Chapter 12 / Capítulo 12

Superintelligence Series
ISSN 3046-4463
Volume 2 – Thinking in Machine Code: Dialogues between technology, knowledge, and culture
ISBN of the complete work: 978-9915-9851-0-7
ISBN of this volume: 978-9915-9851-2-1
DOI of the chapter: https://doi.org/10.62486/978-9915-9851-0-7_202526

©2025 The authors. This is an open access article distributed under the terms of the Creative Commons Attribution (CC BY) 4.0 License.

ORIGINAL

Artificial intelligence from the perspective of Cuban education

La inteligencia artificial desde la perspectiva de la educación cubana

Rafael Jesús Quetglas Pérez[1], Luis Angel Santana Garriga[1], Gustavo Deler Ferrera[1]

[1]Dirección General de Educación. La Habana, Cuba.

ABSTRACT

This paper analyzes the gaps and potential of artificial intelligence (AI) in the Cuban education system, in a context marked by increasing global digitalization and the country's structural challenges. It is based on the recognition that AI can transform pedagogical practices, but its implementation requires a critical, ethical, and contextual approach. The study identifies four main gaps: infrastructural, educational, cultural, and ethical, which limit equitable access, teacher training, the relevance of AI-generated content, and the development of critical thinking in students. Based on a documentary review and analysis of specific experiences, a strategy based on three lines of action is proposed: teacher development programs, development of educational infrastructure through the Intelligent Digital Room (IDR), and the promotion of communities of collaborative practice. The results show progress in digital skills, ethical awareness, and active learning, as well as limitations related to connectivity and the duration of interventions. The effective integration of AI into Cuban education is possible if it is articulated from a sovereign, inclusive, and pedagogical perspective. This work provides guidelines for an educational policy that leverages the potential of AI without abandoning the humanistic principles of the Cuban model.

Keywords: Artificial Intelligence; Cuban Education; Digital Gaps; Teacher Training; Educational Infrastructure; Technological Ethics; Personalized Learning; Communities of Practice

RESUMEN

El presente trabajo analiza las brechas y las potencialidades de la inteligencia artificial (IA) en el Sistema Educativo Cubano, en un contexto marcado por la creciente digitalización global y los desafíos estructurales del país. Se parte del reconocimiento de que la IA puede transformar las prácticas pedagógicas, pero su implementación requiere una mirada crítica, ética y contextualizada. El estudio identifica cuatro brechas principales: infraestructural, formativa, cultural y ética, que limitan el acceso equitativo, la capacitación docente, la pertinencia de los contenidos generados por IA, y el desarrollo del pensamiento crítico en los educandos.
A partir de una revisión documental y el análisis de experiencias concretas, se propone una estrategia basada en tres líneas de acción: programas de superación docente, desarrollo de infraestructura educativa desde la Sala Digital Inteligente (SDI), y fomento de comunidades de prácticas colaborativas. Los resultados evidencian avances en competencias digitales, conciencia ética y aprendizaje activo, así como limitaciones relacionadas con la conectividad y la duración de las intervenciones. La integración efectiva de la IA en la educación cubana, es posible si se articula desde una perspectiva soberana, inclusiva y pedagógica. El trabajo aporta lineamientos para una política educativa que aprovecha las potencialidades de la IA sin renunciar a los principios humanistas del modelo cubano.

Palabras clave: Inteligencia Artificial; Educación Cubana; Brechas Digitales; Formación Docente; Infraestructura Educativa; Ética Tecnológica; Aprendizaje Personalizado; Comunidades de Práctica

INTRODUCTION

Artificial intelligence (AI) has emerged as one of the most transformative technologies of the 21st century, with profound implications for education systems. Its ability to automate processes, personalize learning, and generate predictive analytics has sparked the interest of researchers, teachers, and policymakers. However, its implementation requires a critical eye, especially in contexts such as Cuba, where education is conceived as a universal right, free of charge and based on a humanistic conception of development.

In the words of Rivero[1], "*artificial intelligence in 21st-century education represents an opportunity to rethink pedagogical models, but also an ethical and structural challenge in systems that still face technological inequalities*". This statement is particularly relevant in Cuba, where access to digital infrastructure, teacher training, and technological sovereignty are determining factors for the effective integration of AI.

From a national perspective, Mendoza Pérez[2] warns that *"AI is arriving in Cuba in a context of profound technological inequalities. While a minority has access to mobile devices and connectivity, the majority faces structural barriers that limit their participation in the digital revolution."* This digital divide, amplified by the blockade and economic constraints, conditions the transformative potential of AI in the field of education.

At the international level, Martínez-Márquez[3] argues that "*ethical principles must guide the implementation of AI in education systems, focused on the well-being of the learner, equity, and the protection of personal data*". This vision aligns with the postulates of multilateral organizations, such as UNESCO, which promote inclusive, transparent, and contextually relevant AI.

Within this framework, the present study aims *to analyze the gaps and potential of Artificial Intelligence in the Cuban education system, to propose practices that ensure a practical, critical, and contextualized integration into reality*. This research is part of contemporary debates on educational innovation, technological sovereignty, and social justice, proposing a situated perspective that articulates scientific development.

DEVELOPMENT

The incorporation of AI into education systems has generated a wide range of reflections, from enthusiasm for its potential to concern about its ethical, cultural, and structural implications. In the case of Cuba, this debate assumes a distinct dimension, characterized by the country's technological limitations, the pivotal role of teachers in the educational process, and the need to maintain a unique educational identity in the face of standardized global models.

This article is structured into four sections that systematically address the main challenges and opportunities posed by AI in the national educational context. First, it analyzes the set of *structural and pedagogical gaps* that limit its effective implementation, including the lack of connectivity and adequate devices, inadequate teacher training in digital tools, the risk of cultural decontextualization in AI-generated content, and the need to foster critical thinking that avoids the uncritical use of these technologies.

Next, it explores the *concrete potential* of AI to transform educational practices in Cuba. It highlights proposals such as the flipped classroom 2.0, the use of virtual assistants for personalized tutoring, the stimulation of student creativity through generative tools, and support for scientific research in Cuban universities through the analysis of large datasets.

A set of *strategic proposals* aimed at overcoming the identified gaps is also presented. These include mass training programs for teachers, the development of sufficient and contextually relevant technological infrastructure, and the creation of communities of practice that foster the exchange of experiences among Cuban educators.

Finally, *specific recommendations* are formulated to strengthen the AI ecosystem in education, including the promotion of research and the role of institutions in educational technological sovereignty.

This analytical journey seeks not only to identify the obstacles Cuba faces in integrating AI into its education system but also to highlight the opportunities that can be exploited from a critical, ethical, and deeply contextualized perspective.

Structural and pedagogical gaps for the integration of artificial intelligence in Cuban education

The implementation of AI in the Cuban education system faces several gaps that limit its effective adoption. These are understood as: the digital divide in the indicator of Cuba's national digital transformation strategy, which reveals the actions taken to address the inclusive relationships associated with access, use, and exploitation of technologies in the Cuban education system, which are not only technological but also educational, cultural, and ethical, requiring a comprehensive approach to their analysis.

The infrastructure gap

Limited connectivity and a shortage of technological devices are the primary obstacles to deploying AI-based tools. As Troncoso Heredia et al.[4] point out, *"AI requires a minimum infrastructure that guarantees stable Internet access, data processing, and the availability of smart devices, conditions that are not assured in all Cuban territories"*. This lack generates inequalities in access to modern educational resources, deepening the existing digital divide.

The teacher training gap

Cuban teachers, who play a central role in the educational process, face the challenge of incorporating AI without adequate preparation. The lack of specific training can lead to superficial or erroneous use of these tools. According to the academic blog of the University of Oriente[5], *"AI has burst into the classroom without many teachers being prepared to understand how it works, its limitations, and its pedagogical possibilities*." It is therefore essential to provide ongoing and critical training to prevent AI from becoming a fad or a pedagogical threat.

The content and context gap

One of the most significant risks is that AI-generated content fails to reflect Cuban idiosyncrasies, history, and values accurately. Mendoza Pérez[2] warns that "*AI models trained in foreign contexts reproduce narratives, values, and cultural references that do not always correspond to Cuban reality*". This raises the need to "Cubanize" AI, adapting its algorithms and databases to national references.

The ethical and critical thinking gap

The ease with which AI generates responses can encourage practices such as "copy and paste," weakening reflective learning. Vélez-Rivera et al.[6] point out that "*AI raises ethical dilemmas in higher education, especially about authorship, assessment, and the development of critical thinking*". Teaching students to question AI, rather than use it, is becoming a key skill for the 21st century.

Analysis of these gaps that hinder the integration of artificial intelligence into the Cuban education system reveals a multidimensional problem. It highlights that insufficient

technological infrastructure, characterized by limited connectivity and a shortage of devices, is the root cause of digital exclusion. Added to this is the lack of specialized teacher training, which prevents the critical pedagogical use of AI. In addition, a cultural and contextual gap is identified, where content generated by external algorithms runs the risk of being misaligned with national identity. Finally, the ethical and cognitive dimensions pose challenges in the assessment and development of critical thinking, requiring learners to learn how to question AI, not just consume its answers. These interrelated gaps demand a comprehensive strategy that articulates technology, pedagogy, and cultural sovereignty.

The transformative potential of artificial intelligence in Cuban educational practice

AI not only represents a challenge for education systems, but also an opportunity to reconfigure pedagogical practices in line with the needs of the 21st century. In the Cuban context, its application can help overcome structural limitations and promote innovative approaches, provided that it is integrated in a critical and contextualized manner.

Flipped Classroom 2.0: towards active pedagogy

The flipped classroom model, powered by AI, allows students to access automatically generated materials (summaries, rubrics, exercises) in advance, freeing up classroom time for discussion, tutoring, and collaborative work. Durán Muñoz et al.[7] highlight that "*the combination of AI and the flipped classroom promotes student autonomy and personalized learning, especially in subjects traditionally perceived as* difficult".

Assistant tutor: personalized support in limited environments

In contexts with a shortage of laboratories or physical resources, AI can simulate experiments, solve problems step by step, and offer interactive language practice. Romero Alonso et al.[8] state that "*AI allows for the personalization of distance learning, adapting content and feedback according to the student's profile*". This capability is especially valuable in areas such as mathematics, physics, chemistry, and languages.

Creativity enhancer: AI as an expressive tool

AI can be used to generate draft essays, ideas for art projects, or narratives that serve as a basis for subjects such as Spanish Language, History, or Art Education. Norman-Acevedo[9] argues that "*AI, under teacher supervision, can stimulate creativity and critical thinking by offering multiple perspectives on the same* topic".

Artificial intelligence presents numerous opportunities to enhance educational practice in Cuba, provided it is integrated in a critical and contextually relevant manner. The flipped classroom 2.0 model enables learners to access AI-generated content in advance, thereby freeing up face-to-face time for dialogue and personalized tutoring. Assisted tutoring tools enhance individual learning in areas such as languages, exact sciences, and virtual experimentation, especially in environments with material limitations. Likewise, AI can stimulate student creativity by generating drafts, ideas, and narratives that serve as a starting point for reflection and original production. In the university setting, its ability to process large volumes of data makes it a strategic ally for scientific research. This potential, however, can only be fully realized if accompanied by critical human guidance and educational policies that ensure its national relevance and significance.

Strategic proposals for the effective integration of Artificial Intelligence in Cuban education

Overcoming the gaps identified in the Cuban education system requires concrete proposals that articulate training, infrastructure, and professional collaboration to achieve effective educational outcomes. Three strategic lines are presented that have begun to materialize in

the country, with tangible results and potential for national and/or regional expansion.

Mass training strategy: training to transform

Teacher training is the cornerstone for the critical and pedagogical integration of artificial intelligence. Within the framework of the Scientific Management in Local and Community Educational Development project, based in the municipality of La Lisa, Havana, Cuba, three specific improvement programs were designed for the primary, secondary, and pre-university levels of education. These programs were developed from the country's first Smart Digital Room in the education sector, a joint effort between MINED Cuba and the aforementioned project.

After a systematization process carried out as a participatory action between 2022 and 2024, within the context of Cuban education and the use of information and communication technologies (ICT), the concept of *the Smart Digital Room* was consolidated. This innovative space, conceived as a hub linking technology and pedagogy, is defined by Deler Ferrera et al.[10]:

"An inclusive setting where various advanced technologies are integrated into a teaching-learning ecosystem, to contribute to information and media literacy, promoting adequate levels of digital culture with actions that develop the necessary skills within the teaching sequences of the educational process, adopting an innovative, active methodology to consolidate the use of digital devices, resources, and services incorporated into classes with connectivity, interactivity, automation, collaboration, continuous assessment, and attention to diversity, according to the curricular training spaces of the types of audiences."

The objectives of this SDI are to cooperatively disseminate good practices that have been implemented in the comprehensive training of children, adolescents, and young people, related to the management of services and processes that embrace digital transformation as a socio-educational institutional strategy, in the context of local and community development, and to manage systems for improvement and advice related to digital literacy and the development of digital skills for all government managers and officials and other social actors in the territory in real time and online.

Based on this concept, three improvement programs were structured to respond to the characteristics and needs of each educational level:

- Improvement program for primary school teachers and students: Complementary program with digital technologies: Discovering smart technology.[11]
- Improvement program for teachers and students in basic secondary education: Complementary program with digital technologies: Discovering artificial intelligence in digital education.[12]
- Improvement program for teachers and students in pre-university education: Complementary course with digital technologies: Artificial intelligence applied to active learning: a new perspective on pre-university education.[13]

During the development of these workshops, 60 students from the three educational levels participated, with 20 students from each level being selected to receive specialized training in AI. Additionally, 12 teachers were interviewed and trained as replicators, responsible for implementing this knowledge within their respective institutions.

Participants were selected through non-probabilistic purposive sampling, taking into account their access to digital devices and basic connectivity. Priority was given to the inclusion of students from urban and peri-urban environments with limited technological infrastructure, replicating the real conditions of developing education systems.

Inclusion criteria:

- Students enrolled in institutions.
- Informed consent from parents/guardians (for minors).

- Availability to attend 80 % of the sessions.

SAMPLE OF TWO EXAMPLES FROM TWO WORKSHOPS FROM ONE OF THE PROGRAMS
Prompt construction workshop

- Component: Artificial intelligence (AI)
- Title: The building a prompt s for different content formats
- Type: Treatment of new material
- Objective**:** Develop prompts for use in content generation with AI applications

Specific objectives

- Understand what a prompt is and its importance in content generation.
- Learn how to build effective prompts for different types of content.
- Practice creating specific prompts for various content formats.

Methods and procedures: joint development

Teaching media system**:** TV**,** computers, mobile devices with internet access, prompt generator

Teaching format: workshop

Time**:** 1 hour/classroom session, 3 hours/non-classroom session

Work scenario**:** 2-4 (organizational form of the SDI)

Digital actions

Access to browser, web browsing, generation of educational content, construction of a PORMPT, management of generated content by copying and organizing it into folders or online dissemination sites

Introduction (10 minutes)

- Review of activities from the previous meeting
- Presentation of the topic and objectives of the meeting.
- Definition of what a prompt is in the context of artificial intelligence and content generation.

Elements of an effective prompt (20 minutes)

- Explanation of the key components of a prompt: context, objective, specific details, real examples.
- Examples of poorly constructed prompts and analysis of why they do not work
- Examples of well-constructed prompts and analysis of why they work

Prompt construction for different formats (20 minutes)

- Narrative texts: how to guide AI to generate stories, tales, or narratives.
- Informative articles: structuring prompts for popular science articles, news stories, or essays.
- Question and answer format: creating prompts for interviews, surveys, or assessment questions
- Creative content: generating prompts for poetry, scripts, or advertisements.

Discussion and practice (10 minutes)

- Practical exercise: participants will create their own prompts for different formats and share them to receive feedback.
- Time for questions and discussion on the topics covered.

Assessment: true or false about prompt construction; this assessment can be done online using questionnaire tools.

Guidance for the next meeting

1. Locate the document entitled "Policy for Digital Transformation, Cuban Digital Agenda, and Artificial Intelligence Strategy" approved by the Cuban Ministry of Communications on May 29, 2024.
2. Read and review pages 54 to 66 of the aforementioned document.
3. Prepare a summary based on the points covered in those pages. (maximum 6 pages)
4. Submit all evaluation activities for the meeting and, if possible, bring mobile devices with mobile data or an internet connection.

Workshop: Applications for generating texts and educational materials

Component: Artificial intelligence (AI)
Applications for generating texts and educational materials
Type: Treatment of new material
Objective: Use AI applications to create effective educational content

Specific objective

- Explore the features and functionalities of different applications for generating texts and educational materials.
- Learn how to use these applications to create effective educational content.
- Evaluate the advantages and disadvantages of each application in the educational context.

Methods and procedures: joint development

Teaching media system: TV, computers, mobile devices with internet access, online AI applications (Microsoft Copilot, Perplexity, Paraphrase, Cuenti.to)
Teaching organization: workshop
Time: 1 hour face-to-face, 3 hours online
Work scenario: 2-4

Digital actions

Access to the browser, web browsing, content management by copying and organizing it into folders

Introduction (10 minutes)

- Review of activities from the previous meeting.
- Presentation of the topic and objectives of the meeting.
- Brief description of the applications that will be used: Microsoft Copilot, Perplexity, Paraphrase, Cuenti.to, and Diffit.

Application demonstration (30 minutes)

- Microsoft Copilot: show how it can be used to generate documents, reports, and personalized educational materials.
- Perplexity: explanation of its use to generate complex questions and answers, as well as text summaries.
- Paraphrase: demonstration of how to rewrite and improve the clarity of educational texts.
- Cuenti.to: examples of creating educational stories and narratives adapted to

different learning levels.

- Diffit: presentation of how to transform texts and materials into different formats according to educational needs.

Group practice (15 minutes)

- Participants will use the applications in small groups to generate educational texts and materials.
- Share the results and discuss the experiences.

Discussion and feedback (5 minutes)

- Time for questions, discussion, and feedback on the use of the applications.
- Reflection on how these AI applications can improve education and facilitate the work of teachers.

Evaluation: evaluate the quality of the content generated, as well as the development and use of prompts.

Guidance for the next meeting

Submit all evaluation activities from the meeting and, if possible, bring mobile devices with mobile data or an internet connection.

To evaluate the impact of the educational intervention with artificial intelligence, four key variables were defined related to the development of digital skills, active participation in learning, the quality of feedback, and ethical awareness about the use of intelligent technologies. These variables were measured using specific techniques and instruments, selected for their methodological relevance and ability to capture meaningful evidence in educational contexts. Table 1 summarizes the instruments used and their relationship to the operational definitions of each variable:

- Systematic assessments: digital portfolios, attendance, and workshop participation.
- Pre-post tests: measurement of technical knowledge and attitudes toward AI.
- Semi-structured interviews: 12 teachers and 20 randomly selected students.
- Interaction records: platform usage data (e.g., time spent on Scratch, Copilot, DeepSeek, Cuentito, Autodraw, Leonardo AI, and accuracy on Wolfram Alpha).

Table 1. Instruments and data collection

Variable	Operational Definition	Instrument
Digital Competence	Ability to use AI in educational tasks	Performance rubrics
Active learning	Participation in collaborative projects with AI	Structured observation
Feedback	Effectiveness of AI in personalization	Post-intervention surveys
Technological ethics	Awareness of risks and biases in AI	Focus groups

Limitations

- Self-selection bias: learners with greater technological affinity tended to participate.
- Unequal infrastructure: 30 % of 5th-grade participants lacked a stable connection for independent study.
- Short term: the duration (20 weeks) limited the assessment of long-term impacts.

RESULTS

The three AI-based supplemental programs were implemented in the new SDI setting. The

data collected and analyzed for each grade level is presented below.

The results indicate significant concern about the ethical and equity implications of implementing AI in education. This includes considerations about:

- Equitable access to AI technologies
- Student data privacy
- Impact on student autonomy and social development

The integration of AI is transforming traditional teaching practices. There is a trend toward:

- More personalized learning
- Greater use of data to inform educational decisions
- Changes in the role of the educator to take on AI-assisted tasks

The main challenges identified in the implementation of AI in education include:

- The need for adequate technological infrastructure
- Training teachers in the use of AI technologies
- Adaptation of curricula and assessment methods

Digital objectives and competencies

The three programs share common objectives, such as the ethical use of AI tools and collaborative learning. However, the level of complexity varies:

- 5th grade: emphasis on digital identity and problem solving with basic algorithms, as well as working with AI agents such as Cuentito.
- 7th grade: incorporation of ethical debates and audiovisual production with AI.
- 11th grade: development of advanced projects (portfolios) and programming with AI.

This initiative is complemented by an advanced training course in the municipality of La Lisa, Havana, Cuba, where 30 teachers from various educational levels, ranging from early childhood to pre-university education, were trained in the pedagogical application of AI. In addition, monthly videoconferences will be held between 2023 and 2025, with the participation of national universities such as the Marta Abreu Central University of Villa Clara and the University of Oriente, as well as international universities, including the San Carlos University of Guatemala and the Gabriel René Moreno Autonomous University of Bolivia. These sessions will facilitate the exchange of experiences and strengthen academic networks.

Development of adequate infrastructure: technology with a purpose

The Smart Digital Room is a model of educational infrastructure adapted to the needs of AI training. This space has:

- Networked technology circuit for exhibitions and virtual distance learning: includes hybrid TVs, SMART TVs, Data Show, three laptops, and Hite Vision digital whiteboards with interaction with mobile devices through the Atcnea application.
- Ubiquitous interactive user area: 22 mobile desks that can be configured according to the teaching dynamics.
- Telematic connectivity area: access to institutional Wi-Fi that allows connection to online digital ecosystems.
- Charging and technical support area: space for device maintenance and charging.

In addition, it has 22 mobile devices: 10 Redmi A9 phones and 12 Amazon Fire tablets. Although connectivity is institutional, prior proxy and authentication configuration is required, which highlights a technical gap that still needs to be resolved. This infrastructure, developed

by MINED in conjunction with the project, represents a significant step toward democratizing access to emerging educational technologies.

Fostering a community of practice: sharing to grow

The creation of communities of practice is essential for consolidating collaborative learning and pedagogical innovation. From the Smart Digital Room, the WhatsApp group "Smart Digital Room" has been set up, where Cuban educators share experiences, resources, and best practices in the use of AI. This group also interacts with international communities, strengthening South-South dialogue and the collective construction of knowledge.

Educational scientific research and its communication from the potential of Artificial Intelligence in the Cuban context

Scientific educational research in Cuba faces the challenge of strengthening the management of scientific educational activity, as well as increasing the methodological training of teachers and researchers to achieve greater social impact, international visibility, and quality in scientific results. In addition, there is a need to improve the processes of organization, planning, and socialization of results, systematically integrating technological updates and the use of digital media to disseminate scientific findings.[14,15]

The development of research skills in both teachers and students is a current challenge. Educational professionalization requires ever greater correspondence with modes of research practice, which implies transforming teaching methods, promoting collaborative learning, and offering didactic support to stimulate research initiative from the early stages of training.[16]

In this regard, a significant revolution has occurred thanks to the incorporation of artificial intelligence (AI), particularly in the communication and editorial management processes of scientific journals. This development responds to the growing demand for quality, visibility, and access in scientific production, as well as the need to adapt to international standards and capitalize on emerging technological opportunities for the country's socio-educational advancement.

The challenges faced by Cuban education science researchers necessitate strengthening the management and dissemination of knowledge, transforming educational models to current contexts, enhancing links between schools and communities, innovating in training and publication processes, and updating editorial and technological regulations in line with international standards. All of this will enable progress toward a more relevant and recognized educational science that is capable of positively influencing national development.

In recent years, Cuban scientific journals, especially those focused on educational sciences, have had to adapt their procedures to meet global expectations for good publishing practices. The publishing process, traditionally viewed as a chain that spans manuscript reception, peer review, editing, and publication to the dissemination of results, now incorporates additional challenges arising from the complexity of the contemporary scientific ecosystem. International databases and catalogs impose greater demands, which has been a driver for technological innovation on the island.

The potential of artificial intelligence in editorial management

- Generative artificial intelligence (GAI), through tools such as DeepSeek and other natural language processing platforms, has emerged as a transformative element in scientific communication. Its applications include:
- Automatic manuscript review, with the ability to analyze structure, consistency, and compliance with editorial standards.
- Style, spelling, and grammar correction, adapting to the requirements of each journal.

- Detection of plagiarism and self-plagiarism, ensuring the originality and integrity of published works.
- Automatic abstract generation and keyword generation.
- Optimization of reviewer selection through thematic matching and prior experience analysis.

These features accelerate workflows, reduce publication times, and increase academic rigor, without replacing the necessary human supervision that ensures scientific and ethical judgment at each stage.

Challenges and requirements for ethical implementation

AI-supported editorial automation, however, poses fundamental challenges related to ethics, transparency, and maintaining human control in editorial processes. The main risk lies in the possibility that automation may detract from the depth of the assessment of the relevance, novelty, and scientific contribution of articles.

To address these challenges, the revised article proposes a set of essential best practices:

- Continuous training for editors, reviewers, and authors in the effective and responsible use of digital tools, focusing on both technical and ethical aspects.
- Clear definition of guidelines on the use of AI, establishing roles, limitations, and quality criteria.
- Integration of human reviews in key phases that require qualitative assessment, such as the evaluation of scientific contribution and disciplinary relevance.

Practical experiences in Cuban contexts

The case of the journal Horizonte Pedagógico illustrates how the adoption of systems such as Open Journal System (OJS), combined with specific actions to incorporate AI, has substantially improved editorial management. Among the notable results are:

- Reduced review and publication times.
- Higher quality and depth in initial review and decisions, even by less experienced reviewers.
- Effective systematization of routine and complex tasks, such as plagiarism control, format error detection, and recommendation of suitable reviewers.

To achieve real results in integrating AI and research communication processes through scientific journals, it is necessary to start with the constant improvement of all those involved in the various stages of the editorial process. In addition to designing specialized prompts and workflows for each stage of review using AI. The automated evaluation of sections of the article (abstract, introduction, methodology, results, and conclusions) is complemented by personalized observations and guidance for improvement for the authors.

The integration of AI tools into educational research and scientific communication within the Cuban context must be gradual, critical, and adapted to the particularities of each journal and disciplinary community. The main contributions of AI lie not only in efficiency and technical quality, but also in the potential to democratize access to publications and increase the international visibility of national scientific output.

However, human supervision, ethical training, and contextual adaptation remain indispensable pillars of effective practice. The study also highlights the need for future research to evaluate the actual impact of AI on scientific communication and identify best practices for its effective implementation.

The Cuban experience demonstrates that AI, when well-integrated and regulated, can be a powerful ally for scientific publishing in education, optimizing operations, shortening times,

and enhancing standards of transparency and quality. The key is to combine this technology with ongoing training and supervision, establishing clear and adapted guidelines that preserve academic integrity and prestige while promoting innovation in editorial processes.

This transformation is strategic for Cuba's socio-educational development, ensuring that locally generated knowledge achieves greater impact and legitimacy in the global scientific community.

Applied research and contextualized development of Artificial Intelligence in Cuban educational institutions

The effective integration of AI into the Cuban education system requires not only training and infrastructure, but also applied research and technological development. In this regard, institutions such as the *Smart Digital Room* have begun to implement innovative strategies to overcome connectivity limitations and promote the contextualized use of AI in the classroom.

Research: mobile connectivity as an emerging solution

One of the most promising initiatives is the use of mobile technologies, such as 4G LTE pocket WiFi dongles configured with the Nauta APN, which enable internet sharing in educational environments with limited infrastructure. This solution, currently in the testing phase, aims to address the connectivity gap in schools by utilizing portable devices that serve as wireless access points. According to Zonacel[17], "*Nauta's APN allows internet sharing from mobile devices, facilitating access to educational platforms in areas with low coverage*."

A joint research project is planned between the Ministry of Education (MINED) and the Scientific Management in Local and Community Educational Development project, using this technology at the La Lisa remedial education center in Havana. Teachers previously trained in AI will be responsible for applying this solution in educational improvement centers for all levels of education, from early childhood to pre-university. In addition, they will be utilized in specialized conferences on AI in the Smart Digital Room, featuring the participation of teacher-researchers and administrators, which will enable the evaluation of their impact on continuing education and equitable access.

In-house development: AI tools adapted to the Cuban context

At the same time, the development of open-source AI tools tailored to national realities is being promoted. One example is the *Socia* platform, developed by Avangenio,[18] which allows the creation of personalized virtual assistants for educational environments. This tool offers functionalities such as content generation, semantic analysis, and pedagogical support, all from an accessible interface in Spanish.

Other notable initiatives include the *CecilIA* language model, trained with a Cuban textual corpus, and presented by the University of Computer Science (UCI) at the UCIENCIA 2025 Convention.[19] Likewise, the Union of Computer Scientists of Cuba (UIC) and the University of Havana have promoted digital transformation workshops that encourage the use of indigenous AI in education.

Juventud Técnica[20] reports on five AI projects developed in Cuba, including platforms for educational data analysis, learning simulators, and recommendation systems for teachers. These tools, designed from a sovereign perspective, aim to ensure that AI responds to the country's cultural, linguistic, and pedagogical needs.

Towards sovereign, contextualized, and humanistic educational artificial intelligence in Cuba

Strategic proposals for the effective integration of artificial intelligence into Cuban education are presented, focusing on three lines of action: teacher training, technological infrastructure, and communities of practice. Through the project "Scientific management in local and

community educational development," improvement programs were implemented for primary, secondary, and pre-university levels, with the participation of 60 students and 12 teacher replicators. All participants were evaluated using mixed techniques, which showed progress in digital skills, ethical thinking, and active learning. These actions are complemented by the development of provincial courses, as well as national and international videoconferences, and the use of the Smart Digital Room as a model of educational infrastructure equipped with interactive technologies, institutional connectivity, and mobile devices. Finally, a community of practice is fostered through virtual spaces such as the WhatsApp group "Smart Digital Room," where educators share experiences and resources, strengthening the collaborative ecosystem for the pedagogical use of AI in Cuba.[21]

The analysis conducted during the development process reveals that integrating artificial intelligence into the Cuban education system cannot be approached solely from a technological perspective. The identified infrastructural, training, cultural, and ethical gaps reveal the need for a national strategy that articulates public policies, provides teacher training, ensures sufficient infrastructure, and fosters communities of practice. At the same time, the experiences gathered in projects such as the Smart Digital Room and the improvement programs demonstrate that there is local capacity to transform pedagogical practices through the critical and contextualized use of AI.

Added to this is a fourth strategic line: the application of research and the development of proprietary tools. Initiatives such as the experimental use of 4G LTE Pocket WiFi mobile technologies with APN Nauta aim to address the lack of connectivity in educational centers, enabling access to digital platforms in environments with limited infrastructure. This solution will be evaluated in a joint research project between MINED and the project, with the participation of teachers trained in improvement centers from early childhood to pre-university. In addition, the development of open-source AI tools tailored to the Cuban context is being promoted, such as the SocIA platform and models like CecilIA, which are trained using a national corpus. These actions reinforce technological sovereignty and ensure that AI responds to the real needs of the Cuban education system.

CONCLUSIONS

The findings of this study indicate that integrating artificial intelligence into the Cuban education system necessitates a multifaceted approach that encompasses teacher training, technological infrastructure, communities of practice, and context-specific development. The observations made within the framework of the project "Scientific management in local and community educational development" align with previous studies that emphasize the importance of adapting AI to national contexts to prevent the replication of cultural and pedagogical biases. The implementation of thematic improvement programs, the Smart Digital Room, and mobile connectivity initiatives utilizing 4G LTE Pocket Wifi technology demonstrates that local capacities exist to advance this process. However, limitations persist, such as uneven infrastructure, the short timeframe of interventions, and self-selection bias among participants.

The findings suggest that AI can enhance active learning, educational personalization, and ethical training if used critically and with teacher support. However, further research is needed on the long-term impact of these strategies, especially in rural areas and at early educational levels. It is also recommended to develop further open-source AI tools adapted to the Cuban context, such as Socia and CecilIA, and evaluate their effectiveness in school environments. The conclusions align with the study's objectives, demonstrating that AI, far from being a threat, can become a pedagogical ally when integrated from a sovereign, inclusive, and humanistic perspective.

REFERENCES

1. Rivero Panaqué C, Beltrán Castañón C. La inteligencia artificial en la educación del siglo XXI: avances, desafíos y oportunidades. Educación. 2024;33(64):5-7. https://doi.org/10.18800/educacion.202401.P001

2. Mendoza Pérez O. Inteligencia Artificial en Cuba: Realidades, Retos y la Promesa de CecilIA. CubaSí. 2025 Oct 11. https://cubasi.cu/es/articulo-opinion/inteligencia-artificial-en-cuba-realidades-retos-y-la-promesa-de-cecilia

3. Martínez-Márquez MA. Inteligencia Artificial y Educación. Revista Tecnológica-Educativa Docentes 2.0. 2025;18(1):1-15. https://doi.org/10.37843/rted.v18i1.614

4. Troncoso Heredia MO, Dueñas YK, Verdecia Carballo E. Inteligencia artificial y educación: nuevas relaciones en un mundo interconectado. Estudios del Desarrollo Social: Cuba y América Latina. 2023;11(2):1-14. https://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2308-01322023000200014

5. Universidad de Oriente. La Inteligencia Artificial en el aula: ¿Revolución educativa o amenaza pedagógica? Ciberseguridad. 2025 Oct 14. https://blogs.uo.edu.cu/seginf/?p=4822

6. Vélez-Rivera R, Muñoz-Álvarez D, Leal-Orellana P, Ruiz-Garrido A. Uso de inteligencia artificial en educación superior y sus implicancias éticas: Mapeo sistemático de literatura. Hachetetepé Revista científica de educación y comunicación. 2024;28:1-17. https://www.redalyc.org/journal/6837/683776291008/html/

7. Durán Muñoz ML, Vigueras Moreno JA. Aula invertida inteligente como estrategia didáctica emergente para la enseñanza aprendizaje de matemática. Revista Cubana de Educación Superior. 2023;42(1):1-14. http://www.scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0257-43142023000100016

8. Romero Alonso R, Araya Carvajal K, Reyes Acevedo N. Rol de la Inteligencia Artificial en la personalización de la educación a distancia: una revisión sistemática. RIED-Revista Iberoamericana de Educación a Distancia. 2025;28(1):1-20. https://doi.org/10.5944/ried.28.1.41538

9. Norman-Acevedo E. Inteligencia artificial al servicio de la pedagogía: potenciando la creatividad y el pensamiento crítico. PANORAMA. 2024;18(34):1-13. https://doi.org/10.15765/k3r9jd72

10. Deler Ferrera G, Santana Garriga LÁ, Quetglas Pérez RJ. La sala digital inteligente en la gestión tecnopedagógica desde el contexto del desarrollo local y comunitario. Pedagogía Internacional 2025. https://eventos.mined.gob.cu/event/el-uso-de-los-dispositivos-las-tecnologias-y-los-medios-digitales-en-la-educacion-tic-72/track/la-sala-digital-inteligente-en-la-gestion-tecnopedagogica-desde-el-contexto-del-desarrollo-local-y-comunitario-924

11. Quetglas Pérez RJ, Deler Ferrera G, Santana Garriga LA. Programa complementario con tecnologías digitales: Descubriendo la inteligencia artificial en la educación digital. Zenodo. 2025. https://doi.org/10.5281/zenodo.15079653

12. Quetglas Pérez RJ, Santana Garriga LA, Deler Ferrera G. Curso complementario con tecnologías digitales: Inteligencia artificial aplicada al aprendizaje activo: una nueva mirada en

la educación preuniversitaria. Zenodo. 2025. https://doi.org/10.5281/zenodo.15079671

13. Quetglas Pérez RJ, Santana Garriga LA, Deler Ferrera G. Programa complementario con tecnologías digitales: Descubriendo la tecnología inteligente. Zenodo. 2025. https://doi.org/10.5281/zenodo.15079628

14. Keeling Alvarez M. Actividad Científica Educacional. Una mirada desde su gestión en el Sistema Nacional de Educación. Varona Revista Científico Metodológica. 2023;(78). http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1992-82382023000300020&lng=es&tlng=es

15. Asencio Cabot E, Ibarra López N, Suárez Pons EJ. Experiencias y retos en la difusión del conocimiento científico en revista educativa cubana. Revista Varela. 2024;24(69):232-44. https://doi.org/10.5281/zenodo.13623384

16. García Méndez IM, Carballosa González A. Nuevos retos para el desarrollo de habilidades investigativas en la carrera de medicina. Conrado. 2023;19(91):242-51. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1990-86442023000200242&lng=es&tlng=es

17. Zonacel. Configuración del APN de Nauta para compartir internet. 2025. https://zonacel.net/configuracion-apn-de-nauta-para-compartir-internet-aprende-como/

18. Avangenio. Plataforma Socia. 2025. https://socia.avangenio.ai/personal/login

19. Universidad de las Ciencias Informáticas (UCI). Inteligencia Artificial y software libre en UCIENCIA. 2025. https://www.uci.cu/universidad/noticias/inteligencia-artificial-y-software-libre-protagonizan-la-segunda-jornada-de

20. Juventud Técnica. ¿Conoces estos 5 proyectos de Inteligencia Artificial creados en Cuba? 2023. https://www.juventudtecnica.cu/articulos/5-proyectos-de-inteligencia-artificial-creadas-en-cuba/

21. Cubavisión Internacional. Promueven en Cuba herramientas de Inteligencia Artificial autóctonas. 2025. https://www.cvi.icrt.cu/promueven-en-cuba-herramientas-de-inteligencia-artificial-autoctonas/

USE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence was used as a support tool for proofreading and searching for systematizations related to the content of this work. This assistance was limited to linguistic improvement and conceptual organization functions, without interfering in the critical analysis or original elaboration of the scientific results.

FUNDING

The authors did not receive funding for the development of this research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Rafael Jesús Quetglas Pérez; Luis Angel Santana Garriga.

Research: Rafael Jesús Quetglas Pérez; Luis Angel Santana Garriga; Gustavo Deler Ferrera.

Methodology: Rafael Jesús Quetglas Pérez; Luis Angel Santana Garriga; Gustavo Deler Ferrera.
Validation: Rafael Jesús Quetglas Pérez; Luis Angel Santana Garriga; Gustavo Deler Ferrera.
Visualization: Rafael Jesús Quetglas Pérez; Luis Angel Santana Garriga; Gustavo Deler Ferrera
Writing - original draft: Rafael Jesús Quetglas Pérez; Luis Angel Santana Garriga.
Writing - correction and editing: Luis Angel Santana Garriga; Gustavo Deler Ferrera.