privacy. These considerations informed both the analysis and the recommendations of the study.

RESULTS

Proposal for a comprehensive framework for the implementation of generative AI

Based on a systematic analysis of the specialised literature, a comprehensive framework called the 'Ecuadorian Model of Educational Transformation through Generative Artificial Intelligence' (METE-IAG) is proposed. This model is structured around five interrelated dimensions that address the technical, pedagogical, organisational, and social aspects necessary for successful and sustainable implementation.

Transformative pedagogical dimension

The first dimension of the METE-IAG model focuses on the reconceptualisation of traditional pedagogical practices through the strategic integration of generative AI tools. This dimension proposes a hybrid approach that combines human teaching experience with the adaptive capabilities of artificial intelligence, creating dynamic and personalised learning ecosystems.

The proposed pedagogical model is based on three structural pillars: adaptive personalisation, which allows content and methodologies to be tailored to the individual needs of each student; cognitive facilitation, which uses AI as a scaffolding tool to develop complex thinking skills; and continuous formative assessment, which provides immediate and specific feedback to optimise the learning process.

The implementation of this dimension requires the development of specific teaching skills that enable the effective use of generative AI tools as a complement to, rather than a replacement for, traditional pedagogical expertise. This includes skills for designing effective educational prompts, interpreting AI outputs in pedagogical contexts, and maintaining the essential human dimension of the educational process.



Within the Ecuadorian context, this dimension must consider the country's cultural and linguistic diversity, developing AI applications that recognise and value different regional educational traditions. The proposal includes the creation of repositories of culturally appropriate content and the development of multilingual interfaces that facilitate equitable access to these technologies.

Technological and infrastructural dimension

The second dimension addresses the technical and infrastructural requirements necessary to support the effective implementation of generative AI in the Ecuadorian education system. This dimension recognises budgetary constraints and regional disparities in access to technology, proposing scalable and financially sustainable solutions.

The technological strategy is structured around three levels of implementation: basic level, which includes access to generative AI tools through low-cost web platforms and mobile applications; intermediate level, which incorporates learning management systems integrated with AI capabilities; and advanced level, which includes the development of customised solutions for specific educational needs. The proposal emphasises the use of open-source technologies and collaborative platforms that reduce licensing costs and allow for local customisation. This includes the implementation of regional educational servers that provide AI services in a decentralised manner, reducing dependence on external providers and ensuring service continuity.

The technological dimension also considers aspects of data security and student privacy, proposing specific protocols for handling sensitive educational information. These protocols must comply with national and international regulations while facilitating the effective use of AI technologies for legitimate educational purposes.

Cognitive development and skills dimension

The third dimension focuses specifically on how generative AI can enhance student cognitive development and the acquisition of skills relevant to the 21st century. This dimension goes beyond the mere automation of educational tasks,



proposing approaches that use AI as a catalyst for developing critical thinking, creativity, and complex problem-solving skills.

The proposed framework identifies five priority competency areas: analytical and synthetic thinking, which is developed through structured interaction with AI systems that require the formulation of complex questions; augmented creativity, which combines human innovation capabilities with AI tools to explore expanded creative possibilities; critical digital competence, which includes the ability to evaluate and effectively utilise AI outputs; hybrid collaboration, which prepares students to work effectively in teams that include both humans and AI systems; and meta-learning, which develops the ability to reflect on and optimise one's own learning processes.

The implementation of this dimension requires the design of specific educational activities that leverage the unique strengths of generative AI while developing complementary human capabilities. This includes AI-assisted research projects, collaborative creative writing exercises with generative systems, and complex simulations that require critical analysis of automated outputs.

Within the Ecuadorian context, this dimension must consider the specific needs of the national and regional labour market, ensuring that the skills developed are relevant to local economic opportunities while preparing students to participate in the global digital economy.

Organisational and institutional dimension

The fourth dimension addresses the organisational and institutional changes necessary to support educational transformation through generative AI. This dimension recognises that the successful adoption of these technologies requires substantial modifications to administrative structures, decision-making processes, and institutional cultures.

The organisational proposal is structured around four levels of intervention: the ministerial level, which includes the development of appropriate national policies and regulatory frameworks; the district level, which covers regional coordination and the distribution of technological resources; the institutional level, which



contemplates changes in the administrative and academic structures of schools and universities; and the classroom level, which focuses on the transformation of everyday teaching-learning dynamics.

The model proposes the creation of multidisciplinary teams for educational digital transformation at each organisational level, including specialists in educational technology, educators, administrators, and representatives of the educational community. These teams would be responsible for planning, implementing, and evaluating generative AI initiatives in a coordinated and sustainable manner.

The organisational dimension also considers aspects of change management, recognising that the adoption of generative AI may generate resistance or anxiety among teachers and administrators. The proposal includes communication, training and support strategies designed to facilitate smooth transitions and maximise institutional acceptance.

Ethical dimension and social sustainability

The fifth dimension addresses ethical, equity, and social sustainability considerations associated with the implementation of generative AI in education. This dimension recognises that these technologies can both amplify and reduce existing educational inequalities, depending on how interventions are designed and implemented.

The proposed ethical framework is based on principles of educational equity, algorithmic transparency, respect for cultural diversity, and protection of student rights. These principles are operationalised through specific protocols for auditing AI systems, mechanisms for community participation in technological decisions, and safeguards to prevent discriminatory biases.

The proposal includes the creation of regional ethical observatories responsible for monitoring the social impact of generative AI in education, identifying emerging problems, and proposing appropriate solutions. These observatories would include representatives from different sectors of civil society, ensuring diverse perspectives in the evaluation of technological impacts.



The social sustainability dimension also considers aspects of preservation and valorisation of Ecuadorian cultural heritage, proposing that generative AI applications incorporate and promote traditional knowledge and local cultural practices rather than homogenising educational experiences according to external models.

Contextualised implementation strategies

The implementation of the METE-IAG model requires differentiated strategies that take into account the regional, institutional and socio-cultural particularities of Ecuador. A phased implementation approach is proposed, allowing for progressive adaptation and continuous institutional learning.

Awareness-raising and institutional preparation phase

The first phase of implementation focuses on raising awareness of the transformative potential of generative AI and preparing the institutional conditions necessary for its successful adoption. This phase includes awareness-raising activities targeting different actors in the education system, from ministerial authorities to classroom teachers.

Proposed activities include introductory seminars on generative AI for educational administrators, practical workshops for teachers demonstrating concrete applications of these technologies, and informational sessions for parents addressing common benefits and concerns. These activities should be designed considering different levels of technological familiarity and using cases contextualised to the Ecuadorian environment.

The preparation phase also includes institutional capacity assessments that identify the specific strengths and limitations of each educational institution. These assessments cover technological, pedagogical, organisational, and financial aspects, providing a solid foundation for individualised implementation planning.

During this phase, the technical and pedagogical support infrastructure necessary for subsequent phases is also established, including the formation of



local technical teams and the creation of support networks among educational institutions.

This ensures that institutions do not face technological transformation in isolation.

Pilot and controlled experimentation phase

The second phase implements pilot projects in selected educational institutions, allowing for controlled experimentation and evidence-based learning prior to systemic expansion. These pilots are designed to test different aspects of the METE-IAG model in real-world conditions, generating empirical data on effectiveness and implementation challenges.

The pilot projects are structured into three categories: pedagogical pilots, which test specific applications of generative AI in different subjects and educational levels; organisational pilots, which experiment with new administrative structures and decision-making processes; and technological pilots, which evaluate different AI platforms and tools in real educational contexts.

Each pilot project includes rigorous monitoring and evaluation protocols that capture both quantitative results and qualitative experiences of participants. This includes measurements of academic performance, student engagement indicators, teacher satisfaction evaluations, and organisational impact analyses. The lessons learned from the pilot projects are systematically documented and shared with the entire educational community through accessible reports, detailed case studies, and experience-sharing sessions. This collective learning process informs adjustments to the METE-IAG model and paves the way for further expansion.

Progressive scaling phase

The third phase expands implementation in a gradual and sustainable manner, incorporating lessons learned from previous phases and adapting strategies according to the specific characteristics of different regions and types of institutions. This phase uses organic scaling approaches that respect natural institutional rhythms.



Scaling is structured geographically, taking into account regional disparities in technological infrastructure and institutional capacities. Regions with greater technological preparedness serve as centres for advanced experimentation, while regions with limitations receive additional support and implementation tailored to their specific conditions.

During this phase, inter-institutional support networks are consolidated to facilitate the exchange of experiences, resources, and best practices among educational institutions. These networks include both face-to-face and virtual components, maximising access to specialised knowledge regardless of geographic location.

The scaling phase also includes the development of local capacities for technical and pedagogical support, reducing dependence on external expertise and ensuring long-term sustainability. This includes certification programmes for educational AI specialists and the creation of regional educational innovation centres.

Impact and evaluation indicators

The METE-IAG model includes a comprehensive monitoring and evaluation system designed to capture multiple dimensions of impact and facilitate continuous improvement. This system combines traditional quantitative indicators with innovative metrics specific to AI-assisted learning contexts.

Academic performance indicators

Traditional academic performance indicators remain a central component of the evaluation system, but are complemented by specific metrics that capture the unique benefits of generative AI. These include improvements in AI-assisted writing skills, development of digital research competencies, increases in creativity and originality of student projects, and advances in complex problem-solving that require human-AI collaboration.

Proposed metrics include longitudinal analyses of student progress comparing pre- and post-implementation periods, learning transfer assessments that measure the application of developed competencies in new contexts, and critical



thinking assessments that evaluate the ability to reflectively analyse and evaluate AI outputs.

Of particular importance is the development of assessment tools that distinguish between genuine improvements in learning and excessive dependence on AI tools. This requires careful design of assessment tasks that capture deep understanding and independent application skills, differentiating them from superficial technological utilisation skills.

Cognitive development indicators

The assessment system includes specialised metrics to capture impacts on student cognitive development, recognising that generative AI can influence fundamental thinking and learning processes. These indicators are designed to detect both potential benefits and risks associated with the use of these technologies.

Cognitive development metrics include metacognition assessments that measure students' abilities to reflect on their own learning processes, cognitive flexibility assessments that evaluate mental adaptability to changing situations, and synthesis ability measurements that analyse skills for integrating information from multiple sources, including AI outputs.

Of particular relevance is the monitoring of question-formulation abilities, recognising that effective interaction with generative AI requires sophisticated interrogation and requirement specification skills. Assessments include analysis of the quality of student-generated prompts and the effectiveness of iterative refinement strategies.

The system also includes early warning indicators to identify potential over-reliance or the development of counterproductive cognitive habits. These indicators allow for timely interventions to maintain healthy balances between technological assistance and the development of autonomous capabilities.

Equity and access indicators

Considering the socio-economic inequalities that exist in the Ecuadorian context, the evaluation system includes specific metrics to monitor impacts on educational



equity and access to learning opportunities. These indicators ensure that the implementation of generative AI reduces rather than amplifies existing educational gaps.

Equity indicators include analysis of the geographical distribution of benefits, comparisons of impact between different socioeconomic groups, assessments of differential access to AI technologies, and measurements of the digital divide in the effective use of generative tools. These analyses consider multiple dimensions of diversity, including geographic location, socioeconomic status, gender, ethnicity, and special educational needs.

Particularly important is the monitoring of unintended effects that could disadvantage specific groups, such as algorithmic biases in AI tools or technological requirements that exclude students with limited resources. The system includes protocols for early identification and correction of these problems. The metrics also include assessments of community participation in decisions about technology implementation, ensuring that different sectors of Ecuadorian society have a voice in shaping future educational policies that directly affect them.

DISCUSSION

The systematic review of specialised literature reveals an emerging consensus on the transformative potential of generative artificial intelligence in educational contexts, but also identifies significant challenges that require careful attention during implementation processes. The results suggest that these technologies can function as catalysts for pedagogical innovation, but their effectiveness critically depends on specific contextual and implementation factors.

Consistent with the approaches presented by Bobula (2024), the results indicate that generative AI offers unprecedented opportunities for educational personalisation and learning process optimisation. However, realising this potential requires comprehensive implementation frameworks that simultaneously address technical, pedagogical, organisational, and ethical dimensions. This multidimensional perspective is particularly relevant to the



Ecuadorian context, where resource constraints and regional disparities demand carefully planned strategic approaches.

Consistent with the observations documented by Farrelly and Baker (2023), the results emphasise the importance of practical and institutional considerations in the adoption of generative AI. The reviewed literature suggests that the success of these implementations depends on both technical factors and organisational capacities to manage change and maintain focus on fundamental educational objectives.

Particularly relevant is the convergence among multiple studies on the need to maintain appropriate balances between technological assistance and the development of autonomous human capacities. The contributions made by Chaparro-Banegas et al. (2024) and Gonsalves (2024) reinforce the perspective that generative AI should complement, not replace, the development of critical thinking and analytical skills in students.

The specific implications for the Ecuadorian education system emerge from the analysis of convergences between international evidence and national particularities. The proposed METE-IAG model recognises that the successful adoption of generative AI in Ecuador requires significant adaptations that take into account infrastructural limitations, cultural diversity and national development objectives.

Consistent with the approaches outlined by Bustard and Ghisoïu (2025) on asynchronous approaches in digital education, the Ecuadorian context presents unique opportunities to implement innovative models that transcend traditional geographical and temporal limitations. Disparities between urban and rural regions can be addressed through technological solutions that democratise access to high-quality educational resources, regardless of physical location.

However, the observations described by Zhai et al. (2024) on the risks of excessive dependence are particularly relevant for contexts with limited resources, where the temptation to use generative AI as a substitute for



investments in teacher training or basic educational infrastructure could have counterproductive long-term consequences.

The contributions documented by Vieri and Petrea (2025) on impacts on student academic development suggest that the Ecuadorian context could benefit significantly from carefully designed implementations, particularly in areas where the traditional education system faces persistent challenges such as personalisation of learning and attention to student diversity.

The analysis reveals significant convergences between results from different geographical and educational contexts, suggesting general principles for the effective implementation of generative AI in education. These convergences provide a solid basis for extrapolating best practices to the specific Ecuadorian context.

Multiple studies agree in identifying the personalisation of learning as a central benefit of generative AI, consistent with the approaches presented by Ding et al. (2024) and Narang et al. (2025). This convergence suggests that the adaptive capabilities of these technologies represent genuine competitive advantages over traditional methodologies, regardless of the specific context of implementation.

Similarly, the contributions made by Singh and Huang (2025) on enhancing creativity through generative AI are supported by multiple studies documenting similar benefits in different disciplinary and geographical contexts. This convergence is particularly promising for the Ecuadorian context, where the development of creative economies is a strategic national priority.

Warnings about the need for ethical frameworks and equity considerations, present in works developed by Gerlich (2025) and other authors, also show transnational consistency, suggesting that these challenges transcend specific contextual particularities and require universal attention.

Although the literature shows important convergences, tensions and divergences also emerge that reflect different priorities, contexts, and disciplinary



perspectives. These divergences provide valuable insights into the complexities inherent in the implementation of generative AI in education.

A central tension appears between approaches that emphasise efficiency and scalability versus those that prioritise pedagogical depth and human relationships. While studies such as those developed by Grewal et al. (2025) highlight the benefits of automation and optimisation, other contributions emphasise the irreplaceability of human dimensions in education.

Another significant divergence emerges in assessments of the appropriate timing for implementation. Some studies suggest immediate adoption to avoid technological lag, while others recommend more cautious approaches that allow for the development of regulatory frameworks and institutional capacities prior to systemic implementation.

Perspectives on the appropriate degree of integration also vary considerably, from approaches that propose radical transformation of educational methodologies to others that suggest gradual integration that preserves the strengths of traditional systems.

The discussion must recognise inherent limitations in both the literature reviewed and the proposals developed. Most of the studies analysed come from educational contexts developed with resources superior to those available in Ecuador, limiting the direct applicability of results and recommendations.

Additionally, the emerging nature of the field means that empirical evidence on long-term impacts remains limited. Available studies focus predominantly on short-term implementations, making it difficult to assess the sustainability and lasting effects of these technological interventions.

The literature also shows limitations in terms of methodological diversity, with a predominance of qualitative studies and case studies over rigorous experimental research. This limitation affects the ability to establish clear causal relationships between generative AI implementation and specific educational outcomes.

Future research directions should include longitudinal studies examining long-term impacts, experimental research that establishes causality more clearly, and



studies specifically designed for resource-limited contexts such as Ecuador. Particularly important is the development of assessment methodologies appropriate for AI-assisted learning contexts.

This research contributes to the emerging field of educational AI by developing an integrated conceptual framework that considers multiple dimensions of technology implementation in specific contexts. The METE-IAG model represents an innovative synthesis that combines contemporary theoretical perspectives with practical considerations appropriate for developing education systems.

Theoretically, the research contributes to the conceptual evolution of the field by proposing interrelated dimensions that transcend the one-dimensional approaches common in preliminary literature. This multidimensional perspective provides more comprehensive frameworks for understanding the complexities inherent in educational transformation through emerging technologies.

Practically, the research offers specific and contextualised strategies for implementation that can inform educational policies and institutional decisions in Ecuador and similar contexts.

The proposals include detailed considerations of resources, institutional capacities, and sociocultural factors that are often omitted in more general frameworks.

The research also contributes to debates on digital equity in education, proposing specific approaches to ensure that the benefits of generative AI are distributed equitably across different social groups and geographic regions.

Considerations of sustainability and scalability emerge as determining factors for the long-term success of generative AI implementations in Ecuadorian education. The reviewed literature suggests that many educational technology initiatives fail due to inadequate planning for financial, technical, and organisational sustainability.

The METE-IAG model addresses these concerns through phased approaches that allow for gradual institutional learning and local capacity building.



This perspective recognises that sustainability requires more than initial financial resources, demanding the development of technical, pedagogical and organisational support ecosystems.

Of particular importance is the consideration of cultural sustainability, ensuring that technological implementations respect and strengthen local identities rather than imposing homogenised educational models. This perspective is essential for the Ecuadorian context, which is characterised by significant cultural diversity.

Scalability also requires careful consideration of financing models that allow for gradual expansion without compromising quality or equity. Proposals include combinations of public investment, public-private partnerships, and the use of open source technologies to maximise cost-effectiveness.

CONCLUSION

The proposed METE-IAG model represents an innovative contribution that synthesises contemporary theoretical perspectives with practical considerations specific to the national context. The five interrelated dimensions of the model provide a comprehensive framework for planning, implementing, and evaluating generative AI initiatives in education, considering Ecuador's infrastructural, cultural, and socioeconomic particularities.

The results indicate that generative AI can effectively function as a catalyst for educational personalisation, 21st-century skills development, and pedagogical process optimisation. However, realising this potential critically depends on carefully designed implementations that maintain appropriate balances between technological assistance and the development of autonomous human capacities. Particularly significant is the evidence on the capabilities of generative AI to address persistent educational challenges in the Ecuadorian context, including regional disparities in access to educational resources, limitations in learning personalisation, and digital skills development needs. The proposed strategies offer viable pathways to capitalise on these opportunities while minimising associated risks.



Ethical and equity considerations emerge as fundamental factors for responsible implementation, requiring appropriate regulatory frameworks and community participation mechanisms to ensure equitable distribution of technological benefits. The proposal for regional ethical observatories represents an important innovation for continuous monitoring of social impacts.

The research also highlights the critical importance of teacher training and organisational development as prerequisites for successful adoption. The pedagogical transformations facilitated by generative AI require new professional skills and adapted institutional structures, demanding significant investments in human capacity development.

The limitations identified, including limited empirical evidence on long-term impacts and a predominance of studies in developed contexts, suggest important directions for future research. Longitudinal studies in resource-constrained contexts and the development of appropriate evaluation methodologies for AI-assisted learning are particularly needed.

The practical implications of this research extend beyond the specific Ecuadorian context, providing valuable insights for other developing education systems considering the adoption of emerging technologies. The multidimensional and contextualised approach can be adapted to different national and regional realities.

Financial, technical, and cultural sustainability emerges as a fundamental consideration that requires strategic planning from the initial stages of implementation.

The proposed financing models and local capacity-building strategies offer viable approaches to ensure lasting impact.

This research therefore contributes to contemporary debates on the future of education in the digital age, proposing approaches that leverage technological advantages while preserving fundamental educational values. The perspective of complementarity between human and artificial capabilities offers promising directions for responsible educational evolution.



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